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Elena G. Popkova
Bruno S. Sergi *Editors*

Current Problems of the Global Environmental Economy Under the Conditions of Climate Change and the Perspectives of Sustainable Development

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Elena G. Popkova · Bruno S. Sergi
Editors

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Editors
Elena G. Popkova
MGIMO University
Moscow, Russia

Bruno S. Sergi
Harvard University
Cambridge, USA

University of Messina
Messina, Italy

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Introduction: Review of the Challenges of Sustainable Development of the Global Environmental Economy in the Face of Climate Change

The environmental economy is an area of economic activity in which, on the one hand, there is a high dependence on natural and climatic factors. On the other hand, the economy is conducted with respect for nature, and economic opportunities are used to protect the environment. The concept of sustainable development, embodied in the 17 Sustainable Development Goals (SDGs) formulated by the UN, emphasizes the importance of the environmental economy. The adopted SDGs demonstrated the critical nature of the environment and showed that today's world is on the brink of ecological catastrophe. As reflected in SDG 13, climate change is central to sustainable development.

Six topical problems of sustainable development of the global environmental economy in the context of climate change are distinguished. The first problem is related to the area of finance. Significant investments in sustainable development and combating climate change are required to implement the SDGs fully. Nevertheless, these investments belong to the field of responsible, non-commercial investments with limited payback opportunities and, therefore, are of reduced investment attractiveness.

Green and ESG finance significantly contribute to solving this problem. Their advantage is that they belong to the field of commercial finance and, therefore, guarantee high returns to market participants. In green and ESG finance, environmental protection, although secondary, is given a great deal of attention. The combination of responsible, green, and ESG finance allows the financial sector of the economy to be almost fully engaged in the sustainable development of the global environmental economy in the context of climate change.

The second problem belongs to the field of innovation, the essence of which is contradictory. Green innovations specifically designed to protect the environment reduce the resource and energy intensity of business and the economy, reduce production and consumption waste, and establish and develop circular business practices. However, innovations created without consideration for environmental protection can be detrimental to the environment. For example, robotization, which is the core of Industry 4.0, significantly increases the energy intensity of economic activity and causes an increase in greenhouse gas emissions.

This contradiction can be solved by climate-smart innovations that support the sustainable development of the global environmental economy. Climate-smart innovations allow economic practices to adapt to climate change. Moreover, they help improve the climate. Advanced technologies of Industry 4.0 can and are actively implemented in the creation and application of climate-smart innovations, making a meaningful contribution to the fight against climate change.

The third problem lies in the area of business organization. Commercial business is aimed at making a profit and shows corporate environmental responsibility in a limited way—to the extent that allows, if possible, to recoup the investments made and maintain a break-even point. Each industry needs a specific approach to corporate environmental responsibility.

The development of sufficient in-house experience in business structures is unattainable in the short and medium term. This reduces the availability of corporate environmental responsibility for small and medium-sized businesses, as well as start-ups, and does not allow them to unlock their potential to combat climate change. Therefore, it is necessary to collect, systematize, and broadcast the best practices for sustainable, environmentally responsible business development to support the fight against climate change in every sector of today's environmental economy.

The fourth problem is related to the field of energy. The extraction and use of fossil fuels deplete natural resources and are also associated with the emission of large amounts of greenhouse gases. In this regard, one of the leading roles in strategies to combat climate change in countries worldwide is assigned to the fuel and energy complex. Carbon-neutral energy is being developed to minimize or eliminate greenhouse gas emissions.

Clean energy, based on renewable energy sources, is also very popular nowadays. The problem is that carbon-neutral and clean energy cannot yet fully replace fossil fuel energy. Therefore, it needs further development. The reason for this problem is the unstable and small volume of production, as well as the widespread inapplicability (mainly due to the lack of infrastructure development) of carbon-neutral and clean energy.

The fifth problem lies in the area of society and the country. Along with government regulation and infrastructure, responsible communities play an important role in sustainable economic development and combating climate change. The difficulty of implementing infrastructure projects in the environmental economy is that they require a significant amount of investment and are associated with a long-term and limited payback on these investments. In this regard, public–private partnership projects to develop the infrastructure of the environmental economy are particularly useful.

The environmental economy also relies on a range of social institutions, from public environmental organizations to environmentally responsible consumers. The link between them and responsible business is eco-labeling and product certification. Environmentally friendly and natural (organic) products are characterized by higher costs, which causes a certain probability of counterfeiting. State regulation of the markets of the environmental economy aims to regulate and control eco-labeling and certification.

The sixth problem is related to the legal field. The legal systems of the world's countries and their territories must be aligned with the SDGs. It is a long process that has been successful in recent years. Insufficient regulatory and legal support and gaps in legislation limit the scale of environmentally responsible initiatives by the public and businesses. In addition to regulating permissible practices, the "rules of the game" should also encourage these practices.

The difficulty is that isolated regulatory incentives in the absence of market incentives can reduce the efficiency of economic practices and hinder economic growth. Therefore, an approach is needed to balance regulatory and market self-regulation of environmentally responsible initiatives of the population and businesses. For this purpose, of particular use is the international experience of combating climate change, which needs to be subjected to a problematic analysis, considering the characteristics of developed and developing countries, as well as the categories of countries in other classifications.

This book indicated all problems noted above. The book aims to investigate the current problems of the global environmental economy in the context of climate change and the prospects for sustainable development (implementation of the SDGs). The novelty of this book lies in the fact that it substantiates the systemic role of combating climate change (implementation of SDG 13) in the sustainable development of the environmental economy (implementation of the 17 UN SDGs). The originality of the book also lies in the fact that it, for the first time, presents a systemic view of the whole range of problems of sustainable development of the global environmental economy in the context of climate change.

The book's structure has six parts. The first part examines green and ESG finance to support a sustainable global environmental economy in the face of climate change. The second part focuses on climate-smart innovations and Industry 4.0 cutting-edge technologies to support the sustainability of the global environmental economy. The third part reveals the industry specifics of sustainable development of environmentally responsible businesses to support the fight against climate change.

The fourth part explores carbon-neutral and clean energy to ensure the sustainability of the global environmental economy in the face of climate change. The fifth part looks at social institutions, government regulation, and the infrastructure for ensuring the sustainable development of the economy and combating climate change. The sixth part focuses on the international experience and legal and regulatory features of combating climate change in different countries.

The primary audience for this book is scholars engaged in the environmental economy. In this book, they will find a systemic view of the current problems of sustainable development of the global environmental economy in the context of climate change and an integrated theoretical and methodological approach to solving these problems through implementing the SDGs. Due to its multidisciplinarity, the book is also of interest to representatives of various fields of scientific knowledge, particularly climate economics, energy economics, finance, business management, spatial planning, innovation economics, and other social and human sciences (e.g., sociology, law, etc.).

The secondary audience for the book is practicing experts. In this book, representatives of public administration will find an overview of advanced regulatory mechanisms and promising infrastructure solutions to improve the state regulation of the environmental economy and scale up the fight against climate change at the country level of the countries and at the level of individual territories (regions, cities). Environmentally responsible business actors will find applied solutions for using green finance and climate-smart innovation, optimizing business models, and transitioning to carbon-neutral and clean energy in various industries to combat climate change most effectively.

Elena G. Popkova
Bruno S. Sergi

Contents

Contributors

Meilihan A. Altybaeva Osh State University, Osh, Kyrgyzstan

Natalia S. Andryashina Minin Nizhny Novgorod State Pedagogical University, Nizhny Novgorod, Russia

Elnura T. Avazova Osh State University, Osh, Kyrgyzstan

Daria A. Averianova MGIMO University, Moscow, Russia

Natalia V. Avtionova A. S. Griboyedov Institute of International Law and Economics, Moscow, Russia

Vladimir Ya Babaev MGIMO University, Moscow, Russia

Olga V. Balandina Academy of Labor and Social Relations, Moscow, Russia

Anastasia V. Buniakova MGIMO University, Moscow, Russia

Maxim V. Cherevik MGIMO University, Moscow, Russia

Sofya N. Chernaya MGIMO University, Moscow, Russia

Olga T. Cherney Minin Nizhny Novgorod State Pedagogical University, Nizhny Novgorod, Russia

Matvey G. Chertovskikh MGIMO University, Moscow, Russia

Anna A. Churakova MGIMO University, Moscow, Russia

Pavel A. Degtyarev Sochi Institute (Branch) of the Peoples' Friendship University of Russia, Sochi, Russia

Olga A. Derendyaeva All-Russian Research Institute for Civil Defense and Emergencies EMERCOM of Russia, Moscow, Russia

Taisiya V. Dianova MGIMO University, Moscow, Russia

Igor B. Dolzhenko Delta Consulting LLC, Moscow, Russia

Yuriy A. Episkoposyan MGIMO University, Moscow, Russia

Alim B. Fiapshev Financial University Under the Government of the Russian Federation, Moscow, Russia

Ekaterina P. Garina Minin Nizhny Novgorod State Pedagogical University, Nizhny Novgorod, Russia

Artem S. Genkin ANO “ZVI”—Center for Protection of Bank Clients and Investors, Moscow, Russia

Vera A. Gnevasheva MGIMO University, Moscow, Russia

Galina M. Golobokova Republican Scientific Research Institute of Intellectual Property, Moscow, Russia

Alexander P. Gorbunov Pyatigorsk State University, Pyatigorsk, Russia

Dmitriy I. Gorodetskiy MGIMO University, Moscow, Russia

Igbal A. Guliyev International Institute of Energy Policy and Diplomacy, MGIMO University, Moscow, Russia

Irina O. Ignatova MGIMO University, Moscow, Russia

Tatiana M. Isachenko MGIMO University, Moscow, Russia

Oleg V. Ivanov MGIMO University, Moscow, Russia

Aygerim M. Karagulova Eurasian Economic Commission, Moscow, Russia

Olga V. Khmyz MGIMO University, Moscow, Russia

Anatolii V. Kholkin Vyatka State University, Kirov, Russia

Alisa O. Khubaeva International Institute of Energy Policy and Diplomacy, MGIMO University, Moscow, Russia

Alla V. Kiseleva Southern Federal University, Rostov-on-Don, Russia

Vladislav I. Kiselev MGIMO University, Moscow, Russia

Elena G. Kislova Nizhny Novgorod Institute of Management—Branch of RANEPA, Nizhny Novgorod, Russia

Yuriy A. Kolesnikov Southern Federal University, Rostov-on-Don, Russia

Angelina A. Kolomeytseva MGIMO University, Moscow, Russia

Natalia Yu. Konina MGIMO University, Moscow, Russia

Yuliia S. Korobova Lobachevsky State University of Nizhny Novgorod, Nizhny Novgorod, Russia

Irina A. Koroleva A. S. Griboyedov Institute of International Law and Economics, Moscow, Russia;
Institute of modern art, Moscow, Russia

Elena P. Kozlova Minin Nizhny Novgorod State Pedagogical University, Nizhny Novgorod, Russia

Maria A. Kozlova MGIMO University, Moscow, Russia

Tatyana G. Krotova MGIMO University, Moscow, Russia

Petr A. Kruzhilin International Institute of Energy Policy and Diplomacy, MGIMO University, Moscow, Russia

Victor P. Kuznetsov Minin Nizhny Novgorod State Pedagogical University, Nizhny Novgorod, Russia

Svetlana N. Kuznetsova Minin Nizhny Novgorod State Pedagogical University, Nizhny Novgorod, Russia

Olga B. Lomakina MGIMO University, Moscow, Russia

Yulia A. Lukina MGIMO University, Moscow, Russia

Iman S. Magasheva MGIMO University, Moscow, Russia

Salikhat G. Magomedova Peoples' Friendship University (RUDN University), Moscow, Russia

Maria A. Maksakova MGIMO University, Moscow, Russia;
Institute of Economics of the Russian Academy of Sciences, Moscow, Russia

Irina A. Medvedkova National Research University—Higher School of Economics, Moscow, Russia

Olesya A. Meteleva Vyatka State University, Kirov, Russia

Alexey A. Mikheev MGIMO University, Moscow, Russia

Tatiana V. Miroshnichenko Sochi Institute (Branch) of the Peoples' Friendship University of Russia, Sochi, Russia

Sabir K. Mustafin Bashkir State University, Ufa, Russia

Tatyana G. Oross MGIMO University, Moscow, Russia

Vladimir S. Osipov MGIMO University, Moscow, Russia

Olga I. Ostrovskaya Moscow Polytechnic University, Moscow, Russia

Dmitriy N. Panteleev Vyatka State University, Kirov, Russia

Svetlana Yu. Pertseva MGIMO University, Moscow, Russia

Maksim V. Petrov MGIMO University, Moscow, Russia

Elena V. Pilevina MGIMO University, Moscow, Russia

Elena G. Popkova MGIMO University, Moscow, Russia

Anna A. Prudnikova Financial University Under the Government of the Russian Federation, Moscow, Russia

Natalia V. Przhedetskaya Rostov State University of Economics, Rostov-on-Don, Russia

Valeriya I. Ruzakova MGIMO University, Moscow, Russia

Elizaveta O. Ryabinina MGIMO University, Moscow, Russia

Olesya E. Ryazanova MGIMO University, Moscow, Russia

Yana A. Saltykova MGIMO Univesity, Moscow, Russia

Valery I. Salygin MGIMO University, Moscow, Russia

Elena V. Sapir P G Demidov Yaroslavl State University, Yaroslavl, Russia

Aida G. Sargisyan MGIMO University, Moscow, Russia

Ellina A. Shamanina MGIMO University, Moscow, Russia

Vladimir V. Shapovalov MGIMO University, Moscow, Russia

Anastasia V. Sheveleva MGIMO University, Moscow, Russia

Arina A. Shiptenko MGIMO University, Moscow, Russia

Larisa V. Shmarova MGIMO University, Moscow, Russia

Raisa N. Shpakova MGIMO University, Moscow, Russia

Marina D. Simonova MGIMO University, Moscow, Russia

Zhanna V. Smirnova Minin Nizhny Novgorod State Pedagogical University, Nizhny Novgorod, Russia

Alexander M. Solntsev Peoples' Friendship University (RUDN University), Moscow, Russia

Yulia V. Solovova International Institute of Energy Policy and Diplomacy, MGIMO University, Moscow, Russia

Kaukhar A. Sooronbaeva Osh State University, Osh, Kyrgyzstan

Victor V. Sorokin MGIMO University, Moscow, Russia

Anastasia A. Sozinova Vyatka State University, Kirov, Russia

Dmitry A. Sukhanov «Biota–Plus», Nizhny Novgorod, Russia

Alexey V. Sysolyatin Vyatka State University, Kirov, Russia

Vera A. Tikhomirova Private Educational Institution of Higher Education "Moscow International Academy", Moscow, Russia;
Federal State Budgetary Institution "Federal Center for Development of Agricultural Exports of the Russian Federation" (FSBI "Agroexport"), Moscow, Russia

Vasiliy N. Tkachev MGIMO University, Moscow, Russia

Evgeny P. Torkanovskiy Russian Academy of Sciences Institute of Economics, Moscow, Russia

Capitolina E. Tourbina MGIMO University, Moscow, Russia

Sergey D. Tsymbalov Minin Nizhny Novgorod State Pedagogical University, Nizhny Novgorod, Russia

Raykhan Zh. Turganbaeva Osh State University, Osh, Kyrgyzstan

Igor B. Turuev MGIMO University, Moscow, Russia

Parul Tyagi People's Friendship University of Russia (RUDN University), Moscow, Russia

Sergey G. Tyaglov Rostov State University of Economics, Rostov on Don, Russia

Natalia V. Ushakova MGIMO University, Moscow, Russia

Alexander I. Voinov MGIMO University, Moscow, Russia;
International Institute of Energy Policy and Innovation Management, Odintsovo, Russia;
Russian State Academy of Intellectual Property (RGAIS), Moscow, Russia

Ekaterina Yu. Voronova MGIMO University, Moscow, Russia

Sergey N. Yashin Lobachevsky State University of Nizhny Novgorod, Nizhny Novgorod, Russia

Natalia S. Zagrebelnaya MGIMO University, Moscow, Russia

Viacheslav E. Zakharov Ministry of Foreign Affairs of the Russian Federation, Moscow, Russia

Yuliia V. Zakharova Lobachevsky State University of Nizhny Novgorod, Nizhny Novgorod, Russia

Elena B. Zavyalova MGIMO University, Moscow, Russia

Dmitry S. Zhukov Rostov State University of Economics, Rostov-on-Don, Russia

Part I
Green and ESG Finance in Support of Sustainable Development of the Global Environmental Economy in the Face of Climate Change

Chapter 1
A Systemic View of Ecological Economics in a Changing Climate from the Perspective of the Sustainable Development Goals (SDGs)

Elena G. Popkova

1.1 Introduction

Ecological economics is an economic activity (and a set of relations in the process of this activity) that involves careful and responsible use of natural resources and care for the environment. The problem is that, despite the development of the Theory of Ecological Economics, the cause-and-effect relations of its formation and development are insufficiently clear, and the approach to the organization and management of the ecological economics is not formed.

Insufficient involvement and suboptimal use of management levers inhibit the development of ecological economics, which does not allow unlocking the potential of reducing the environmental costs of economic growth. Based on the works of Inshakova and Solntsev, (2022), Karbekova et al., (2022), Popkova, (2022c), and Revunov et al., (2021), which note that the exacerbation of the manifestations of climate change is a determining factor in the current economic context, this paper hypothesizes a systemic interconnection of the problems of the ecological economics in the context of climate change.

This research is devoted to testing the hypothesis and aims to form a systemic view of the problems of ecological economics in the context of climate change from the perspective of the Sustainable Development Goals (SDGs). The set goal is achieved through two research tasks. The first task is related to the formation of a systemic vision of the problems of ecological economics from the perspective of the SDGs. The second task is to develop a systemic approach to solving the problems of ecological economics based on combating climate change from the perspective of the SDGs.

E. G. Popkova (✉)
MGIMO University, Moscow, Russia
e-mail: E.Popkova@inno.mgimo.ru

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1.2 Literature Review

This research is based on the Theory of Ecological Economics. The works of Sinha et al. (2020) and Zang et al. (2021) indicate that the SDGs that characterize the development of the ecological economics are implemented separately, and each of them experiences its own specific problems:

- The core of ecological economics is the preservation of ecosystems and the protection of biodiversity. The implementation of SDG 14 and SDG 15 raises the problems of waste and depletion of natural resources, urbanization (Bian et al., 2022);
- Waste from production and consumption pollutes water and is a problem in the implementation of SDG 6; thus, clean water and sanitation are part of the ecological economics (Timmerman et al., 2022);
- The state of the environment in cities and towns, which determines their sustainability, also belongs to the ecological economics. The implementation of SDG 11 raises the problem of environmental responsibility of society (Zhang et al., 2021);
- Agriculture, which provides food security, is determined by natural conditions and, therefore, belongs to ecological economics. In the implementation of SDG 2, a considerable problem is the lack of funding (Popkova, 2022a, Popkova, 2022b; Yankovskaya et al., 2022);
- Health care is directly dependent on the environment. Thus, it can also be classified as related to ecological economics. In the implementation of SDG 3, the problem lies in the slow pace of technology development and implementation of innovations (Rice et al., 2022).

Charnock and Hoskin, (2020), Doni and Johannsdottir, (2021), Hwang et al., (2021), and Popkova and Shi, (2022) note that combating climate change is a separate Sustainable Development Goal (SDG 13), implemented separately and linked to unique challenges (not typical of other SDGs).

The literature review revealed a fragmentary study of ecological economics and the lack of a holistic view of it from the perspective of sustainable development (SDGs), which is a gap in the literature. To fill the identified gap, this research reimagines the problems of ecological economics in the overall context of climate change from the perspective of the Sustainable Development Goals (SDGs) and forms a systemic view of these problems and the prospects for addressing them through combating climate change.

1.3 Materials and Methods

The testing of the hypothesis is conducted in two consecutive steps. The first stage (within the first research task) determines the system interrelation of the components of ecological economics from the perspective of the SDGs. For this purpose, the author applied correlation analysis to determine the cross-correlation of SDG 2, SDG 3, SDG 6, SDG 11, SDG 14, and SDG 15 (based on UNDP statistics (UNDP, 2022)). The arithmetic mean of the correlation coefficients of each of these SDGs with the others listed is calculated. Positive arithmetic averages of correlation coefficients are evidence of a systemic relationship between the components of ecological economics from the perspective of the SDGs.

The research objects are the countries of the world, which demonstrated the highest "green" economic growth (Global Green Growth Index, score 0–100) in 2021 (according to the results of 2020) according to the Global Green Growth Institute (Global Green Growth Institute, 2022), that is, they are the leading green economies. Four countries were chosen from each region of the world; only two countries were taken from Oceania (to avoid data gaps) because this region has incomplete statistics on ecological economics.

From Africa, the sample includes Morocco (51.52 points), Tunisia (49.65 points), South Africa (48.79 points), and Egypt (42.66 points). From America, the sample includes Mexico (61.64 points), the USA (60.31 points), Canada (59.11 points), and Brazil (55.18 points). From Asia, Japan (61.83 points), Georgia (58.65 points), China (58.33 points), and India (43.54 points) are selected. From Europe, Sweden (78.72 points), Denmark (76.77 points), Finland (74.49 points), and Russia (53.46 points) are taken to cover both Western and Eastern Europe. From Oceania, New Zealand (56.33 points) and Australia (53.67 points) are taken. Statistics on the green economy from the perspective of the SDGs for these countries in 2022 are given in Table 1.1.

The second stage (the second research task) develops a systemic approach to solving the problems of ecological economics based on combating climate change from the perspective of the SDGs. For this purpose, the connection between the components of ecological economics and the fight against climate change is justified. Regression analysis is used to model the relationship between climate change results (under SDG 13) and potential factors for achieving them: improved access to and development of clean energy (under SDG 7) and the development of responsible production and consumption (under SDG 12).

The most achievable in practice Pareto-optimum of obtaining the complete results on the implementation of SDG 13 is determined based on the accrual of the results of SDG 7 and SDG 12 as a prospect of systemic solution of urgent problems of energy economics in conditions of climate change from the perspective of SDGs.

1.4 Results

1.4.1 Systemic Vision of the Problems of the Ecological Economics from the SDGs Perspective

In the framework of the first research task, based on the statistics from Table 1.1, the author applied correlation analysis to determine the systemic relationship between

Table 1.1 Implementation of the SDGs in the world's leading ecological economies in 2022, score 1–100

Region of the world	Countries/Territories	SDG 2 score	SDG 3 score	SDG 6 score	SDG 7 score	SDG 11 score	SDG 12 score	SDG 13 score	SDG 14 score	SDG 15 score
Africa	Egypt	59.0	70.7	67.1	70.6	66.3	92.8	95.1	51.6	68.6
	Morocco	62.5	74.6	64.5	70.5	75.5	93.4	93.5	56.9	69.2
	Tunisia	54.9	78.7	65.9	74.3	69.0	89.1	92.5	61.6	71.8
	South Africa	59.6	55.8	65.2	60.3	79.9	88.7	81.7	67.0	57.7
America	Mexico	60.5	78.3	77.5	68.3	81.2	86.0	84.9	66.4	55.0
	USA	69.5	88.0	85.1	72.5	90.6	67.8	45.1	62.3	56.0
	Canada	67.6	93.1	87.3	78.0	89.4	61.2	30.5	62.9	60.6
	Brazil	69.9	78.3	87.1	93.0	78.3	84.6	93.3	63.1	62.2
Asia	Japan	75.30	94.80	85.89	72.06	86.92	67.26	69.12	55.11	63.86
	Georgia	54.5	74.5	82.2	78.0	79.7	90.8	90.0	65.5	68.9
	China	82.0	82.6	70.9	63.8	79.5	90.6	85.5	51.4	49.2
	India	52.0	62.3	58.6	68.7	50.3	96.2	96.2	54.5	50.6
Europe	Sweden	63.4	95.7	95.1	93.3	92.0	63.1	60.2	67.3	80.1
	Denmark	66.4	95.4	89.8	88.1	95.1	54.8	58.5	71.3	92.8
	Finland	64.2	94.7	93.6	89.0	92.0	70.2	60.2	85.1	85.0
	Russia	57.5	79.4	78.0	65.3	85.5	84.7	70.8	55.5	66.1
Oceania	New Zealand	66.6	92.8	90.3	91.0	89.2	52.5	56.5	53.4	49.6
	Australia	59.3	95.4	94.1	71.0	89.4	58.3	12.7	66.0	63.6

Source Compiled by the author based on the materials of the UNDP (UNDP, 2022) the components of ecological economics from the perspective of the SDGs (Table 1.2).

As given in Table 1.2, almost all of the obtained correlation coefficients are positive and indicate a positive influence of the results of the implementation of the SDGs in the ecological economics on each other. The exceptions are the negative correlation coefficients of SDG 2 with SDG 14 and with SDG 15 because the development of agriculture implies the cultivation of wildlife and the reduction of its area. The arithmetic mean correlation coefficients of each of these SDGs with the others listed are calculated and illustrated in Fig. 1.1.

According to Fig. 1.1, the leading ecological economies in the regions of the world have achieved the best results by 2022 in the implementation of SDG 3 (82.51 points) and SDG 11 (81.66 points), which are most closely related to other SDGs of the ecological economics: Average correlation is 55.59% and 58.58%, respectively.

Table 1.2 Cross-correlation of SDGs in the ecological economics in 2022

Cross-correlation, %	SDG 2 score	SDG 3 score	SDG 6 score	SDG 11 score	SDG 14 score	SDG 15 score
SDG 2 score	1	–	–	–	–	–
SDG 3 score	48.06	1.00	–	–	–	–
SDG 6 score	33.78	85.68	1.00	–	–	–
SDG 11 score	46.18	77.38	84.89	1.00	–	–
SDG 14 score	−13.98	29.72	50.16	48.14	1.00	–
SDG 15 score	−15.62	37.11	36.41	36.30	62.43	1.00

Source Calculated and compiled by the author

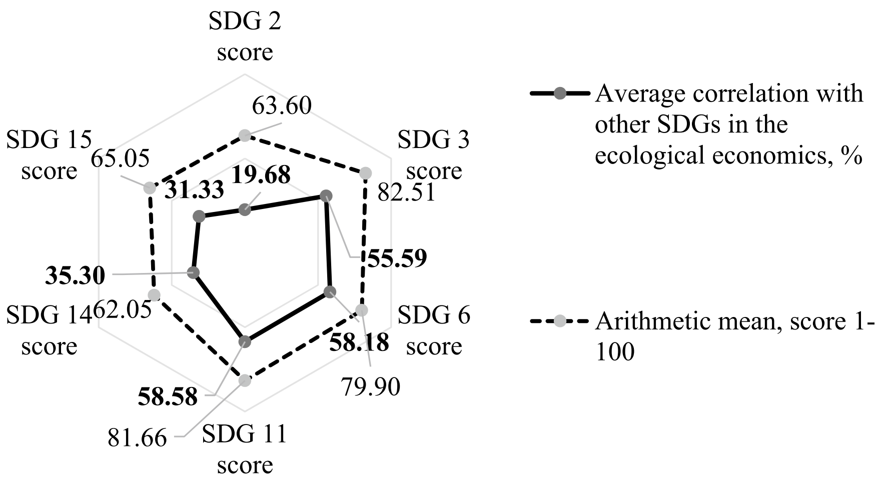

Fig. 1.1 Systemic relationship of the SDGs in the ecological economics in 2022. *Source* Calculated and compiled by the author

SDG 6 is linked to other SDGs of the ecological economics by 58.18%, SDG 14—by 35.30%, SDG 15—by 31.33%, and SDG 2—by 19.68%. The obtained results indicate the presence of a systemic relationship between the components of the ecological economics from the perspective of the SDGs (the arithmetic mean of the correlation coefficients in Fig. 1.1 is 43.11%).

1.4.2 Systemic Approach to Addressing the Ecological Economics from the Perspective of Climate Change: A View from the SDGs

The second research objective identifies the link between the components of ecological economics and the fight against climate change. Thus, ecosystem conservation and biodiversity protection (SDG 14 and SDG 15) depend on favorable climate (absence of droughts, floods, and abrupt climate change). Availability of clean water and sanitation (SDG 6) and related health care (SDG 3) also depends on the amount and frequency of rainfall (absence of droughts). The state of the environment in cities and human settlements, which determines their sustainability (SDG 11), and agriculture (SDG 2) is determined by the favorability of climate.

Based on the statistics from Table 1.1 and using regression analysis, the author developed Table 1.3, which contains economic and mathematical modeling of the relationship between climate change results (for SDG 13) and potential factors for their achievement: improved access to and development of clean energy (for SDG 7) and the development of responsible production and consumption (for SDG 12).

According to the results of the regression analysis in Table 1.3, 90.53% of climate change outcomes (for SDG 13) are determined by the combined outcomes of SDG 7 and SDG 12. A one-point increase in the availability and development of clean energy (when SDG 7 is implemented) increases the results in combating climate change by 0.90 points. A one-point increase in responsible production and consumption (when SDG 12 is implemented) improves the results in combating climate change by 1.71 points. The model is robust and reliable at a significance level of 0.01.

Based on the established regression dependence in Fig. 1.2, the author determined one of the most achievable in practice Pareto-optimums of obtaining the complete results on the implementation of SDG 13 based on the increase in the results of SDG 7 and SDG 12 as a perspective for the system solution of urgent problems of the energy economics in a changing climate from the perspective of SDG.

The systematic approach to solving the problems of ecological economics based on combating climate change from the standpoint of SDGs presented in Fig. 1.2 allows for achieving the most comprehensive results in implementing SDG 13 (100 points) by increasing the availability and development of clean energy (when implementing SDG 7) to 83.03 points (+ 9.27%) and developing responsible production and consumption (when implementing SDG 12) to 90.66 points (+ 17.22%).

Table 1.3 Regression statistics for the dependence of SDG 13 results on SDG 7 and SDG 12 results in 2022

Regression statistics	
Multiple R	0.9053
R-square	0.8195
Normalized R-square	0.7954
Standard error	10.8977
Observations	18

Variance analysis

	df	*SS*	*MS*	*F*	*Significance of F*
Regression	2	8088.5553	4044.2777	34.0542	0.000003
Balance	15	1781.3983	118.7599		
Total	17	9869.9536			

	Coefficients	Standard error	t-statistics	P-value	Lower 95%	Upper 95%
Y-intersection	−129.7199	35.2461	−3.6804	0.0022	−204.8453	−54.5945
SDG 7 score	0.9027	0.3048	2.9611	0.0097	0.2529	1.5524
SDG 12 score	1.7072	0.2125	8.0330	0.000001	1.2542	2.1602

Source Calculated and compiled by the author.

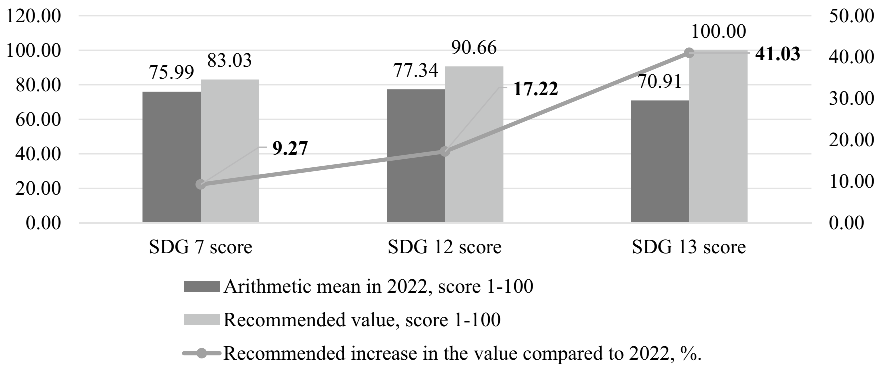

Fig. 1.2 Systemic approach to solving the problems of the ecological economics based on climate change from the perspective of the SDGs. *Source* Calculated and compiled by the author

Given the close relationship between climate change and the rest of the ecological economics, the author's approach will ensure its systemic progress.

1.5 Discussion and Conclusion

The chapter contributed to the development of the Theory of Ecological Economics by justifying the systemic role of combating climate change in the development of ecological economics. In contrast to Bian et al., (2022), Rice et al., (2022), Timmerman et al., (2022), Yankovskaya et al., (2022), and Zhang et al., (2021), the author substantiated that the components of the ecological economics are not disparate but are closely interrelated (interdependent by 43.11%) and experience common problems due to climate change. In contrast to Charnock and Hoskin, (2020), Doni and Johannsdottir, (2021), Hwang et al., (2021), and Popkova and Shi, (2022), it is proven that combating climate change is not a private problem (limited to SDG 13) but a general problem of the development of the ecological economics, which affects the opportunities and results of all SDGs, in particular SDG 2, SDG 3, SDG 6, SDG 11, SDG 14, and SDG 15.

A systemic approach to solving the problems of the ecological economics through combating climate change has been proposed, making it possible to fully implement SDG13 by increasing the availability and development of "clean" energy (when implementing SDG 7) by 9.27% and developing responsible production and consumption (when implementing SDG 12) by 17.22%. The theoretical significance of the results obtained is that they formed a systemic view of ecological economics and its key problem (climate change) and provided a holistic view of ecological economics from the perspective of sustainable development (SDGs).

The practical significance of the proposed systemic approach to solving the problems of the ecological economics based on combating climate change is that it makes it possible to most fully engage and optimally use management levers and stimulates the development of the ecological economics, unlocking the potential of reducing the environmental costs of economic growth.

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Chapter 2
The Harm of Cryptocurrency Mining to the Environment: How Serious is It

Aida G. Sargisyan

2.1 Introduction

In May 2021, Elon Musk announced that Tesla would no longer accept Bitcoin as a means of payment and named the reason: increasing environmental pollution due to Bitcoin mining (Musk, 2021). Thus, Musk raised a point of unsustainable cryptocurrency mining.

Researchers at the University of Cambridge concluded that bitcoin uses more electricity annually than all of Argentina: about 121.36 terawatt-hours (TWh) of electricity per year (Criddle, 2021). According to the experts, this figure is unlikely to decrease in the foreseeable future.

The Greenpeace organization has already been interested in the problem of environmental pollution due to mining (Palmer, 2021). Concerns about the non-environmental friendliness of mining have been voiced more than once. In April, Nature Communication magazine predicted that by 2024, the greenhouse effect from mining farms in China will exceed the Philippines' greenhouse effect (Jiang et al., 2021).

In addition to the "green" ones, the environmental problem of mining was also highlighted in China. For example, the Xinhua News Agency in its statement on a possible mining ban in the country indicated that mining consumes a lot of energy resources, so the cryptocurrency does not meet the goal of "carbon neutrality" (Xinhua, 2021).

Thus, according to the above, the question of the dangers of mining cryptocurrency for the environment is an open and urgent issue, and the solution to the problem is ambiguous.

A. G. Sargisyan (✉)
MGIMO University, Moscow, Russia
e-mail: sargisyanaida@gmail.com

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2.2 Methodology

The research methods in this study contain a synthesis of theoretical and empirical analysis. In the framework of the theoretical part, a comprehensive and multifaceted study of the literature was carried out in relation to the issues of cryptocurrency mining, its environmental friendliness and harm to the environment.

In the framework of the empirical part, a survey was conducted on the dangers of cryptocurrency mining for the environment and the possibilities of more environmentally friendly production.

The minimum required number of respondents was calculated using the following formula:

$$SS = \frac{(1 - p)x(p)xZ^2}{C^2},$$

where *SS*—sample size; *Z*—factor for the confidence level; *p*—the percentage of respondents or answers of interest, in decimal form (0.5 by default); *C*—confidence interval in decimal form.

The confidence level allows estimating with what probability a random answer will fall within the confidence interval, in other words, the sampling accuracy. In a limited research environment, the confidence level was determined at the level of 90%. The Z factor for statistical certainty of 90% is 1.64.

The confidence interval is the measure of inaccuracy (error) that specifies the range of the portion of the distribution curve on either side of the selected point where the answers can fall. In the context of a limited research environment, the confidence interval was determined at the level of ±10%.

When setting the data in the formula, the following result was obtained:

$$SS = \frac{(1 - 0.5)x(0.5)x1.64^2}{0.1^2} = 67.25.$$

Thus, 68 respondents (aged 19 to 63 years) took part in the survey. The general population was divided into two categories (groups), representing a representative sample, for conducting a comparative analysis. Simple random sampling was used in this study. The first group (48 respondents) is thoroughly enlightened on a subject (cryptocurrency and mining). The second group (20 respondents) has poor knowledge of the subject.

The respondents were asked to answer the following questions:

- Would you like to use cryptocurrency as an alternative to money?
- In your opinion, does the mining/production of cryptocurrency harm the ecology and the environment?
- Do you think alternative production could make cryptocurrency mining more sustainable?

- In your opinion, can "green" mining be a blessing not only for the environment but for humanity as a whole?
- Which of the following methods do you consider the most effective for reducing the negative impact of cryptocurrency production on the environment?

2.3 Results

The results of the study are presented below (Fig. 2.1).

According to the results, the following conclusions can be drawn:

- As of today, neither the first group (54.2%) nor the second group (76.5%) would like to use cryptocurrency as an alternative to money. At the same time, the first group is more inclined to use cryptocurrency in everyday life (45.8%) compared to the second one (23.5%).
- More than 2/3 of respondents from the first group (70.80%) are convinced that cryptocurrency mining is harmful to the environment. The answers of respondents from the second group were almost equally divided: 47.10% believe that mining is harmful to the environment and 52.90% have the opposite opinion.
- More than 2/3 of the respondents from the first group (72.90%) believe that alternative production could make the mining of cryptocurrency more environmentally

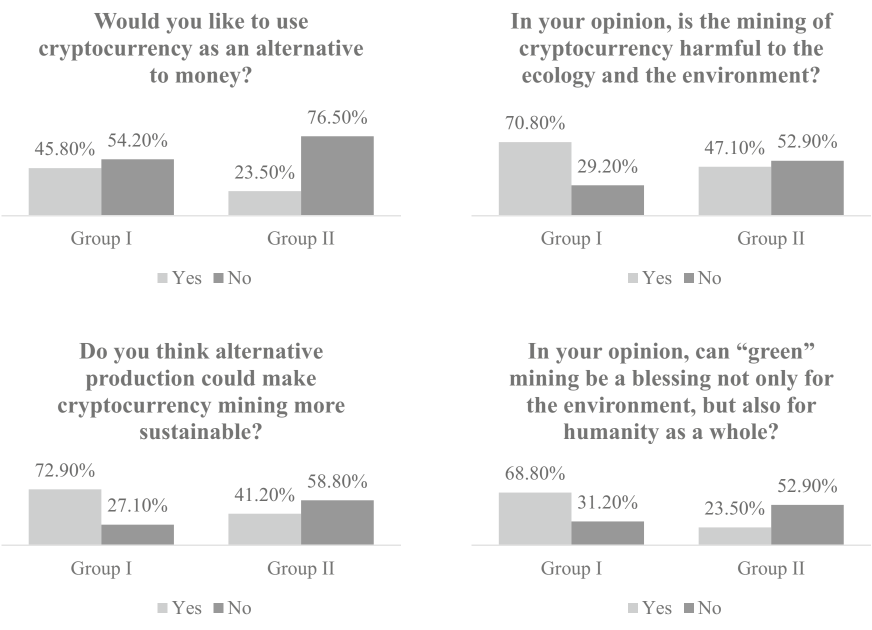

Fig. 2.1 Results of the conducted study. *Source* Compiled by the author

friendly. Only 41.2% of the respondents from the second group answered positively to this question, the rest (58.8%) are convinced that alternative production is not the key to success.

- When asked about the possible benefits of "green" mining not only for the environment but for humanity, 68.8% of respondents from the first group and only 23.5% of respondents from the second group answered positively.

The respondents were also asked to determine which methods, in their opinion, are the most effective in reducing the negative impact of cryptocurrency production on the environment. The results of the study are presented below (Fig. 2.2).

In both groups, the renewable energy sources scored the highest (58.3% and 52.9%, respectively). However, the second group equally preferred options to limit or completely ban the production of cryptocurrency. The first group turned out to be less inclined towards total prohibition and restriction but believes that other methods are also possible.

Thus, it is obvious that the respondents from the second group who are not entirely familiar with cryptocurrency have a more negative attitude towards cryptocurrency in terms of its use and towards mining in terms of environmental damage. The respondents from the first group answered the proposed questions more positively. In addition, some of the respondents from the first group offered the option of changing Proof of Work (PoW) to Proof of Stake (PoS) as an additional answer to the question about the most effective methods for reducing the negative impact of cryptocurrency production on the environment. This issue should be considered in more detail from

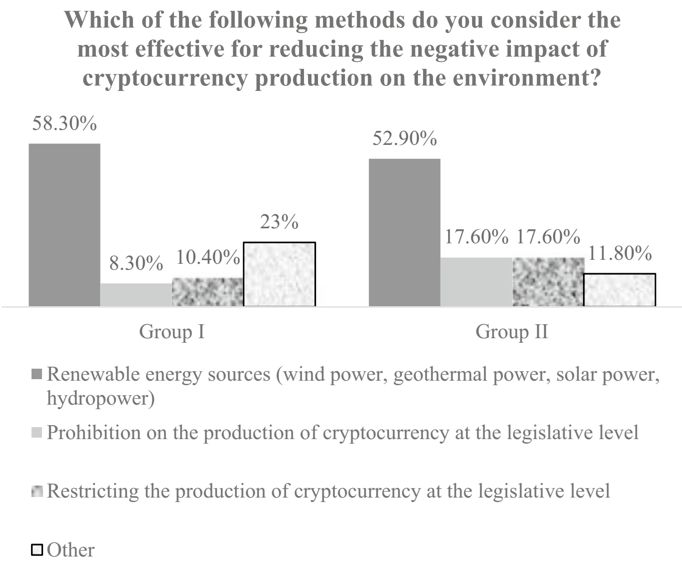

Fig. 2.2 Results of the conducted study. *Source* Compiled by the author

the theoretical and practical points of view, as well as other previously raised issues in the study.

Major cryptocurrencies, such as Bitcoin and Ethereum, use Proof of Work, a protocol for determining value (Sigalos, 2021). Essentially, Proof of Work is a way of confirming that computational resources were actually expended by the "prover" (the system performing the task). The idea was originally conceived back in 1993 as a way to counter spam or bots (Komodo, 2021). Proof of Work was supposed to be invisible to ordinary users, but, at the same time, it should make it difficult for such things as DDoS-attacks, in the form of thousands of concurrent requests to a complete denial of service (Komodo, 2021).

In 2009, Proof of Work, along with another technology called blockchain, was used for a very different purpose: creating the digital currency Bitcoin. This is a simplified explanation, but, in general, the process of mining bitcoins looks like this: miners instruct their specialized computers to solve certain puzzles competing for the right to check the next block in the blockchain. For a successful solution, the miner is rewarded with new coins. The more a computer works (and uses more energy), the more competitive it is.

Mining in 2009 was just a background process that could be run on a simple laptop in idle mode. However, over time, the difficulty of mining grows. This is due to the fact that, since the network grows, the rate of mining of new coins remains stable (for Bitcoin, one block is mined every ten minutes) (Borate, 2021).

To solve the problem with an increase in the number of mining devices, the computational task becomes more complicated. Miners are buying more computers and improving graphics processing units (GPUs). But when the puzzles get more complicated, miners move to places with cheaper electricity and/or upgrade farms and place them in air-conditioned sea containers. Thus, after more than a decade of growing the cryptocurrency market, we have a network that consumes more electricity than all of Argentina, without any regulatory structure or federal oversight (Criddle, 2021).

This is not a new issue, as the Proof of Work mechanism has been created almost since the launch of the cryptocurrency and is damaging the environment due to its uncontrolled system. This is also not a long-term problem, since we are already seeing devastating costs. According to a recent study of the University of New Mexico, in 2018, every dollar of the cost of one bitcoin is responsible for $0.49 in damage to the health and climate in the USA (Goodkind et al., 2019).

The price of cryptocurrencies has skyrocketed over the past twelve years. In particular, the value of bitcoin has risen dramatically. Bitcoins bought for $100 in 2010 (1 BTC = $0.5, 200 BTC = $100) could average $12 million in 2021 (Hakobyan, 2021). Such rapid growth is not universal for all cryptocurrencies (there are thousands of cryptocurrencies, the price of which fluctuates like the value of any other currency), but the general trend is observed. For example, Ethereum, which powers many other cryptocurrencies, has grown approximately by 216,500% since its launch (Gidaspov, 2021).

Many reasons can explain such an increase in value—this is general acceptance, anonymity, which gives comparative impunity, the ability to manipulate rates for a quick profit, etc. But there is another crucial reason, and it is electricity consumption, i.e., generating new coins requires expended energy, which is the value of each coin (Carter, 2021).

Indeed, in some measures, the rate of cryptocurrencies depends on the cost of electricity. This is because the growth in the value of cryptocurrencies should stimulate miners. After all, if the dependence did not exist, the potential income from the sale of bitcoins could fall below the cost of their production.

Thus, further financial return on Bitcoin depends on whether the difficulty of mining coins grows. People, who invest in bitcoin, as well as those who trade in futures, are betting that tomorrow it will be more profitable to be just a holder of the cryptocurrency than to mine it.

Anyone who has faced the increase in prices for staple foods throughout the crisis can understand how shortages are affecting the market. However, in a digital context, scarcity is a blessing, although, in fact, there is nothing that would require the complication of mining each subsequent block. It could even be the other way around because computers are becoming more efficient and powerful. This means that, in this case, scarcity is an artificial process that requires more and more energy and resources that are expended to keep working and making a profit.

Proof of Work is not the only algorithm in existence. The most well-known alternative of PoW is Proof of Stake (PoS), which is not associated with any environmental concerns (Tikhomirov, 2021). Indeed, while coins with Proof of Work require solving more and more energy-intensive puzzles in order to participate in the "lottery" for the right to receive the next portion of coins, Proof of Stake has another approach: the right to take part in the "lottery" is distributed according to the system's "held rate", i.e. coins held by a separate wallet.

In black and white, it looks like the environmental problem has been resolved. However, PoS and PoW currencies operate on the same conceptual model. Despite the existence of a few genuinely functioning PoS currencies, most commonly the standard PoS use case is increasingly committed to the transition to PoW (Lau, 2021).

Ethereum aims to use Proof of Stake for almost as long as it has been existing. Every time the ecology has to pay more for Proof of Work, Proof of Stake is presented as atonement—it is just necessary to wait, and the network will become "environmentally friendly".

Meanwhile, the annual energy consumption of the Ethereum networks ranges around 24.43 gigawatt hours (GWh), which is roughly equivalent to the electricity consumption of Ecuador (Geere, 2021). Even if Ethereum begins to use PoS someday, we don't have time to wait.

In addition, Proof of Stake has always been an interesting bait and alternative, but it has other obvious problems as well as other algorithms (Bitnovosti, 2019). Proof of Stake coins use a variety of ways to distribute the chances of receiving a reward, a "lottery ticket". Generally, one coin in your wallet is one lottery ticket. But there are such options:

- Confirmation of the amount of data storage gives you a “lottery ticket” for each available hard disc segment;
- The certificate of handover of the device for use gives a “lottery ticket” for each smart device and other consumer electronics related to the Internet of Things that you own;
- Confirmation of a donation gives you a “lottery ticket” for each donation to a charitable organization.

Thus, no scheme does not reward those who are already rich, have surplus capital or have access to enormous computing power. And this is also a climate problem, which, not least, depends on social justice. The truth is that the worst effects of climate collapse are felt by those who have no way of avoiding them, and those with the material resources easily flee to other places.

As PoW coins require investors to buy in the face of ever-increasing computing power, we find ourselves in a terrifying skyrocketing flow of energy consumption and environmental devastation. In turn, while cryptocurrencies without PoW are less harmful to the environment, they represent a risky scheme that could lead to financial shortages.

According to the expert Daniel Frumkin, along with the recent ban on mining in Iran, restrictions in China could improve the sustainability of mining and increase the use of renewable energy sources (Frumkin, 2021). Frumkin determined the amount of energy expended on mining. For example, the amount of waste gas produced in the USA alone is certainly enough to keep the Bitcoin network running (Frumkin, 2021). According to Frumkin, the reasoning about the benefits or harms of this or that type of energy consumption is illogical without reference to the context and specific conditions.

The production of solar panels, which are actively supported by the advocates of renewable energy, does some harm to the environment. The high-scale manufacture of solar panels is concentrated in Xinjiang province, which also hosts a large number of mining farms accused of polluting the environment (Tully, 2021). In June 2021, the Xinjiang Uygur Autonomous Region authorities ordered the urgent termination of miners’ operations (Zhao, 2021). Other Chinese regions can take up a similar option.

A joint study by Square and ARK Invest indicated the possibility of using solar energy in mining taking into account the change in the power of the sun’s energy throughout the year and day (Square, 2021). The document specifies the Levelized Cost of Electricity (LCOE): the total cost of construction and operation of a power generation facility over its entire service life divided by the total amount of energy produced. The authors found the use of solar energy for mining will only be rational if investors believe that the price of BTC will rise significantly over the next 4 years (Square, 2021).

2.4 Conclusion

According to the University of Cambridge, only 39% of miners completed the carbon neutrality threshold in September 2020 (Blandin et al., 2020). Thus, about 39% of mining is performed on renewable energy sources, and this percentage can grow subject to attention, investment and the passage of time. The 2019 report also indicated that specifically for Bitcoin, this percentage was 74% (Bendiksen and Gibbons, 2019).

"Green" mining is becoming an increasingly strategic pathway for the blockchain industry's development. The energy consumption for the needs of farms will only grow, which means that people will need more diverse energy sources. Eco-friendly mining has every chance of becoming a boon not only for the environment, but also for humanity, and there are some reasons for this. The use of surplus generated electricity and the development of "green" industrial methods will lower the cost. The migration of miners to countries that are not rich but convenient to produce cryptocurrencies can have a positive effect on the economy.

Thus, there are no doubt, that "green" energy is incredibly important for the future of society, but it is not free energy. The cost of producing solar panels, wind turbines, hydroelectric dams, etc., is an irretrievable environmental cost in mining, manufacturing and construction. This is usually less expensive, but not the best option. The best bet is to simply keep power consumption as low as possible.

In addition, the production of "green" energy for mining does not work as a separate power system. The use of sustainable energy sources still requires taking electricity from the grid, which is also used to distribute electricity to homes, increasing consumption and stimulating the development of new energy projects, including those that utilize coal, oil and gas.

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Chapter 3
Current Trends in the Green Bond Market

Svetlana Yu. Pertseva

3.1 Introduction

Green bonds are a fixed-income instrument issued to finance environmental protection projects and reduce hazardous emissions into the atmosphere.

Green bonds are a crucial tool for socially responsible investment (ESG-environmental, social, governance). The targeted nature of the use of funds is the main characteristic of this security and its main difference from traditional bonds. Green bonds serve as a kind of springboard on the way of countries to a green economy and are an integral part of the system of green finance, formed at the junction of the financial field and the environmental sphere.

3.2 Methodology

Currently, the countries are participating in various agreements on the greening of the world economic space. Such agreements include the Paris Agreement of 2015, the Kyoto Protocol of 2005 (The Kyoto Protocol—Status of Ratification, 2021), signed within the UN Framework Convention on Climate Change of 1994 (United Nations Climate Change).

Thus, green bonds combine two aspects—environmental and financial, since, on the one hand, this type of security is aimed at solving environmental problems, and, on the other hand, it is an innovative and effective instrument for financing activities. Green bonds open up vast investment opportunities and stimulate the creation of the necessary infrastructure for the emission reduction targets set by the Paris Agreement.

S. Y. Pertseva (✉)
MGIMO University, Moscow, Russia
e-mail: sup.05@mail.ru

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This financial instrument is characterized by moderate profitability and risk for the investor, low cost of raising capital for the issuer, mainly for issuing securities with a high credit rating of institutional or supranational structures that receive significant advantages in raising funds. In comparison with other instruments (e.g., by attracting borrowed funds through a loan), green bonds are a more attractive way of financing environmental projects due to the high degree of liquidity of this security.

The green bond market is a system of relationships between counterparties regarding the sale of debt securities issued to receive funds for the development of projects and programs to protect the environment and combat climate change, as well as the standards for issuing a green financial instrument, the necessary infrastructure for the functioning of this market and regulatory institutions (United Nations Climate Change, 2021).

The emergence of the green bond market correlates with the objective prerequisites and factors of the formation of this segment. In this regard, the following categories of reasons for the emergence of the green bond market can be distinguished:

- Economic factors: lack of financing for environmental protection projects, the need for a green financial instrument with transparent proceeds for a green economy.
- Environmental factors: aggravation of environmental problems, the importance of reducing environmental risks and energy efficiency and achieving sustainable development goals to prevent an environmental catastrophe.
- Social factors: increased interest in environmental problems, the issue of reputation—the issuer of green bonds acquires the status of an innovative company concerned about the current state.

According to the Climate Bonds Initiative (Explaining Green Bonds, 2021; The Green Bond Principles, 2021), bonds are divided into five types. These types depend on the sale of bonds and the right of recourse of the debt, the environment.

1. Standard green bonds;
2. Green income-related bonds;
3. Project green bonds;
4. Securitized green bonds;
5. Green covered bonds.

The proceeds from the sale of standard green bonds are used to finance green projects, while such securities are legal debt obligations with the right of recourse to the issuer. The funds received from the placement of profitable green bonds are used to refinance projects to protect the environment and combat climate change. The collateral for the debt is income streams, excluding taxes and fees. Project green bonds are tailored to a specific project, and the right of recourse arises only concerning the assets of this project. Securitized green bonds are intended to finance or refinance a group of projects, while the right of debt recourse is associated with the entire group of combined projects (Balcilar et al., 2018). When issuing green covered bonds, a pool of acceptable projects is created with the right of recourse of the debt to the issuer or, in case of the issuer's inability to meet its obligations, to the pool of assets of the included projects. Thus, when issuing green bonds, the investor receives an additional guarantee, a "double regression". At the same time, the issuers of such bonds are mainly banking structures.

Recently, investors have shown increased interest in the market of socially responsible investments. The problem's relevance is related to the complex of measures of administrative regulation of the level of environmental pollution. At the same time, experts predict the possibility of a correction in the ESG instruments market in the short term and at the same time a significant growth potential in the long term. It should be noted that within the ESG segment of the financial market, green bonds have the most significant weight among all bonds related to the Sustainable Development Goals. The share of green bonds in the total accumulated volume as of December 2020 is 63.5% (Sustainable Debt Global State of the Market 2020 CBI, 2020).

The total accumulated issue of green bonds from 2007 to 2020 exceeded $1 trillion and currently amounts to almost $1.2 trillion ($1 Trillion Mark Reached, 2020). From 2015 to 2020, the volume of annual issuance of green bonds increased by more than 5.8 times. The average growth rate of green bond issuance from 2012 to 2020 is 78.6% per year (Table 3.1).

A significant trend in the green bonds market is the annual increase in the volume of issuance of green bonds. According to the Climate Bonds Initiative report, in 2020, a record level of green bond issuance was reached for $ 269 billion, which is 4.4% higher than in 2019 and 57.7% higher than in 2018 (Shades of Green, 2019).

However, within the framework of the global bond market, the volume of green bonds is insignificant and in 2019 amounted to only 3.6% (Debt volume in, 2019a, 2019b) of the total volume of issued bonds. According to data for the period from January to April 2021, the global issue of green bonds amounted to $121.2 (Climate Bonds Initiative, 2021) billion, of which $10.5 billion related to certified green bonds following the Climate Bonds Standard (Guideline on the green & sustainable Finance

Table 3.1 Issue of the green bond market from 2012 to 2020

	Issue of the green bonds, bln USD	Annual growth rate, %
2012	2.6	–
2013	11.5	342.3
2014	37.0	221.7
2015	41.8	13.0
2016	81.0	93.8
2017	160.2	97.8
2018	167.6	4.6
2019	257.7	54.3
2020	269.0	4.4

Source Compiled by the authors

Grant Scheme, 2021) and $110.7 billion represent standard green bonds following the definition of the Climate Bonds Initiative.

The upward trend in the dynamics of green bonds indicates investor interest in this financial market segment, according to a study by the Russian state corporation VEB. RF (VEB.RF., 2020). The annual growth of green bond funds from 2017 to 2020 amounted to 50%, and the share of such funds in the total number of ESG bond funds reached 80%.

Among the green bond funds are the iShares Global Green Bond ETF, the third ESG fund according to the results of 2020 with assets of $156.5 million (Green Bond Pricing in the Primary Market 2020 H2, 2020) as of December 2020, with an increase in assets since the foundation of the fund amounted to $131.5 million. The Lyxor Green Bond DR UCITS ETF has assets of €548.7 million (Bauer, R. & Hann, D., 2010).

Significant trends in the market are the leadership of the European region in terms of output volumes and the growth of the share of the Azat-Pacific region from 2014 to 2020. In 2020, the output of the European region reached the level of $156 billion, which is almost 50% of the entire market, primarily due to significant output volumes in Germany and France (Sustainable Debt Global State of the Market 2020 CBI, 2020).

The increase in the share of the Asia–Pacific region since 2015 was due to the increased share of China, one of the fastest-growing green bond markets. In 2019, the volume of Chinese green bond issuance in the domestic and foreign markets increased by 33% and only in the domestic market—by 60% compared to the level of 2018. Experts attribute such a sharp increase to significant support from the regulator.

By the end of November 2020, the cumulative accumulated volume of the issue of green bonds of the People's Republic of China for the entire period of the segment's operation in the country amounted to $164.9 billion, which is a reasonably high indicator compared to 2014, when this indicator was less than $1 billion (China's new green bond catalog could be greener, 2021).

According to the analysis of the market structure of green bonds, the geography of such securities is currently changing. For example, if earlier issuers were advanced economies (USA, Japan, France, Germany), now green bonds are issued in many developing (China) and developed (South Korea) countries of the Asian region. At the same time, in 2018–2020, the leaders in issuing bonds intended to finance green projects were the USA, France, Germany and China, whose share in the whole issue of green bonds decreased in 2020 Green Bonds. Global State of the Market 2020, 2019a, 2019b).

It is logical to assume that the euro, the US dollar and the yuan dominate among the currencies in which green debt securities are issued. Although the share of these currencies has slightly decreased due to the expansion of the geography of the issue of green bonds, these currencies accounted for 81% (90% in 2016) of the total volume of the issue of green type bonds in 2019, and the share of the euro was 40% (China Corporates Snapshot—December 2020, 2020).

A vital characteristic of the green bond market is the significant role of institutional investors. Thus, in 2017, the International Finance Corporation (IFC) developed the concept of a target program for green bonds (GCBP) (IFC, 2021).

In 2018, the French company Amandi, in partnership with the International Finance Corporation, created the Amundi Planet Emerging Green One (AP EGO) green bond trust fund to develop the ESG segment in developing countries. Amundi Planet Emerging Green One is a fund with a built-in mechanism for improving credit quality, established to expand investments in climate protection programs in developing countries. This fund was an innovative platform dealing with experienced asset management and assistance in promoting sustainable growth and development of emerging markets. The fund was closed when it reached the level of $1.42 billion. According to forecasts, by reinvesting the funds received, the trust fund will use the $2 billion to invest in green debt securities of developing countries over 12 years of operation. The investments of the European Investment Bank in the fund amounted to $100 million (Green Bond Cornerstone Fund, 2017).

At the same time, there is an upward trend in the issuance of corporate green bonds, the driver of which was the American mortgage agency Fannie Mae with an issue volume of $22.9 billion or 9% of the total issue of green bonds. Since the beginning of the first issue of green bonds in 2012, the company has strengthened its position in the market and has become the sector leader in terms of corporate issuance volumes. In addition, Fannie Mae is the largest issuer of ABS green bonds. As part of the company's green bond program, Fannie Mae has issued green bonds secured by a mortgage loan (Single-Family Green Mortgage-Backed Securities, or MBS), as well as Guaranteed Multifamily Structures, or GeMS for short.

The green financial product, which is initially issued in an MBS, is provided by a green loan. It is by the volume of the issue of green MBS that the annual volume of the issue of green bonds of this issuer is estimated. In 2019, Fannie Mae issued green MBS for a total value of $22.8 billion, which accounted for 32.5% of all MBS securities of the issuer. In addition, green MBS was reclassified at $2.9 billion (Multifamily Green Bond Impact Report, 2021) in the category of GeMS for investors who are more interested in having a diversified collateral pool of assets.

With the acceleration of the development process of the green bonds market, the structure of issuers is also changing.

More and more countries are issuing green bonds at the state level, and in this regard, the volume of sovereign green bonds is growing. For example, in 2019, the following countries issued sovereign debt in the format of green bonds (Green Bonds (2019a, 2019b). Global State of the Market, 2019a, 2019b. Climate Bonds Initiative., 2019a, 2019b):

1. France (total output amounted to $23.3 billion);
2. Belgium ($8.2 billion);
3. The Netherlands ($6.7 billion);
4. Ireland ($5.7 billion);
5. Poland ($4.3 billion);
6. Chile ($2.4 billion).

The necessary incentive for developing the green bond market is benefits and subsidies from the state, primarily tax benefits.

Climate Bonds Initiative highlights the following stimulating tax measures on the part of the state:

1. Provision of a tax credit. Investors who purchase bonds receive tax benefits instead of coupon payments, so the issuer does not incur additional costs for paying coupon income on green bonds. An example is the American program of bonds for renewable energy sources (the U.S. Federal Government Clean Renewable Energy Bonds, CREBs), as well as conservation bonds (Qualified Energy Conservation Bonds, QECBs), issued until 2018 since changes were introduced in 2017 on the impossibility of issuing bonds with direct payments. This program involved the issue of municipal bonds to increase the efficiency of electricity use. 70% (Tax Incentives, 2019) of the coupon income was paid by providing a tax discount or subsidy to the state's investor who purchased the bond. At the same time, the maximum maturity of the bond was limited since, with a long term, investors received more benefits, which, in turn, led to more expenses of the U.S. Treasury. The restriction was 14–15 years. At the same time, as interest rates decreased, the maximum maturity of bonds increased. For example, in April 2009, the adjusted rate (AFR) decreased from 4.56% 2 to 4.53% (Financing public sector projects with Clean Renewable Energy Bonds, 2009). In May 2009, which led to an increase in the maximum maturity of the issued bonds, from 14 to 15 years. In April 2021, a bill was published in the USA on the resumption of the issuance of bonds with direct payments, in particular Clean Energy Bonds, for which a subsidy of up to 70% will be paid (Clean Bond Energy would have a direct pay subsidy of up to 70%, 2020).
2. Bonds with direct payments (direct subsidies). Issuers receive subsidies from the state for interest payments. This scheme, as mentioned above, was used within the framework of the CREBs and QECBs programs.
3. Tax-free bonds. When purchasing bonds, the investor is exempt from income tax on interest on green bonds (thus, issuers make payments at a lower rate). For example, such tax-free bonds were issued in Brazil to finance wind energy projects. Direct subsidies to issuers are also a significant incentive for developing the segment of green bonds at the national level. In some provinces of China, local authorities are implementing programs to support companies entering the market of green bonds. For example, in 2019, the Zhongguancun Research Center approved an annual subsidy to issuers, amounting to $141 thousand. The policy of the Jiangsu Province assumes subsidizing 30% of the amount paid by such an issuer—a non-financial organization of coupon income, for two years. The maximum allowable payment is $850 thousand (China's Green Bond Issuance, 2020).

One of the illustrative examples of practical state support can be the initiative of the Hong Kong Monetary Regulation Authority (The Government of Hong Kong Special Administration Region, 2021). Following the guidelines published in May 2021, a scheme for granting green issuers grants was developed. Such a program will cover the total costs of the issuer of green bonds for the direct issue of securities and additional costs for external evaluation, that is, verification, for three years. At the same time, the amount of the subsidy will be half of the related expenses of the issuer, but not more than 2.5 million Hong Kong dollars if the credit rating of the issue meets the management criteria and 1.25 million Hong Kong dollars if the credit rating does not meet the management criteria.

The grant system is also used in Japan, where the issuer can be provided with financial assistance in the amount of 90% of the expenses incurred, but not more than 40 million yen, provided that the criteria of Green Bond Principles, ASEAN Green Bond Standard or Limit Bonds Initiative are met (The Green Bond Issuance Promotion Platform, 2021).

COVID-19 has become a significant barrier to the further development of the green bond market. According to a study prepared by the Climate Bonds Initiative, in the first half of 2020, the volume of issuance of green bonds decreased by more than half compared to the level of 2019 in all regions, except for the Latin American region (mainly due to the issuance of Chile's sovereign debt in the format of green bonds).

The most significant drop occurred in March 2020, while subsequently, the monthly issue of green bonds did not rise above the pre-crisis level. Experts attributed the decline in interest in green bonds in 2020 to the impact of the pandemic, the slowdown in global economic growth and a sharp decline in oil prices since the cost of using renewable energy sources was several times higher than the cost of using hydrocarbons, and the gap, which was already significant, increased even more, which undoubtedly negatively affected the attractiveness of this instrument for investors.

3.3 Results

The COVID-19 pandemic has made the world realize the importance of achieving sustainable development and responsible financing. Therefore, leading European countries and some states of the Asian region (primarily Japan and the Republic of Korea) have stated that the recovery during the post-pandemic COVID-19 should be carried out with a focus on the principles of a green economy. However, the decline in the volume of green bond issuance in the first half of 2020 in North America was 66% and corresponded to the global level of decline, which reached 65%. The reason for the reduction was a decrease in the volume of placement of green bonds by the mortgage agency Fannie Mae, the issue of which in the first half of 2020 amounted to $2.6 billion. Excluding the African region, where no green bond issues were held in the first half of 2020, the Asia–Pacific region showed the most significant decline, issuing bonds for $12 billion, compared to $64 billion for the same period in 2019. Although the main reason for such low indicators was a significant reduction in the volume of issued bonds of the People's Republic of China, a sharp decline, from 80%, was observed in Malaysia, New Zealand, Thailand and Saudi Arabia.

In the first half of 2020, there was a smoother decline in developed countries compared to developing economies. Although, as a result, the share of developed countries in global output reached a record high of 81% (72% in 2019), the share of developing countries reached a minimum of 13% (23% a year earlier). However, the bond issuance volume by supranational institutions increased slightly (from 5% in 2019 to 6% in 2020).

The upward trend was present in the framework of the placement of public sector securities, where a smaller volume of green bonds issuance compared to the private sector was entirely expected, taking into account the less flexible investment plans of public sector issuers and their less dependence on market dynamics, especially in the short term (De Clerck & F., 2009).

Despite the negative consequences of the crisis, there were also positive changes in the green bonds market, which indicated an increase in demand and an improvement in the indicators of green debt instruments.

The market has seen an increase in the volume of green bonds issued to finance projects related to renewable energy sources, projects for introducing environmentally friendly transport and green buildings. Green bonds issued to finance transport projects have become the main driver of market development, mainly due to investments in railway programs by sovereign institutions and state-supported structures. Despite the negative dynamics of the development of the green bonds market, by the end of 2020, the volume of issuance of green bonds exceeded the indicator of 2019. Furthermore, following the forecast of the Climate Bonds Initiative from 2019, it is expected that in 2020–21 the volume of issuance of green bonds by financial institutions, sovereign states and the volume of certified bonds will increase.

3.4 Conclusions

The analysis showed that the green bonds market is a fast-growing segment of the debt financing market using ESG instruments. Every year, the green bonds market shows an increase in the volume of bond issuance and accounts for about 2/3 of the market of issued bonds related to the Sustainable Development Goals. Undoubtedly, the crisis associated with the COVID-19 pandemic harmed the state of the green bond market. Furthermore, a significant drop in oil prices has led to a decrease in the comparative attractiveness of the green economy instruments and green bonds, in particular.

In the course of the conducted research of the market of green bonds, the following trends were identified:

1. A long-term trend within the green bond sector is the increased interest of investors in this instrument since it shows sufficient liquidity in the market, in some cases exceeding the liquidity of traditional bonds. At the same time, this trend is inherent mainly in developed markets.

2. Simultaneously, with the expansion of the geography, there is a significant unevenness in the placement of green bonds. However, the green bonds market is expanding and already covers some countries of Eastern Europe, the Middle East and Africa. At the same time, the world's largest economies—the USA, France, Germany and China—remain the leading issuers of green bonds.
3. The tendency to expand the presence of states in the debt financing market is revealed. As a result, governments are significantly increasing the volume of issuance of sovereign green bonds.
4. During the pandemic, governments have expanded measures to support the development of the green bond market by providing subsidies, benefits and stimulating tax measures.

We believe that strengthening the identified trends will allow the green bond market to develop rapidly and accelerate the transition to a global green economy.

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Chapter 4
Factors of Attractiveness of Green Bonds as a Financing Tool for Countering Adverse Climate Change

Olga V. Khmyz, Tatyana G. Oross, and Anna A. Prudnikova

4.1 Introduction

The need to attract financial resources to ensure financing of the fight against unfavorable climate change is beyond doubt and is confirmed by an increasing number of opinions of experts from the professional and scientific community (Sandberg & Juravle, 2009; Dogru et al., 2019; Khmyz, 2019; Abdelzaher et al., 2020).

Moreover, as the climate continues to deteriorate, more and more financial resources are required to work on improving the ecosystem. First of all, it refers to an energy transition that requires significant costs (World Economic Forum, 2021). So, less than 15% of the funds allocated for the recovery from the COVID-19 pandemic ($2.4 trillion worldwide) were related to “clean energy”, this is clearly not enough (Krylova and Sergeeva, 2021), because the transition to environmentally friendly energy sources (in order to maintain a favorable climate and combat climate change, especially with global warming) is estimated at about $100 trillion (Bennett et al., 2021).

In the first half of the past decade, assets under sustainable financing projects grew at a moderate pace, and since 2016, there has been a surge in their growth. For 2016–2020 it accounted for almost 95% of ten-year volumes, or about $1.5 trillion (Climate Bond Initiative, 2021). This is due, firstly, to the signing of the Paris Agreement on the threat by risks, secondly, with increasing sensitivity to climate change and the associated risks, thirdly, with state and supranational incentives. Various mechanisms and instruments are used, but primarily debt securities. The global sustainable bond market is showing stable growth (Volksbanken Raiffeisenbanken, 2021). Green

O. V. Khmyz (✉) · T. G. Oross
MGIMO University, Moscow, Russia

A. A. Prudnikova
Financial University Under the Government of the Russian Federation, Moscow, Russia
e-mail: AAPrudnikova@fa.ru

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bonds are one of the most popular and promising instruments for attracting financial resources.

In connection with the above, the purpose of this work is to identify and analyze the main factors of the attractiveness of green bonds, for which it is necessary (research objectives) to analyze the current situation and state of the global green bond market and the Russian green bond market (the Sustainable Development Sector of the Moscow Exchange). This will make it possible to assess the prospects for green bonds and the market they form, including the immature Russian market.

However, the global green bond market is also relatively young. Only a little over ten years ago, the European Investment Bank initiated the issue of climate bonds, becoming an example to follow. More and more institutional investors are joining the green bond market, demonstrating interest in fixed-income green products, in particular, sustainable development bonds and social bonds, which acts as a stimulating factor for their market. Accumulated issues of green bonds for 2007–2020 exceeded US$ 1 trillion, and by June 2021 amounted to almost US$ 1.2 trillion. The annual issues of these securities increased by more than 5.8 times for 2015–2020. From January to April 2021, the global green bond issue totalled US$ 121.2 billion (Climate Bond Initiative, 2021).

4.2 Methodology

An analysis of green projects, for which green bonds were issued, shows that from 2016 to 2020 most of the projects were related to the energy resources usage efficiency. Consequently, the mentioned energy transition, from its side, continues to influence the financial market.

Simultaneously, an important financial reason for the attractiveness of green bonds, which has turned into a trend in the global financial market, is the availability of a discount to yield—"greenium", or green premium (Climate Bonds Initiative, 2020). According to the analytical agency ACRA, from 2007 to 2020, green bonds showed yields lower than conventional bonds, the discount to the yield on green bonds compared to conventional bonds was about 1–2 basis points (ACRA, 2020). However, according to a study by the Russian state corporation VEB.RF, the yield discount for issuers of this type of securities ranged from 10 to 20 basis points (VEB, 2020).

At the same time, some varieties of green bonds can be traded at a greater discount due to a different time interval, since as the security circulates, the discount to yield decreases. Also, this characteristic can be inherent in the segments of green bonds in the markets of developing countries, where investors show less interest in this financial instrument.

In addition, among the possible reasons for the presence of a discount to profitability, one can single out the difference between supply and demand, called "the phenomenon of oversubscription".

Moreover, according to the CBI report, during the second quarter of 2020, the average level of "oversubscription" in the green bond market was 4.2 times for bonds issued in euros and 3.5 times for bonds issued in US dollars; for conventional bonds, this indicator reached the mark 2.9 times (in euros) and 3.3 times (in dollars) (Climate Bond, 2021b).

The average spread contraction for green bonds issued in EUR amounted to 24 and 25 bp—for green bonds issued in US dollars. At the same time, it should be noted that "oversubscription" and further reduction of spreads—just like in the conventional bond market–is a normal pricing process. It is also noteworthy that since March 2020, for both conventional and green bonds, the level of "oversubscription" and spread reduction has been increased. Moreover, in the first quarter of 2020, there was the largest reduction in spreads on green bonds since 2016.

In terms of liquidity, green bonds are usually on par with conventional ones and sometimes show even better results. For example, the bid-ask spread that is, the difference between the highest acceptable purchase price and the lowest possible selling price, for green bonds is almost 48% lower than that calculated for conventional bonds.

In general, the relatively low return on green bonds suggests that the demand for these debt securities is growing, investors are increasingly following the principles of responsible investing, and also points to the gap between supply and demand. However, on the other hand, taking into account the general upward trend in the global green bond market, it can be assumed that the supply of this financial instrument will be expanded and, possibly, this phenomenon will lead to an increase in the level of profitability and a reduction in the discount to yield on green bonds.

In addition, the value of "greenium" varies depending on the affiliation of the issuer to the industry. So, in the financial sector, the discount can be about 25–30 basis points for dollar-denominated bonds and about 10–15 basis points for those issued in euros. The largest discount to yield is observed in the energy and telecommunications sectors, where this indicator exceeds 30 basis points (Fig. 4.1).

Following the best world practice, at present in the Russian Federation, much attention is paid to the possibilities of responsible financing and development of the green sector of the financial market. Fostering green finance is part of the national development strategy toward a green economy. In 2005, the Russian Federation ratified the Kyoto Protocol, and in 2019 joined the Paris Climate Agreement (UN, 2015), which implies a reduction in the level of harmful emissions into the atmosphere. In the same year, the national project "Ecology" (Gov, 2019) was developed and adopted, which regulates the normative environmental indicators for the period up to 2024.

The history of the development of the green bonds sector of the stock market in the Russian Federation began with the creation of a specialized ESG-sector within the framework of MOEX. In 2019, the Moscow Exchange launched the Sustainable Development Sector, a platform for placing green, social bonds and bonds, the proceeds of which are used to finance national programs. Securities are placed by Russian and foreign organizations in accordance with international standards and principles (ICMA, CBI) to finance ESG projects.

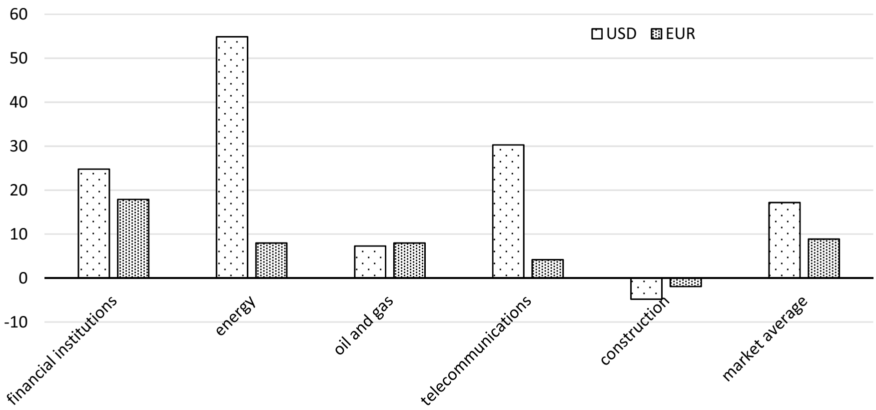

Fig. 4.1 Weighted average value of the discount to yield on green bonds. 2020 *Source* Compiled by the authors based on (VEB,) statistics

The first Russian green bonds on the Moscow Exchange were issued by Center-Invest Bank in November 2019 for RUB 250 million (MoEx, 2021) for a period of 1 year. Now more green bonds of the issuer are circulating in the sector, also issued for 1 year with an issue volume of RUB 300 thousand and a coupon rate of 5.75%. Center-Invest bonds are the only green bonds issued in the Sustainable Development Sector, issued for 1 year, less than the benchmark (less than RUB 500 thousand). Bank Center-Invest uses the proceeds from the sale of green bonds to issue loans to stimulate the sector of environmentally friendly vehicles and efficient use of energy.

As of mid-2021, bonds of five green issuers were in circulation in the Sustainable Development Sector: FPC Garant-Invest, Siberian Federal District Rusol 1, Transport Concession Company, Bank Center-Invest and the Moscow Government. It should be noted that the majority of bonds in circulation in the Sustainable Development Sector of the Moscow Exchange are long-term debt securities. The total value of bonds issued in the Sustainable Development Sector was RUB 88.9 billion or 90.06% of the total issue of ESG bonds in the sector (MoEx, 2021).

It seems crucial to define and analyze the value of the yield to maturity of some green bonds in circulation in the Sustainable Development Sector of the Moscow Exchange (MoEx, 2021), which will make it possible to analyze the "greenium" trend in the Russian market. The data obtained indicate that there is an important tendency on the Russian market—the absence of a green discount to profitability, or the "greenium" phenomenon. The average level of yield to maturity, ceteris paribus, in mature markets was 0.471% (JPX, 2021; Euronext, 2021). As we can see, in the Russian market, investors are offered an increased yield to maturity, which differs from the values shown by green bonds in mature markets.

Indeed, as estimated by the analytical agency Ekspert (Katasonova and Mitrofanov, 2021), the Russian green bond market has not yet seen a stable "greenium" phenomenon or a negative discount to the yield on green bonds. However, this phenomenon may arise due to measures of state support.

It should be noted that this trend is present in almost all emerging markets, which testifies to the underdevelopment and insufficient base of the green bonds sector of the Moscow Exchange.

In order to determine the characteristics of the Russian green bond market and to prove the hypothesis that it is inferior in some parameters to foreign, relatively more developed, green bond markets, we will conduct a comparative analysis of green bond issues on the Moscow Exchange (MoEx, 2021) and foreign platforms such as the Tokyo Stock Exchange (JPX, 2021), Euronext Paris and Euronext Amsterdam (Euronext, 2021). According to the data obtained, the depth of the Russian market is still significantly lagging behind the volumes of foreign exchanges, both in the number of issuers that entered the market and in the total cost of green bond issues. Simultaneously, a specialized segment of the financial market dedicated to the issue of bonds related to the achievement of the Sustainable Development Goals has not yet been created on some European sites. One of the leading stock exchanges is the Paris Stock Exchange, where 23 issuers were registered, and the Dublin Stock Exchange (Euronext), where 51 issuers carried out green bond issues (Euronext, 2021). At the same time, Russian issuers offer a higher coupon on green bonds (the maximum coupon is 16.016%) (MoEx, 2021).

A complete register of Russian issuers that placed both Russian and foreign stock exchanges is maintained by the Competence and Green Expertise Center of the National Association of Concessionaires and Long-Term Investors in Infrastructure. In February 2020, the Expertise Center developed and submitted the Register of Russian issuers of green bonds, which includes the specifics of the placement and issuance of green debt securities. As of the beginning of April 2021, the register included six issuers (LLC Resursosberezhenie KhMAO, JSC Russian Railways, PJSC CB Center-Invest, FPC Garant-Invest, LLC SFO Rusol 1 and Transport concession company) and 17 issues of green bonds. According to the register, the total volume of green bonds issued by Russian companies amounted to RUB 7.6 billion, EUR 500 million and SHF 500 million. Among the issuers presented, all securities were listed on the Moscow Exchange, except for the green bonds of JSC Russian Railways, which were issued on the Irish and Swiss stock exchanges on May 23, 2019, and March 11, 2020, respectively. At the same time, information on the issues of the instrument by the Russian Railways company was included in the ICMA and CBI databases. Thus, taking into account the absence of the "greenium" phenomenon in the Russian green bond market, we can conclude that Russian issuers enter foreign exchanges in order to obtain "greenium", a discount on the yield on issued green bonds.

Thus, in May 2019, JSC Russian Railways for the first time carried outplacement of Eurobonds to finance green projects, following the principles of ICMA green bonds. The funds raised via the issuing will be used to purchase electric locomotives, modernize railroad infrastructure and build special treatment facilities, which will subsequently reduce energy consumption and minimize the greenhouse effect, provided that electronic locomotives are used. It should be noted that the share of green bonds in the total volume of the company's bond issues is small, and in the volume of Eurobonds issued by the company, it is only 11%.

In March 2021, the company issued perpetual green bonds in the amount of SHF 25 million (about RUB 2 billion) on the Swiss Stock Exchange with a coupon of 3.125%. These green bonds were rated BB + (Fitch).

By private subscription, JSC Russian Railways also issued perpetual green bonds on the Russian market. This bond issue, in accordance with the principles of the green economy, was verified according to the VEB.RF methodology. However, according to the statement of the head of the company in January 2021, one of the largest global bond funds, PIMCO, was unable to purchase the company's ESG bonds, since half of the company's turnover falls on cargos of carbon origin.

According to a study by the analytical agency ACRA, there was also a phenomenon in the Russian market when the growing demand was not supported by the corresponding supply due to "oversubscription", in particular, during the placement of green bonds of Russian Railways and Center-invest bank. This phenomenon assumes a situation when the volume of applications for the purchase of a security exceeds the established volume of the issue.

At present, the Russian green bond market is expanding its boundaries toward the issuance of sovereign green bonds. On May 27, 2021, the Moscow Government carried out the first issue of sub-federal debt in Russia for 7 years in the format of green bonds for the RUB 70 billion, and the coupon was 7.38%, in the Sustainable Development Sector of the Moscow Exchange. (MoEx, 2021) The funds received from the issuance of such bonds, first of all, will be used to finance infrastructure programs and environmental projects, including the construction of new metro lines, the purchase of electric buses, which will lead to a significant reduction in the level of air pollution. These bonds were also characterized by the phenomenon of "oversubscription" of almost 20%.

When developing the project, the authorities noted that the Government would not be able to receive a discount on the coupon rate of green bonds for compliance with the Sustainable Development Goals. Indeed, the coupon on these bonds was 7.38%, which is higher than the coupon values for longer-term corporate bonds but below the coupon value of seven-year corporate bonds circulating in the Sustainable Development Sector. Undoubtedly, such a decision became an important stimulus for the development of the market in the Russian Federation and set a new trajectory for state green financing.

It should also be noted that Russian green bonds, like foreign ones, are issued mainly for institutional investors.

4.3 Results

To analyze and establish the significance of the influence of factors on the yield to maturity of green bonds and the coupon on green bonds, we will test two econometric models (for the yield to maturity of green bonds—econometric model No. 1 and on the coupon for green bonds—econometric model No. 2).

When constructing econometric model No. 1, we analyzed 100 corporate and sovereign issues of green bonds in circulation (as of May 2021), including issuers whose bonds circulate in the Sustainable Development Sector of the Moscow Exchange. In order to determine the significance of the influence of factors on the yield to maturity of green bonds, the following regression specification was compiled (4.1).

$$\begin{aligned} \text{YLDM} = &\beta_0 + \beta_1 * \text{CPN} + \beta_2 * \text{VLM} + \beta_3 * \text{CRCPRD} \\ &+ \beta_4 * \text{MRKT} + \beta_5 * \text{ISS} + u \end{aligned} \tag{4.1}$$

where YLDM—dependent variable, yield to maturity (percentage), CPN—regressor, green bond coupon (percentage), VLM—regressor, green bond issue (in EUR million), CRCPRD—regressor, maturity of green bonds of this issue (in years), MRKT—binary factor, the type of market in which the green bonds were issued (1—developed market, 0—emerging market), ISS—binary factor, issue (1—corporate, 0—sovereign), u—regression error, a β_1, β_2, β_3, β_4 и β_0—regressor coefficients.

Based on the obtained sample, the following indicators were calculated that characterize the regression model:

- The coefficient of determination, the "quality of fit indicator" is 0.79206404 that is, the model describes 79% of the data variance, or 79% of the change in the dependent variable is interpreted based on the regressors of this model.
- The value of the F-statistic with degrees of freedom of 5.94 was 71,612.
- The p-value calculated for the model is less than 0.05, which indicates that the model as a whole is significant.

It is possible to analyze the indicators calculated for each of the model regressors (Table 4.1).

Using the least squares method, the coefficients of the regressors were calculated (Fig. 4.2).

The coefficient at the factor "coupon of a green bond" determines that when the coupon on a green bond changes by 1%, the yield to maturity on this green bond on average, ceteris paribus, increases by 0.863154%. The value of the coefficient for the factor "volume of issue" suggests that with an increase in the volume of issuance of green bonds by EUR 1 trillion, the value of the yield to maturity on average, ceteris paribus, increases by 0.088936%. According to the obtained coefficient β3, with an

Table 4.1 Indicators of factors in the econometric model No. 1

	CPN	VLI	CRCPRD	MRKT	ISS	Const
Coefficient (β_0, β_1, β_2, β_3, β_4)	0.86315	0.889352	0.047272	−2.3155	−2.31647	1.10235
p-value	0	0.570624	0.787057	0	0.532504	–
Standard deviation	0.075093	0.60469	0.49239	0.066002	0.49052	–

Source Authors' calculations based on data (MoEx, 2021; JPX, 2021; Euronext, 2021)

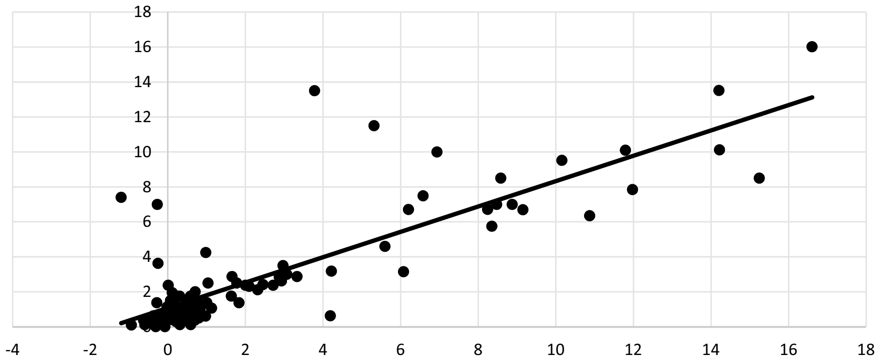

Fig. 4.2 Equation of the dependent variable (yield to maturity) and the regressor (coupon on the green bond), built using the method of least squares *Source* Author's calculations based on data (MoEx, 2021; JPX, 2021; Euronext, 2021). Built by the authors

increase in the circulation period of green bonds by 1 year, the yield on green bonds on average, other factors being equal, increases by 0.047272. The coefficient for the binary factor "the market in which the issue of green bonds was carried out" means that other factors being equal on average, the yield to maturity of green bonds issued in more developed markets is lower than the yield to maturity calculated for bonds issued in emerging markets by 2.32%. Similarly, the binary factor "type of green bond issue" shows that all other conditions are equal, for the issuance of sovereign green bonds, the yield to maturity is on average 2.316% higher than the yield to maturity of corporate green bonds.

We also find it important to determine the degree of stability of the obtained coefficients, based on the values of the standard deviation. Thus, the most stable regressors of econometric model No. 1 are the green bond coupon factor (0.075093) and the regressor characterizing the market on which the issue was carried out (0.066002).

However, when considering the p-value indicator (Table 4.1), which is critical and indicates the significance of each regressor, it was determined that the significant factors were the "green bond coupon" factor and the "green bond market" regressor because the p-value for these regressors (about 0 for both factors) is less than 0.05.

Graphical analysis of the equation of the dependent variable and the coupon for green bonds (Fig. 4.2) showed that, indeed, the "coupon" factor is significant in the tested regression model.

Thus, the study found that significant regressors, i.e., factors influencing the yield to maturity of green bonds, are the coupon for green bonds and the type of market where the green bonds were issued. Also, the analysis of the obtained sample revealed that in developed markets the yield to maturity of green bonds on average in May 2021 was 0.471%.

Taking into account the fact that the coupon on green bonds is a significant factor in regression model No. 1, it is advisable to identify the determinants that affect the coupon size on green bonds.

In the same sample, an econometric model No. 2 was developed and tested, the specification of which is as follows (4.2).

$$CPN = \beta_0 + \beta_1 * VLM + \beta_2 * CRCPRD + \beta_3 * MRKT + \beta_4 * SCTR + u \tag{4.2}$$

where CPN—fixed annual coupon rate for a given green bond, calculated as a percentage, and dependent variable, VLM—volume of the issuer's issue (in EUR million), CRCPRD—maturity of the green bond (in years), MRKT—binary factor, developed or emerging market, SCTR—binary factor, the sector of operation of a given company (a company whose activities are directly related to environmentally friendly production, the use of renewable energy sources, waste processing, or a company whose main activities are not directly related to achieving the Sustainable Development Goals, that is, financial, production private or other company), u—regression model error. VLM, MRKT, CRCPRD and SCTR are the regressors of the given econometric model. Coefficients β_1, β_2, β_3, β_4 и β_0—regression coefficients characterizing the effect of regressors on the dependent variable CPN.

This makes it possible to identify the degree of influence of factors (VLM, CRCPRD, SCTR) on the coupon value for green bonds and to test the hypothesis assuming that the factors specified in the specification are significant. Equation (4.2) reflects the dependence of the coupon of the green bond on the selected regressors.

Based on the data in Table 4.2 and the obtained regression coefficients, it is possible to analyze their effect on the dependent variable. It can be noted that when the factor "issue volume" changes by EUR 1 million, the dependent variable, i.e., the coupon of the green bond, on average, other factors being equal, changes by -2.319e-11. If the "maturity" regressor is changed by 1 year, the coupon, ceteris paribus, is reduced by 0.013 percentage points on average. The binary factor "the market in which the issuance of green bonds was carried out" shows that the coupon on green bonds in developed markets, ceteris paribus, is on average 4.8854% lower than in emerging markets. This means that the coupon on green bonds issued by organizations directly related to the achievement of the Sustainable Development Goals, the use of renewable energy sources, waste recycling, etc., is 1.2% higher than the same indicator for green bonds issued by other organizations.

It is possible to determine the degree of stability of the coefficients $\beta 1$, $\beta 2$, $\beta 3$, $\beta 4$ by analyzing the values of the standard deviation of the coefficients. The most stable

Table 4.2 Indicators of factors in the econometric model No. 2

	VLM	CRCPRD	MRKT	SCTR	Constant
Coefficient (β_0, β_1, β_2, β_3, β_4)	−2.319e-11	−0.013	−4.8854	1.2040	6.1499
p-value	0.739	0.944	0	0.030	0
Standard deviation	6.94e−11	0.019	0.525	0.546	0.474

Source Author's calculations based on data (MoEx, 2021; JPX, 2021; Euronext, 2021) coefficients are the coefficients $\beta 2$ (0.019) and $\beta 3$ (0.525) that is, the coefficients of the factors “maturity” and “market in which the company operates”.

In accordance with the obtained result in terms of p-value, the most significant factors are “the market in which the bonds were issued” and the regressor “the sector of the company’s functioning” (0 and 0.03, respectively).

4.4 Conclusion

The analysis of the current situation in the global green bonds market make it possible to conclude that even taking into account the global force majeure factor that has emerged in recent years, this market continues to develop progressively. The lockdowns introduced in different countries did not have an adverse effect on it, and industrial, transport and technical restrictions (together with the energy transition carried out in many developed countries), on the contrary, led to an increase in the demand for environmentally friendly projects and, accordingly, an increase in demand for green bonds.

The analysis showed that the following trends are typical for the Russian green bond market:

- an increase in the yield to maturity on bonds circulating in the Sustainable Development Sector of the Moscow Exchange due to the absence of the “greenium”;
- increasing the volume of issues (however, the base of issues is still insufficient in comparison with the world’s leading stock exchanges);
- expansion of the market toward the issue of sub-federal green bonds.

The study of possible factors of the appearance of the “greenium” phenomenon, discounts to the yield on green bonds, is of great scientific and applied importance and allows us to find out which regressors are significant and affect the analyzed indicator.

In the study, it was found that the significant factors influencing the level of the fixed coupon rate are the binary factors of the model, namely, the regressor characterizing the sector of the company’s functioning, and the factor “the market in where the green bonds were issued”.

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Chapter 5
Green Financing as a Tool to Fight Climate Change

Vladimir Ya Babaev

5.1 Introduction

The past decades have been marked by increasing concern about the impact of human activity on the environment (Nica & Potcovaru, 2014).

These concerns have led to the need to develop new ways of doing and assessing enterprises. Governments as well as many international organizations have taken all the necessary steps to develop new tools to stimulate and change the way our daily activities affect the environment. These actions are aimed at facilitating the transition to a low-carbon economy that will be resilient to climate change and at the same time resource-efficient (Mccahery & Vermeulen, 2014).

However, an obstacle to achieving this goal is the cost of moving from a high-carbon economy to low carbon (Popescu, 2014). As the world is embarking on a low-carbon development path, the focus is on directly using renewable energy sources to meet energy demand while maintaining ecological integrity (Somorin & Induhiu, 2020).

There was a lot of controversy about how best to achieve this goal, it was proposed to introduce a carbon tax or carbon trading, however, the most important change was the promotion of environmentally friendly investments, better known as green investments (Voicaa et al., 2014).

A generally accepted definition is difficult to come up with, however, green investments are considered to be low-carbon or climate-resilient investments in companies or projects that focus on climate change as well as renewable energies and clean technologies. Paris Climate Agreement, which was signed by 195 member countries in 2015 noted the importance of reducing the global average temperature by 2 °C above the pre-industrial level. Subsequently, the Intergovernmental Panel on

V. Y. Babaev (✉)
MGIMO University, Moscow, Russia
e-mail: v.babaev@odin.mgimo.ru; babaev_v_a@my.mgimo.ru

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Climate Change in 2018 reduced this figure to 1.5 °C, to prevent further global warming around the world and possible further catastrophic damage.

The conference held in Marrakech was dedicated to how to fight climate change and decarbonizing energy supplies to reduce emissions and also the adoption of financing mechanisms that facilitate the transition to a low-carbon economy. Ever since financing sustainable land transitions by finding real incentives and the promotion of green products to raise funds has become a paramount concern (Report of the High-Level Commission, 2017).

This is relevant for developing countries that have sufficiently limited access to capital to invest, for example, in water, electricity, the transport system, as well as housing to cover all the needs of a rapidly growing population under the influence of negative conditions caused by the effects of global warming. Funding is at the core of projects to reduce emissions and energy. Investors, private, or public, find it necessary to obtain sufficient effective capital in case it concerns green projects.

The government can promote a range of measures to assist in the development of clean technologies. Green bonds issued for the first time in 2007 are an effective way for investors to gain access to sustainable investments and provide financial support to green technologies and projects aimed at preserving the environment (Agliardi & Agliardi, 2019).

Green bonds are commonly referred to as any type of bonds for which income will be only used to finance or refinance, in part or whole, new and existing green projects that meet the criteria, in other words, projects that are environmentally or climate-friendly (ICMA, 2017).

Renewable energies, clean transport, sustainable garbage management, and land use, as well as purified water, to name a few can be examples of such projects. Green investments provide the issuer with capital for further financing of green projects, and investors, in turn, receive income in interest terms (CBI, 2017, 2018; ICMA, 2017, 2018).

According to Galaz et al. (2015) and Scholtens (2017), the development of financial innovation positively affects aspects of human society and the impact that takes place on the ecological environment is quite low. It follows from this that there are tremendous opportunities for improving the ecological environment with the use of financial resources. Scientists looked at the more important issues of green finance as a means of protecting the environment. Questions concerned more active participation of private green capital in projects related to environmental protection and also, an important role of the government was assigned in the development of green finance (Ruiz et al., 2016; Taghizadeh-Hesary & Yoshino, 2019; Wang & Zhi, 2016; Owen et al., 2018).

Green funds can be considered as another form of green investment. The World Bank distinguishes three categories of green funds namely fiscal, equity, and cat bond funds.

For EU countries, investing in the renewable energy sector offers many opportunities for continuing to fulfil its obligations by financing projects aimed at climate change in partnership with governments, development partners, climate funds, as well as private sectors to pool financial resources and introduce innovative technologies and at the same time solutions in this particular sector.

Despite the positive dynamics that green investment has in mitigating the effects of climate change, some scientists believe that the development of green financing can have a negative impact on the issuance of loans by banking institutions, which to some extent reduces the efficiency of investments in renewable energy sources and, as a result, can negatively affect the quality of the environment (He et al., 2019). A sharp drop in funding took place after the financial crisis, although emissions of harmful substances emitted into the atmosphere also declined, this suggests that the regression in funding has contributed to some improvement in the environment (Pacca et al., 2020).

What conclusion can be drawn based on the research conducted by the above scientists that green investment can contribute to some improvement or stimulate the flow of funds to support environmentally friendly enterprises and all kinds of projects, but examination of opportunities for a green transition for companies and the identification of challenges that may arise are not fully disclosed as well as the advantages and disadvantages of new green finance instruments and institutions, in particular, green bonds and green funds are not fully discussed. This particular paper will try to address the gaps identified and propose some recommendations for the governments in their effort to attract green finance in the fight against climate change.

5.2 Methodology

Data used in the paper was acquired from publicly available sources such as the World Bank official website The World Bank (2021) based on World Bank World Development Indicators. Furthermore, data on ecological footprint was acquired from ADB 2020 (Asian Development Bank, 2021) and Global Footprint Network (2021). Data in the paper mainly concerns the Asia–Pacific region and covers the period of 2011–2019. The article is not limited by the Asia–Pacific region alone and the footprints in Europe, Africa together with the US are taken into consideration with the period of 1960–2020. It is clear from the data provided that climate financing is on the rise owing to several approvals approved. The reason is a dramatic increase in CO_2 emissions in the Asian region, particularly in China and India. The highest footprint refers to 2002–2012. A high number is due to poor environmental behaviour in developing countries in comparison with developed counterparts. Indonesia and Malaysia demonstrate serious environmental problems turning into a global issue as a result environmental protection is a call for action in these countries (Jelin, 2000; Riaz & Saeed, 2020). According to Inglehart (1995), environmental financial support in countries with developing economies is more or less the same as in developed economy countries. This fact proves that environmental awareness is on the rise in developing countries without regard to countries' environmental behaviour. ADB, in turn, increased the environmental changes financing to 6 billion by 2020 on annual basis.

5.3 Results

Green bonds can be considered one of the key tools in attracting financial resources to reduce carbon emissions. Green bonds can significantly reduce carbon dioxide emissions by 2030. Due to the development of green finance, share of non-fossil energy resources will be increased from 42 to 46% (Glomsrød & Wei, 2018).

Green finance does not have a negative impact on the environment, but quite the opposite, provides all kinds of support to environmentally friendly enterprises, including various projects, and as a result, improves the state of the environment. Banks approved the concept of green credit and as a result, the financial capabilities of enterprises with high levels of pollution have significantly decreased (Liu & Shen, 2011).

For shareholders, green bonds are beneficial from a financial point of view and will serve as a kind of incentive for the company to participate in green projects. In turn, green projects that support sustainable development are beneficial for investors, as a result of which investments will be directed to a large extent on green projects. Investment in the renewable energy sector can be increased if the government encourages green finance policies (Romano et al., 2017). According to IEA (2021), green financing can reduce fossil fuel consumption by 26% which in turn can decrease CO_2 emissions by 12.4%.

One of the barriers to green investment is the carbon price. Until the carbon price becomes more stable, predictable, and also reliable, it is unlikely to be of interest to investors.

According to Baietti et al. (2012), fossil fuel subsidies can be another barrier to green investment. Due to the undervalued prices of fossil fuels including traditional technologies, prices and resource allocation is skewed, making green investments less attractive.

Initially, high costs and long payback periods can also be attributed to barriers to green investment. Green investments are generally expensive, although some are financially viable. This is the reason why green investments require higher rates of return, often these rates are supported by countries through pricing mechanisms or subsidies in the form of green certificates.

Another barrier can be the so-called technological risks. Viability and functionality are risks for any new technology. It is difficult enough to finance and develop new technologies if there is no support from the public or venture capital. Until the risk and return profiles become more stable, it is unlikely that the financial community will fund these projects.

Revenue risks can also be attributed to green finance barriers. Funding by banks and investors can be complicated by the ambiguity of new technologies in terms of profitability, including the risks associated with low credit ratings and the necessity to provide collateral to cover potential risks, including other financing needs.

As Hoen (2014) indicates, besides the impediments mentioned above, there are some more challenges for green investment but with lower impact such as high transaction costs, lack of knowledge and skills, inadequate international participation, and high costs of system integration of clean energy sources. Political and regulatory risks should be also taken into consideration together with unclear rights of intellectual property and insufficient domestic financial tools.

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Recommendations
Governments need to intensify their efforts to apply appropriate green financial mechanisms, for example, speed up investments into infrastructure and renewable energy sources.

Green bonds can rightfully be considered as one of the most affordable and cost-effective options for helping to attract large sums of capital for infrastructure development following environmental goals.

Governments need to develop incentive structures at both the national and subnational levels to create a favourable environment for investments in renewable energy sources.

Governments, together with their development partners, should design funding models that strengthen strategic partnerships between stakeholders in order to pool financial resources and at the same time reduce risk and increase investment in renewable energy.

Once the issue of climate change attracts the necessary attention from the public, governments, and international organizations, only then will alternative business practices be possible.

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Chapter 6
Stock Exchanges and Institutional Support of ESG Reporting: Evidence from Russia

Anastasia V. Buniakova and Elena B. Zavyalova

6.1 Introduction

Currently, Environmental Social Governance (ESG) is becoming increasingly popular with a wide variety of stakeholders: customers, suppliers, employees, governments, etc. (Rimmel, 2021). All sorts of entities ranging from international organizations to rating agencies and standard-setting bodies drive ESG transparency all over the world. Financial markets are disrupted by ESG investing, with investors seeking and corporations disclosing ESG-related data as sustainable companies are perceived as interesting investments (Arvidsson, 2021). Also, from the scientific point of view, the topic provides a lot of research opportunities (Renneboog, 2008).

Of all the stakeholders focusing on the issue, stock exchanges may have one of the most significant macroeconomic impacts. They are in a unique position to accelerate and facilitate the disclosure of environmental, social and governance information to satisfy the demands of financial markets and other stakeholders (Bizoumi et al., 2019). Given that the market capitalization of listed public companies is roughly equal to the global GDP, even small changes in reporting practices may trigger profound economic implications (Nasdaq ESG Reporting Guide 2.0, 2019). According to researchers, proper stock exchanges' guidelines for ESG disclosures can help address the issues of sustainability data variety and inconsistency (Kotsantonis et al., 2019). Thus, looking into stock exchanges' activities in this field is considered quite reasonable.

Not only the developed economies but also emerging markets are embracing the agenda. Namely, Russia is getting more-and-more engaged in ESG practices, and its

A. V. Buniakova (✉) · E. B. Zavyalova
MGIMO University, Moscow, Russia
e-mail: bunyakova.a@inno.mgimo.ru

E. B. Zavyalova
e-mail: e.zavyalova@inno.mgimo.ru

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stance on ESG reporting may yet seem ambiguous. So, to gain a better understanding of the country's standing in corporate ESG reporting from an institutional standpoint, one may want to compare and contrast it with its peers.

6.2 Methodology

Stock exchanges' guiding documents may shed light on how they encourage companies to disclose ESG-related data. Seeing certain patterns in this field proves extremely important for its further development. The article features a comparative analysis that is considered to provide insights concerning the stance of different countries, including Russia. Stock exchanges chosen for the comparative analysis are the London Stock Exchange and Nasdaq because they are located in two financial centers of similar global importance but on different continents (in different cultural, political, economic, etc., types of the environment).

6.3 Results

According to the United Nations Sustainable Stock Exchanges statistics, the Moscow Exchange became SSE Partner Exchange in 2019, and it has its annual sustainability report (Table 6.1). On the other hand, the Moscow Exchange is behind its London and New York peers on such dimensions as ESG-related training and written guidance. While LSE provides ESG ratings and data to the investment community globally through its FTSE and Practicing Integrated Thinking and Reporting, Nasdaq unveils ESG training platform to help companies navigate the ESG landscape, and the Moscow Exchange offers no ESG training whatsoever. Moreover, according to SSE data, it has no official ESG reporting guidelines in a contrast to LSE with its ESG Guidance Report and Nasdaq with ESG Reporting Guide 2.0: a support resource for companies (London Stock Exchange ESG Guidance Report, 2016).

Table 6.1 Comparative analysis: LSE, Nasdaq and MOEX ESG involvement

	London stock exchange	Nasdaq	Moscow exchange
SSE partner exchange	Yes	Yes	Yes
Has annual sustainability report	Yes	Yes	Yes
ESG reporting required as a listing rule	No	No	No
Has written guidance on ESG reporting	Yes	Yes	*No*
Offers ESG-related training	Yes	Yes	*No*

Source Compiled by the authors based on (SSE ESG Guidance Database, 2021)

From a practical perspective, for lack of extensive stock exchange, guidance listed companies in Russia are likely to (and in fact, do) analyze the Bank of Russia's recommendations on non-financial disclosures for public companies. They are both of similar nature and structure, and for this analysis can be taken as a proxy for a stock exchange guidance.

Essentially, these recommendations represent a set of guidelines on such aspects of disclosing non-financial data like goals, key points, materiality, principles, contents, international reporting standards, dates and procedures, independent external audit (Bank of Russia Recommendations on Non-Financial Disclosures, 2021). The recommendations emphasized environment, social aspects, human rights, anti-corruption activities and supply chains and thus can be easily grouped for comparative analysis with LSE and Nasdaq.

Stock exchanges throughout the world actively pursue the ESG agenda. Sustainable Stock Exchanges (SSE) Initiative, an international initiative, has set the goal for all stock exchanges to guide environmental social governance reporting to listed companies. As is seen in Fig. 6.1, currently, out of 110 SSE partner exchanges, 61 exchanges (55% of exchanges) provide written guidance on sustainability reporting—and 26 exchanges have mandatory ESG listing requirements (SSE ESG Guidance Database, 2021). This represents a significant increase compared with 2015 when only one-third of exchanges had written guidance. Thanks to the SSE Model Guidance, stock exchanges are increasingly embracing ESG reporting recommendations (SSE Model Guidance on Reporting ESG Information to Investors, 2019). Thus, in 2019 and 2020, the figure saw double-digit growth demonstrating a hike in the total number of exchanges with guidance and emphasizing the growing interest of exchanges in ESG reporting.

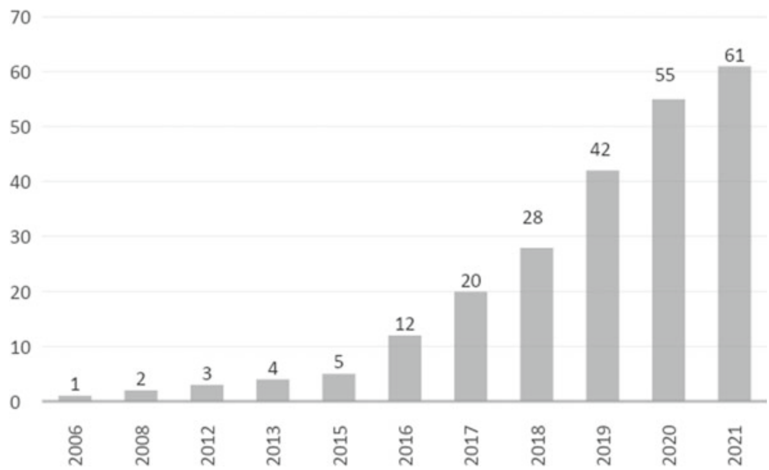

Fig. 6.1 Total number of stock exchanges providing written ESG reporting guidance. *Source* Compiled by the authors based on (SSE ESG Guidance Database, 2021)

The reporting instruments most often referenced in stock exchange guiding documents are GRI (95%), SASB (78%), IIRC (75%), CDP (67%), TCFD (57%). The international standards are kept up-to-date and provide an increasingly detailed and industry-specific approach to better satisfy the demands of stakeholders. These reporting standards gather an ever-growing number of supporters both in developed countries and in emerging markets. For instance, the number of entities supporting TCFD standards has grown more than 15-fold from June 2017 (101 entities) to October 2020 (1512 entities). Most of these entities are located in Europe (39%), the Asia–Pacific Region (36%), North America (20%), and importantly, the majority of them are companies (88.9%) (TCFD, 2020).

Essentially, many stock exchanges and other institutions focus on their sustainability guidelines. Below, the authors consider the key subcategories of ESG factors for the London Stock Exchange, Nasdaq and the Bank of Russia.

First, environmental aspects feature such subcategories as climate agenda (greenhouse gas (GHG) emissions), energy use, waste and water management. Notably, in all of the above subcategories, all three entities have very similar requirements, both in terms of scale and in terms of contents.

As for climate strategy and greenhouse gas emissions, all of them suggest reporting GHG emissions of Scope 1 and Scope 2. Nasdaq and the Bank of Russia mention Scope 3 and emissions intensity, though. Nasdaq also focuses on oversight and management of climate risks and annual investments in climate-related infrastructure, resilience and products, and LSE provides a specific time frame (3 years)—here and in other subcategories—and recommendations on the breakdown by GHG type, preferable compliance with CDP standards, global warming potential, etc.

As for energy, all of them suggest reporting the total amount of energy consumed. But Nasdaq and the Bank of Russia mention energy intensity, and Nasdaq specifies that energy usage by generation type should be reported in percentage. The Bank of Russia also encourages considering a wider range of indicators and/or targets.

As for waste, all of them suggest reporting on the topic, however, the exact requirements are different. LSE recommends showing recycled, non-recycled and hazardous waste, whereas Nasdaq only focuses on waste policies, and the Bank of Russia provides more vague recommendations with a wide range of indicators of waste generation, management and disposal indicators cited as examples.

As for water, all of them suggest reporting on the topic. Both LSE and Nasdaq focus on water consumption and reclaim, LSE adding a breakdown by water withdrawal, water used and water discharged. However, the Bank of Russia provides less specific recommendations about natural resources in general, citing water as one of the examples but providing no specific reference to disclosure.

Apart from the subcategories mentioned above, there are some specific issues of interest to each of the three entities in question. Thus, LSE points out the importance of environmental management (percentage of sites covered by recognized environmental management systems such as ISO14001 or EMAS); disclosures of other emissions (NOx, SOx, volatile organic compound); environmental fines (total costs of environmental fines and penalties during the financial year (or a complete statement that no fines were levied)). Nasdaq rather focuses on environmental operations (adopting environmental policies and recognized energy management systems) and climate risk mitigation.

The Bank of Russia suggests dedicating a separate section to disclosing the impact of climate on the business model and the impact of the business model on climate, the resilience of the business model; major risks and opportunities related to the impact of the company on the environment, society and economy and vice versa; ESG-related risk-management; environmental violations and liability for such violations (briefly).

Second, social aspects feature such subcategories as staff turnover rate, temporary employees, health and safety, where all the three entities have very similar requirements.

In terms of staff turnover, all the entities suggest reporting on the subject. However, the Bank of Russia only mentions the turnover rate in general, without any specific details to the disclosure; LSE provides hints on the calculation method; and Nasdaq focuses on the dynamics of turnover rates and the breakdown by full-time employees, part-time employees and contractors and/or consultants, implying greater responsibility of a company.

In terms of employees' structure, all the entities suggest reporting on the subject with little difference between their requirements. Notably, Nasdaq recommends disclosing total enterprise headcount broken down into part-time employees and contractors/consultants (separately).

In terms of health and safety, all the entities suggest reporting on the subject with certain differences between their requirements. For instance, LSE is interested in the number of sites with occupational health and safety assessment series standards and health and safety training; Nasdaq points out the importance of occupational health and/or global health and safety policy; and the Bank of Russia states disclosures of employees taking part in activities with a high risk of incidents or professional disease, the number of incidents, etc.

There are also some specific issues of interest to each of the three entities, apart from the above-mentioned subcategories. Thus, Nasdaq covers such fields as CEO pay ratio, gender pay ratio, gender diversity, non-discrimination (policy availability), child and forced labor (policy availability and whether it covers vendors and suppliers), human rights (policy availability and whether it covers vendors and suppliers). LSE emphasizes the total amount of corporate or group donations and community investments made to registered not-for-profit organizations, as well as on employee training in different fields (hours of training).

As for the Bank of Russia, just like LSE, its guidelines contain a general statement about community investment disclosures (without specific details), employee training (average number of hours per employee with a breakdown by gender, region, citizenship, etc.), diversity and inclusivity (employees with disabilities, gender, ethnic, etc., diversity, pay gap).

Third, governance aspects feature such subcategories as independent members of the Board of Directors and ethics and anti-corruption activities of the company.

As for board independence, all three entities agree on its importance. LSE requires both the number and percentage of independent directors on the board; Nasdaq—the relevant percentage and statement of whether the company prohibit CEO from serving as board chair; and the Bank of Russia makes a reference to its Code of Corporate Governance, one of its provisions being on the independence of the board members—preferably not less than 1/3 of the BoD members (Bank of Russia On the Code of Corporate Governance, 2014).

As for ethics and anti-corruption, similarly, all the three entities recommend disclosing such data, but they differ in terms of specific requirements. For example, LSE mainly focuses on the fines for anti-corruption activities; Nasdaq focuses on policy availability and the share of the workforce that has formally certified its compliance with the policy. Finally, the Bank of Russia provides a whole set of indicators ranging from policies and criteria for corruption-related risk assessment to training, anti-corruption activities financing and lawsuits.

Both LSE and Nasdaq place great importance on board gender diversity, highlighting the number/share of women on board in separate subcategories. The Bank of Russia's Code of Corporate Governance does not mention women in the subsection dedicated to the "balanced composition" of the Board of Directors. And its guidelines do not provide extensive comments on the matter, nevertheless, one of the multiple appendices (the one based on the GRI standard) contains gender indications.

On top of that, Nasdaq focuses on such issues as incentivized pay (whether executives are formally incentivized to perform on sustainability), collective bargaining (total company headcount covered by collective bargaining agreements), supplier code of conduct (whether vendors and suppliers are required to follow a code of conduct), data privacy (data privacy policy, compliance with GDPR), ESG reporting (whether a company publishes a sustainability report), disclosure practices (data provided to sustainability reporting frameworks, SDG focus, SDG targets), external assurance (validation by third parties).

For LSE matter political contributions, both direct and indirect are in line with GRI standards, as well as provisions for fines and settlements specified for ESG issues in audited accounts.

Interestingly, in many regards, the Bank of Russia follows the same pattern as Nasdaq. For instance, it also recommends disclosing data on collective bargaining, incentivized pay, data protection (measures taken, risks, incidents related to data protection), supply chain (total number of suppliers, their types, geographical breakdown, suppliers monitoring, their GHG emissions, etc.).

6.4 Conclusion

Overall, the comparative analysis carried out in the article suggests a few curious conclusions. First and foremost, all the three entities examined—the London Stock Exchange, Nasdaq and the Moscow Stock Exchange—consider the following subcategories important enough to disclose:

- Environmental (E)—climate agenda (GHG emissions), energy use, waste and water management;
- Social (S)—turnover rate, temporary employees, health and safety;
- Governance (G)—independent members of the Board of Directors and ethics and anti-corruption activities of the company.

In addition, all of the above-mentioned entities provide references to international sustainability standards. However, each entity has its specific focus and additional fields of interest.

For example, Nasdaq seems to emphasize:

- Availability of various policies (waste, health and safety, anti-corruption, data privacy, non-discrimination, human rights, etc.);
- The importance of covering the whole supply chain with ESG data (breakdowns featuring information on consultants, contractors, vendors, suppliers, etc.);
- Reporting frameworks (interaction with international sustainability reporting frameworks, SDG focuses and targets, availability of sustainability reports and their third party assurance, etc.).
- The London Stock Exchange indicates three years for comparison and places importance on:
- Employees' training (training to enhance knowledge or individual skills, health and safety training, etc.);
- Community investments and political contributions;
- Non-GHG emissions (NOx, SOx, volatile organic compound).

As for the Bank of Russia, its guidelines are not fully in line with those of LSE and Nasdaq, in essence, some aspects are vaguer, being indications rather than specific criteria to follow. However, in many respects, its recommendations are in line with its peers' and even provide a broader range of indicators to consider. For instance, in terms of environment and climate, it mentions Scope 3 GHG emissions, emissions and energy intensity, etc., but needs to be more specific in its water and waste guidance.

In terms of social policy, it does not dig as deep as Nasdaq to recommend disclosures of data on contractors and suppliers, but elsewhere is in line with LSE and Nasdaq. In terms of corporate governance, it has a separate code featuring detailed guidance on the relevant aspects that is very similar to the requirements of its peers. The only aspect insufficiently covered in the document is gender diversity of the board of directors.

On top of that, the Bank of Russia suggests reporting the information on the impact of a company's model and climate on each other, key risks and opportunities concerning the impact of the company on the environment, society and economy, ESG-related risk-management, etc.

Overall, judging by the entities and indicators chosen for comparative analysis—and disregarding other factors such as national legal frameworks, customers and employees' engagement in ESG issues, investors and companies' eagerness to obtain and provide full information—one may conclude that in general, Bank of Russia's guidelines for listed companies are in line with those of the London Stock Exchange and Nasdaq. Thus, in this respect, Russia may be moving in the same direction as Western countries, yet at a different pace.

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Chapter 7
Environmental Accounting and Reporting as a Tool of Ensuring the Sustainable Development of the Economy

Larisa V. Shmarova and Irina O. Ignatova

7.1 Introduction

Today, the international community is concerned with addressing environmental issues the negative effects of which are becoming increasingly tangible year after year (Postnikova, 2019). The company's operation is aimed at complying with consumers' demands. Their activity is directly connected with the use of different natural resources the amount of which is limited. The functioning of numerous enterprises is related to emissions of harmful substances into the environment, which results in irreparable harm to nature (Bednarova et al., 2020).

To preserve the ecological balance, currently, it is essential to reduce the negative impact of organisations on nature and maintain the natural-resource potential of territories. In this regard, companies need to assess their impact on the environment and perform environmental protection activities. It is a matter of urgency to organise environmental accounting within the enterprise and to generate environmental reporting (Eremeeva, 2019).

An integral component of responsible business is providing stakeholders with information on the company's activity in the field of nature conservation. The compilation and publication of environmental reporting significantly contribute to increasing the investment attractiveness of the organisation and the confidence of stakeholders as well as enhancing the enterprise's image (Khomutova & Arzamasova, 2020).

The company's adverse effects on the environment have resulted in irreversible consequences in the biosphere. To date, a global goal is to create and develop a

L. V. Shmarova (✉) · I. O. Ignatova
MGIMO University, Moscow, Russia
e-mail: l.shmarova@inno.mgimo.ru

I. O. Ignatova
e-mail: Ignatova_I_O@my.mgimo.ru

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new environmental economy aimed at restoring and preserving the natural balance (Athambawa & Hilal, 2021).

7.2 Methods

The aim of the study is to analyse the prerequisites of placing environmental accounting in a separate subsystem of accounting as well as to examine the trends of its development. To achieve the set goal, the following tasks have been defined:

- To identify the factors contributing to the emergence of environmental accounting as a separate sphere of accounting;
- To determine the aim, tasks, objects of environmental accounting and the users of environmental reporting;
- To consider the ways to present accounting data in the environmental accounting system as well as its methods;
- To analyse international standards which regulate environmental accounting and environmental reporting generation;
- To define the positive and negative aspects of environmental reporting compilation.

In the process of research, two types of general scientific methods have been used: empirical (the studying of educational literature and regulatory legal acts, the systematisation of materials, description and comparison) and theoretical (the analysis of schemes, comparable data presented in the form of tables, the generalisation and formalisation of the obtained results, synthesis, detailing, abstraction, induction, deduction, systems approach and chronological analysis).

7.3 Results

A number of prerequisites contributed to the emergence of environmental accounting as a separate subsystem of accounting. The necessity of the formation of environmental accounting and reporting system became particularly acute in the early 1970s. This is connected with the fact that excessive consumption of natural resources and environmental pollution considerably reduced development opportunities for future generations. The pursuit of profit maximisation, in the short term, resulted in natural resource depletion and a reduction in economic development rates. Natural resource depletion caused commodity and energy crises.

The problem of the inability of the market mechanism to counteract the negative impact of enterprises on the environment became clear. This situation is because the key functions of the market economy are efficiency enhancement and regulatory process automation. The market cannot ensure the environmental safety of society on its own (Klymenko, 2019).

Companies strive to widen the scope of their activities to maximise profits. As a result, the issue of the irrational use of natural resources is getting worse. A scarcity of natural resources and environmental pollution has become a global environmental problem. Currently, one of the important tasks of the economy is control over natural resource consumption at all stages of the production process.

Today, environmental accounting constitutes an innovative and rapidly developing area of accounting. It is closely related to such a sphere as environmental management (Novozhilova, 2020). Environmental accounting significantly contributes to realising the concept of sustainable development since it serves as a tool of providing rational nature management and environmental conservation. This type of accounting allows assessing the environmental efficiency of the organisation's operation.

Environmental accounting is the system of collecting and grouping different data characterising the environmental aspects of the enterprise's activity (Ivanova, 2021). The environmental component of the company's operation implies the element of the organisation's financial and economic activity which is connected with maintaining the level of a harmful impact on nature within the norms set for the organisation as well as performing environmental protection activities aimed at improving the environmental situation. In accounting, it is essential to comply with such principles typical for corporate reporting as comparability, reliability, consistency, materiality, neutrality and data completeness (Sekerez, 2017).

The goal of environmental accounting is to harmonise economic and environmental components of the business, to identify potential environmental risks and to determine possible ways of mitigating them. Consequently, its main tasks are to accumulate data on the company's environmental costs and obligations, to plan the enterprise's activity in the field of ecology and to exercise control over it. The objects of environmental accounting are all economic operations of the organisation related to nature protection activities. Information of the environmental accounting system is a basis for the generation of environmental reporting which is intended for both internal and external users. They are company owners, enterprise staff, investors, tax authorities, creditors, government bodies and so on. The specific feature of environmental accounting implies that indicators characterising the environmental aspects of the company's operation could be presented not only in monetary but also in physical terms. The organisation selects the methods with the help of which it will maintain environmental accounting records, i.e. there are no established restrictions (Ekundayo & Odhigu, 2021).

Environmental reporting is classified as non-financial reports of the company. It constitutes the system of indicators and data on the enterprise's performance in the field of social responsibility and sustainable development. An incentive to compile integrated reporting might be, on the one hand, the desire to minimise risks and to reduce costs, and on the other hand, the aspiration to create the conditions for the company's development. Environmental reporting generation may facilitate the process of the organisation's penetration into new markets as well as contribute to enhancing relations with stakeholders (Makushina, 2021).

In some countries, the elements of environmental reporting are enshrined at the statutory level. Denmark, Netherlands, Norway, France, etc. are among such states (Johnson & Adegbie, 2021).

At the international level, several standards are regulating environmental accounting and environmental reporting generation. In particular, they include the GRI Standards, the International Integrated Reporting Framework, the rules of the Task Force on Climate-related Financial Disclosures at the Financial Stability Board, the standards of the Carbon Disclosure Project, the rules of the United Nations Global Compact and the standards of the European Union Directive 2014/95/EU. These guidelines are non-binding: they are implemented into the company's accounting practice voluntarily. The most widespread standards around the globe are the GRI Standards and the Integrated Reporting Framework (Zhao et al., 2021).

The Global Reporting Initiative sets the rules that regulate the formulation of the company's sustainable report disclosing information on the economic, social and environmental aspects of the enterprise's activity. An initial version of the GRI Standards was passed in 2000. In 2013, the fourth version of these standards (G4) came into effect (Sorokina, 2020).

As to the environmental component of the organisation's operation, a sustainability report reveals the following aspects: materials, energy, water, biodiversity, emissions, waste, goods and services, compliance with requirements, transport, general information, supplier evaluation from an environmental perspective, and mechanisms for filing complaints about environmental issues (*G4 Sustainability Reporting Guidelines*, n.d.).

According to GRI, 93% out of 250 largest multinational corporations prepare a sustainability report. 65% of organisations (approximately 9000 companies), that generate this report, apply the GRI Standards. As of October 2021, in the world, 35,000 sustainability reports have been compiled following the GRI Standards.

The GRI Standards establish the following principles for defining report content:

- Reliability—a sustainability report has to reflect only material and reliable information;
- Balance—a sustainability report must contain data on the positive and negative aspects of the enterprise's activity;
- Timeliness—sustainability reporting has to be generated regularly so that stakeholders could make informed decisions based on it;
- Comparability—a sustainability report must present information based on which stakeholders can conduct a retrospective analysis of the company's performance as well as compare it with other organisations;
- Clarity—data in sustainability reporting has to be published in terms that are comprehensible and accessible for stakeholders;
- Accuracy—a sustainability report must reveal accurate and detailed information allowing stakeholders to assess the company's performance (The Global Reporting Initiative Standards, n.d.).

As to the International Integrated Reporting Framework, its initial version was published in 2013. To date, the second version of this standard, which was passed in 2020, is in effect.

Integrated reporting is a single document, which presents transparent and reliable data on the strategic plans of the enterprise's development and the system of its corporate management as well as economic performance indicators, information on the social and environmental responsibility of the organisation.

The key feature of the International Integrated Reporting Framework is the identification of six types of capital that take part in the process of creating the company's value (financial, manufactured, intellectual, human, social and relationship as well as natural capitals). Environmental accounting enables the generation of information on natural capital.

Natural capital is the totality of renewable and non-renewable resources as well as natural processes that allow the company to create various goods and services and thus provide prosperity. It includes land, air, water, forests and minerals as well as biodiversity and ecosystem health (International Integrated Reporting Framework. January 2021, n.d.).

Integrated reporting has to reflect information on the enterprise's land resources, data on ultimate, probable and possible mineral reserves (metal, fuel, and non-ore). Apart from that, an integrated report must present information on the cost of natural capital and the number of years for which the organisation will have enough natural resources. As analytical indicators, integrated reporting might contain the occurrence depth of natural resources, mineral output, location, composition and properties.

The significance of natural capital in the contemporary economy is enormous since a great number of manufacturing companies cannot conduct business without the use of mineral resources. It is natural capital that considerably contributes to creating the value of numerous Russian enterprises.

The list of possible indicators characterising the organisation's natural capital is presented in the below table (Table 7.1).

Absolute leaders in the field of environmental reporting compilation are companies located in North America and Western Europe (Baldarelli et al., 2017). In Russia, the system of environmental accounting and reporting is in its infancy.

According to the National Register of Corporate Non-Financial Reports, in Russia, 62 non-financial reports were published in 2020: 30 sustainability reports, 31 integrated reports and 1 environmental report (Fig. 7.1).

Like any initiative of the organisation, the decision to generate environmental reporting has its pros and cons. However, the positive aspects of environmental report compilation significantly outnumber its drawbacks (Fig. 7.2).

Table 7.1 Non-financial indicators of integrated reporting characterising natural capital

Indicator	Source
The volume of resource consumption	Data of the accounting information system (AIS) reflected in accounting registers
Water consumption and water disposal. The volume of water withdrawal and water consumption	Data of the AIS reflected in accounting registers
The level of environmental impact (waste production, sewage disposal, greenhouse gas emission, soil pollution, etc.)	Data of the AIS reflected in accounting registers
The volume and structure of environmental expenditures	Data of the AIS reflected in accounting registers
The volume and structure of payments for a negative impact on the environment	Data of the AIS reflected in accounting registers
Fines and penalties for environmental impact in damages	Data of the AIS reflected in accounting registers
Ecological properties of goods	Environmental certification
Measures taken to protect the environment	Regulations on labour protection and natural resources

Source Compiled by the authors based on (Klymenko, 2019)

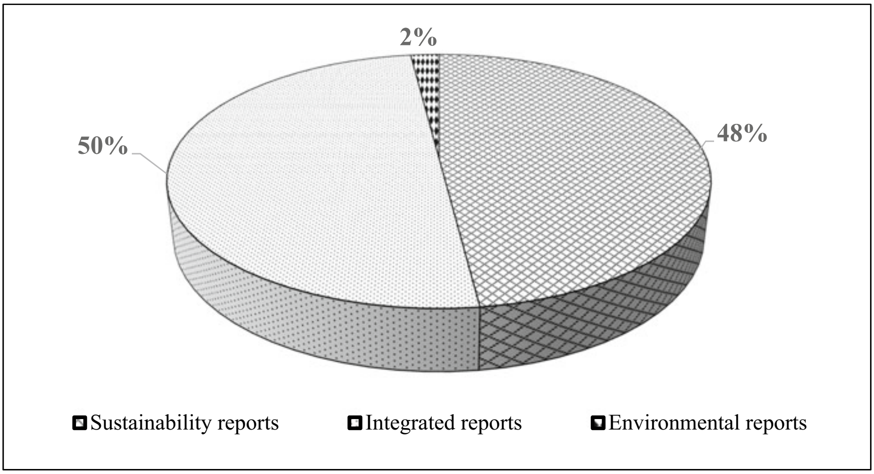

Fig. 7.1 Non-financial reports published in Russia in 2020 *Source* Compiled by the authors based on (Merova, 2020)

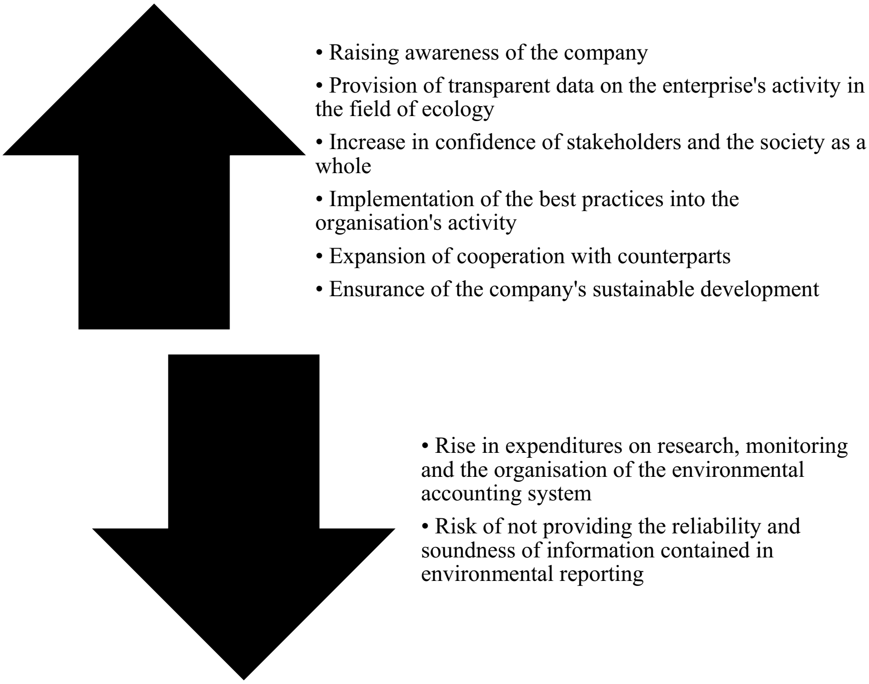

Fig. 7.2 Positive and negative aspects of environmental reporting generation *Source* Developed by the authors

7.4 Conclusion

Thus, environmental accounting and reporting are crucial tools for providing the sustainable development of the economy that implies rational nature management and preserving the natural-resource potential of territories (Shilova et al., 2021).

The significance of the system of environmental accounting and reporting lies in the fact that efficient environmental management is possible only if a continuous analysis is carried out. The assessment of the company's operation in the field of environmental conservation allows evaluating the harmony of the enterprise's development in terms of its economic indicators and a harmful impact on nature. The result of the conducted analysis is a basis for devising the environmental strategy of the organisation and adjusting its environmental policy (Merova, 2020).

Taking into account the fact that in the modern world a growing number of countries pay substantial attention to dealing with environmental problems, providing stable economic development, the authors conclude that the role of environmental accounting and reporting will be increasing year after year, the scope of their dissemination will be expanding (Kelsall, 2020).

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Chapter 8
Prospects of International Cooperation in the Arctic Under the Russian Chairmanship of the Arctic Council in 2021–2023: Sustainable Shipping, "Green" Technology and Innovation

Valery I. Salygin, Igbal A. Guliyev, and Valeriya I. Ruzakova

8.1 Introduction

The Arctic region plays an important strategic role in the development of both the Russian economy and the economy of other Arctic states. The Arctic contains huge reserves of hydrocarbons and critical minerals, and the region has a unique potential for the development of transport infrastructure and technologies, but at the same time, it is extremely vulnerable to the negative effects of climate change.

In 2021, the Chairmanship of the Arctic Council—the leading intergovernmental forum in the Arctic—passed to the Russian Federation which proclaimed the sustainable development agenda as the key theme of the organization's work for the next two years. It is underlined that to ensure sustainable economic development in the Arctic, where environmental safety issues are indivisible, close cooperation of all Arctic countries is necessary. Russia's Chairmanship of the Arctic Council allows drawing the attention of the Arctic states to issues of high importance both for the entire region and for the Russian Arctic. The purpose of this article is to consider priority areas for the Russian Federation as the chairing country in the Arctic Council, such as sustainable shipping and innovation.

V. I. Salygin · I. A. Guliyev · V. I. Ruzakova (✉)
MGIMO University, Moscow, Russia
e-mail: ruzakova.v@inno.mgimo.ru

V. I. Salygin
e-mail: miep@mgimo.ru

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8.2 Methodology

Within the study, the authors used both general and specific methods of analysis, including comparative legal analysis.

Problems of international cooperation in the Arctic are studied in the works of Ivanov (2013), Brigham (2004), Panichkin (2014), Petrovsky and Filippova (2018), Thoman et al. (2020), Zagorskiy (2017). Information about technologies was taken from the official sites of Equinor, Deltares, Offshore Engineer, the JRC Research Institute at the European Commission, «Arctic Response Technology» (Equinor official website, 2021; Official website of Deltares; Offshore Engineer; JRC Technical Report, 2019; Official website of Arctic Response Technology, 2018). To determine the policies of Russia in the Arctic, Russia's Chairmanship Priorities for the Arctic Council (2021–2023), Russia's Chairmanship Program for the Arctic Council (2021–2023) and Arctic climate change update were analysed (Website of the Government of the Russian Federation; Arctic Council; Arctic Council, Arctic Climate Change Update, 2019).

In 2021–2023, Russia is the country chairing the Arctic Council. The programme and tasks of the Chairmanship were based on the principle of "responsible management for the sustainable development of the Arctic Circle". Russia intends to maintain the continuity of the policy pursued by the previous Chair of the Arctic Council and to help strengthen cooperation between the Arctic countries. According to the Minister for the Development of the Far East and the Arctic: "Russia is interested in preserving the Arctic as a territory of peace, stable, and mutually beneficial cooperation. Any interaction in the North should be based on the strategic interests of all mankind", which directly reflects the principle of sustainable development.

The comprehensive programme of Russia's Chairmanship in the Arctic Council assumes the promotion of international cooperation in the Arctic region in four different areas—with particular attention to the development of economic cooperation in the Arctic region. This block of questions covers topics such as sustainable shipping and digitalization. Sustainable shipping and innovative activity are emerging as key aspects of the Russian-chaired Arctic Council's activities in the context of sustainable development. Let us consider these directions in more detail.

8.2.1 Sustainable Shipping in the Arctic Ocean, "Green" Technology and Innovation

An objective trend that determines the conditions for the development of shipping in the Arctic is climate change. The dynamics of changes in the ice cover in the Arctic zone is presented in the report "On the state and protection of the environment of the Russian Federation in 2019" and in the report of the Arctic Council on climate change for 2019. The area of winter ice cover in 1985 was 15.9 million sq kilometres, and in 2015—14.4 million sq kilometres, thus the trend has worsened. Moreover, recent data indicates a record low ice area in 2020 (Thoman et al., 2020).

Climate change in the Arctic is ascertained based on annual observations of the region: for example, satellite monitoring of the thickness of sea ice shows an annual drop in winter highs and summer lows (Thoman et al., 2020). These statistics allow speculation about wider opportunities for the development of maritime navigation that are gradually opening up in the region. Reduction of the ice cover area provides more opportunities for ships of different ice classes for transportation; and the duration of the navigation period along the Northern Sea Route (NSR) is increasing—today it is the key sea transport corridor in the region.

At the same time, the largest risk to the environmental safety of the Arctic region amid the development of cargo shipping are oil spills, including during tanker transportation of hydrocarbons. Only in 2000—2008 in the region, 28 cases of oil spills with a volume of up to 1 thousand litres were registered as a result of accidents on ships (Zagorskiy, 2017). As a result of the accident that the oil tanker Exxon-Valdez caused off the coast of Alaska in 1989, oil was released into the sea about 260 thousand barrels of oil which led to the formation of an oil slick with an area of 28 thousand km^2 (Panichkin, 2014). The spill resulted in a significant decrease in the pink salmon population, and it took about 30 years to restore the habitats of some other affected species. It is important to note that the negative consequences of oil pollution are most pronounced in polar ecosystems since low temperatures slow down the oxidation of hydrocarbons even in the summer months (Ivanov, 2013). In these conditions, the states carry out joint regulation of oil and gas production in the Arctic and their transportation (including by sea transport), joint monitoring and assessment, as well as joint measures to prevent and eliminate negative consequences of possible emergencies.

It should be noted that not only Russia but also some other countries are interested in using the transport routes of the Arctic Ocean for foreign trade—in particular, interest in the potential of the NSR increased after the accident with the tanker "Ever Given" and the rising awareness of the need to create an alternative to the traditional corridor of the international trade through the Suez Canal. China, the largest foreign investor in LNG projects, shows particular interest in this (Petrovsky & Filippova, 2018).

In the field of regulation of Arctic shipping, including tanker transportation of hydrocarbons in the Arctic, the development of additional rules for navigation in polar waters to the SOLAS and MARPOL Conventions (i.e. the "International Code for Ships Operating in Polar Waters"—the Polar Code) began under the International Maritime Organization (IMO) back in 1993 at the initiative of the five coastal Arctic states and Germany (Brigham, 2004). The Working Groups of the Arctic Council also interacted with IMO in the development of the Polar Code. Already in 2002 and 2009, IMO adopted two guidelines of a recommendatory nature: first for the Arctic shipping only, and later for the regulation of shipping in the Arctic and Antarctic regions.

And the corresponding amendments to the above named conventions were adopted in 2014 and 2015 accordingly—the Polar Code entered into force on 1 January

2017. This document consists of two parts—binding and recommendatory. The first, binding part, deals with the functional requirements for ships for their purpose, as well as the area and season of the planned polar shipping. At the same time, the Russian side is in favour of further specifying the requirements in the general part of the Code (in particular, some Russian experts note that when drawing up the Polar Code, Russia's experience in dividing ships into classes according to purpose and ice qualities, regulating the need for ice support, supply ice safety recommendations, etc. was not fully taken into account). As part of the Russian Chairmanship of the Arctic Council, there is an opportunity to develop a regulatory and organizational framework to further ensure sustainable shipping in the Arctic in the named spheres. Within the framework of the Working Group on Sustainable Development of the Arctic Council, a project on sustainable shipping is already being implemented, and the prospects for cooperation in this area are extremely broad. On the one hand, they cover issues of international cooperation on investment and infrastructure issues related to the flow of financial investments in the infrastructure of the Arctic region (ports of the NSR and oil and gas projects in the water area of the NSR). On the other hand, educational issues are being raised: ensuring year-round, sustainable shipping in the Arctic region requires professional training.

With regard to the environmental aspect, the factor of the development of marine technologies is important. The precautionary approach to the development of marine resources is connected to the "best available technology" principle (Vylegzhanin, 2021). In particular, the transition of tankers to LNG can reduce the negative impact on the vulnerable ecosystems of the region. Many foreign companies are currently researching the possibilities of equipping their ships with hybrid engines to reduce CO_2 emissions.

It is obvious that the issue of the development of marine technologies in the context of sustainable development creates higher demand for specific research and development in the industry. For example, Equinor is developing specialized "green" batteries that store energy, while the main engine is running and improving the ship's energy efficiency and manoeuvrability (Equinor, 2021). The development of green marine technologies for shipping can be stimulated within the framework of the work of the Arctic Council structures and implemented in the activities of interested Russian companies possibly in cooperation with foreign colleagues in such legal forms as a joint venture (JV) or a joint industrial project (JIP).

JIP is a type of joint venture focused on research and development. The specificity of JIP is that in practice it is often used to solve research problems in the development of environmentally friendly technologies, and its ultimate goal is not necessarily the profit as such, but often the creation of ecologically sound technology, standard or method. In this context, another perspective region is the Arctic, where harsh climates and fragile ecosystems combined with the ongoing climate changes consequences pose additional challenges (Arctic Response Technology, 2018). A successful example of JIP in the field of development and transfer of marine technology was a joint programme of BP, Shell, Chevron, ConocoPhilips, ExxonMobil, Eni, Total, and Equinor companies "Arctic Response Technology", which was launched in 2012 and focused on developing technologies for oil spill control in the Arctic conditions within six thematic projects. JIP has the relevant specificity of the provisions governing the allocation of rights to project deliverables, including a strong emphasis on intellectual property rights protection. JIP regulates also the distribution of risks in a special way—taking into account the peculiarities of innovative research (Dahab et al., 1998). It is also important to note, that governmental participation in JIP is a common practice: for example, one of the members of the "NORSOK Z standards for Technical Information (Z-TI)" JIP aimed at actualization of the digitalization standards within the oil and gas industry is the Petroleum Safety Authority of Norway. States may provide financial support to JIPs: for example, the JIP "Hydraulic Pile Extraction Scale Tests" aimed at sustainable decommissioning of offshore wind turbine foundations and led by Innogy and Deltares in partnership with four other companies receives financial support from the Dutch Ministry of Economic Affairs and Climate (DNV-GL, 2018). In addition, due to the research focus of projects, not only companies and government agencies but also academia (universities, research centres) often become parties to JIP agreements.

8.3 Results

Sustainable development issues are being actively worked upon in the Arctic. In 2021, under the Chairmanship, the Arctic Council Strategic Plan which presents a strategic vision for the sustainable development of the Arctic and the Arctic Council for the next ten years was developed. At the same time, a fairly large number of problems remain unresolved. In this regard, the Chairmanship opens up the opportunity for the state to contribute both to the implementation of the strategic goals of the forum and to draw the attention of the states of the Arctic region to those issues which are of great importance for the Arctic zone of the Russian Federation.

Based on the analysis conducted, it is also possible to make the following recommendations on the considered priority areas of the Russian Chairmanship of the Arctic Council:

1. Development of sustainable shipping in the Arctic by enhancing the activities of the Working Groups of the Arctic Council, in particular by studying the prospects for the development of the Northern Sea Route in the context of the global energy transition and climate change, as well as stimulating the development of "green" marine technologies;
2. Promotion of international cooperation in the development of environmentally sound technologies, including their further refinement and operational testing in the Arctic region, with a focus on up-to-date marine technologies.

8.4 Conclusion

In summary, it can be said that in the Arctic, under Russia's Chairmanship of the Arctic Council, important issues related to achieving sustainable development goals are on the agenda, with sustainable shipping being one of the priorities. Russia's Chairmanship of the Arctic Council can become an engine that will stimulate international cooperation in the development of environmental research and "green" innovation. Encouraging the exchange of experience between the Arctic countries is a strategic task for Russia, and under the Chairmanship, it will undoubtedly contribute to the development of international cooperation in this area.

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Chapter 9
Developing Responsible Investing

Vladimir V. Shapovalov

9.1 Introduction

Nowadays, the so-called responsible investment is developing actively. Responsible refers to investments in companies and projects that take into account environmental, social and governance (ESG) factors.

ESG agenda evolved from a slowly moving trend to today's new normal. It was driven by increasing popularity of the climate agenda, spread of environmentally friendly technologies and growing pressure from various stakeholders.

Investors and regulators now pay special attention to these non-financial factors not only because of their concerns for the planet, emission reduction and future society. Non-compliance with ESG principles can lead to additional risks for companies and affect their growth in the long run. The market value of companies is now directly affected by their compliance with the ESG agenda.

9.2 Materials and Method

The article uses methods for comparing various investment indices. It is worth highlighting: the MSCI KLD 400 Social Index, the World Sustainability Index and the ESG Index.

Russian regulation aimed at stimulating responsible investment has also been considered. The features of promoting responsible investments were studied in the works of Kruchkova (2015); Podkolzina and Masayev (2021); Vostrikova and Meshkova (2020); Savina (2015); Friede et al. (2015) etc.

V. V. Shapovalov (✉)
MGIMO University, Moscow, Russia
e-mail: v.shapovalov@inno.mgimo.ru

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9.3 Results

The leading companies disclose ESG related information in their annual financial statements or publish special reports on sustainable development. Some European companies have already committed to achieving a zero balance of carbon emissions by 2050. 160 companies who established the Glasgow Financial Alliance joined their forces to finance carbon neutrality by 2050. In addition, an alliance of 43 banks have committed to invest in companies with zero emissions.

Responsible financing is not a new phenomenon. The environmental, social and governance responsibility of business has been discussed for almost half a century. However, over the last few years, the interest in this topic increased significantly. Regulations associated with it are coming into force.

In 1971, Pax World Funds launched the first investment fund based on the principles of responsible financing. The fund over the past year showed more than 15% in return for investors (Pax Sustainable Allocation Inv PAXINV, 2021).

13 years, the US SIF Association (The Forum for Sustainable and Responsible Investment) was established. It unites funds, management companies and investors with total assets of more than 5 billion dollars intending to conduct educational and research activities. Five years later, the non-profit organization Ceres appeared with the goal to influence the principles of responsible corporate management of the largest participants of the capital market.

The MSCI KLD 400 Social Index is being calculated for 400 American companies-leaders in ESG ratings (MSCI KLD 400 Social Index (USD), 2021). It includes stock of Microsoft, Tesla, Alphabet, NVIDIA, Home Depot, Procter and Gamble, Visa, Mastercard and Disney. In five years, the International Corporate Governance Network (ICGN) organization was established in Brussels to assist leading institutional investors in developing responsible corporate management.

Dow Jones launched Sustainability World Index in 1999 (Dow Jones Sustainability World Index, 2021). Today, it includes 323 companies from 30 countries. The leading companies are Microsoft and Alphabet, while the IT and healthcare sectors account for more than 50%. Two years later, the FTSE4 Good Index Series was launched as another benchmark for ESG investments (FTSE4 Good Service Index, 2021).

In 2006, the principles of responsible investments (PRI) were developed at the initiative of the UN. A year later, the European Investment Bank issued its first “green” bond-Climate Awareness Bond (promoting clarity to facilitate sustainable investments). The same year MSCI launched its World ESG Leaders Index (MSCI World ESG Leaders Index (USD), 2021). In 2019, S&P 500 ESG Index was launched (S&P 500 ESG Index, 2021).

According to Delloite, the volume of investments in ESG funds exceeded 50 billion dollars by the end of 2020, and by 2025, this indicator is projected to triple. The same year the global ESG loans and bond market exceeded 700 billion dollars (The Sustainable Debt Market Is All Grown Up, 2021).

As for ESG ratings MSCI, FRSE Russell and FTSE4Good, besides index calculations, prepare corresponding corporate ratings. S&P, Moody's, Sustainalytics, CDP and ISS also work in this area. Some of them base their assessments on company and media reports, the others require to provide additional information.

There are about 40 Russian companies in the global ESG ratings. S&P prepares ratings for 7000 companies from 61 industries, but it includes only one Russian company "Polymetal". The MSCI rating consists of 2800 companies with 10 from Russia. Sustainalytics analyzes about 14,000 companies, 24 of which are Russian. In Russia, the ESG ratings are being prepared by RAEX and include 121 local companies.

Nevertheless, questions remain at what extent investments in ESG funds affect the climate change agenda. In order to get the answers, commonly accepted ESG metrics are required. Regulators and professional associations continue to develop ESG standards that businesses should comply with. It will reduce the risk of misuse of the ESG agenda to attract new investors. Companies have to bear additional costs to meet the ESG criteria which contradicts the purpose of their profit maximization. Consequently, investors will have fewer funds for dividend payments. However, compliance with the ESG criteria may attract new money which will lead to the growth of the company's market value.

At the end of last year, the International Sustainability Standards Board (ISSB) was established (International sustainability standards: The official start is given). It will develop standards which will be used as the basis for national sustainability reporting requirements.

Initiatives of stimulating the shift to a green economy and the creation of appropriate regulations are being actively implemented in Russia. At the end of the previous year, the Federal Law "on limiting greenhouse gas emissions" came into force. The government together with the Bank of Russia develop incentives to encourage ESG investments. In July 2020, the Bank of Russia published recommendations on responsible investment for institutional investors. The Ministry of Economic Development prepared a draft ordinance containing documents required for launching sustainable development projects, as well as instruments for their financing.

This package includes guidance for grading projects as "green". It should use the best technologies, be environmentally friendly and have no side effects.

In the Bank of Russia recommendations the section Principle 2 is particularly interesting. It recommends addressing the factors of sustainable development and their significant risks. The analysis implies the use of qualitative and quantitative data. The factors of sustainable development are analyzed throughout the group of companies. It is recommended to analyze this factors regarding at least one investment that makes up the majority of the portfolio.

Among ecological factors, data on greenhouse gas emissions, energy and water consumption and waste management are taken into account. The environmental protection policy is also considered. The quality of environmental, climate risk management and environmental projects are being assessed.

As to social factors, it is recommended to take into account working conditions, payroll, average wages, staff turnover, labor protection, accidents at work, employee training costs, etc. The human capital formation involves a career management system, competence assessment, remuneration system. The quality of management and ongoing projects is also being assessed.

Among the factors of corporate governance, the structure of capital, controlling shareholders, company fit into the country's economy, history of shareholders' meetings, rights of investors, corporate actions, conflict of interest and the implementation of the Corporate Governance Code of Conduct are taken into consideration. It is advised for the Board of Directors to implement risk management and internal control, audit, conflict of interest management procedures, remuneration policies, disclosure of information about the social and environmental responsibility. The effectiveness of the management system is determined following International Financial Reporting Standards.

The importance of investments in the portfolio is determined by the investor itself. The information is being disclosed following the Recommendations of the Task Force on Climate-related Financial Disclosures and Carbon Disclosure Project. The investor is encouraged to publish the rules for the analysis of sustainable development projects on the official Website and include them in the investment policy.

Sustainable development factors may influence the decision while choosing an investment project with comparable financial indicators. Investors should study internal documents and compliance with standards, codes or international principles of such development. Financial statements and reports on it can be sources of information. It is recommended to interact with the company regarding disclosure of information about sustainable development.

Last year, the Bank of Russia discussed recommendations for the Board of Directors in the field of sustainable development. Responsibility to employees, counterparties, local society becomes more important. The Board of Directors should assess how familiar their members are with ESG principles, and whether additional training is required, determine the goals of sustainable development and integrate plans into the strategy, risk management or internal control systems. It is recommended to establish a committee for sustainable development. The Board of Directors should monitor the process of information disclosure. Information on social and environmental responsibility should include a policy in the social and environmental spheres, a report on sustainable development, the results of technical audit, quality control system audit and their compliance with international standards. Among other internal documents, it is recommended to prepare a code of corporate ethics, corporate governance, information security policy, health policy, anti-corruption policy, climate strategy, remuneration policy. The Bank of Russia recommends including KPIs on sustainable development in the top management remuneration system. It is also recommended to consider the company's compliance with the criteria of ESG ratings and indices.

According to the CFA Institute survey, among more than 7000 participants (CFA Institute, 2020), only 19% of institutional and 10% of private investors choose financial instruments whose issuers take ESG factors into account in their activities. At the same time, 2/3 of investors from both categories is interested in responsible investing and agrees to give up profitability if other values are being achieved.

According to the estimates of the Bank of Russia, the global green bond market accounts for 1.4 trillion dollars. In Russia, it is estimated at the level of 2 billion dollars. According to the Ministry of Economic Development, the green bond market in Russia may triple by 2024.

The sustainable development sector has been functioning at the Moscow Stock Exchange for more than two years to attract investments in ecological, environmental protection and socially important projects. In 2021, the city of Moscow placed its green bonds in this sector.

9.4 Conclusion

Russian government is discussing different ways of easing regulation, tax preferences for green bonds, reimbursement of costs for verification of green projects to stimulate the development of ESG investments. In many countries, some state support measures in this area are already being applied.

In order to stimulate the inclusion of the green agenda in the companies' management processes, it is necessary to assess climate risks in the financial markets and develop the market of green bonds and loans, as well as financial instruments tied to the sustainable development goals. There should be the logic shift in doing business, which implies the transition from a model of maximizing short-term profits to achieving long-term goals taking into consideration environmental, social and corporate governance agenda. The role of the investors is to encourage companies to move to sustainable development principles.

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Chapter 10
Financial Aspects of Increasing the Effectiveness of Innovative Activities of Enterprises in the Framework of the Concept of Sustainable Development

Sergey N. Yashin, Yuliia S. Korobova, Yuliia V. Zakharova, Dmitry A. Sukhanov, and Victor P. Kuznetsov

10.1 Introduction

Innovative activity is a key factor in maintaining the long-term competitiveness of the country and the most important aspect of public policy (The Strategy of Scientific and Technological Development of the Russian Federation 2016).

The level of effectiveness of innovation activity directly depends on the amount of financing of innovation projects and programs (Hahn et al., 2019). As you know, due to the lack of funds, many promising innovative ideas remain unrealized, which hinders the improvement of the quality of life in the country.

The problems of this study are presented in the works of the authors Trifilova (2005), Anshina and Dagaeva (2007), Mindeli and Vasin (2011) and Voynarenko et al. (2020), and many other scientists. The current realities of an unstable external

S. N. Yashin (✉) · Y. S. Korobova · Y. V. Zakharova
Lobachevsky State University of Nizhny Novgorod, Nizhny Novgorod, Russia
e-mail: jashinsn@yandex.ru

Y. S. Korobova
e-mail: korobovays@iee.unn.ru

Y. V. Zakharova
e-mail: zayv@yandex.ru

D. A. Sukhanov
«Biota–Plus», Nizhny Novgorod, Russia
e-mail: svx85@yandex.ru

V. P. Kuznetsov
Minin Nizhny Novgorod State Pedagogical University, Nizhny Novgorod, Russia
e-mail: kuzneczov-vp@mail.ru

E. G. Popkova and B. S. Sergi (eds.), *Current Problems of the Global Environmental Economy Under the Conditions of Climate Change and the Perspectives of Sustainable Development*, Advances in Global Change Research 73, https://doi.org/10.1007/978-3-031-19979-0_10

environment, widespread digitalization and a difficult epidemiological situation in connection with the COVID-19 pandemic require constant monitoring of problems in the innovation sphere (Grilli et al., 2018; Padilla-Ospina et al., 2018), their timely identification and solution (Yurlov et al., 2009).

10.2 Methodology

Statistical data of the Federal State Statistics Service in the form of the annual form of federal statistical observation No. 4-innovation «Information on the innovative activity of the organization» serve as the initial data when analyzing the impact of enterprises' costs on the effectiveness of innovative activity (Federal State Statistics Service, 2021).

To determine a quantitative characteristic that reflects the dependence of the effectiveness of ongoing innovation activities on the share of innovation costs, a correlation analysis technique was used. In addition, within the framework of this study, the Chaddock scale was used, which makes it possible to determine the strength of the identified correlation and convert the obtained value of the Pearson correlation coefficient into a qualitative characteristic necessary for interpreting the results obtained during the study. To substantiate the statistical relationship between costs and their effectiveness, the authors calculated the critical value of Pearson's correlation coefficients, calculated the number of degrees of freedom and chose a significance level that reflects the probability of error in making a decision.

10.3 Results

In 2013, 2.9% of the total costs of enterprises were spent on innovation activities across the country, which is a quarter more than in 2019. According to the data for 2020, there is an increase in this indicator to a value of 2.3%, which is a positive trend (Federal State Statistics Service, 2021).

The increase in the share of costs for innovation activities in 2020 is due to an increase in the costs of acquiring rights to patents, as well as licenses to use utility models, industrial designs and inventions; acquisition of fixed assets, software and R&D costs. So, for example, in 2020, Russian enterprises spent 56,523 million rubles on the acquisition of fixed assets necessary for the implementation of innovative projects, more than in 2019.

But, unfortunately, for a number of components of the cost structure for innovation activities, there is a negative trend. At Russian enterprises in 2020, 1412 million rubles were spent on education and training of personnel employed in innovative projects, less than in 2019. Also, there is a downward trend in the amount of engineering costs (according to 2020 data, 29,245 million rubles less than in 2019) and the costs of planning and implementing new business methods (according to 2020 data, by

1627 million rubles, less than in 2019). In addition, at Russian enterprises, one can note a reduction in the costs of marketing and creating a brand of innovative products: for the period from 2019 to 2020, 1,789 rubles were spent on this component of the cost structure less.

Reducing the cost of such critical components as engineering, education and training of personnel, marketing, as well as planning and developing new business methods cannot but lead to a decrease in the effectiveness of innovation, even in the face of increased costs for R&D and the acquisition of fixed assets, about which evidenced by the negative dynamics of the innovation performance indicator (Federal State Statistics Service, 2021).

However, despite the difficult external environment, it is innovations that can become a factor in ensuring a sustainable position in the market and increase the competitiveness of an enterprise in the long term (Fonseca & Lima, 2015; Morais et al., 2021).

For the most in-depth study of the relationship between the effectiveness of innovative activity and the innovative costs of enterprises, we construct a correlation field in the form of a set of points in a Cartesian coordinate system, where x is an indicator of the share of costs and y is an indicator of the effectiveness of innovative activity (Fig. 10.1).

Next, we proceed to the calculation of the Pearson correlation coefficient between innovation costs and the effectiveness of innovation activity according to the formula (Kerr & Nanda, 2015):

$$r_{xy} = \frac{\overline{xy} - \overline{x} \times \overline{y}}{\sigma_x \times \sigma_y} = \frac{15.59 - 2.30 \times 6.73}{0.16 \times 1.04} = 0.79$$

where $\overline{x}$—average value of the indicator of the share of costs for innovation, 2016–2020 ($\overline{x} = \frac{\sum_{i=1}^{n} x_i}{n}$, where n—number of observations in the sample);

$\overline{y}$—average value of the innovation performance indicator, 2016–2020 ($\overline{y} = \frac{\sum_{i=1}^{n} y_i}{n}$, where n—number of observations in the sample);

$\overline{xy}$—the average value of the products of indicators of the share of innovation costs and the effectiveness of innovation activities for the period from 2016 to 2020;

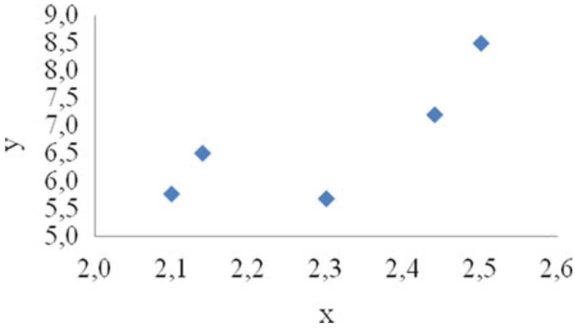

Fig. 10.1 Correlation field of the share of costs for innovation and the effectiveness of innovation. *Source* Compiled by the authors

Table 10.1 Chaddock scale

Correlation coefficient range	$0.1 < r_{xy} \leq 0.3$	$0.3 < r_{xy} \leq 0.5$	$0.5 < r_{xy} \leq 0.7$	$0.7 < r_{xy} \leq 0.9$	$0.9 < r_{xy} \leq 1$
Qualitative characteristic of the bond strength	Very weak	Weak	Average	High	Very high

Source Compiled by the authors based on Orlov (2020)

σ_x, σ_y—standard deviations ($\sigma_x = \sqrt{D} = \sqrt{\frac{\sum_{i=1}^{n}(x_i - \overline{x})^2}{n}}$, $\sigma_y = \sqrt{D} = \sqrt{\frac{\sum_{i=1}^{n}(y_i - \overline{y})^2}{n}}$, where D—dispersion) (Saadalov et al., 2021).

To interpret the obtained value of the Pearson correlation coefficient $r_{xy} = 0.79$ and to determine the strength of the correlation between the costs of innovation and their effectiveness, we will use the Chaddock scale (Table 10.1) (Orlov, 2020).

Comparing the value of $r_{xy} = 0.79$ with the data on the ranges of the Chaddock scale, we can conclude that there is a high strength of the relationship between the costs of innovation and the effectiveness of innovation. Thus, we have translated the quantitative value of the Pearson correlation coefficient into a qualitative characteristic.

The methodology for conducting correlation analysis also involves determining the statistical significance and reliability of the identified correlation (Popova, 2021). To do this, we compare the value $r_{xy} = 0.79$ with the values from the table of critical values of Pearson's correlation coefficients, choosing the significance level $p = 0{,}05$, according to which it will be possible to assert that the correct decision was made with a probability of 95%. At the same time, in addition to choosing the significance level p, the analysis according to the table of critical values of the Pearson correlation coefficients involves the calculation of the number of degrees of freedom by the formula:

$k = n - 2$, where.

N—the total number of values in all samples taken for the study.

$n = 10$ within the ongoing study, hence $k = 8$.

That is, for a sample with a total number of values $n = 10$ and a significance level $p = 0.05$, the critical value of the Pearson correlation coefficient will be 0.63. The resulting calculated value of the Pearson correlation coefficient is considered reliable only if it turns out to be greater than the corresponding value of the correlation coefficient from the table of critical values (Saadalov et al., 2021). The value $r_{xy} > r_{\text{crit}}$ calculated in the course of this study indicates the existence of a direct correlation between the costs of innovation and their effectiveness.

10.4 Conclusion

As measures that contribute to the development of the innovation financing system, the following can be distinguished:

- improving the system of financial measures of state support for innovative projects (e.g., developing a system of tax benefits, subsidizing R&D costs, acquiring fixed assets, etc., expanding mechanisms for grant support for promising innovations);
- simplification of access to various instruments of financial support at the state level;
- the formation of new digital tools for financing innovations, allowing to integrate all kinds of free financial sources;
- development of the infrastructure of digital platforms for financing innovative projects, which helps to reduce the time for decision-making in terms of innovative financing. At the same time, a digital platform can be understood as a platform for communications that provides various services that act as a basis for the formation of financial relations between all participants in the innovation process;
- development of new tools for financial support of innovative projects (Kerr & Nanda, 2015), taking into account the peculiarities of the national and world economy. In addition to implementing a set of measures to develop a system for financing innovation activities, it is necessary to develop other measures aimed at improving the effectiveness of innovative projects. Such activities may include:
- development of the intellectual potential of the innovation sphere (Voynarenko et al., 2020) by improving the system of social support for scientists and creating opportunities to attract talented youth and provide them with the conditions necessary to build a career in science and innovation;
- solving the problems of infrastructural support of innovative activity;
- development of new systems of cooperation and interaction between all participants in the innovation process that meet modern requirements (Avhustyn & Demkiv, 2020; Garina et al., 2016);
- improvement of the procurement system for the implementation of innovative projects, taking into account the high-risk nature of this area.

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Part II
Climate-Smart Innovations and Advanced Industry 4.0 Technologies to Support the Sustainable Development of the Global Environmental Economy

Chapter 11
Smart Climate Innovations Impacting Industrial Systems

Yana A. Saltykova

11.1 Introduction

To achieve high productivity, comfortable climatic conditions in workshop premises are to be ensured. These include adequate air temperature, its harmless and clean composition, appropriate humidity and other key parameters. These parameters can be attained in case effective climate equipment is used, which includes air conditioners, radiators, heaters, humidifiers and dehumidifiers, cleaners and different ventilators. However, climate system management is getting more complex and costly with the intensified production digitalization. That is why such equipment is starting to integrate into "smart production".

These trends are not only associated with the need to supply complex industries with unpolluted air but are aimed to use energy efficiently and reduce costs. Responsive and user-friendly control is ensured through the use of controllers, detachable modules and station consoles.

A new trend in climatic technology is its integration into smart production where these systems can be managed with no need to visit a workshop personally and is carried out autonomously—by using one operator station. In this case, risks of human error when a person may forget to timely switch on climate equipment are eliminated. In addition, there is no need to attract people responsible for these processes, a comfortable work environment is created, and the costs of repairing and adjusting climate equipment are reduced to the minimum.

The article aims to analyze the use of digital innovations for climate equipment used in industrial companies.

Y. A. Saltykova (✉)
MGIMO Univesity, Moscow, Russia
e-mail: saltykova.ya@mail.ru

E. G. Popkova and B. S. Sergi (eds.), *Current Problems of the Global Environmental Economy Under the Conditions of Climate Change and the Perspectives of Sustainable Development*, Advances in Global Change Research 73, https://doi.org/10.1007/978-3-031-19979-0_11

Objects of the article:

- to compare different digitization processes in climate technology and their impact on the business environment;
- to analyze the return on investment in smart climate technologies;
- to study adaptation to innovative climate technologies when managing production areas, with integration into a single remote control centre.

11.2 Materials and Method

Comparative-historical method, regression and visual data analysis, comparison and analogies, statistical empirical data processing, expert-analytical method and others.

11.3 The Main Body

Climate equipment includes ventilation, noise insulation, air conditioning and heating systems. This market was formed quite a long time ago and is represented by Asian and European manufacturers mainly. However, the widely spread digitization and digital technology integration obliged climate technology manufacturers to improve their products as well. Air conditioning transition to cloud technologies was a breakthrough in climate technology. If air conditioner design was of a top priority earlier, now it is autonomous service control and the possibility to implement other functions that are of primary importance. The key requirement for these innovations is to reduce energy intensity and increase their energy efficiency. The key benefits to users imply time-saving, improved air conditioning operation and reduced energy consumption, and labour resources involved in managing them.

Previously, such innovations were high-end products, but the latest developments made it possible to reduce the cost of these products, reducing smart climate technology costs to 60% (a new framework for digital design…, 2017). Thus, businesses not only could reduce climate equipment costs and enjoy improved operating conditions, but they could also reduce and simplify their operation, which somehow benefits the industry (Hmutsky, 2019).

To show the benefits, let us consider split climate system (VRF and VRV) operating conditions used by large industrial businesses to supply production spaces with air conditioning. Noteworthy is the fact that not each company has switched to the use of “cloud” technologies which allows stressing the advantages of innovations over traditional systems (optimizing the heating system in the shop).

Shows peculiarities of split climatic systems produced by Midea Group Co (innovation as a way to increase efficiency). The company is one of the largest climate technology manufacturers and has a representative office in Russia. Notably, split systems are built on modules and installations purchased from climate system manufacturers, being designed and adjusted by licenced companies. When using cloud technologies, equipment heat capacity increases from 1.7 to 4 kW, and equipment is controlled autonomously using any device, thus no control centre is required. In addition, maintenance becomes easier, which reduces the number of employees involved in system operation from 5 to 1 and increases equipment service life up to 10 years. Finally, cloud technologies are less expensive: savings reach $6–7 thousand (Zherlykina, 2017).

Thus, by analyzing general climate system characteristics and parameters operating conventionally and those using cloud technologies, it becomes clear that the latter is more beneficial for a company since they reduce operating costs and have higher efficiency and heat response. Given that innovations enable independent air control, their advantages become even more explicit.

Thus, in the premises where people work, a certain air oxygen level, a certain temperature or other indicators can be automatically adjusted with no human assistance. This enables using big data or machine learning technologies that build specific algorithms through the use of neural networks and enables using these capacities (Tsygankov & Grimitlin, 2013).

In recent years, the smart climate technology trend has been considered as the ability to sensor people in the room (Chinese air conditioner manufacturer). That is, the technology takes into account how many people are in the room in a certain period and adjusts the required cooling, or heating in the workshop, as well as air purification. For these purposes, the smart eye technology which limits energy consumption to the level predetermined and a motion sensor is used. The task of the smart eye is to put the internal unit on standby and save mode if there are no people in the room. This saves electricity up to 80%. When people come into the room, the unit switches to the previous operation mode (Tikhonov, 2018).

Smart solutions are used in heating mode as well (optimizing the heating system in the shop). If the weather changes from cloudy to sunny or morning comes, the system recognizes the increased sunlight intensity and reduces heating by a value equivalent to a decrease in the specified temperature by 1 °C. In real-world terms, it is shown in the change in heat temperature depending on weather conditions and time of day. Changing is automatic and is based on light mode changes (Hmutsky, 2019).

Certainly, all these technologies not only lead to reduced energy consumption but improve the comfort of people's work, which is the reason for the increase in their productivity. For example, Flaig + Hommel iron and steel company has adopted the Daikin concept in their production when all business processes in the workshops are fully based on cloud management, including climate control and supplying workshops with smart Daikin-based air conditioning systems. Let us clarify that Flaig + Hommel Group is a global manufacturer of metal products and universal connecting elements operating on the market since 1946 products are used in the automotive industry, railway transport, agricultural equipment and other industries.

The new company location was its territory with an area of 25,000 m^2 (Flaig + Hommel official Website).

The work was carried out in a workshop located in an industrial brick building built in 1965, with an area of 3740 m^2 and a height of 10.5 m to the load-bearing

Table 11.1 Benefits from smart climate technologies introduced at the non-ferrous metal machining plant

Parameter	Before introduction	After introduction
Costs for climatic equipment maintenance, per production unit per month, thousand rubles	336.0	228.1
Costs for personnel maintaining climate equipment per month, thousand rubles	400.1	80.5
Labour productivity, thousand rubles/person per month	1587	6889.0
Financial losses associated with diseases of personnel due to their working in severe environment, thousand rubles. per year	228.0	95.0

Source Compiled by the author based on Flaig + Hommel internal documentation

structure. The structures were common for the Soviet buildings—the water system had radiators and the air system used air-heating units. Radiators installed around the production workshop perimeter did not allow the full use of the space to locate equipment, so they were dismantled.

Table 11.1 shows the benefits for the plant.

It is clear that the greatest effect is produced by an increase in labour productivity. In a healthy climate, people work more efficiently, get less tired and therefore produce more products, thereby increasing production volumes.

The arguments presented emphasize how significant is innovations for climate equipment. With that, the return on investment is implicit. The return is difficult to detect since it is shown in improving working conditions and indicators related to labour productivity.

However, the return on investments in smart climate technologies is to be analyzed, since these estimations help determine the feasibility of financial investment. Notably, the impact will be economic and social. The set of economic impact indicators will involve the increase in business profit, which will be influenced by the following factors (Zherlykina, 2017):

– reducing heating and electricity costs when maintaining workshops and other premises;
– reducing expenses for personnel involved in equipment maintenance;
– reducing costs for equipment repair and maintenance.

Considering these impacts, cost-effectiveness indicators that include net discounted income, profitability index, return on investment and other indicators are calculated.

Table 11.2 shows the calculation of return on investment in the project on replacing conventional climate equipment with smart one. The calculation is made based on Flaig + Hommel data, the company that adopted the Daikin concept in their production in 2020.

Table 11.2 Calculation of return on investment in the project on replacing conventional climate equipment

Indicator	2020	2021	2023
Capital expenditure, thousand rubles	840		
Reduced heat and electricity costs, thousand rubles per year	320	330	345
Reduced expenses for personnel involved in equipment maintenance, thousand rubles	1440	1500	1600
Reduced equipment maintenance costs, thousand rubles	80	85	90
Depreciation of equipment per year, thousand rubles	168	168	168
Total net income per year, thousand rubles	2008	2083	2203
Discount rate (5.75 discount rate 3 risk premium), %	94	89	83
Net discounted income, thousand rubles	1892.54	1843.46	1824.08
Project rate of return, years	0.44		

Source Compiled by the author

The calculation presented justifies the economic efficiency and feasibility to adapt businesses to smart climate technologies. Considering its social component, it is notably will result in reduced incidence of disease and higher productivity of employees working indoor. In the example presented, the company was monitoring the work of employees throughout 2020 after the equipment had been upgraded. They highlighted the following positive aspects that staff mentioned more frequently:

1. comfortable plant temperature;
2. tools, fittings and structures which people touch have become warmer, which creates a sense of comfort;
3. silent equipment operation;
4. disease duration has decreased.

Adapting to the overall infrastructure of innovative climate technologies and managing production sites integrated into a single remote dispatch centre of the company is a challenge. In fact, most large industrial companies have already formed their smart systems to manage production business processes, which are controlled from a single dispatch centre (LG air conditioners. World-class climate technology). To successfully integrate them, technologies enabling further adjust the corresponding processes are required, which will adapt systems to the existing information environment. In this case, AGI technologies can serve as assistants that are associated with artificial intelligence and increase its effectiveness and capacity. Controlling neural networks accurately the AGI unit technically incorporates an invisible assistant in the overall workshop business process management and complements these processes with new climate technologies. The unit accepts all requirements and settings showing how to regulate the workshop environment; it noiselessly and with no odd actions, independently adjusts all equipment operation ensuring the most comfortable working conditions for employees (Tikhonov, 2018).

Modern sensors detect each person's movement and transmit data on the number of people in the room to the principal controller (Vasiliev and Abramov, 2018).

The sensor signal is processed by a controller, which analyzes data obtained from similar sensors installed in other rooms, and generates a signal to control the fan capacity and control valve passage section at each doorway. Along with that, support systems are controlled, for example, controlling water flow for heaters. Regarding air conditioning systems, an internal and external unit operation is corrected. When there are no people, the internal units switch to an efficient routine and turn off after a while. When people come, air conditioning operation resumes.

Thus, the presented examples and analytical calculations justify the potential to improve climate technologies in industrial systems. The so-called smart digital technologies that can be controlled unmanned and which solutions can be integrated into business infrastructure systems are the most advanced (2017 Open Innovations Forum). Notably, these are smart technologies that significantly reduce electricity and other resource consumption, while increasing labour productivity, improving employees' satisfaction with their jobs.

All this proves the feasibility of investing and applying smart climate technology systems in business operations. In addition, these parameters indicate that climate innovations will develop industrial systems, since the increase in labour productivity cannot but result in new developments, improving work quality, increased community commitment and staff satisfaction.

Improved working conditions correlate with high production factors at industrial businesses, help new products enter the market and reduce their costs.

11.4 Conclusion

The studies have shown that new climate systems are currently entering the market and use smart management for their control. These systems reduce product costs by reducing maintenance costs and reducing energy costs while increasing the overall production energy efficiency. In addition, these systems significantly improve the climate in production premises, as a result of which labour productivity increases, employees become engaged in obtaining the highest labour efficiency possible.

Thus, the feasibility to develop climate innovations and introducing them into industrial systems to optimize production is justified. Along with that, reduced costs will certainly affect the product quality that will increase its competitiveness due to lower price and high quality generated by high labour efficiency that employees show working in comfortable conditions.

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Chapter 12
Marketing HR Strategy for Creating Green Jobs to Support the Fight Against Climate Change

Natalia V. Przhedetskaya and Dmitry S. Zhukov

12.1 Introduction

Combating climate change is critical and is being done at the global level. In recent years, the Paris Agreement (United Nations, 2022), adopted in 2015 and supported worldwide, has developed a strong legal framework at the national level. The majority of the world community has adopted strategies of gradual decarbonization up to the achievement of a completely carbon-neutral economy. In these strategies, environmentally responsible business plays an important role, contributing to the fight against climate change by introducing climate-resilient innovations.

The problem is that the potential of businesses in fighting climate change is far from being fully disclosed (Yankovskaya & Kukushkin, 2019; Yankovskaya et al., 2021). In the current approach to corporate environmental responsibility, the business focuses on government support, expects ready-made application solutions (e.g., carbon-neutral infrastructure), and heavily relies on government incentives through a carbon tax (Dudukalov et al., 2020; Popkova et al., 2019) and greenhouse gas emission allowances (Hori & Syugyo, 2020; Sree Kumar et al., 2020). In the current approach, entrepreneurial ability as an engine of progress and a catalyst for change in the business environment is poorly engaged.

This raises the first research question (RQ_1): "What is the way to build support for combating climate change in business?" This research proposes hypothesis H_1 that green jobs allow businesses to build support for combating climate change. The jobs solve the problem by making businesses more proactive in the fight against climate

N. V. Przhedetskaya (✉) · D. S. Zhukov
Rostov State University of Economics, Rostov-on-Don, Russia
e-mail: nvpr@bk.ru

D. S. Zhukov
e-mail: z@alibaba-service.ru

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change by having their own generators of climate-resilient innovation in the form of green jobs.

In this case, the challenge is that despite significant progress, the proportion of green jobs remains small. Thus, according to Economic Graph (LinkedIn, 2022), the change in the share of global green jobs hired in 2021 was nearly 1.2 relative to 2016 hiring levels. However, even among the top 25 relative green skill intensity countries (New Zealand, Colombia, Denmark, Peru, Singapore, and Ireland), there are countries that are below the global average and significantly behind the top-ranking countries.

This raises the second research question (RQ_2): "What are the ways to increase the number of green jobs in businesses?" Thus, the research proposes hypothesis H_2 that the development of knowledge-intensive employment and research talents is necessary to increase the number of green jobs in the business. The current practice of creating green jobs through higher corporate environmental standards and stricter requirements for employees does not justify itself (Bohnenberger, 2022; Sharpe & Martinez-Fernandez, 2021). The current practice should be replaced by more flexible practices related to building human capacity to address climate change.

Based on the above, this research aims to study the prospects for improving HR marketing strategies for green jobs to support the fight against climate change.

12.2 Literature Review

The fundamental basis for this research is the theory of green jobs. The essence and characteristics of green jobs as decent jobs with safe working conditions, stable and protected employment, and adequate wages, on the one hand, and employment aimed at protecting the environment and creating and implementing environmental innovations, on the other hand, are revealed in the works of Chernyshov et al. (2021), Popkova (2022), and Zhak et al. (2021). The foundations of HR marketing of green jobs are laid in the works of Akopova et al. (2016), Inshakova and Solntsev (2022), Muraveva et al. (2021), and Przhedetskaya and Zhukov (2021).

Nevertheless, the literature review revealed uncertainty about the cause-and-effect relationship of green jobs. The first gap in the literature is that the determinants of green jobs are poorly understood and unclear. The second gap is related to the lack of elaboration on the contribution of green jobs to combating climate change. This research seeks to fill both identified gaps by clarifying the causal relationships of green jobs: identifying the role of HR marketing in their creation and in assessing the contribution of green jobs to combating climate change, drawing on international best practices.

12.3 Materials and Methods

This research relies on econometric methodology. To test hypothesis H_1 and determine the contribution of green jobs to combat climate change, the authors applied the method of regression analysis—simple linear regression. The resulting variable is the "SDG 13 score" (Cl) as a reliable indicator of achievements in combating climate change, as measured by the UNDP (2022). The factor variable is "Green employment" (ge) as a reliable indicator of the activity of green job creation as measured by the Global Green Growth Institute (Global Green Growth Institute, 2022).

To test hypothesis H_2 and determine the role of knowledge-intensive employment and research talents in increasing the number of green jobs in business, the authors also applied the method of regression analysis—multiple linear regression. The resultant variable is the indicator "Green employment" (ge) mentioned above. The factor variables are "Knowledge-intensive employment" (kie) and "Research talent" (rt) as indicators of HR marketing and "ISO 14001 environmental certificates" (ec) as an indicator of environmental management beyond HR management (HRM). All factor variables are taken from a reliable source—WIPO (Dutta et al., 2022).

The research model is as follows:

$$\begin{cases} \mathrm{C1} = a_{\mathrm{C1}} + b_{\mathrm{C1}} * \mathrm{ge}; \\ \mathrm{ge} = a_{\mathrm{ge}} + b_{\mathrm{ge1}} * \mathrm{kie} + b_{\mathrm{ge2}} * \mathrm{rt} + b_{\mathrm{ge3}} * \mathrm{ec} \end{cases} \tag{12.1}$$

Based on the research model (1), hypothesis H_1 is considered proven when the regression coefficient b_{Cl} is positive. Hypothesis H_2 is considered proven when regression coefficients b_{ge1} and b_{ge2} are positive and (all conditions must be met simultaneously) when $b_{\mathrm{ge1}} > b_{\mathrm{ge3}}$ and $b_{\mathrm{ge2}} > b_{\mathrm{ge3}}$. The empirical basis of the research is shown in Table 12.1.

For the study, the authors developed a sample of ten countries included in the Economic Graph's "Relative green skill intensity (Top 25)" rating (LinkedIn, 2022) in 2022, according to the Global green skills report 2022. The following countries are included in the sample:

- Developed countries in North America:

– The USA, whose relative green skills intensity in 2022 is 2.65 relative to the global average. The USA has the "2030 Greenhouse Gas Pollution Reduction Target" (House, 2021);
– Canada, whose relative green skills intensity in 2022 is 1.75 relative to the global average. Canada has the "Net-Zero Emissions by 2050" act (Government of Canada, 2050).

Table 12.1 Statistics on climate change, green jobs, and their factors in 2021–2022

Country	SDG 13, score 0–100	Green employment, score 0–100	Knowledge-intensive employment, %	Research talent, % in businesses	ISO 14001 environmental certificates/bn PPP$ GDP
	Cl	ge	kie	rt	ec
USA	45.1	76.50	52.0	72.5	0.2
Germany	55.6	88.53	46.1	60.7	1.9
Australia	12.7	52.25	46.1	27.9	1.9
Canada	30.5	69.67	43.7	56.7	0.4
Russia	70.8	49.54	44.9	48.0	0.2
Denmark	58.5	94.80	48.8	58.5	3.0
Spain	76.3	57.19	33.8	38.1	6.4
Sweden	60.2	62.97	54.4	71.5	6.7
Finland	60.2	69.85	48.8	57.2	5.4
UAE	8.7	54.52	36.0	77.9	2.8

Source Compiled by the author based on Global Green Growth Institute (2022), UNDP (2022), and WIPO (2022)

- Developed countries of Western Europe (EU) (In the EU, there is the "European green deal" (Commission, 2022):

– Germany, whose relative green skills intensity in 2022 is 1.25 relative to the global average;
– Denmark, whose relative green skills intensity in 2022 is 0.90 relative to the global average;
– Spain, whose relative green skills intensity in 2022 is 1.78 relative to the global average;
– Sweden, whose relative green skills intensity in 2022 is 1.40 relative to the global average;
– Finland, whose relative green skills intensity in 2022 is 1.10 relative to the global average.

- A developed country in Oceania included in the OECD is Australia. Its relative green skills intensity in 2022 is 1.85 relative to the global average. The country has a number of Australia's climate change strategies (2022);
- Developing countries: The United Arab Emirates (UAE), whose relative green skills intensity in 2022 is 1.35 relative to the global average. The UAE has "UAE Net-Zero 2050" in effect (United Arab Emirates' Government, 2022).

The sample also includes Russia, which is not in the Economic Graph's "Relative green skill intensity (Top 25)" rating (LinkedIn, 2022) in 2022 but is actively creating green jobs and successfully implementing the "Strategy for socio-economic development of the Russian Federation with low greenhouse gas emissions until 2050" (Government of the Russian Federation, 2022).

12.4 Results

As a result of econometric modeling based on the data from Table 12.1, the following regression models were obtained:

- Model 1: Cl = 25.54 + 0.33 * ge. The resulting model suggests that a one-point increase in green employment increases climate change outcomes (according to SDG 13) by 0.33 points. This confirms hypothesis H_1 about the significant contribution of green jobs to the fight against climate change;
- Model 2: ge = 17.91 + 0.82 * kie + 0.24 * rt − 0.38 * ec. According to the resulting model, a 1% increase in knowledge-intensive employment increases green employment by 0.82 points. A 1% increase in research talent in businesses increases green employment by 0.24 points. However, the spread of ISO 14001 environmental certificates/bn PPP$ GDP has no positive effect on green employment, as evidenced by the negative value of the regression coefficient (−0.38). This confirms hypothesis H_2 about the key role of HR marketing in creating green jobs.

Based on the obtained regression models, the authors performed a multi-factor optimization of green jobs, which revealed HR marketing priorities and benefits for combating climate change (Fig. 12.1).

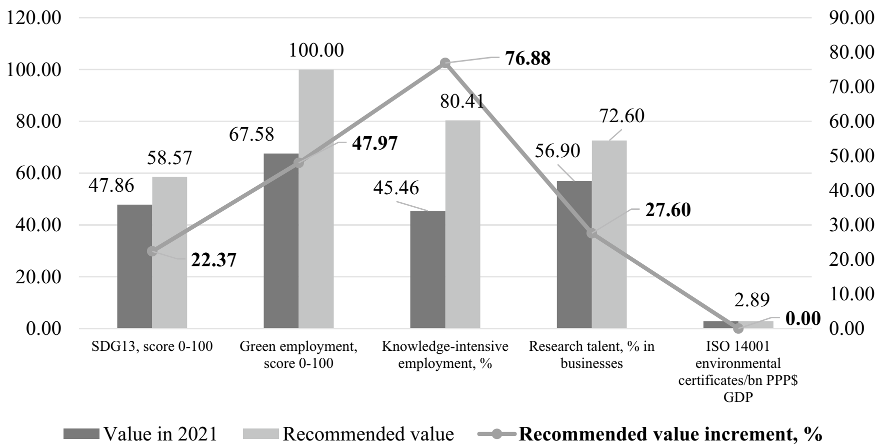

Fig. 12.1 Prospects for combating climate change through the creation of green jobs based on HR marketing. *Source* Developed by the authors

In line with the perspectives presented in Fig. 12.1, the following HR marketing strategy for creating green jobs to support the fight against climate change is proposed. The author's strategy is based on increasing knowledge-intensive employment to 80.41% (+76.88% compared to 2021) and increasing research talent to 72.60% in businesses (+27.60% compared to 2021). This will increase the number of green jobs up to 100 points (the maximum, +47.97% compared to 2021). This will ensure progress on climate change—in the implementation of the SDGs up to 58.57 points (+22.37% over 2022).

12.5 Conclusion

Thus, the research provided answers to both of the RQs posed. First, hypothesis H_1 is proven, and it is substantiated that green jobs allow businesses to increase their support for combating climate change. At the maximum level of (widespread) green employment, the results in the fight against climate change could increase by 22.37%.

Second, hypothesis H_2 is proven, and it is confirmed that the development of knowledge-intensive employment and research talents is necessary to increase the number of green jobs in the business. Based on the identified econometric models, the authors developed an HR marketing strategy for creating green jobs to support the fight against climate change, assuming an increase in knowledge-intensive employment by 76.88% and research talent by 27.60%.

The contribution of this research to the literature lies in developing the scientific positions of the theory of green jobs. The theoretical significance of the research is that the author's findings clarified the causal relationships of green jobs. In contrast to Hori and Syugyo (2020) and Sree Kumar et al. (2020), the authors substantiated that the approach to corporate environmental responsibility of business should be focused not on the government support but on the own opportunities and initiatives of business, implemented in the green workplaces. In contrast to Bohnenberger (2022) and Sharpe and Martinez-Fernandez (2021), the authors show that the practice of creating green jobs should involve not the adoption of higher corporate environmental standards and stricter requirements for employees but rather the creation of flexible opportunities through the development of knowledge-intensive employment and research talents.

The practical significance of the results is that the developed HR marketing strategy to create green jobs will more fully reveal the potential of businesses to combat climate change: better utilize entrepreneurial ability as an engine of progress and a catalyst for change in the business environment. The social significance of the research lies in the fact that the author's recommendations will increase the share of green jobs and improve the results of the implementation of SDG 13.

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Chapter 13
Industry 4.0 Innovations in the Global Fashion Sector and Their Role in Contributing to Minimizing Its Negative Impact on the Climate

Igor B. Dolzhenko and Anna A. Churakova

13.1 Introduction

The fashion industry is one of the most important industries with significant economic impact worldwide, where research and investment continue in various related sectors. These investments include using cutting-edge technologies that improve, accelerate, improve quality, and increase profitability for stakeholders. Recently, significant innovations have focused on both green products. Moreover, it processes because of the fashion industry's considerable contribution to global warming and ecological problems.

As part of Industry 4.0, 3D printing technology, the Internet of Things (IoT), virtual and augmented reality, artificial intelligence, and simulation offer considerable opportunities by transforming the traditional product design methods, manufacturing, marketing, and sales. Not only has design and manufacturing changed, but also the fabrics. Smart textiles are becoming a more viable option, and their applicability is growing. Each of them shapes the fashion industry's future by creating new opportunities within specific sectors and new challenging demands.

Several studies review the implications of technology for the fashion industry, but they are still limited in scope. They mainly discuss benefits for companies rather than consumers, such as improved supply chain efficiency and staff training or the role of business models.

New technologies are helping to overcome the inefficiencies of the existing production system and boost consumption. During the First Industrial Revolution, invented technologies led to increased production. These efforts to increase

I. B. Dolzhenko (✉)
Delta Consulting LLC, Moscow, Russia
e-mail: primestyle@mail.ru

A. A. Churakova
MGIMO University, Moscow, Russia

E. G. Popkova and B. S. Sergi (eds.), *Current Problems of the Global Environmental Economy Under the Conditions of Climate Change and the Perspectives of Sustainable Development*, Advances in Global Change Research 73, https://doi.org/10.1007/978-3-031-19979-0_13

productivity continued during the Second Industrial Revolution, culminating in mass production factories. During the Third Industrial Revolution, to defeat the heightened competition in the global economy caused by the Internet, digital technologies were implemented to improve management and increase productivity, reducing the additional cost of producing another unit of goods or services (Konina, 2018). The technologies of the first three industrial revolutions led to the transformation of the fashion industry into a global complex industry, in which a large number of technologies and processes are used to produce a significant number of products and services at reduced prices and time by increasing productivity.

13.2 Methodology

The article is devoted to the problems of practical solutions based on Industry 4.0 to reduce the impact of the global fashion industry on global warming.

The trends and impact of the Fourth Industrial Revolution and digital transformation are studied in the works of Esposito (2020), Konina (2018), Stonehouse and Konina (2020), and Vladimirova et al. (2021).

The specific features and perspectives of the formation of Industry 4.0 and digital transformation of the companies of the fashion industry are researched in the works of Bertola and Teunissen (2018), Canonico (2021), Jin and Shin (2021), and Konina (2021).

The specific features and perspectives of buyers' behaviour and circular economy in the fashion sector are studied in the works of Chae and Hinestroza (2020), Jacometti (2019), Jia et al. (2020), Konina et al. (2020), Lu (2018), Moran et al. (2021), and Shirvanimoghaddam et al. (2020).

The characteristic features and perspectives of the global fast fashion sector environmental impact are studied in the works of Change (2018), Kong et al. (2016), Konina and Sapir (2021), Morlet et al. (2017), Niinimäki et al. (2020), and Statista (2021).

Different features and perspectives of fast fashion companies climate impact are researched in the works of Berg et al. (2020), Morlet et al. (2017), Muthu (2014), and Rana et al. (2015).

New innovative approaches and digital disruption inventions in the environment-friendly approach of the textile and apparel industry are studied in the works of Chae and Hinestroza (2020), Jacometti (2019), Moazzem et al. (2018), Marques et. al (2019), and Thin (2020).

The research focuses on the combination of technology and organizational efforts needed to improve the fashion industry's climate impact.

The leading research method is the systematic and comparative analysis based on statistical data trend research, comparison, and systematization. An integrated approach is applied to analysing aspects of global warming and changes in the worldwide fashion industry. The authors used an interdisciplinary approach as a fundamental principle.

The authors used a targeted sample approach when selecting company cases since it offers the most representative cases. The sampling criterion was whether the company had implemented at least one of the 4IR technologies, which impacted carbon footprint. To identify common issues, we ran a broad web search.

The most important theoretical and practical issue of the fashion industry's influence on global climate change is determining the pace of implementation of measures necessary to minimize the fashion industry's negative impact on the climate. In conclusion, based on the generalization of the data obtained, the main findings are drawn.

13.3 Results

Global apparel production doubled between 2000 and 2014. By 2050, global textile consumption is expected to triple from 2015 levels.

The carbon footprint measures the number of greenhouse gases produced when fossil fuels are burned for electricity, heating, transportation, etc., in tonnes or kilograms or grams of CO_2 equivalent. The world's average per capita greenhouse gas emissions is around 5.8 tonnes of CO_2. Reducing industry carbon footprint can be achieved in several ways: reducing energy consumption, increasing productivity, reducing waste generation, recycling waste, and using less.

The current business model that most sewing companies use is: push supply system. The supply push approach inevitably leads to a considerable discrepancy between projected and actual demand, resulting in significant markdowns and surplus after each season. Due to the combination of real unmet demand and excess supply, this enormous gap between supply and demand invariably makes the industry environmentally unsustainable. Fast fashion has fuelled the idea of disposable clothing, which is an additional factor in the industry's environmental impact.

4IR technologies enable hyper-personalized products and services to be delivered on a large scale and limit oversupply. Within Industry 4.0, 3D printing technologies, the Internet of Things (IoT), virtual and augmented reality, artificial intelligence, modelling, and more offer significant opportunities, transforming traditional product design methods, manufacturing, marketing and sales.

Industry 4.0 Technologies lead to changes not only in design and production but also in fabrics. Smart textiles are becoming more viable, and their applicability is growing. Each new technology shapes the fashion industry's future, creating new opportunities in specific sectors and new challenges.

The significant carbon footprint of the global fashion industry is associated with several reasons. Berg et al. (2020) indicate that there are resource depletion and greenhouse gas emissions from the processing of fossil fuels to produce synthetic fibres, effective use of energy, water and chemicals associated with fibre crop production, and significant greenhouse gas emissions from recycling materials in the textile industry.

Consulting company McKinsey estimates that the most significant potential for reducing the carbon footprint in the global fashion industry is associated with operations related to the production of raw materials and their subsequent processing by the textile and light industries. Decarbonized textile materials manufacturing implies a 20% increase in energy efficiency in polyester production and a 40% reduction in pesticides and chemicals in cotton production (Berg et al., 2020).

Global fibre production reached 111 million metric tonnes in 2019, doubling in the last 20 years, and there is a likelihood of rising to 146 million metric tonnes by 2030 (Shirvanimoghaddam et al., 2020).

Fibres and yarns used in the fashion industry fall into two main categories: natural and synthetic fibres. Natural fibres exist in nature, such as cotton, wool, sisal, silk. CO_2 emissions in the case of natural fibres occur during preparation, planting and cultivation of fields (for weed control, mechanical irrigation, pest control, and fertilization), harvest and yield. In producing natural fibres, two fertilizers are commonly used, such as manure and synthetic chemicals (Morlet et al., 2017). The use of synthetic fertilizers results in a significant carbon footprint. One tonne of nitrogen fertilizers emits about 7 tonnes of greenhouse gases in CO_2 equivalent.

The ability of startups to innovate and attract the attention of large apparel brands is fundamental. According to Thin (2020), co-founder and CEO of the French startup Fairbrics, a significant proportion of fashion emissions—up to 40%—comes from the production of polyester, the most commonly used fabric. Fabrics startup uses electricity and a catalyst to convert fossil fuel carbon dioxide, a significant contributor to climate change, into synthetic fibres.

London-based Post Carbon Lab wants to further reduce emissions by converting fabrics into carbon-absorbing surfaces. Designers and researchers Dian-Jen Lin and Hannes Hulstaert use photosynthetic coating technology, introducing microorganisms such as seaweed. The resulting textiles with living organisms can absorb climate-changing carbon dioxide (Thin, 2020).

Industry 4.0 developments are focused on value chain segments due to the low-tech nature of the industry and the implications for the sustainability of fibre origins, production, and processing. Significant potential for reducing the carbon footprint in the global fashion industry is associated with operations related to the subsequent processing of raw materials by textile and light industries into finished fabrics and knitted fabrics. Consulting firm McKinsey estimates the potential for reducing the carbon footprint in this segment of the global fashion industry at 703 million tonnes of carbon dioxide (Berg et al., 2020).

Improvements in the processing of raw materials are by textile and light industries enterprises into finished fabrics and knitted fabrics with a transition to electricity from renewable energy sources, a decrease in energy consumption in spinning and weaving, and a transition to dry technologies for processing fibres from wet ones (Muthu, 2014).

The garment manufacturing process includes design, layout, cutting, pattern making, sewing, ironing, and finishing. According to recent research, the garment manufacturing process has relatively little environmental impact among other subprocesses. At the same time, it is necessary to consider waste in the production process, amounting to 10–15% of the loss of raw materials during an inspection, laying, cutting, and sewing. Consulting firm McKinsey estimates that the potential for reducing the carbon footprint of the garment manufacturing process is 90 million tonnes of carbon dioxide (Berg et al., 2020).

As noted in a study by the World Economic Forum, the Fourth Industrial Revolution Technologies can change production systems in the textile, clothing, and footwear industries in 12 ways through innovations in digital, physical, and biological technologies (Esposito, 2020).

Significant developments in the fibre industry are the long-standing cellulose fibres Tencel-Lyocell and Modal from Lenzing, Austria. Of interest for reducing the carbon footprint is Lenzing's new RefibraTM fibre, which uses cellulose from cotton trim as a raw material. The ultimate goal is to close the cycle for household waste as well. Technologies have become better chemically and mechanically. The challenge for manufacturers is to determine the chemical composition of the waste fibre streams. Digital technology can help solve this problem in the value chain.

The promising technology of the Fourth Industrial Revolution is the production of alternative natural fibres. These are textile fibres made from inedible plants or plant parts with a high cellulose content (e.g. pineapple leaves, coconut husks, banana stems). The source of fibre is agricultural waste, which often has little commercial value. It also includes natural textile fibres that can be used to alternative cotton and oil-based textiles, neat or in textile blends such as flax, hemp, bamboo, and seaweed. These plants can produce fibres with excellent renewable and biodegradable properties (Esposito, 2020).

There are several young companies actively developing promising technologies related to materials for the fashion industry. Bolt Threads, in particular, is another US biotech startup that uses proteins harvested from naturally occurring mushrooms to create a skin-like fabric called Mylo and a silky Microsilk fabric.

Shifting to greener materials is not the only way 4IR technology is being used to help the fashion industry move towards reducing its carbon footprint. Recently, various modern machinery and equipment, technologies, and processes have been used to reduce the carbon footprint of the textile industry, not only related to the achievements of 4IR. 4IR technologies allow minimizing the fashion industry's carbon footprint through automation and robotization of production and personalization (Niinimäki et al., 2020).

The capabilities of Industry 4.0 enable the smart factory concept to be realized in the world of fashion and footwear by integrating with sensors and automation functions of an increasing number of production lines, machines, components, and technologies. Smart manufacturing can optimize energy consumption and the manufacturing process, resulting in fewer defects and recalls, which means less waste.

Smart Factory also enables closer connectivity throughout the supply chain, connecting designers with manufacturers and manufacturers with retailers, resulting in faster, more informed decision-making and dramatically reduced time to market.

In March 2017, Amazon received a US patent for apparel on-demand, officially described as a system that uses custom software to pre-collect and analyses various requests for new clothing lines from around the world. Then some “effective plan” for the accelerated serial production of these products.

Many brands use automated storage and retrieval systems (ASRS) to store and transport products.

Robots and AI are one solution for a more climate-neutral sustainable fashion industry. Thanks to fully automated T-shirt production lines, a sewing robot from Tianyuan Garments, a significant manufacturer of sportswear brands such as Adidas and Reebok, can cut the fabric and sew a T-shirt in about four minutes. With the help of machine vision, sewing robots can detect fabric distortions and make the necessary adjustments. With a fully operational production line, automation is expected to reduce manual labour by 90%, bringing the cost of each T-shirt to 33 cents (Moran et al., 2021). Robots are also used to increase productivity in warehouses. At Amazon and Uniqlo’s flagship warehouses, robots have replaced up to 90% of human workers. Gap has also implemented a robotic system for picking and sorting goods and plans to triple the number of robots to 106 by fall 2020.

The 3D printing in the fashion industry is limited to accessories and, most notably, footwear due to plastic as its primary material. The 3D knitting allows companies to make products in small batches or on-demand, dramatically reducing excess inventory (Canonico, 2021). B2C companies using 3D knitting include the Ministry of Supply, a Boston-based high-performance business casual brand, and Son of a Tailor, a bespoke menswear brand from Denmark. Ministry of Supply offers the ability to personalize 3D printed jersey jackets in-store. Buyers can choose size, yarn, button, and colour. These brands highlight how technology reduces material waste to nearly zero compared to conventional waste in 21–35% of fabrics.

Both retailers and brands have experimented with VR and AR technologies to improve in-store and online shopping in the fashion industry. These retailers and brands include casual, fast, luxury, and contemporary clothing, from Gap and Zara to Neiman Marcus and Rebecca Minkoff, to name just a few.

Another area where 4IR technology can improve the fashion industry’s carbon footprint is reducing returns, which are currently a significant source of waste in the fashion industry (particularly in the e-commerce segment). According to the reverse logistics company Happy Returns, customers return up to 40% of online clothes and shoes. Reasons for refusals may include inappropriate size, features of patterns that are not suitable for a given customer, poor quality fabric, as well as the unsatisfactory quality of the item or tailoring. As a result, consumers send goods back to stores, clothes move between warehouse and store, increasing their carbon footprint. Reducing the percentage of returns will lead to lower carbon dioxide emissions. The virtual fitting function, supported by VR and AR technologies, can reduce the main risk of shopping online, reducing the likelihood of a return (Marques et al., 2019).

Platforms for resale and consignment, such as Depop, ThredUp, and Poshmark, which allow people to buy and sell second-hand clothes, have gained popularity as environmental friendliness is becoming increasingly important to consumers.

ThredUp went public in March 2021, raising $168 million. The company boasts nearly 2.4 million listings for more than 35,000 brands and reported revenue of

$186 million in 2020. Online second-hand bookstores will grow 69% between 2019 and 2021, compared with a 15% decline in the broader retail market in according to the online party report of the ThredUp platform (Thin, 2020).

Industry consensus analyst CB Insights expects the used clothing market to grow to $64 billion by 2028. RENTAL runway model and reselling The RealReal model maximize product lifecycle through reuse and incentivize consumers to buy less. They promote a circular economy where the use of resources and waste is minimized.

Large retailers are already gaining popularity. In August 2020, London-based retailer Selfridges announced a sustainability plan that includes sustainable apparel, apparel rental services, and second hand. The Cos brand, owned by H&M, also launched its own resale business. Meanwhile, fashion brands such as Anna Sui, Rodarte, and Christopher Raeburn have launched sales on the Depop resale platform to attract Gen Z shoppers.

A particular indirect potential for reducing greenhouse gas emissions is associated with smart retail technology (RFID tags, online and offline connectivity) (Canonico, 2021).

The use of big data allows production and logistics to be made more accurate and adapted to actual conditions, which means that the fashion industry's impact on the environment is reduced. Today, the value of each item includes huge logistics costs, inefficient overproduction, and sometimes storage of leftovers and dumping of unbought goods.

Frequent transport of goods is economically ineffective for companies, increases costs, and negatively impacts the environment. AI-powered services that help customers find the right products can help reduce returns and optimize the entire production and distribution chain. For example, in Russia, a fitting service was launched—Sizolution, based on big data processing technologies, which connects each client's individual preferences in terms of size and style with up-to-date product data. Solution not only reduces the number of returns but also increases customer confidence and shopping behaviour. Thanks to the power of data and artificial intelligence, brands can better account for shopping behaviour and customer preferences. Interaction with products that support augmented reality leads to a 94% increase in conversions, and the likelihood of a return on purchases made using virtual reality technologies is a quarter lower. Similar results reveal and study the Shopify platform: augmented reality to reduce the impact to 40%.

Another area of the fashion industry, which will inevitably affect the total output of products, is digital fashion, digital clothing, into reality. Digital fashion is a sustainable, extravagant, and unusual fashion trend. Digital outfits do not exist, but celebrities spend fortunes on virtual clothing. Russian designers have become pioneers in this direction. Digital apparel is connected with the demand for sustainable development; it is life trend style for Generation Z.

13.4 Conclusion

In the new emerging architecture of the world economy, global warming and sustainable development are playing an increasingly important role. Prospects for existing technologies ranging from AI smart factories, RFID tags, AI analytics and forecasting can minimize waste and improve the efficiency of fashion companies and their carbon footprint. Textile and garment factories can and should switch to clean energy.

While no alternative to natural fibres can replace cotton or take over a significant market share, combining these materials can significantly reduce the industry's environmental footprint. The technology is already improving the primary synthetic fibre polyester production and reducing the carbon footprint, but further research and investment are needed. Significant opportunities to accelerate sustainable production are associated with artificial cellulose fibres such as Tencel-Lyocell. It appears that existing efforts to scale up developments in new, more climate-friendly materials could benefit from a more clearly articulated government support system, similar to the way traditional fibre subsidies are used, for example, for the US cotton programme. Big data can dramatically improve consumer response and behaviour prediction. The next frontier has to do with AD and VR and virtual clothing.

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Chapter 14
Environmental Assessment of Companies and Organizations in Russia in the Context of Industry 4.0

Daria A. Averianova

14.1 Introduction

There is no denying that the planet's climate is changing significantly. Environmentalists warn of an increase in average annual temperatures, an increase in sea levels due to melting glaciers, a change in precipitation patterns, and an increase in natural anomalies such as droughts, floods, and hurricanes. The average global temperature has increased by about 1.1 °C since the eighties of the nineteenth century (Rowlatt, 2021). In 2020, the Northern Hemisphere land and ocean surface temperature was the highest in 141 years of observations. By 2050, global temperatures are projected to rise by 2.3 °C. A key factor in the temperature rise over the past two decades is certainly a large amount of greenhouse gas emissions into the atmosphere (CO_2, methane, nitrous oxide). The concentration of carbon dioxide in the atmosphere has increased by 67% since the beginning of the Industrial Revolution in the eighteenth century, with CO_2 emissions of about 2.5 trillion metric tons (McKinsey, 2020).

The use of fossil fuels accelerates climate change and has a detrimental effect on the environment. The average temperature of the planet will continue to rise until zero emissions are achieved. Today, it is extremely important for companies and organizations to take an active part in fighting climate change, reduce carbon dioxide emissions, and increase the use of renewable energy sources, etc. Konstantin Polunin, the partner in the Moscow office of BCG, outlined several reasons why it is beneficial for companies to be environmentally friendly: global competitiveness, signals from the government, demand from the public, and a sharp shift of job applicants toward environmentally friendly companies. For example, the German company Volkswagen has invested 1 billion Euros in a renewable energy project in order to provide itself

D. A. Averianova (✉)
MGIMO University, Moscow, Russia
e-mail: Averianova.D.A@gmail.com

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with energy from its on-site production. An effective carbon strategy and commitment to sustainability can be seen in many Fortune 500 companies. Bentley Motors implemented an energy management system to reduce energy waste and optimize energy consumption, which resulted in a 14% reduction. In Sweden, Coca-Cola uses reusable pallets, reducing costs by $700 million. World cement leader Dalmia Cement gets 32% of its raw materials from industrial waste (BCG, 2021a, b).

Modern technology and widespread digitalization are making a significant contribution to the “greening” of companies. With the help of the Internet of Things, it is possible to reduce the load on transportation, increase the safety level of cities, and save energy consumption. Predictive maintenance and timely repairs prevent accidents and leaks in production, which have a negative impact on the environment. In the oil and gas industry, there is an option to model the field, improve the efficiency of the drilling process, and reduce energy costs. Using drones, remote fields can be monitored; yield analysis can be performed, and special sensors in the production of steel companies can prevent unwanted oxidation of steel (Marr & Ward, 2020).

Swedish telecommunications equipment manufacturer Ericsson is using 5G technology to create a safer transportation ecosystem. It provides the connectivity necessary for the safe introduction of electric cars on the road. In turn, the switch to automated transport would reduce CO_2 emissions by 90%. The Digital Owl drone, developed by Fujitsu of Japan, provides conservationists in the Australian state of New South Wales with the information they need about endangered species or invasive plants, while significantly reducing costs and emissions. Using artificial intelligence and the Internet of Things (IoT), IBM is working with Portuguese technology company Compta Emerging Business to develop an innovative product for firefighting, detection, and control (DigitalES, 2020). Tata Steel uses machine learning to optimize production processes, and in-depth analytics significantly reduces material waste and saves about 50 million Euros per year (Lorenz et al., 2020).

The organization of the workplace can also have an impact on mitigating the effects of climate change. By improving the office space and making it more environmentally friendly, companies/organizations create new eco-savings habits for employees, increase their interest in caring for the environment, make them think about moderate consumption, etc. A modern green office will allow companies/organizations to prioritize energy saving and energy efficiency, essential tools in the fight against climate change (Heinänen, 2021).

14.2 Methodology

The purpose of the study is to assess the level of environmental friendliness of public organizations, large, medium (100–250 employees), and small companies/organizations (fewer than 100 employees) in Russia in terms of workspace and process. The methodology of the work is based on theoretical and empirical analysis. The theoretical part included a review of sources and literature on the topic of green companies in Russia. The empirical part of the study included a survey of respondents regarding the environmental friendliness of their offices.

The survey involved 130 people working in Moscow and the Moscow region, as well as other major Russian cities such as St. Petersburg, Yekaterinburg, Tomsk, Rostov-on-Don, and Vladivostok.

The largest percentage of respondents, 24%, is employees of large Russian companies/organizations, including Gazprom, Yandex, SIBUR Holding, Sberbank, Russian Railways, and Rosneft. 19% of the respondents work in the Russian offices of major international companies, such as AliExpress, EY, KPMG, McKinsey & Company, Mars, BCG, BBDO Group, Google, Dentsu International, and PepsiCo. 18% of respondents work in state organizations: State Duma of the Federal Assembly of the Russian Federation, Ministry of Foreign Affairs of Russia, Ministry of Internal Affairs of Russia, MGIMO University, National Research University Higher School of Economics, Russian Academy of National Economy and Public Administration. Employees of medium and small companies/organizations account for 10% and 17% of the total number of respondents, respectively. The remaining 12% are individual entrepreneurs in retail, education, construction, etc.

The survey consisted of 13 questions aimed at assessing the office of Russian companies/organizations in terms of compliance with environmental principles:

1. Does your company/organization have a zero-waste policy?
2. Which suppliers and partners does your company/organization prefer?
3. Does your company/organization collect and dispose of unnecessary items (e.g., old clothes, shoes, books, batteries)?
4. Does your company/organization collect and dispose of plastic?
5. Do you have containers for separate waste collection in the office?
6. Does your company/organization organize different eco-events (e.g., clean-up day)?
7. Does your company/organization provide environmental awareness to employees (e.g., a "weekly newsletter" about careful consumption)?
8. Does your company/organization incorporate modern technology into the work process?
9. Do you mostly use single-use dishes in the office?
10. How often do you print documents at work?
11. Do you use double-sided printing?
12. How often do you use air-conditioning in the workplace?
13. Does your company/organization use energy-saving technology?

During the survey, employees supplemented their responses with comments, which were extremely helpful in getting the most objective view of the organization of office space in Russia.

14.3 Results

Question No. 1 “Does your company/organization have a zero-waste policy?” The main goal of this policy is to achieve a maximum reduction of waste, based on 5 principles: the rejection of waste, reduction of consumption, reuse, recycling, and composting of waste (Simon et al., 2020). Only, 28% of employees responded positively to this question, while 72% gave a negative answer. Table 14.1 clearly shows that the zero-waste policy mainly applies only to large international companies (67%); in all other cases, the share of companies/organizations that follow the zero-waste policy does not exceed 32%, among medium and small companies they are 8% and 4%, respectively.

Question No. 2 “What suppliers and partners does your company/organization prefer?” was aimed at identifying the genuine interest of companies/organizations of the Russian Federation in improving the environment. Only, 14% of the companies are careful in their choice of suppliers in terms of environmental friendliness, while 49% do not consider it is important, 37% of respondents were unable to answer the question. Several individual entrepreneurs responding to the question stated that for some products it is impossible to find suppliers who meet all the principles of environmental friendliness. Moreover, in today’s pandemic environment, making a profit is much more important to many sole proprietors in Russia than being environmentally friendly. Table 14.2 shows that most companies/organizations in Russia do not yet consider it is important to select suppliers and partners according to the criterion of environmental friendliness.

The next few questions helped determine what eco-initiatives Russian companies/organizations offer and how successful they are. To question No. 3 “Does your company/organization collect and dispose of unnecessary things (e.g., old clothes, shoes, books, batteries)?” 29.1% of respondents gave a positive answer; 47.2% said No, and 23.6% could not give a definite answer. Table 14.3 shows that, for the most part, large international and large Russian companies (46 and 39%) are involved in collecting unnecessary items. For example, BCG’s Moscow office has special containers for collecting old shoes and clothes for charity, and BBDO employees

Table 14.1 Distribution of answers to question no. 1 by working groups

	Yes (%)	No (%)
Large international company	67	33
Large Russian company	32	68
Medium Russian company (100–250 people)	8	92
Small Russian company (up to 100 people)	4	96
Governmental organization	23	77
Sole proprietor	20	80

Source Compiled by the author based on collected data

Table 14.2 Distribution of answers to question no. 2 by working groups

	Important (%)	Not important (%)	Hard to answer (%)
Large international company	25	25	50
Large Russian company	13	45	42
Medium Russian company (100–250 people)	23	38	38
Small Russian company (up to 100 people)	9	83	9
Governmental organization	9	41	50
Sole proprietor	7	67	27

Source Compiled by the author based on collected data

collect old phones and other equipment for recycling. However, the share of companies that collect unnecessary items for reuse or recycling, even among the large Russian and international, does not exceed 50%. As for individual entrepreneurs, state organizations, medium and small Russian companies, such eco-initiatives, are held by only a small percentage and are usually limited to the collection of waste paper or batteries once every six months.

Question No. 4 "Does your company/organization collect and recycle plastic?" showed that the majority of companies in the Russian Federation (57.9%) do not collect and recycle plastic (Table 14.4).

Question No. 5 was about the possibility of separate waste collection with the following answers: Yes, my company/organization has containers for separate waste collection, and all employees try to sort waste; Yes, my company/organization has containers for separate waste collection, but employees do not sort waste; No, my company/organization has no containers for separate waste collection. According to the survey results, 67.7% of companies/organizations do not have containers for separate waste collection in their offices. The opportunity to sort garbage is provided mainly to employees of large international companies (75%). It is worth noting that in some large international companies (13%), this opportunity is not used. For example, at EY, the employees do not sort the garbage, despite the availability of

Table 14.3 Distribution of answers to question no. 3 by working groups

	Yes (%)	No (%)	Hard to answer (%)
Large international company	46	25	29
Large Russian company	39	39	22
Medium Russian company (100–250 people)	15	70	15
Small Russian company (up to 100 people)	17	66	17
Governmental organization	27	41	32
Sole proprietor	20	60	20

Source Compiled by the author based on collected data

Table 14.4 Distribution of answers to question no. 4 by working groups

	Yes (%)	No (%)	Hard to answer (%)
Large international company	46	13	41
Large Russian company	19	52	29
Medium Russian company (100–250 people)	7	85	8
Small Russian company (up to 100 people)	13	87	0
Governmental organization	0	68	32
Sole proprietor	13	67	20

Source Compiled by the author based on collected data

special containers, reasoning that there is no time and no point, because later all the garbage is piled into a common pile. On the contrary, the employees of the large Russian company Mercury would like to sort the garbage in the office, but they do not have special containers for this (Table 14.5).

Questions No. 6 and No. 7 allowed us to find out how strongly companies/organizations in Russia motivate and educate their employees about environmental issues. To question No. 6 "Does your company/organization organize different eco-events (e.g., clean-up day)?" 46.5% of respondents answered that their company/organization does not conduct any eco-events; 13.4% of respondents said that their company/organization conducts such events, but the majority of employees do not participate in them; 24.4% found it difficult to answer the question posed. Only, 15.7% of companies have eco-events in which most employees participate, and many of them are large international companies (29%). For example, Dentsu International has an eco-event called "Bike to Work" for which employees are rewarded with fruit. It is worth noting that, according to many survey participants, the number of eco-events in their companies dropped sharply after the COVID-19 pandemic (Table 14.6).

Table 14.5 Distribution of answers to question no. 5 by working groups

	Yes, sort (%)	Yes, do not sort (%)	No (%)
Large international company	75	13	12
Large Russian company	16	7	77
Medium Russian company (100–250 people)	0	0	100
Small Russian company (up to 100 people)	22	0	78
Governmental organization	14	9	77
Sole proprietor	13	13	74

Source Compiled by the author based on collected data

Table 14.6 Distribution of answers to question no. 6 by working groups

	Yes, most people participate (%)	Yes, most people do not participate (%)	No (%)	Hard to answer (%)
Large international company	29	21	17	33
Large Russian company	19	13	39	29
Medium Russian company (100–250 people)	7	8	77	8
Small Russian company (up to 100 people)	9	4	74	13
Governmental organization	14	23	36	27
Sole proprietor	6	7	60	27

Source Compiled by the author based on collected data

Analysis of the answers to question No. 7 revealed that only 19.5% of companies/organizations are engaged in environmental education; 64.1% of companies/organizations are not doing it. Small and medium-sized Russian companies are not at all interested in employee awareness of environmental issues. The leaders in environmental education of employees among workgroups are large international companies (46%). For example, in the Russian office of KPMG, employees receive an email every Monday about the importance of energy conservation, and special webinars on sustainable development and the importance of ecology are held with a certain frequency (Table 14.7).

Question No. 8 allowed evaluating the level of technological development of Russian companies/organizations. Modern technologies are actively implemented by 36.7% of companies/organizations, mostly large international and Russian companies (79% and 48%, respectively) with significant financial capabilities; 24.2% of respondents said that their companies/organizations try to use modern technologies,

Table 14.7 Distribution of answers to question no. 7 by working groups

	Yes (%)	No (%)	Hard to answer (%)
Large international company	46	29	25
Large Russian company	29	45	26
Medium Russian company (100–250 people)	0	100	0
Small Russian company (up to 100 people)	0	100	0
Governmental organization	18	64	18
Sole proprietor	7	73	20

Source Compiled by the author based on collected data

but not actively; 28.1% of companies/organizations do not implement modern technologies in their work process. Among them are individual entrepreneurs (60%), who cite a lack of additional funds and the need for automatization. According to many sole proprietors, all the work processes in their companies are quite simple; in addition, any technological modernization will require additional costs for staff training, which is extremely unprofitable (Table 14.8).

The last five questions focused on the organization of the workplace and the willingness of companies/organizations in the Russian Federation to engage in the formation of environmental awareness among employees. The answers to question No. 9 "Do you mostly use disposable tableware at the office/workplace?" indicate the desire of many companies/organizations in Russia to reduce the amount of waste and the use of plastic. Disposable tableware is used only in 20.3% of companies/organizations. The lowest indicator is in small Russian companies—9%. 60.2% of companies/organizations use porcelain or glassware, with the leaders being state organizations (73%), medium and small Russian companies (69 and 70%). 19.5% of survey participants prefer to eat at the nearest café or restaurant (Table 14.9).

About 400 million tons of paper are used worldwide each year; rational consumption of paper conserves natural resources and reduces toxic waste (Rudevich, 2020). Questions No. 10 and No. 11 help determine how careful employees in different companies/organizations are about paper consumption. The results of the answers to question No. 10 "How often do you have to print out documents at work?" are as follows: every day print out documents—28.1%, print out documents more than 1–2 times a week—17.2%, print out documents less than 1–2 times a week—29.7%, do not print out documents at work—25% (Table 14.10).

To question No. 11 "Do you use double-sided printing?", 60.2% of respondents answered positively, and 39.8% answered negatively. The majority of employees in all workgroups under consideration try to use paper economically, especially in

Table 14.8 Distribution of answers to question no. 8 by working groups

	Yes, active (%)	Yes, not active (%)	No (%)	Hard to answer (%)
Large international company	79	13	8	0
Large Russian company	48	14	19	19
Medium Russian company (100–250 people)	23	46	23	8
Small Russian company (up to 100 people)	22	30	35	13
Governmental organization	23	36	36	5
Sole proprietor	0	20	60	20

Source Compiled by the author based on collected data

Table 14.9 Distribution of answers to question no. 9 by working groups

	Yes (%)	No (%)	Eat out (%)
Large international company	37	50	13
Large Russian company	19	65	16
Medium Russian company (100–250 people)	23	69	8
Small Russian company (up to 100 people)	9	70	21
Governmental organization	18	73	9
Sole proprietor	13	27	60

Source Compiled by the author based on collected data

Table 14.10 Distribution of answers to question no. 10 by working groups

	Every day (%)	More than 1–2 times a week (%)	Less than 1–2 times a week (%)	Do not print (%)
Large international company	12	4	42	42
Large Russian company	26	29	26	19
Medium Russian company (100–250 people)	31	8	31	30
Small Russian company (up to 100 people)	35	13	30	22
Governmental organization	50	23	14	13
Sole proprietor	13	20	40	27

Source Compiled by the author based on collected data

government organizations (82%). Although it should be emphasized that often in medium and small Russian companies, as well as among individual entrepreneurs, the economic use of paper is not due to careful consumption and concern for the environment, but rather to the intention of reducing administrative costs (Table 14.11).

Question No. 12. "How often do you use air-conditioning in the workplace?" the problem with using air-conditioning is that a large number of cooling systems require a huge amount of electricity, which in turn increases carbon dioxide emissions, and many air conditioners use refrigerants (e.g., Freon) that deplete the ozone layer. Air conditioners are not installed only in 14.2% of companies/organizations and mainly because of cost savings. 51.2% of companies/organizations have special air-conditioning systems of class A+ and A++, which consume less electricity. 34.6% use class A or B air conditioners (Table 14.12).

Table 14.11 Distribution of answers to question no. 11 by working groups

	Yes (%)	No (%)
Large international company	54	46
Large Russian company	52	48
Medium Russian company (100–250 people)	46	54
Small Russian company (up to 100 people)	61	39
Governmental organization	82	18
Sole proprietor	67	33

Source Compiled by the author based on collected data

Table 14.12 Distribution of answers to question no. 12 by working groups

	A, B (%)	A+, A++ (%)	No air conditioner (%)
Large international company	29	71	0
Large Russian company	45	52	3
Medium Russian company (100–250 people)	62	38	0
Small Russian company (up to 100 people)	39	39	22
Governmental organization	23	45	32
Sole proprietor	27	33	40

Source Compiled by the author based on collected data

The last question is related to the use of energy-saving technology in offices. The results of the survey revealed that energy-saving technologies are used in 26% of companies/organizations. The leaders again were large international and Russian companies with 34% and 32%, respectively. The next were individual entrepreneurs and small Russian companies (27 and 26%), who more often proceed from the goals of saving energy costs. The most common energy-saving appliances are LED lights, indoor motion detectors, and A++ computers. Employees of many large international and Russian companies added that in the office they are constantly asked to turn off unused appliances from the network. Nevertheless, 31.5% of respondents stated that their companies/organizations are not equipped with special energy-saving equipment. As a rule, these are state organizations (46%), individual entrepreneurs (53%), medium and small Russian companies (31 and 35%). The majority of respondents (42.5%) could not give a precise answer to the question asked (Table 14.13).

If we display the results of the survey on the graph (Fig. 14.1), we can observe the following picture: the leaders in "environmental friendliness" among companies/organizations in Russia are mostly large international companies, followed by large Russian companies. State organizations and individual entrepreneurs are in the middle. Medium and small Russian companies are the environmental anti-leaders (Fig. 14.2).

Table 14.13 Distribution of answers to question no. 13 by working groups

	Yes (%)	No (%)	Hard to answer (%)
Large international company	34	8	58
Large Russian company	32	26	42
Medium Russian company (100–250 people)	15	31	54
Small Russian company (up to 100 people)	26	35	39
Governmental organization	18	46	36
Sole proprietor	27	53	20

Source Compiled by the author based on collected data

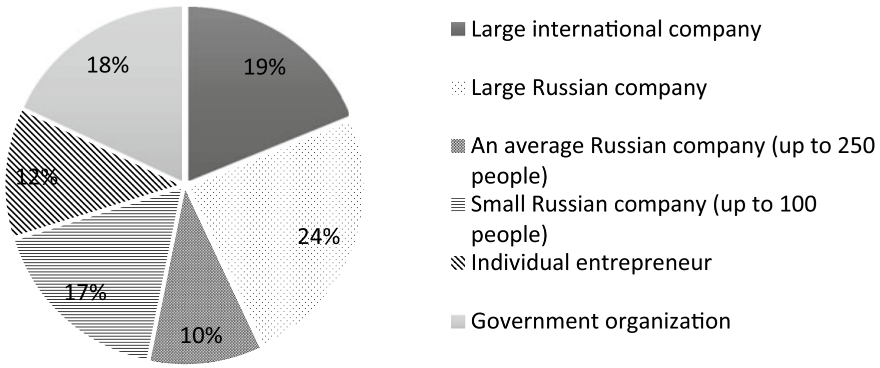

Fig. 14.1 Place of work of the surveyed employees. *Source* Compiled by the author based on collected data

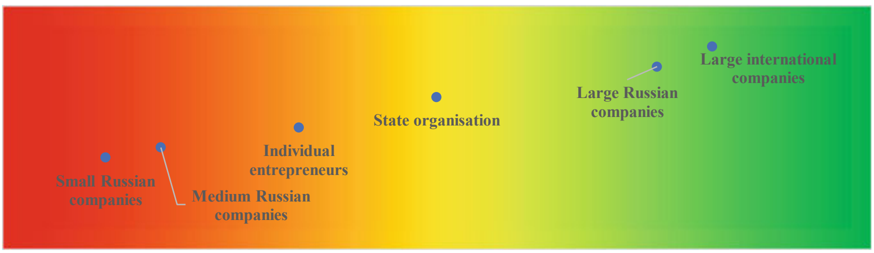

Fig. 14.2 Distribution of Russian companies/organizations according to their "environmental friendliness" level. *Source* Compiled by the author based on collected data

It is important to note that Russia has been paying special attention to the environment for the last 1.5 years, which was largely influenced by the diesel fuel spill in Norilsk in May 2020. Nornickel was ordered to pay a fine of 146.1 billion rubles and the head of Rosprirodnadzor began inspecting all major Russian enterprises for compliance with environmental norms and standards (Podcerob, 2021). Having analyzed what had happened, Nornickel seriously upgraded its ESG strategy for business development until 2030 and actively engaged in the program to reduce environmental risks. In March 2021, Vladimir Potanin, Chairman of the company's Management Board, stated that the transition to a green economy creates significant competitive advantages. Thus, some new environmental initiatives have emerged in the company. In addition to keeping the air clean, the focus is now on waste management and tailings management, biodiversity conservation, land reclamation, and responsible water consumption. An important goal of the company is to keep emissions from the production below 10 million tons (BCG, 2021a, b).

Evraz, a mining and metallurgical company in Russia, pays attention to the environment by reducing its annual water consumption from 226 to 207 million tons, reducing greenhouse gas emissions to 1.97 tons of CO_2 equivalent per 1 ton of steel, and exceeding its waste recycling target of 95%. Evraz metallurgical plants located in Novokuznetsk and Nizhny Tagil participate in the Clean Air project. Maxim Epifantsev, Evraz's director for environmental coordination, said that 10 projects worth 6.4 billion rubles should be implemented by 2025, which will reduce atmospheric emissions by 62,600 tons. So far, the company has already implemented six projects, which have reduced emissions by 22,000 tons (Pahomova, 2021).

An example of a company in Russia that uses the benefits of digitalization to improve the environment is Megafon. The company actively uses modern Internet of Things technology in its work. According to Natalya Burchilina, head of the company today, to control certain things, it is necessary to be able to measure them. "Megafon Ecology" project allows industrial companies to manage emissions and plan the work process intelligently (Pahomova, 2021).

According to a study by the Russian Institute of Directors and Sberbank, which analyzed three components of the approach to ESG strategy: Russian companies develop regulations and competently formulate the principles of the ESG concept, but many companies fail to implement and monitor their implementation. Regarding the environmental aspect, Russian companies focus only on compliance with legal requirements and try to minimize the risk of fines. Only, a small share of Russian companies takes voluntary environmental initiatives, such as the implementation of the "green office" program (RID, 2021).

Researchers from the South Federal University, Chelyabinsk State University, and National Research University Higher School of Economics conducted a study of the environmental activities of Russian corporations. After examining missions of the 100 largest Russian companies from five industries (transport, chemical production, hydrocarbon production, electricity generation and transmission, ore and coal mining), the researchers found that only 18.5% of the companies are publicly engaged in environmental issues, most of which are in the top 25–100 leading companies in the country, except for Rosneft (top 10 largest companies in Russia). Although the above indicator is generally similar to the global average, it cannot be ignored that only a small number of Russian companies demonstrate active "pro-environmental" behavior. Nevertheless, Russian business leaders are striving for it. In terms of industries, the following picture emerges: the environmental component is in the missions of 67% of mining companies, 47% of energy companies, 40% of chemical and 33% of carbon companies, 20% of companies in the transport industry. The key environmental items for Russian companies were energy efficiency, the greening of production, development of environmental standards, as well as environmental protection (Molchanova et al., 2020).

14.4 Conclusion

Thus, assessing the environmental friendliness of Russian companies in terms of organizing office space, the following positive points can be noted: many companies/organizations in the Russian Federation do not use disposable dishes, save paper, and try to print less. Moreover, the COVID-19 pandemic has forced more and more companies/organizations to switch over to electronic document management. The vast majority of Russian offices are equipped with A+, A++ class air conditioners, which consume less energy. Russian companies/organizations also strive to introduce modern technologies into work processes; some do it not as actively as large international companies, and in the case of private business, there is almost no technological modernization; in general, the trend is favorable. The leaders in the "green office" criterion are large international and Russian companies.

Nevertheless, there are currently more negative moments in domestic companies/organizations in terms of environmental friendliness. Firstly, it is obvious that while companies/organizations in Russia have not yet developed a genuine interest in complying with environmental norms and rules, companies/organizations often do not care with whom to cooperate; today, they are more guided by profit indicators and cost reduction. Secondly, the vast majority of Russian companies/organizations has no "zero-waste" policy, no containers for separate waste collection, and rarely offers eco-initiatives such as plastic recycling or collection of things for recycling. The exceptions are large international companies. Thirdly, Russian companies/organizations have little motivation to motivate their employees to take care of the environment. They organize a few eco-events and do almost nothing to educate their employees about the environment, especially small and medium-sized Russian companies stand out on this point.

At the moment, companies and organizations in Russia are not very concerned about complying with environmental norms and regulations. The priority for them is revenue and profit margins. The exception is largely international and Russian companies. Domestic small and medium-sized companies, as well as government organizations and individual entrepreneurs, need to introduce digital technologies into the work process and carry out project activities in the field of the green economy. Also, Russian companies need to more actively attract financing from the global market with the help of "green bonds," through cooperation with international and Russian institutional investors (Khmyz, 2003).

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Chapter 15
Development of National Systems of Green Finance in the Context of Industry 4.0

Maksim V. Petrov, Vasiliy N. Tkachev, and Igor B. Turuev

15.1 Introduction

Currently, an increasing number of states declare the transition to a low-carbon resource-saving green economy as their long-term socio-economic development strategy. Its implementation requires large-scale investments in reducing greenhouse gas emissions and sustainable environmental management. Thus, in the 2020s, the need for investments for the green transformation of the EU economy within the framework of the European Green Deal is estimated at 260 billion euros per year (The European Green Deal Investment Plan and Just Transition Mechanism). It is obvious that the mobilization of such significant financial resources requires the formation of effective national systems of green finance, which would allow attracting capital from various sources and ensure its high availability to a wide range of investors in environmental projects, including large and medium-sized companies, innovative startups, and research centers.

In recent years, the processes of formation of the NSGFs in the world have significantly accelerated, and in a number of countries they have reached a fairly high level of development. The dynamics of growth, the scale, and structural features of such systems are determined by a set of factors, in particular, the state policy in the field of green transit, the capacity of the domestic financial market and the degree of social responsibility of the business sector. Industry 4.0 is also having an increasingly noticeable impact on the formation of green finance today. The study of the current state, problems, and prospects for the development of NSGFs is the purpose of this article.

M. V. Petrov (✉) · V. N. Tkachev · I. B. Turuev
MGIMO University, Moscow, Russia
e-mail: maxim2769@mail.ru

I. B. Turuev
e-mail: igor.turuev@gazprombank.ru

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15.2 Methodology and Literature Review

As part of the study of the NSGFs, the following issues are considered in the article: (a) the content of the concept of the NSGF; (b) basic features of national models of the NSGFs; (c) forms and directions of state participation in the NSGFs; and (d) the role of digital technologies in the development of the NSGFs. The research methodology in the article is a system analysis that allows analyzing NSGFs as integral objects, identifying their structural elements and establishing relationships between them. The work is based on the study of academic literature, publications of international organizations, information and consulting agencies, and statistical materials.

Despite the relative novelty of the concept of green finance, which entered scientific circulation only in the early 2000s, a rather significant and actively growing array of publications devoted to the study of this phenomenon has been accumulated to date. First of all, it is necessary to highlight the works analyzing the general issues of the functioning of green finance, including their definition, principles of organization, functions, and institutional structure. Among the recent publications of this kind, we note the following: Arkhipova (2017), Berensmann and Lindenberg (2016), Bogacheva and Smorodinov (2018), Ezroj (2021), Porfiryev (2016), Rubtsov et al. (2018), Sachs et al. (2019), and Thompson (2021).

Another layer of literature is represented by publications that consider individual institutions and instruments of green finance, in particular, green banks, bonds, stocks, and loans. As an example, we can mention the works of Banga (2019), Barua (2020), Chebanov (2019), Heine et al. (2019), Miroshnichenko and Brand (2021), Tyutyukina and Sedash (2020).

In the context of the topic of this article, studies of green finance systems in the various countries are of particular interest. The objects of study were the NSGFs and their individual segments in China (Hu et al., 2020; Peng et al., 2018), India (Jha & Bakhshi, 2019), Germany (Schafer, 2017), Japan (Schumacher et al., 2020), Russia (Bazhenov 2018; Semenova et al., 2020), and in some other states.

Separately, we should mention the works studying the impact of Industry 4.0 on green finance. The number of such publications has been rapidly increasing recently. Most of them are devoted to analyzing the prospects for using blockchain technology. The authors note that the introduction of this technology, although it is fraught with technical difficulties and risks, can give a serious impetus to the development of green finance, in particular, by expanding the ability to control the targeted use of funds invested in green bonds and other financial assets and thereby increasing the transparency and investment attractiveness of their markets: Dorfleitner and Braun (2019), Dorofeev (2020), and Marke (2018).

To date, there is a consensus in the academic literature and in the expert community about the need for the rapid formation of green finance systems at the national and international levels as a key factor in the successful green transformation of the economies of individual countries and the world economy as a whole. However, there are still serious discrepancies on a number of significant aspects, including the interpretation of the concept of green finance (OECD, 2020; Porfiryev, 2016;

Tarkhanova & Fricler, 2020), assessment of the role of the government in their development, risks to financial stability arising from the use of green instruments and ways to regulate them.

15.3 Results

An analysis of national green finance systems should begin with a definition of this concept. This is a methodologically difficult task, since generally accepted criteria for classifying certain financial instruments, services and institutions as “green” have not been developed. This makes possible various interpretations of green finance. In a broad sense, they include any financing of investments that contribute to the achievement of positive environmental effects, including those carried out by non-specialized financial institutions using traditional instruments of financing. An example is the allocation by a commercial bank of a loan to a company for the implementation of an investment project for the modernization of industrial production, primarily pursuing commercial goals, but at the same time allowing reducing emissions into the environment. In a narrow sense, green finance includes only specialized financial instruments and institutions (e.g., green bonds and investment funds) used to finance a limited list of green areas of economic activity (electricity generation from renewable energy sources, waste disposal, etc.) according to the accepted taxonomy. Note that, the taxonomy of green activities may differ significantly from country to country (OECD, 2020).

The considered approaches to the definition of green finance have their advantages and disadvantages. A broad interpretation lays the conceptual basis for the implementation of measures to greening of national and global financial systems and increasing their contribution to solving global environmental and climate problems: Arkhipova (2017) and Spinaci (2021). At the same time, it dilutes the concept of green finance and makes it difficult to study. A narrow interpretation, on the other hand, allows for a clearer definition of the boundaries and structure of “green” finance, which facilitates their research and statistical observation. However, in our opinion, it somewhat simplifies the essence of green finance and leaves out of the field of view of researchers the processes of greening traditional finance.

In this paper, it is proposed to include in the category of green finance financial products and services that are used to finance green investments on a targeted basis, providing for a preliminary assessment of environmental results and monitoring their achievement. This interpretation allows us to classify as green finance not only specialized innovative products and services that have appeared in recent years in connection with the development of green investment, but also classical instruments, in particular, corporate loans, leasing products and venture financing, if they are provided in a targeted manner for the implementation of projects with a positive environmental impact. At the same time, instruments and mechanisms for financing projects, the green effects of which are not assessed or monitored by investors, are not classified as green finance. In this regard, we can say that green finance is a sphere of financial relations, the participants of which set the goal of obtaining not only economic, but also environmental return on investment, and make efforts to achieve it (or, at least, declare it).

Based on the proposed criteria, *the national system of green finance can be defined as a set of financial institutions, as well as markets for financial instruments and services that provide targeted financing of environmentally oriented (green) projects and economic activities.*

The NSGFs of the countries are at different stages of formation. The USA, a number of EU countries, Japan, UK, Canada, Australia, China, and some other states, which consistently pursue a policy of green transformation of the economy, have made the most progress in building green finances. The NSGFs of these countries are characterized by the following features: (a) a variety of sources of financing for green investments; (b) developed institutional structure that includes a wide range of financial institutions, infrastructure, and service organizations (exchanges, investment platforms, crowdfunding platforms, verification agencies, etc.); and (c) availability of sufficiently capacious, rapidly growing markets for green finance instruments (green bonds, loans, etc.) (Table 15.1). All of these factors increase the availability of financial resources for green investments.

Since the formation of NSGFs of the countries took place almost simultaneously in the conditions of coordination of efforts and an active exchange of experience by countries of their construction, they have a noticeable similarity in terms of the typology of existing green financial institutions and the financing instruments used, as well as approaches to regulating this area. At the same time, the NSGFs have its own specific features, primarily due to significant differences between states in the level of development of individual markets for green financial instruments and the role of institutions serving them in the institutional structure of the NSGFs. It can be assumed that these differences, in turn, are largely determined by the specifics of national models of financial intermediation. This is quite understandable, since green finance appears in every country not from scratch, but within the framework of the existing financial system, the structural features of which affect the emerging model of the NSGF.

It should be emphasized that this assumption needs further elaboration and clarification as the necessary statistical information becomes available, especially on the green loans market. Currently, there are no recognized sources of international statistical information on the national markets of green loans. Nevertheless, it can be preliminarily illustrated with a few examples.

The USA has the most developed stock market in the world, which plays a dominant role in their financial system. Therefore, it is quite natural that the largest market of green bonds has developed in this country (Table 15.2). In terms of the total value of bonds issued, the USA in 2020 was almost two times ahead of China, which ranked second in the world. The main investors in the bonds, as well as in the shares of environmentally oriented companies, are American investment funds that adhere to the principles of socially responsible investment (ESG). Their assets are growing rapidly and reached $304 billion in mid-2021, almost doubling compared to the same period in 2019 (Morningstar, 2021). At the same time, the market for green loans

Table 15.1 Financial institutions and instruments for financing green investments

Financial institutions	Financial instruments
National development institutions: Traditional banks, corporations and development agencies Specialized green banks, funds and agencies	Loans, credit guarantees and insurance Green project financing Investments in the capital of green companies and financial institutions Grants for small and medium green businesses
Commercial banks	Green corporate loans Green project financing Green mortgage Green car loans for the purchase of electric vehicles Other green credit products Investments in green debt and equity securities
Leasing companies	Financial and operational leasing of environmental and technological equipment, machines and vehicles used in environmentally friendly projects and activities
Institutional investors: Investment funds, including specialized green funds Pension funds Insurance companies Investment companies	Investments in green securities, including: green bonds, including asset-backed bonds (ABS) shares of green companies shares of income-generating companies (Yieldco) and real estate investment trusts (REITs) holding renewable energy assets
Green venture funds and private equity funds	Investments in the capital of startups and growing companies implementing green projects or developing green technologies

Source Compiled by the author

that meet the Green Loan Principles of the Credit Market Association in the United States is relatively small. According to Nordea estimates, in terms of the volume of loans issued, which amounted to less than $10 billion per year in 2019–2020, the North America region (USA and Canada) was about 2.5 times lower than Europe and two times lower than the Asia-Pacific region (Nordea, 2020). Thus, the available data make it possible, albeit with reservations about the lack of statistical information, to assert about the formation of the NSGF model in the USA focused primarily on the stock market.

The core of China's financial system is a huge banking sector, the size of which it is far ahead of other countries. Therefore, in China, although it has the second largest green bond market after the United States, credit institutions traditionally play a key role in financing green investments. The total volume of loans provided by 21 leading Chinese banks to finance investments in three strategic sectors (energy conservation and environmental protection, new energy and energy vehicles), as well as for the implementation of green investment projects in other areas, amounted to 11.6 trillion yuan ($1.8 trillion) by the end of 2020 (China Banking and Insurance

Table 15.2 National green bond markets

Country	Market size in 2020, USD billion		Main issuers
	New issues	Accumulated volume	
USA	52.1	223.7	Fannie Mae (40% of the market), financial institutions, state and municipal governments, non-financial corporations
Germany	41.8	93.3	Government, KfW, financial institutions, government-backed entities, non-financial corporations
France	37.0	124.3	Government, non-financial corporations, government-backed entities
China	22.3	129.6	Financial institutions, non-financial corporations, government-backed entities
Japan	10.6	26.15	Financial institutions, government-backed entities, non-financial corporations

Source Compiled by the author based on the Climate Bonds Initiative

Regulatory Commission). Of course, the data provided by the Chinese regulator cannot be directly compared with the indicators of green lending in other countries, calculated using other approaches, as a rule, more narrowly interpreting the concept of green loans (Sa, 2020). However, they undoubtedly indicate a significant scale of the green bank lending market in China, which forms the basis of its NSGF.

The financial intermediation model in Japan is mixed. It is characterized by an important, but not dominant role of the banking sector with a high level of development of other financial intermediaries, including state financial institutions. These features are reflected in the system of green finance in Japan. The volume of green bonds issued in 2020 amounted to $10.6 billion, green loans-$7.8 billion (Ministry of the Environment Government of Japan, 2021), i.e., there is an approximate parity in the use of these instruments. The main issuers of bonds include Japanese banks (e.g., Mitsubishi UFG and Sumitomo Mitsui Banking Corp.) and other financial institutions, which accounted for about half of the total volume of securities issued in 2014–2020, as well as government financial and non-financial organizations. The largest green bond issue in the amount of $1 billion was carried out in 2017 by the Development Bank of Japan.

Historically, Germany has a bank-oriented model of the financial system with a well-developed debt securities market. Therefore, it is quite natural that credit institutions, including commercial, mortgage, savings, land, and cooperative banks, as well as the state development bank KfW, are the key participants of the German NSGF. In particular, they predominate in the structure of issuers of green bonds in Germany. The major player is KfW, which issued in 2014–2020 such securities totaling 30.9 billion euros (about 40% of all green bonds issued in the country) (KfW, 2021). The funds raised were directed by KfW mainly to finance renewable energy projects, which allowed Germany to become one of the world leaders in this field. Leading issuers of green bonds also include Berlin Hyp, Deutsche Hypo, Deutche

Bank, Commerzbank, and Landesbank Baden-Wuerttemberg. A special niche in the German NSGF is occupied by small alternative banks specializing in green and sustainable investments, including GLS Bank, EthicsBank, Umweltbank, and Pax-Bank. At the same time, the importance of stock market institutions in the German NSGF is relatively low, as evidenced by the small size of the national industry of green investment funds, whose assets in 2018 amounted to only 2.5 billion euros-only 7% of the total assets of European green funds (Novethic. The European Green Funds Market 2018).

Currently, the development of national systems of green finance occurs both through the emergence of new financial institutions (e.g., specialized public, private and hybrid investment funds and banks) and products initially focused on the targeted support for green investments, as well as through the greening of the business of existing traditional financial organizations that are adapting their product line and, sometimes, organizational structure in accordance with the principles of green and sustainable financing.

In most countries, a significant role in the formation of the NSGF belongs to the state, which is interested in attracting private capital to the environmental sector with the help of green financial instruments and institutions. Governments are making efforts to improve the institutional environment for the development of green finance, and also provide financial support to private investors in green projects through subsidies, grants, concessional loans, and guarantees (Heine et al., 2019). To do these states can create new green development institutions (for example, Green Investment Bank in the UK, later privatized) or reorient existing institutions to support green investments. In some countries, especially in Germany, China and Brazil, state-owned development banks are one of the key elements of NSGFs, serving as a catalyst for their growth. They themselves actively invest in environmental projects, attract capital from private sources, in particular by issuing green bonds, and sometimes act as developers of innovative green financial products. So, in 2019 China Development Bank invested $132 billion in environmental projects, German KfW-32.6 billion, Agence Française de Développement-7.1 billion, BNDES-2.2 billion (IDFC Green Finance Mapping Report 2020).

In order to fund the green transformation of the economy, states resort to the issue of sovereign green bonds. By the end of 2020, the number of issuing countries reached 21, and the total value of issued securities approached $100 billion. Among the largest issuers are Germany (two issues for $13.6 billion), France (one issue for $7.5 billion). USD), Poland (four issues for $4.3 billion) (Climate Bonds Initiative…, 2021). States' participations in the green bond market enhance investor interest in it and stimulates market growth.

Digital technologies have recently become a significant factor in the development of green finance. The main effect of their implementation is that they increase the opportunities for targeted investment in environmentally oriented projects for a wide range of investors, including retail, and thereby contribute to the growth of green finance markets. This is ensured primarily through the development of new technological solutions that simplify and make it more accessible for everyone to invest in renewable energy, waste disposal and recycling, biodiversity conservation, and other green activities. Such opportunities are offered by green fintech startups appearing in large numbers today, specialized crowdfunding platforms, as well as software applications launched by financial institutions that help investors work in the market of green financing, in particular, to form investment portfolios with an environmental focus.

A good example of a green fintech company is Aspiration Corporation, founded in 2013 in the USA. It offers savings, settlement and investment products that enable consumers to earn income and simultaneously participate in reducing greenhouse gas emissions and protecting the environment. The corporation promises that clients' funds will not be used to finance polluting industries, including oil and coal production. In mid-2021, the number of Aspiration's clients has reached 5 million, which confirms the attractiveness of the concept of socially and environmentally responsible behavior proposed by it. The emergence of such fintech companies as Aspiration, offering innovative solutions in the field of green investment, adapted to different categories of consumers, in the nearest future can become an important driver of the development of the NSGFs.

Many researchers believe that the widespread adoption of blockchain can become another factor in the growth of green finance (Dorfleitner & Braun, 2019; Dorofeev, 2020). This technology makes it possible to establish effective control over the targeted use of funds and the achievement of planned environmental effects when investing in green debt instruments, and thereby increase the transparency and attractiveness of their markets. This is possible due to the fact that all information about the debt instrument, including the issuer's obligations and execution reports, entered into the blockchain and confirmed by digital signatures, cannot be changed in the future and remains available to investors. Thus, they get the opportunity to minimize their financial and reputational risks associated with inappropriate spending of funds. The first blockchain platform for green investors was the Green Assets Wallet (GAW), developed in 2017 by the Swedish non-profit organization Stockholm Green Digital Finance. The platform contains structured information on the fulfillment of financial and environmental obligations by issuers of green bonds, as well as relevant verifier reports, providing access to the posted information for investors.

15.4 Conclusions

The article examines the processes of formation of national systems of green finance. It is shown that NSGFs of the countries has a lot in common, but there are also structural features, which are manifested primarily in significant differences between states in the level of development of individual markets for green financial instruments and the role of various types of financial institutions in financing green investments. The example of several countries shows that such differences may be related to the specifics of national models of financial intermediation. This allows us to explain why the NSGF, which is formed in the United States, like the entire financial system of this country, is more focused on the stock market, whereas the NSGF of China and Germany is focused on the banking sector.

NSGFs also differ in the scale and forms of state participation. In particular, this reveals itself in the different role that national development banks and agencies play in the NDGFs. In some countries, e.g., in Germany and China, they are a backbone element of the NSGFs. At the same time, in the USA and the UK the role of such organizations is relatively small.

In recent years, the development of green finance in many countries has accelerated markedly. This is facilitated by the introduction of digital technologies in green financing. Thanks to the development of innovative solutions, green fintech startups, specialized investment applications, and platforms are emerging. They offer investors new, simpler, and more affordable ways to operate in the green finance market. Thus, fintech expands opportunities for targeted investment in environmentally oriented projects for a wide range of investors, including retail, and thereby contributes to the inflow of capital into the green finance markets.

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Chapter 16
Applying Digital Technology to Combat Climate Change in Russia and the EU

Natalia S. Zagrebelnaya and Anastasia V. Sheveleva

16.1 Introduction

Multiple scientific studies conducted in recent years demonstrate that our planet's climate is constantly changing, and first and foremost the global warming. Moreover, this global environmental problem has threatening consequences for humanity: Many species of flora and fauna are dying out, ecosystems are being destroyed, and in some countries, unbearably hot weather and floods are lasting for a long time. In this regard, more and more countries are striving to reduce greenhouse gas emissions, which are the main cause of climate change.

For example, European Union countries in 2019 adopted an environmental development strategy, the European Green Deal, which is a plan to create a carbon–neutral space by 2050. At the same time, the EU tightened its 2030 Climate Target Plan, raising the minimum target for emissions reductions from 40 to 55% from 1990 levels. And in June 2021, the European Council adopted the "Climate Law," which gives carbon neutrality, to be achieved by 2050, a legally binding status and requires all EU countries to achieve it.

Russia is also not far from climate problems. The Ministry of Economic Development of the Russian Federation in 2020 prepared a strategy for the long-term development of Russia with low greenhouse gas emissions until 2050. The strategy envisages two scenarios of low-carbon development: the baseline and intensive, according to which Russia should reduce emissions by 36% and 48% respectively by 2050 compared to 1990 levels. Carbon neutrality is to be achieved by 2100.

The realization of the goals set by the EU countries and Russia requires the application of appropriate measures, one of the main places among which is occupied by digital technologies. Firstly, cloud platforms based on visualization, forecasting, and

N. S. Zagrebelnaya (✉) · A. V. Sheveleva
MGIMO University, Moscow, Russia
e-mail: nzagrebelnaya@mail.ru

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machine learning technologies make it possible to optimize and transform companies' core business processes, which, in turn, will reduce their carbon footprint. Secondly, thanks to artificial intelligence, companies will be able to obtain real-time information on emissions, promptly account for them, and develop ways to minimize them. Thirdly, by creating a unified system of dispatch control, companies will be able to prevent emergencies and, accordingly, the accompanying harmful emissions.

In this regard, of particular interest is a comparative analysis of the use of digital technologies to combat climate change in Russia and the EU.

16.2 Methodology

The authors have studied a large amount of scientific literature on the aspect under study, as a result of which the existing points of view on this issue were identified and the authors' vision was formulated that the use of digital technology not only expands communication capabilities, makes financial, commercial and government services more accessible, increases the efficiency of business processes of companies, but also accelerates the achievement of all seventeen UN Sustainable Development Goals, including the thirteenth goal "Taking urgent action to combat climate change and its impacts". General issues of digitalization and the use of digital technology have already been addressed in some detail in the works of Russian and foreign authors Abd-Rabo and Hashaikeh (2021); Corejova and Chinoracký (2021); Ershova et al. (2020); Kleinert (2021); Konina (2021a, 2021b); Rysina (2021); Sekerin et al. (2019); Sheveleva and Zagrebelnaya (2020); Sheveleva et al. (2021); Vasil'eva et al. (2021).

The main trends and directions of digital technology in Russia are presented in several papers Kamensky (2020); Romanovskaya et al. (2021); Sidorova (2018); Zhura and Markin (2019).

Some scholars have devoted their work to the application of digital technology in the EU (Bednarčíková and Repiská (2021); Edverton (2021); Kopkova and Manukalov (2018); Konina (2018); Sheveleva et al. (2020); Tsirenshchikov (2019)).

There are also separate studies of the role of digital technology in achieving sustainable development goals, conducted by Russian and foreign authors Abdul Karim, et al. (2021); Bekmurzaev et al. (2021); Benkhider and Kherbachi (2021); Elmassah and Mohieldin (2020); Fedulova (2020); Holzinger et al. (2021); Viktorova et al. (2019).

The issues of using digital technologies in the implementation of the sustainable development goal have been studied to a lesser extent Bettini et al. (2020); Lapão (2020); Sheveleva et al. (2021).

Thus, it can be concluded that the above-mentioned works are devoted to certain aspects and directions of digitalization and the topic of the application of digital technologies to combat climate change in Russia and the EU remains understudied. In this regard, the authors of this chapter suggest that the inclusion of digital technologies in the development strategies of the EU and Russia as a method of combating climate change will allow these countries to achieve the goals of a low-carbon economy in the future.

By taking a systematic approach, the authors have been able to examine some isolated aspects, which were previously considered separately. In particular, digitalization processes, sustainable development goals, climate change, and long-term development strategies of Russia and the EU have been studied together.

The analysis revealed that digital technologies play an important role in the fight against climate change, that the EU and Russia are beginning to apply them to achieve this goal, and that some progress has already been made in this direction.

In conclusion, the authors have drawn the following conclusions, using methods of generalization, synthesis, and comparative analysis of the data studied.

16.3 Results

In recent years, the problem of climate change has worsened, according to the US Federal Office of the National Aeronautics and Space Administration (NASA) only over the past 20 years, the average ambient temperature has increased by more than 2.5 times, that is there is active global warming (Fig. 16.1).

The ongoing climate change poses several threats, such as the extinction of many animal and plant species, the destruction of ecosystems, and flooding. According to the results of the analysis on the map of the organization Climate Central, which is engaged in climate research, the newspaper India Times compiled a list of cities that

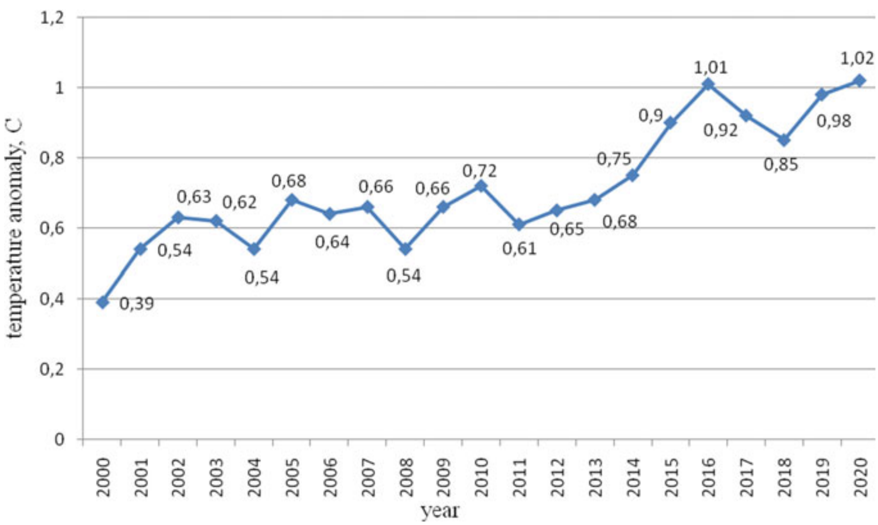

Fig. 16.1 Land–ocean temperature index (C). *Source* Compiled by the authors according to NASA's Goddard institute for space studies (GISS)

will be under the water by 2030. Among them are: Amsterdam in the Netherlands, the Iraqi port of Basra, New Orleans in the USA, Italian Venice, Ho Chi Minh City in Vietnam, and Calcutta in India.

Scientists call the main cause of global warming carbon dioxide emissions into the atmosphere as they create a greenhouse effect. At the same time, an implementation by some countries of the Kyoto Protocol provisions, beginning of the fulfillment of obligations under the Paris Agreement, transition to alternative energy sources have not yet brought positive results, emissions growth is observed. Thus, for the period from 2000 to 2019, global CO_2 emissions increased by almost 36%, in 2020 they decreased by 6%, but this happened due to the coronavirus pandemic, and according to preliminary calculations in 2021, this indicator will increase again (Fig. 16.2).

In this regard, countries began to highlight the goal of zero emissions in their development strategies and actively develop national regulations that make carbon neutrality legally binding.

In the EU countries in 2019, an environmental development strategy, the European Green Deal, was adopted 2019. This is a plan to create a carbon–neutral space by 2050, which includes the following activities:

- EU countries allocate 1–2% of their GDP to create new industrial infrastructure and new "green" jobs, re-equip production, and develop new areas of research and development;
- Increasing transition funding and mobilizing at least 1 trillion euros to support sustainable investment over the coming decades through the EU budget and InvestEU (a program to attract public and private investment through EU budget guarantees) (A European Green Deal, 2019).

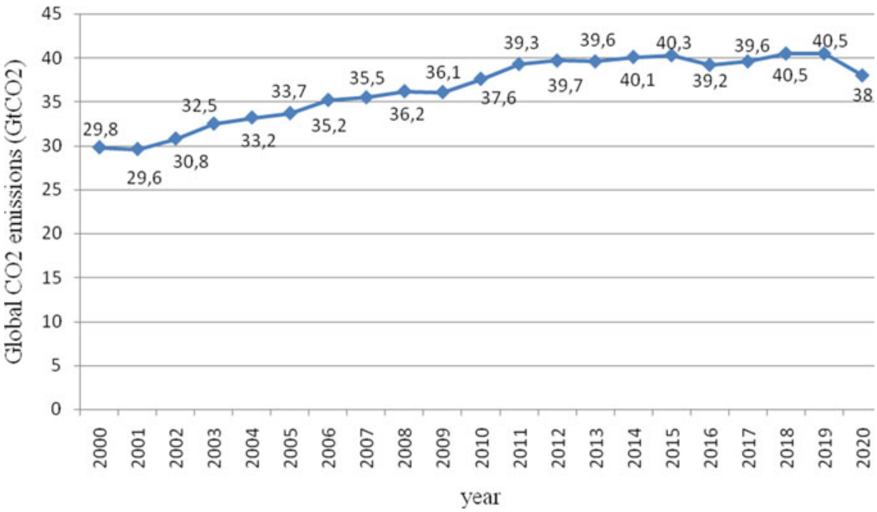

Fig. 16.2 Global CO_2 emissions. *Source* Compiled by the authors according to global CO_2 emissions have been flat for a decade, new data reveals

In June 2021, the European Council adopted the "Climate Law," which makes carbon neutrality a legally binding goal. The law outlines new targets, in particular reducing emissions from 40 to 55% of 1990 levels by 2030, the proposal of a target for the period up to 2040, an indicative budget for greenhouse gases for 2030–2050. To assess the consistency of EU countries' actions and progress in the implementation of climate goals, the law proposes to create a scientific advisory committee. It is also planned to introduce a mechanism of cross-border carbon regulation, under which a specially created authorized body will sell certificates for goods imported into the EU carbon-intensive production within a specified list. The tool of this regulation will be the introduction of a cross-border carbon tax on imported goods, the amount of which will depend on the amount of CO_2 emissions during the production of these goods.

The mechanism for implementing the above goals in the EU countries is spelt out in the new "Industrial Strategy for a globally competitive, green and digital Europe," which was presented by the European Commission in 2020. According to this document, by 2050, EU countries must achieve such long-term goals as climate neutrality and digital leadership. As a result, EU countries have begun to actively implement digital technologies to combat climate change.

In 2020, the European Commission adopted the EU Digital Strategy, which included provisions on the principles of developing the legal regulations necessary to develop and implement artificial intelligence. The main principle is that humans will retain full control over the decisions made by artificial intelligence, including those related to combating climate change. In particular, according to the strategy, artificial intelligence should reduce climate risks in various industries.

Artificial intelligence technology provides an understanding of the nature of climate processes and possible scenarios for their development. Artificial intelligence will be used to process and systematize large amounts of climate data collected by satellites, which will make it possible to make more accurate forecasts. Thanks to artificial intelligence, it will be possible to take into account uncertainties in climate models and scenarios. Given the above, society and the environment will be able to adapt more effectively to the future situation.

British scientists working at the Antarctic Research Directorate within the Turing Institute have trained artificial intelligence in an algorithm that predicts future changes in the ice sheet and provides an interpretation of the results of these predictions, helping to understand how climate variables affect each other in time and space.

Experts at Google's DeepMind UK lab are using artificial intelligence to predict the amount of production and demand for energy that wind farms can produce, resulting in suppliers more effectively integrating renewable resources into the national grid, as well as reducing CO_2 emissions.

Artificial intelligence helps scientists discover new materials and model their new properties, allowing them to replace old materials whose use is associated with high greenhouse gas emissions.

Artificial intelligence is helping to optimize the transportation sector by reducing the number of trips, increasing vehicle efficiency, and replacing the most polluting modes of transportation with more environmentally friendly unmanned vehicles.

Artificial intelligence, by analyzing satellite imagery, will be able to determine where exactly the greatest harm is being done to the environment, such as where forests are excessively cut down, which accumulate carbon dioxide through photosynthesis for years, and irresponsible agricultural activities, resulting in large amounts of this gas being released into the atmosphere. This will protect these natural stores of CO_2.

The leader in the implementation of digital technology among EU countries is Germany. Experts of the industry association of the German information and telecommunications industry Bitkom have calculated that by introducing digital technologies in the processes of combating climate change by 2030 the country will be able to reduce annual greenhouse gas emissions by 120 million tons compared with the figures for 2019. With the help of digital technology will better regulate the volume of emissions, so, for example, the introduction of these technologies in industry will lead to a reduction of emissions by 35–61 million tons, in the transport sector—by 17–28 million tons. Of course, experts note that the production of digital technologies themselves involves greenhouse gas emissions, but this is five times less than the result of their use (Germany can achieve dramatic reductions in CO2 emissions by investing in digital technology, 2020).[1]

Russia has also adopted some documents aimed at combating climate change and achieving carbon neutrality (Tyaglov et al., 2021). Thus, the Ministry of Economic Development of the Russian Federation prepared and in October 2021 approved by order of the Government of the Russian Federation the Strategy of socioeconomic development of the Russian Federation with low greenhouse gas emissions until 2050. The Strategy provides two scenarios of low-carbon development: basic and intensive, according to which Russia by 2050 should reduce emissions by 36% and 48% respectively compared to 1990 levels. Carbon neutrality is to be achieved by 2100.

The intensive scenario of the Strategy provides for the introduction of digital technologies in the transport sector and technological processes in the sectors of the economy, to reduce carbon dioxide emissions from their operation. The main focus of the Strategy is on the smart "digital" management of energy resources consumption in sectors of the economy, which is designed to contribute to the reduction of energy consumption and greenhouse gas emissions.

In addition, the Federal Greenhouse Gas Emissions Control Act was passed on July 2, 2021, and is scheduled to take effect on December 30, 2021. This law introduces a phased-in model for regulating greenhouse gas emissions without taxation and mandatory payments but based on mandatory carbon reporting, which must be submitted by the largest emitters of greenhouse gases. Thus, an information base

[1] Germany can achieve dramatic reductions in CO2 emissions by investing in digital technology.—https://plus-one.ru/news/2020/11/26/germaniya-mozhet-dobitsya-rezkogo-sokrashcheniya-vybrosov-co2-za-schet-vlozheniy-v-cifrovye-tehnologii.

is created, which will be based on digital technologies to manage greenhouse gas emissions in the economy and its industries.

Also to combat climate change, the Ministry of Natural Resources and Environment of the Russian Federation in June 2021 developed a draft strategy for the digital transformation of the ecology and natural resource management industry. This Strategy, first of all, defines the main approaches to achieve “digital maturity” for the period 2021–2030 (the ability to develop individual approaches and methods of digital transformation of the environmental industry) for companies that harm the environment. Big data technologies, the Internet of things (IoT), and artificial intelligence are considered key digital technologies.

A priority area of digital maturity is the creation in Russia of an Integrated Information System for monitoring the state of the environment in the Russian Federation, which will provide timely information on the state of the environment and forecast its changes. This will enable the Unified Environmental Dispatch to make effective decisions in the field of ecology and environmental protection.

As part of the initiative “New Climate Policy” provides for measures to create a federal center for climate services, which will provide information and analytical support for the implementation of a unified state policy of the Russian Federation on climate for sustainable development of the country—following the Climate Doctrine of the Russian Federation, including information and analytical support for the development of the regulatory framework and the organization of state regulation in the field of climate change.

The Strategy for Digital Transformation of the Ecology and Natural Resources Sector also involves automating the processes of planning, conducting, and analyzing the results of control and supervisory activities in the field of rationing, accounting and control of negative impact on the environment.

The implementation of the Strategy for Digital Transformation of the Ecology and Natural Resources Sector should result in the achievement of the following results in comparison with 2020, in particular:

- it will be possible to prevent damage caused by polluted waters by more than 8%;
- using artificial intelligence technologies, about 80% of unauthorized landfills will be identified;
- 10% more residents will be protected from the negative impact of accidents occurring on water bodies (Draft Strategy for Digital Transformation of the Ecology and Natural Resources Industry, 2021).

Russia has initiated the intensification of joint work on climate change and environmental protection within the Eurasian Economic Union. EAEU member-states (the Republic of Armenia, Republic of Belarus, Republic of Kazakhstan, Kyrgyz Republic, and Russian Federation) need to jointly develop and introduce green technologies and implement innovative projects in this area. In May 2001, the President of the Russian Federation V. V. Putin at the meeting of the Supreme Eurasian Economic Council proposed to create a bank of climate data and digital initiatives, including carbon footprint accounting. It is necessary to build a transparent system of accounting for CO_2 emissions using digital tools.

For Russian companies, reducing their carbon footprint should become part of their development strategy and cover the entire value chain. However, it is important to track not only our CO_2 emissions but also those present in the company's value chain. In this regard, appropriate tools are needed to help collect the necessary emissions data and conduct their qualitative analysis, resulting in companies can draw conclusions and adjust their production processes in real time.

For example, Russian companies Surgutneftegaz and Severstal are investing in energy efficiency monitoring systems. Based on more than 2500 metering devices, Severstal, using predictive analysis and machine learning technology, not only forecasts energy consumption more accurately but also monitors anomalies. Thus, digital tools and artificial intelligence help these companies neutralize the number of emissions into the atmosphere.

Angara Technologies Group, a Russian information security system integrator, helps companies in the petrochemical, oil and energy industries to keep their heat-exchange equipment clean by using a new physical cleaning principle controlled by digital technology. This reduces fossil fuel consumption and carbon dioxide emissions by up to 40% without stopping the companies' technological processes.

Thus, we can conclude that digital technologies play an important role in combating climate change, both in the EU and in Russia. At the same time, there are both similarities and differences in their application in these countries (Table 16.1).

As can be seen from the table, both Russia and the EU countries reflect in their development strategies the possibility of using digital technologies to combat climate change; they have adopted laws aimed at preserving the climate, but only Russia mentions digital technologies as a way to achieve the goals set. And in Russia and the EU countries, artificial intelligence is considered as a priority digital technology for solving the problem of climate change, at the same time in Russia for these purposes it is supposed to use big data and the Internet of things (IoT). In the EU countries, there are no priority sectors in which digital technologies should first be applied to combat climate change, while Russia primarily emphasizes the environmental and natural resource management, petrochemical, oil and energy, and transport sectors. For the EU countries, the main objectives of digital technology to combat climate change are to reduce climate risks, the systematization of large amounts of data, the development of climate models, more accurate predictions of climatic parameters, and for Russia—to monitor the environment and predict its changes, taking into account the carbon footprint. In any case, both EU countries and Russia believe that the use of digital technology to combat climate change will reduce CO_2 emissions and achieve carbon neutrality. Only in the EU countries, it is planned to implement by 2050 and in Russia only in 2100.

16.4 Conclusions

With the aggravation of the problem of climate change as a result of the growth of CO_2 emissions into the atmosphere, all countries in the world, including the EU countries

Table 16.1 Comparative analysis of the use of digital technologies to combat climate change in Russia and the EU

Comparison criteria	Russian federation	EU countries
Reflecting digital opportunities to combat climate change in development strategies	In the strategy of socioeconomic development of the Russian federation with low greenhouse gas emissions until 2050, the strategy of digital transformation of ecology and nature management industry	In the industrial strategy for a globally competitive, green and digital Europe, the EU digital strategy
Existence of a legal and regulatory framework governing the use of digital technologies to combat climate change	The federal law "On limiting greenhouse gas emissions" is passed	The climate law is passed, but there is no mention of digital technology
Priority digital technologies for combating climate change	Big data technologies, the internet of things (IoT), and artificial intelligence	Artificial intelligence technology
Industries that should apply digital technologies to combat climate change first	In the sectors of ecology and environmental management, petrochemical, oil and energy industries, transport sector	In various sectors of the economy. In Germany, primarily in industry and transportation
The main goals of applying digital technologies to combat climate change	Environmental monitoring and forecasting of environmental changes, carbon footprint	Reduction of climate risks, systematization of large amounts of data, development of climate models, more accurate prediction of climate parameters
Expected results from the application of digital technologies to combat climate change	Reduce CO_2 emissions and achieve carbon neutrality by 2100	Reduce CO_2 emissions and achieve carbon neutrality by 2050

Source Compiled by the authors based on the results of the study

and Russia, are forced to look for new ways to solve it. The practice has shown that one of the ways to increase resource and energy efficiency, and as a consequence, to reduce emissions, is digital technology. In this regard, green transformation, based on digital technologies, has become an important part of many national development strategies affecting the fight against climate change.

EU countries have adopted some strategic documents and regulations aimed at creating a carbon–neutral space. In particular, a new Industrial Strategy for a globally competitive, green and digital Europe has been adopted, which has intensified the application of digital technologies to combat climate change. European countries put the main emphasis on artificial intelligence, believing that it is this technology that will reduce climate risks, as it becomes possible to collect process climate data and make predictions and scenarios of events, which makes it possible to take preventive measures to contribute to adaptation to the future situation and reduce emissions.

Russia is also actively involved in combating climate change and in its development strategies and regulatory documents provide for the use of digital technologies to achieve results in this area. In addition to artificial intelligence, Russia also proposes the use of big data and the Internet of things. As a priority area of their application, Russia considers environmental monitoring, accounting and control of the negative impact on the environment, which will make it possible to promptly adjust the production and business processes of companies and help neutralize the number of emissions into the atmosphere.

A comparative analysis of the use of digital technologies to combat climate change in Russia and the EU has shown the following. In the countries under study, strategic documents addressing this aspect have been adopted; artificial intelligence is a priority digital technology in solving this problem; digital technology should lead to reduced CO_2 emissions and carbon neutrality. However, only in Russia is the use of digital technologies to combat climate change regulated at the legislative level; in addition to artificial intelligence the possibility of using other digital technologies to address the identified problem is also considered; priority sectors in which these technologies are primarily to achieve the desired climate goals are identified. Also in the countries under consideration, there are differences in the main objectives of the use of digital technologies to combat climate change: in the EU, it is primarily the reduction of climate risks, while in Russia, the carbon footprint. And the timing of the expected results of the use of digital technologies to combat climate change are different: in the EU it is 2050, in Russia 2100.

In any case, the use of digital technology is considered by Russia and EU countries as one of the new ways to finally help deal with the problem of climate change.

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Chapter 17
Industry 4.0 Climate Risk Management in International Oil & Gas Companies

Anastasia V. Sheveleva and Maxim V. Cherevik

17.1 Introduction

At a time when some international organizations regulating greenhouse gas emissions into the environment are tightening requirements for activities in the extraction, processing and transportation of oil and gas, the UN Sustainable Development Goal aimed at combating climate change is becoming increasingly important for oil and gas companies, forcing them to integrate climate change mitigation issues into their strategies and operations.

The introduction of Industry 4.0 technologies is one of the most effective means to solve this problem. At the same time, their implementation is associated with many risks; to minimize these oil and gas companies find themselves driven to rebuild an existing risk management system or introduce a brand new one. An analysis of Russian and foreign sources showed that this problem, due to its novelty, has not yet received sufficiently deep coverage. In this regard, the analysis of risk management of combating climate change based on Industry 4.0 in international oil and gas companies is quite relevant and has a practical use, since it allows the management of oil and gas companies to make more informed and effective decisions to minimize the risks associated with the introduction of digital technologies into their activities.

A. V. Sheveleva (✉) · M. V. Cherevik
MGIMO University, Moscow, Russia
e-mail: a_sheveleva@rambler.ru

M. V. Cherevik
e-mail: mxcherevik@yandex.ru

E. G. Popkova and B. S. Sergi (eds.), *Current Problems of the Global Environmental Economy Under the Conditions of Climate Change and the Perspectives of Sustainable Development*, Advances in Global Change Research 73, https://doi.org/10.1007/978-3-031-19979-0_17

17.2 Methodology

The authors analyzed many sources on the aspect under study, which made it possible to identify existing approaches and give the author's proposals on this issue.

The issues of integrating Industry 4.0 technologies into the processes of ensuring sustainable development of industrial companies in general, and the oil and gas sector in particular, are covered in the works of international and Russian authors (Zavyalova & Starikova, 2018; Bobylev et al., 2018; Daneeva, 2019; Konina & Sapir, 2021; Konina et al., 2021; Lomachenko, 2020; Sheveleva & Zagrebelnaya, 2020; Stonehouse & Konina, 2020).

Some works deal with the use of digital technologies to combat climate change (Bettini et al., 2020; Lapão, 2020; Sheveleva et al., 2021).

However, it should be noted that the above works do not consider either the risks or methods of risk management of digitalization in the oil and gas sector. This area remains practically unexplored. In this regard, we suggest that the introduction of digital technologies in the fight against climate change is fraught with several threats, which can be dealt with by a large-scale update of the existing risk management system.

The use of analysis and synthesis methods made it possible to identify the major risks for international oil and gas companies caused by the digitalization of the processes as they fight against climate change, as well as to present a model of an updated risk management system adapted to the specifics of Industry 4.0.

Based on the results of the study, conclusions were drawn and the relevant recommendations were given.

17.3 Results

According to PricewaterhouseCoopers, the Sustainable Development Goal (SDG) "Taking urgent action to combat climate change and its impacts, ranks first in the business strategies of oil and gas companies (PWC, 2019).

This is due to them being required to comply with the requirements set by international organizations regulating greenhouse gas emissions, primarily carbon dioxide (CO_2) and methane (CH_4).

Having realized the urgency of the problem of climate change, major international oil and gas companies have already begun to implement Industry 4.0 technologies in their operations to reduce greenhouse gas emissions.

In a broad sense, Industry 4.0 implies a cyber-physical system that combines digital and analog technologies, labor resources, the Internet of things, services, people and energy (Tupa et al., 2017).

Specifically, for the oil and gas industry, this means the use of digital technologies and solutions such as artificial intelligence, cognitive analytics, digital twins, unified dispatch control systems, CO_2 capture, utilization and storage technologies, Big Data, automated emission accounting systems, drones and robots.

By integrating them into practice, it becomes possible to manage devices and equipment remotely in real-time, which, in turn, contributes to prompt obtainment of analytical information, predicting and preventing problems and failures before they occur, and accordingly allows for avoiding or preventing leaks and accidents that can lead to the release of greenhouse gases into the atmosphere.

At the same time, the use of Industry 4.0 technologies is associated with some risks:

(1) technological;
(2) managerial;
(3) financial;
(4) socio-psychological;
(5) informational;
(6) risks of interaction with counterparties (Kuznetsova, 2018).

It should be noted that given the vertically integrated organization principle of most of the major oil and gas companies, these risks arise throughout the entire value chain.

Technological risks are due to digital technologies being integrated into existing facilities and already running production processes. In our opinion, the following examples of risks are most significant in this category:

- violation of technical standards when introducing new technologies;
- breakdown of electronic equipment;
- communication systems failures.

Oil and gas companies are based on a production principle. Their operational activities are strictly framed by technological regulations and standards having been developed over the years of practice. When such solutions as automation or robotization are being introduced, it is happening based on the existing facilities and requires significant work at the stage of designing. At the same time, there is a high risk of violating production standards and safety practices by eliminating the presence of technical personnel in the field, especially with old projects.

A lot of deposits are located in extreme weather and climatic conditions: heat, cold, wind, sand, permafrost, etc. These conditions can lead to the failure of digital equipment and, as a consequence, the impossibility of executing control over the processes.

The realization of this risk can be caused by some factors, many of which cannot be directly influenced by the company itself: weather, cyberattacks, failure of the infrastructure of telecom service provider, etc. In any of these scenarios, the company loses the ability to control its processes on sites, which can lead to several negative physical, economic, and social consequences.

To reduce the likelihood of the above risks being realized, we believe it expedient to follow the following recommendations:

- taking into account weather, climatic, and other physical parameters at the planning stage to prevent equipment failure in extreme conditions;
- testing new configurations using “digital twins” before actual implementation to prevent cases of electronic equipment failure;
- exercise regular monitoring of the condition of the equipment and its timely maintenance;
- provide backup communication and control systems to ensure the facility’s operability in the event of a failure of the main system;
- ensure the presence of minimum necessary technical personnel in the field or within the limits of quick access to them for prompt response to failures and accidents.

The next category of risks is *managerial* ones, arising since the introduction of digital technologies requires a restructuring of the existing organizational structure of the company as well as its planning and control processes.

The most significant practical examples in this category include the following:

- excessive bureaucratization;
- inadequate distribution of access rights to current information between divisions.

Industry 4.0 technologies allow transferring and interpreting large amounts of data in a short time. Oil and gas companies, due to their hierarchical management structure, are usually characterized by excessive bureaucratization of processes, which leads to delays in the decision-making process and does not allow making the maximum use of the digital technologies’ potential.

The above-mentioned principle of hierarchical management structure also leads to the fragmentation of the information flow coming from various divisions of the company, negatively affecting the rapid formation of a complete picture of what is happening. In addition, some functional divisions often avoid exchanging data with other divisions without instructions “from above”, which also negatively affects the speed of response to incoming information.

As countermeasures, we consider it reasonable to highlight the following recommendations:

- partial departure from the hierarchical organization structure, introduction of matrix principles and making better use of horizontal links between divisions;
- adequate distribution of access rights between divisions to achieve synergy from prompt information exchange;
- acceleration of control procedures and decision-making on the improvements.

The next important category of risks is the *financial* ones associated with the costs of financing Industry 4.0 projects.

The main examples in this category are:

- the fast pace of technology development;
- varying viability of different types of technologies;
- possible incompatibility of certain Industry 4.0 technologies with the processes/material base of the company of earlier generations (Statista, 2020).

The pace of digital technologies' development is quite high: equipment generations change almost every year, making it difficult for companies to create long-term competitive advantages in the field of digitalization.

In addition to proven "mature" technologies (automation and robots, remote control systems, predictive maintenance, digital customer services), there are new areas (cognitive computing, digital data exchange via blockchain, and smart contracts) that have not yet been tested on a large-scale and are characterized by higher implementation costs and risk levels (WEF, Accenture, 2017).

As a response to these risks, we propose to address the following considerations:

- capital investment pays off by digital technologies reducing operating costs significantly (WEF, Accenture, 2017);
- investment in technologies that have proven their effectiveness in practice should be considered primarily;
- it is advisable to conduct an in-depth analysis of the design conditions of the project before implementing any specific digital technology;
- it is necessary to take into account the regional regulatory framework (in terms of subsidies, benefits, etc.).

In recent years, the largest international oil and gas companies have accumulated some experience in the implementation of Industry 4.0 technologies (BP's exploration techniques based on machine learning, Austrian OMV using the digital twin of its Schwechat refinery for increasing its efficacy). It is advisable to adopt the already successfully tested solutions.

The choice of a particular technology should be dictated by a set of design conditions (climatic, infrastructural, production) and the company's goals.

Activities aimed at achieving climate goals, as well as fostering digitalization, receive diverse (and often uneven) support from individual states. Choosing a technology that is eligible for subsidies or other incentives increases the financial return on its adoption (Potts, 2021).

With Industry 4.0, as with previous technological revolutions, the emergence of *socio-psychological* risks associated with the resistance of managers and employees to the ongoing changes is inevitable.

In practice, they can emerge in two ways:

- fear of layoffs associated with staff being afraid that robotization and automation will lead to their jobs being cut;
- "Inertness" of management, also on top-level.

The top management of oil and gas companies often includes experts with vast experience, however, adhering to a conservative mindset. Introducing innovations that accelerate and change decision-making processes takes them out of their comfort zone and can be met with their resistance.

As measures aimed at reducing the likelihood of this category of risks, the following seems appropriate:

- explanatory work aimed at increasing the attractiveness of the transition to digital;

- providing opportunities for employees to improve their qualifications so that they can work in a new environment (Kuznetsova, 2021);
- hiring new specialists, including the top management level, to ensure the necessary staffing prerequisites for digital transformation (PWC, 2020);
- creation of incentives for top management to make them perceive the transition to Industry 4.0 technologies as attractive.

All of these measures should contribute to the overall transition of the company to a corporate culture focused on innovation.

The most important category of risks for the implementation of Industry 4.0 technologies are *information risks* associated with threats to data confidentiality.

In 2019, EY identified the following main information security risks associated with digitalization:

- accidental information leaks through open, unencrypted, channels;
- cyberattacks—deliberate actions of digital intruders to penetrate or disable the local information systems of a company;
- substitution of data coming from equipment;
- unauthorized access to control systems (EY, 2019).

The substitution of data received from the equipment can be executed both by criminal structures and unscrupulous competitors to cause economic and reputational damage to the company.

Malefactors, criminals and international terrorism can infiltrate a company's information system and gain control over it. The consequences range from economic and image damage to large-scale disasters.

The main measures aimed at reducing the likelihood of this category of risks being realized are the following:

- cyber security investment;
- "hybrid clouds";
- analysis and prevention of possible risks using "digital twins";
- explanatory work at all levels to educate employees on the rules of "digital hygiene" (for example, phishing emails);
- carrying out "hackathons" and cyber trainings.

Investments in cyber security mean investments in equipment and software products that ensure the safety of the information system and communication channels from penetration or disabling by intruders (Bazhitov et al., 2019).

"Hybrid clouds" come down to companies having a protected inner and a relatively unprotected outer contour of their information systems. The first is used within the company, whereas in the second it interacts with third parties and organizations. Before the implementation of an information system based on Industry 4.0 technologies, its "digital twin" should be modeled and tested for possible vulnerabilities, which allows eliminating them in advance (Alekseev, 2021).

Hackathons are open-call events for digital security professionals/hackers who compete for monetary rewards in identifying vulnerabilities in individual elements of a company's information system. Cyber trainings mean that the information security departments themselves are testing an existing or developing system for vulnerabilities in close-to-real conditions within the company (Alekseev, 2021).

Last but not least, digital technologies imply *risks of interaction with counterparties*. These risks drive companies to develop new communication formats.

Examples of such risks include the following:

- incompatibility of technologies and information exchange standards;
- leakage of confidential data when interacting with counterparties;
- incompatibility with regional technologies and consumer habits.

At the industry level, there are no uniform standards for the accumulation, storage, transfer and processing of data, which limits the capabilities of some technologies, including Big Data, since entails additional costs for their convergence.

Threats of confidential data leakage when interacting with counterparties can also be classified as information risks.

Above that, there are risks associated with the unequal level of development of digital infrastructure across regions. For example, digital products and loyalty programs at gas stations will most likely not be equally in demand in Western Europe and Central Africa due to the different scopes of motorization and cellular communications in these regions.

As measures aimed at combating these threats, it seems appropriate to highlight the following:

- the adoption of uniform industry standards for greater efficiency of transactions and deeper analytics through the accumulation of larger amounts of data (across different ecosystems);
- use of blockchain contracts;
- consumer preferences analysis/creation.

The development of a common blockchain contracts platform within the industry will significantly reduce transaction risks, reduce time, and accounting costs (WEF, Accenture, 2017).

Consumer preferences analysis/creation involves investing mainly those digital services products that are in demand in each specific region.

The results of the analysis of risks arising from the application of Industry 4.0 technologies by international oil and gas companies to combat climate change and possible ways to manage each of the identified types of risks are presented in Table 17.1.

The analysis shows that companies do face several risks when implementing Industry 4.0 technologies to combat climate change. The number and scale of the adverse consequences of digitalization necessitate the adaptation of the risk management system to the new economic and technological reality. In this regard, we propose a scheme of such an updated risk management system, taking into account the above risks and recommendations for their mitigation (Fig. 17.1).

Table 17.1 Risks of oil and gas companies associated with the implementation of Industry 4.0 technologies to combat climate change

Risk type	Risk components	Ways to reduce risk
Production	• Violation of technical standards during implementation • Breakdown of robotic equipment • Failure of communication systems	• Consideration of weather, climatic, and other physical parameters when planning • Preliminary testing of configurations using "digital twins" • Regular monitoring of the condition and timely maintenance of equipment • Backup communication and control systems • Availability of the minimum required technical staff in the field
Managerial	• Excessive bureaucratization • Inadequate distribution of access rights to operational information between departments	• Partial departure from hierarchy in the organization, usage of horizontal links • Adequate distribution of access rights between divisions • Acceleration of control and decision-making procedures
Financial	• Increased costs for digitalization • High rate of technology development • Unequal viability of certain types of technologies • Incompatibility of new technologies with an old material base • Duplication of services	• Capital investment pays off by reducing operating costs • Investing in technologies that have practically proven their effectiveness • Choosing technologies effectively applicable to specific project conditions • Taking into account the regional regulatory framework (subsidies, benefits, etc.)
Socio-psychological	• Fear of layoffs • "Inertness" of management, including the top-level	• Explanatory work • Opportunities for staff development • Hiring new specialists • Creation of adequate incentives • A corporate culture focused on innovation

(continued)

Table 17.1 (continued)

Risk type	Risk components	Ways to reduce risk
Information	• Accidental information leaks • Cyberattacks • Data substitution • Unauthorized access to control systems	• Cyber security investment • Usage of hybrid clouds • Preliminary testing on digital twins • Explanatory work • Conducting “hackathons” and cyber exercises
Interaction with counterparties	• Inconsistency of technologies and information exchange standards • Leaks of confidential data • Incompatibility with the technological level of development of the region, consumer habits	• Adopting uniform industry standards • Using blockchain contracts • Analysis/creation of consumer preferences

Source Compiled by the authors based on (Kuznetsova, 2018)

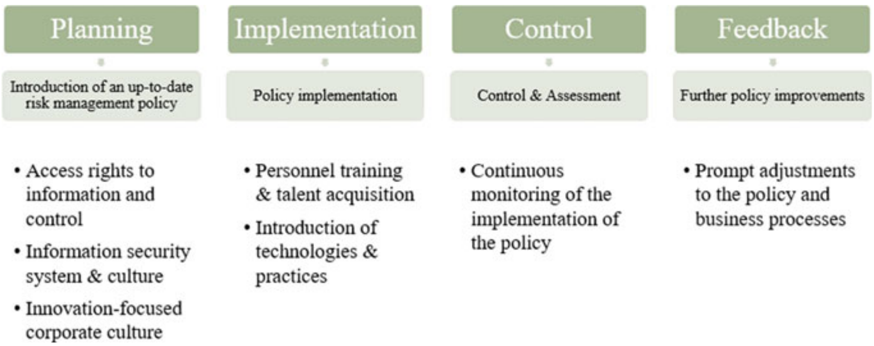

Fig. 17.1 Adapted to Industry 4.0 conditions climate change risk management system for oil and gas companies. *Source* Compiled by the authors based on research results

This system is a cycle consisting of the planning, implementation, control, and feedback stages. At the first stage, an up-to-date risk management policy is introduced: control and information access rights are adequately distributed between divisions, the information security system is put into operation, and a corporate culture focused on innovation is adopted. At the second stage, the implementation of this policy is being carried out: the qualifications of the workers improved, new talent acquired, digital technologies introduced into the company’s processes. At the same time, continuous monitoring and evaluation of the implementation of the risk management policy are being carried out leading to prompt introduction of adjustments to the policy aimed at improving it. This climate change risk management system maximizes the potential of Industry 4.0 technologies to minimize the risks not only arising in the process of their introduction but also other risks unrelated to them.

17.4 Conclusions

Oil and gas companies face several risks when using Industry 4.0-based technologies to combat climate change. Firstly, technological risks are caused by the need to integrate digital technologies into already existing production facilities and run technological processes. Secondly, the financial risks associated with an increase in the cost of financing digitalization projects. Thirdly, a managerial risk, since the introduction of digital technologies requires a restructuring of the existing organizational structure, as well as planning and control processes. Fourth, socio-psychological risks arise from the resistance of employees to changes that may lead to their dismissal. Fifth, information risks, which pose a threat to confidential data. Sixth, the risks of interaction with buyers, suppliers, transport companies, and contact audiences, causing the need for new communication formats.

Possible ways to manage these risks include taking into account weather, climatic and other physical parameters when planning; preliminary testing of configurations using "digital twins"; partial departure from the hierarchy in the organizational structure; acceleration of control and decision-making procedures; creation of incentives for employees; advanced personnel training; talent acquisition; explanatory work with employees; cyber security investment; "hackathons" and cyber exercises; adoption of uniform industry standards; use of blockchain contracts; analysis and creation of consumer preferences.

In addition, businesses need to bring existing risk management systems in line with the specifics of Industry 4.0: ensure that information security system is strong; develop and adopt industry-wide data exchange standards; make the necessary changes in the management model, speed up decision-making processes, adequately distribute control and access rights between divisions; adopt a corporate culture focused on innovation and digital transformation; bring the qualifications of human resources in line with the capabilities of digital technologies; ensure a balance between the sustainable development goals and tapping consumer demand.

The above measures will enable international oil and gas companies to manage the risks of combating climate change based on Industry 4.0 more effectively and minimize the consequences should they do occur.

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Chapter 18
Prospects of International Cooperation in the Arctic Under the Russian Chairmanship of the Arctic Council in 2021–2023: Social Projects and ESG Financing

Valeriya I. Ruzakova, Arina A. Shiptenko, and Elizaveta O. Ryabinina

18.1 Introduction

The Arctic region is extremely vulnerable to the problem of climate change, and most of the issues related to the indigenous populace of the Arctic remain highly acute. In 2021, the Chairmanship of the Arctic Council—the leading Arctic intergovernmental forum—passed to the Russian Federation, which proclaimed the sustainable development agenda as a key theme of the organization's work. The comprehensive program of Russia's Chairmanship in the Arctic Council assumes the strengthening of international cooperation in the Arctic region in four key areas. One of the key areas identified by Russia in the Chairmanship program is the social sphere, namely improving the quality of life, education, well-being, and the healthcare system of the Arctic population, including the numerically small indigenous groups of the North. In the course of the Chairmanship, the Russian Federation also intends to carry out significant work in the socio-economic area, which to some extent will balance the significant emphasis on the ecological and environmental vector of activities (Program of the chairmanship…, 2021a, b; Arctic Council, 2021a, b).

18.2 Methodology

In the study, interdisciplinary methods of analysis were used (statistical analysis, forecasting, statistical, and comparative legal analysis). A contextual analysis was

V. I. Ruzakova (✉) · A. A. Shiptenko · E. O. Ryabinina
MGIMO University, Moscow, Russia
e-mail: ruzakova.v@inno.mgimo.ru

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used in the study of strategic national documents, news resources, and other sources of information.

18.2.1 Well-Being of the Indigenous Peoples

The correlation between environmental and social well-being is a long-standing concept of International law, fundamentally established in the 1972 Declaration of the United Nations Conference on the Human Environment (Declaration of the United Nations…, 1972). It is also part of the level of the national policy of the Arctic countries—for example, the concept is reflected within the 2015 "Announcement of U.S. Support for the United Nations Declaration on the Rights of Indigenous Peoples" (2011).

The concept of "well-being of indigenous peoples and local communities" correlates with most of the SDGs, including "Goal 3: good health and well-being," "Goal 4: quality education," "Goal 6: clean water and sanitation," "Goal 11: make cities inclusive, safe, resilient and sustainable," etc. The main challenge is to invest in the development of community strength in the Arctic, which includes a very wide range of issues, from education and medicine to the conservation of the traditional way of life of indigenous peoples (Zadorin, 2011), development of the most sound and eco-friendly technology, etc.

Today, the interests of organizations of indigenous peoples are widely represented within the Arctic Council (Zagorskiy, 2015). As part of the Chairmanship for this thematic block, a number of conferences are planned on education, attracting personnel to the Arctic, preserving health and providing a comfortable urban infrastructure. It is not surprising that it was Russia that put forward this direction as a priority, since it is in the Russian Arctic that the majority population of the Arctic lives, including 47 small indigenous groups of the North.

Today, Russia is actively involved in such projects of the Arctic Council as regards the education of indigenous children as "Children of the Arctic," "Nomadic School," "International Arctic School" (Arctic Council, 2021a, b), and others, advocating the fostering of international cooperation and exchange of experience in this area. Cooperation between states to improve the level of education of the population is seen as a necessary and promising direction, both by improving the quality of services provided and by ensuring universal access to educational services. In particular, the Russian Federation, within the Arctic Council, proposes to examine the possibility of using digitalization tools to preserve the customary way of life of the original inhabitants, including to preserve the cultural and linguistic heritage.

It seems expedient to introduce hybrid educational programs based on a multicultural educational approach and take into account the local conditions of the region. Such areas of personnel training as the provision of shipping and energy supply in the Arctic, international Arctic tourism, industry, and international trade are promising as educational priorities.

Moreover, the social dimension forms the second component of the concept of ecological, social, and corporate governance factors in investing (ESG). The stimulation of investment in projects that involve the inducing of human capital in the Arctic is a promising way for the development of the social component of the economic activity in the Arctic region.

18.2.2 Sustainable Financing in the Arctic

During the Chairmanship of the Arctic Council, the Russian Federation intends to carry out significant work in the socio-economic area, which to some extent will balance the significant emphasis on the ecological, nature conservation vector of activities. As noted in the document "Priorities of the Chairmanship of the Russian Federation in the Arctic Council", the focus is on improving the investment climate, revitalizing investment activity, and implementing sustainable financing projects. Let us consider this aspect in greater detail (Priorities of the chairmanship…, 2021a, b).

Within the context of the worldwide energy transition, establishing of a fundraising system for Arctic projects that make contributions to the achievement of SDGs is becoming urgent for the Arctic states. In the course of preparation for the Russian Chairmanship of the Arctic Council, the proposal "Sustainable Arctic Financing" was put forward. The project is planned to be introduced to determine the financing model for "green" projects in the Arctic. Importantly, ESG is also a mechanism of investing in eco-friendly technology development, e.g., the projects of development of eco-sound marine technologies. It is expected that this will create a benchmark, a financial standard for development institutions and investors in the continuation of the Arctic Investment Protocol and the Northern Business Index (Zvorykina, 2020).

According to a number of experts, the idea of Arctic Development Bank can become an efficient option for organizing the accumulation of funds for financing sustainable development projects. Similar financial institutions are already operating, for example, within the BRICS (e.g., New Development Bank BRICS) (Rakov, 2017); an example of a national development bank is the UK Green Investment Bank (GIB) (Rakov, 2017). The establishment of such an international institution will make it possible to organize financing in projects aimed at achieving sustainable development more clearly, as well as could increase the transparency of the accumulation and distribution of funds and, subsequently, attract international investors (Rakov, 2017).

Also, some researchers propose the idea of creating compensation funds that can be accumulated in regional budgets when implementing programs for the socio-economic progress of territories. This mechanism, for example, is already working in the Republic of Sakha (Yakutia). According to the authors, as an initial step in this direction, the formation of a separate "taxonomy" (categorization) of ESG factors (ecological, social and corporate governance factors in investing, ESG) should be carried out—taking into account the characteristics of the Arctic region, including the peculiarities of the climate and social structure.

The fact that the existing taxonomies are not sufficient for the correct evaluation of projects carried out in the Arctic region can be proven on the example of the S-dimension, which is very particular in the Arctic.

During the research, major international ESG taxonomies were compared, including UN PRI, UN Financial Initiative, UN Global Compact, OSCD, World Bank, CFA, GRI, etc. The S-dimension of non-financial performance largely correlates with the issue of infrastructure, and namely the importance of infrastructure development for the quality of life of indigenous peoples. In the Arctic, poor transport infrastructure is a crucial issue, and the situation is exacerbated by the fact that the main industrial areas and production bases are long distances away. For this reason, a set of measures, such as the Northern Delivery, is being implemented in the Russian Arctic in order to provide the Arctic areas with vital goods in preparation for the winter period.

This is a specific problem for the region since the lack of transport connectivity endangers the accessibility of food, medicine, and other vital supplies. In this regard, major corporations implement their corporate social responsibility in the form of setting up individual projects related to the improvement of transport accessibility—as an example, the socially oriented activities in the transportation sector of the Nornickel company can be examined. This company, for instance, is engaged in the reconstruction of a civilian sector of the airport in Norilsk, as well as offers regular assistance in response to specific requests from Taimyr municipalities and provides sponsorship support for economic and social development of indigenous peoples of the North, majorly through arranging air transportation (PJSC "MMC "Norilsk Nickel" report, 2019).

Potravnaya (2021) in the research "Social Problems of Industrial Development of the Arctic Territories" highlights priority social problems in the region identified through conducting a sociological survey among the local population (the rural localities of Olenyok and Kharyyalakh, August–September 2020, 130 respondents). The issues of major concern identified by residents include an increase in food prices (32.2%), low income (20%), and a lack of employment opportunities (18.0%), transportation problems (17.6%), and low level of health care (11.5%). As follows from the research, the most acute and Arctic-specific social issues may be grouped into three categories: supplies and products accessibility, income and employment, and access to medical care. In the Arctic region, big corporations should be considered community-forming enterprises and therefore are expected to invest in infrastructure and healthcare projects.

To recap, the named factors are not only crucial to the social well-being of the Arctic but also are highly determined by the geographical and climatic specifics of the region. They are worth being taken into consideration in developing and implementing various industrial projects in the region, and one of the efficient steps on the way to ensure this development, according to the authors, could be the inclusion of those factors into an Arctic-specific ESG taxonomy.

18.3 Results

The Chairmanship of the Arctic Council opens up an opportunity for Russia to contribute both to the achievement of the strategic objectives of the forum and to raise awareness of the participating States of the Arctic region to problems that are crucial for the Arctic zone of the Russian Federation. In 2021, under the Russian Chairmanship, the Arctic Council Strategic Plan which sets out a strategic vision for the sustainable development of the Arctic and the Arctic Council was developed for the next ten years.

Based on the executed analysis, it is possible to define the following recommendations on the considered priority area of the Russian Chairmanship in the Arctic Council:

1. To consider in more detail, the social factors when evaluating industrial projects in the Arctic—along with the issues of ecology and carbon footprint;
2. To elaborate practical instruments of preservation of traditional knowledge and develop human capital in the Arctic, including opportunities for digitalization and integration of knowledge and skills of indigenous peoples;
3. To develop institutions for sustainable financing in the Arctic—starting from the formation of a separate taxonomy of ESG factors, taking into account the distinguishing traits of the Arctic region.

18.4 Conclusion

The consequences of global warming in the Arctic are most noticeable, and it threatens the usual way of life of indigenous peoples. In addition to working to prevent further changes in the environment, the opportunities for community development should not be overlooked, namely the opportunities for digitalization and the integration of the knowledge and skills of indigenous peoples.

There is a lot of work to be done for the Arctic states in the direction of improving the educational level of the population of the Arctic. The key point on this issue is taking into consideration the multiculturalism of the region, the traditional "northern" skills of young people and the needs of the Arctic economy for the formation of educational programs and infrastructure.

One of the promising ways to attract more capital into ecologically and socially oriented projects in the Arctic is the development of specific institutions aimed at the promotion of sustainable financing, where the first step could be the elaboration of an Arctic-specific ESG taxonomy.

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Chapter 19
The Use of Blockchain Technology to Solve Problems in the Field of Ecology and Health Care

Artem S. Genkin and Alexey A. Mikheev

19.1 Introduction

Distributed ledger technology (blockchain) has become ubiquitous in almost all areas of human activity over the past approximately 5 years. However, its spread has revealed a number of interesting trends. If in 2018 we recorded the large-scale adoption of this technology in many areas, primarily the financial sector (Genkin & Mikheev, 2018), and some other sectors of the economy demonstrated at best its adoption at the early adopter's level, now, on the contrary, it is the non-financial sector that acts as the locomotive of the ongoing blockchain revolution and the generator of new cases and successful practices of its application.

For this article, we have selected two areas that historically have not been pioneers of blockchain adoption and have been actively implementing this innovation only in recent years: these are the spheres of ecology and health care.

In the field of ecology, blockchain initially had an ambiguous reputation in the expert environment. This was primarily due to loud public discussions about the significant energy consumption and the allegedly negative energy footprint from cryptocurrency mining operations. At the same time, the potential positive aspects of the impact of blockchain technology on solving environmental problems often remained in the shadows. This article partially corrects this "default error."

As for the use of blockchain in medicine, the situation here is much more researched. Spending in the healthcare industry in 2020 in the United States alone exceeded $4 trillion. However, according to the Institute of Medicine (IOM), almost 20–30% of these costs are unnecessary and could be avoided (IOM, 2012).

A. S. Genkin (✉)
ANO "ZVI"—Center for Protection of Bank Clients and Investors, Moscow, Russia
e-mail: konsul3000@yahoo.com

A. A. Mikheev
MGIMO University, Moscow, Russia

E. G. Popkova and B. S. Sergi (eds.), *Current Problems of the Global Environmental Economy Under the Conditions of Climate Change and the Perspectives of Sustainable Development*, Advances in Global Change Research 73, https://doi.org/10.1007/978-3-031-19979-0_19

The main sources of excess expenses are inflated medical bills, fraud with medical services, high administrative costs, complex document flow, etc. Poor communication, poor budgeting, and lack of data make health care expensive and not optimal for the population.

Blockchain technology can change health care by ending fraud, reducing operating costs, optimizing data storage, as well as eliminating duplication of work and increasing transparency.

The coronavirus pandemic has even more clearly exposed the pain points of the modern healthcare system, to the cure and correction of which blockchain technology can be applied.

The purpose of this article is to select and analyze the accumulated positive experience of the best cases and practices of effective use of blockchain technology to solve problems in the field of ecology and health care.

To do this, it is necessary to solve the following tasks:

– analyze the existing precedents for the effective use of blockchain technology to solve problems in the field of ecology and health care;
– to identify the qualities and features of the technology that led to the success of its use in these areas;
– to substantiate the advantages that certain stakeholders receive from the use of technology in the cases under consideration;
– identify the most effective niches, ways, and methods of technology application and best practices of their application;
– to conclude the prospects for expanding and deepening its application in the analyzed areas.

19.2 Methodology

The object of our research is the system of economic relations that develops in national economies with the introduction of distributed ledger technology (blockchain).

Our analysis covers:

– Functional—areas of production, distribution, exchange, consumption of material goods.
– In the industry aspect, the main focus is on the sector of production of medical devices and medicines, as well as the IT services sector. The scope of activities of non-profit organizations is also affected.
– Geographically—in the presence of examples from almost all continents, however, three theaters of operations receive special attention in the work: these are the EU countries, North America and China.

The information and empirical base of the study are analytical reviews of the studied industries as a whole and their representatives, data from press releases and Internet sites of large technology companies, as well as the authors' developments.

The methodological basis of the study is a set of modern methods of analysis: a retrospective, expert, and scenario. The research methodology is based on system analysis, which ensures its integrity and comprehensiveness.

19.3 Results

19.3.1 How Blockchain Contributes to Saving the Environment

Currently, the environment is facing a number of serious problems. Various negative impacts, from air pollution to climate change, to which our planet is exposed, affect our health and the future of our Earth.

More and more people around the world are aware of these problems and are working to find solutions for each of them, but it is in the field of environmental protection that blockchain technology can make a huge difference.

One of its applications is that blockchain can help save the environment by making it easier for companies to track their environmental impact.

In December 2020, the coalition of blockchain companies Universal Protocol Alliance (the leader is Uphold, participants: Bittrex Global, Certik, Infinigold, Ledger) announced the release of Universal Carbon tokens (UPCO2). Each such token is equivalent to a certain volume of carbon dioxide. According to the coalition, these tokens can be purchased and stored as an investment or burned: in this case, they will become compensation for the carbon footprint of any company or individual. Thus, tokens representing carbon credits can become an object of purchase and sale on regulated markets or voluntary carbon compensation. The negative effect of carbon emissions is reduced: the funds received from the sale of tokens can be directed to environmental projects (planting trees, installing sewage treatment plants, etc.).

Similarly, the mass media mentioned the release in the 1st quarter of 2020 of the carbon credit token MCO2 with a reserve of 2 million tons of carbon credit by the Brazilian environmental platform MOSS.

In addition, the blockchain can be used to donate to environmental charities in new ways. For example, the Next Earth project is a virtual copy of the Earth on the blockchain, in which users can purchase land plots with objects located on them in the NFT format: from agricultural land to, for example, the Statue of Liberty. At the same time, 10% of the cost of these purchases is directed to environmental needs. As part of the initial offering of its tokens, the project raised over $1.3 million, which means that over $130,000 was donated to charities such as The Ocean Cleanup and Amazon Watch.

Plastic Bank startup uses blockchain technology to ensure transparency of the turnover of plastic bottles during their processing, tracking, and monetization of their collection, thereby solving a huge environmental problem.

With current food delivery methods, 30–40% of the food produced in the United States is never eaten (Mikheev, 2021). The constant increase in food production to meet the growing global demand not only requires more land and natural resources but also increases the pollution of the planet by slowly decomposing packaging. Blockchain-based solutions that optimize supply and inventory logistics in product chains help reduce unnecessary waste.

19.3.2 The Impact of Cryptocurrency Mining on the Environment

Recently, serious discussions have been arising on this issue, given the high energy consumption of mining activities that feed the entire ecosystem (Smith, 2021).

As you know, cryptocurrency miners check previous transactions recorded in blockchains, thereby guaranteeing the constancy and immutability of these blockchains, and in exchange for this service, they receive cryptocurrency as a reward for each successful verification of a new block—and this operation requires significant computing power (Genkin & Mikheev, 2018).

On the one hand, financial institutions that have realized the danger of climate change and intend to invest only in sustainable business models see that this technology requires serious energy consumption. The BBC reported in February 2021 that the Bitcoin network consumes 121.4 TWh of electricity per year, making it the 29th country in the world in terms of energy consumption, between Norway and Argentina (Criddle, 2021).

Cryptocurrency adherents, in turn, argue that in the long term, the activities of miners can even stimulate investments in environmentally friendly energy.

Carter (2021), for example, points out that cryptocurrency miners can use energy that would otherwise remain unused, using the example of the largest crypto-mining regions of China, Sichuan, and Yunnan. Miners in these areas rely on hydropower. GRES power plants are usually located in sparsely populated rural areas and often produce more energy than can be transferred to densely populated areas. Miners can use excess energy.

Carter notes that the same can be done with natural gas, for example, methane. Methane is a natural by-product of oil production, but it is practically impossible to transport, so it is usually burned on the spot with a "torch" or released into the atmosphere. Both options cause pollution. Bitcoin miners can organize work at oil production facilities and use this methane to generate energy, ensuring its productive use with even less pollution. The natural gas burned annually is more than enough to power the entire Bitcoin network, and mining companies such as EZ Blockchain and Crusoe Energy are already using it.

This is the idea of Bitcoin as a "battery." Miners cannot store excess energy, but they can effectively convert it into a liquid asset—a cryptocurrency—which can then be sent anywhere in the world, exchanged for dollars and even reinvested in improving power grids or green energy projects. Kjell Inge Rokke, the head of the Norwegian energy conglomerate Aker ASA, explained his plans to launch the Seetee project on environmentally friendly Bitcoin mining using energy produced in areas without sufficient local demand (n.a, 2021). $58 million is being invested in this project.

A recent CoinDesk report showed that in 2019 39% of the energy for Bitcoin mining came from renewable sources, compared to 28% in 2018, so the process may have already begun (Kaloudis, 2021).

At some point, crypto-investors and miners may not have a choice, and they will have to become eco-friendly. Already, a bill has been submitted to the New York State Senate to ban the work of miners until the state can assess their impact on the environment (Chainalysis, 2021).

Perhaps, the market will begin to give preference to "green" Bitcoins extracted from more environmentally friendly sources. Then, the focus on renewable energy sources can become a competitive advantage for miners and crypto-exchanges serving them.

19.3.3 Blockchain Application in Health Care: General Aspects

Among the advantages of using blockchain when working with medical data, the following ones are usually distinguished:

- records cannot be changed or deleted imperceptibly and irrevocably;
- the data source is fixed in the blockchain, allowing to verification their authenticity;
- blockchain itself is the best protection against hacker attacks;
- the patient controls his data and determines who has access to them;
- access to data is possible in the absence of the Internet.

The main directions of using blockchain in the field of health care:

- drug supply chain management and anti-counterfeiting;
- improvement of insurance and billing procedures;
- management of electronic medical records;
- analysis of medical data;
- conducting clinical and biomedical research;
- control over the distribution of donor organs;
- remote monitoring of patients (Svirsky, 2020).

19.3.4 Blockchain and Clinical Research

Clinical trials in large numbers of patients should be conducted before any new drugs or medical devices are introduced to the market. To study the efficacy and safety of a medicine, as well as to identify side effects, the confidentiality, security, and immutability of the records are required for the participants in the process.

Blockchain speeds up and reduces the cost of clinical trials. Thus, it ensures the protection of personal data, verification of the movement of information, checking the violations of the research protocol, obtaining patient consent, etc.

The University of Missouri and Taiwan's PAIR lab have explored ways to optimize the collection and storage of patient data through blockchain-based smart contracts.

A team of Israeli scientists from Massachusetts Institute of Technology (MIT) has been developing the MedRec project based on Ethereum since 2016. This blockchain system for patients' medical records allows the registration and storage of medical records in a form accessible to patients, their relatives, doctors, and other healthcare providers.

19.3.5 Blockchain Solutions from Ant Group

Ant Group (formerly Ant Financial) is the fintech arm of Chinese tech giant Alibaba Group and China's largest online and mobile payments network. It owns an Alipay processor (serving 1 billion active users and 50 million businesses).

In the summer of 2018, Zhang Hui, director of the company's blockchain department, said that blockchain, along with AI, security, IoT and computing, is one of the key technologies that the company intends to develop and test for use "on a large commercial scale," and expressed his hope that blockchain will create new business models for his company (Balovsyak, 2018).

The vice president of Ant Financial said blockchain is the "most valuable" technology in the current era. "We believe that in the future, blockchain will change people's production and lifelike mobile payments and become the infrastructure of the digital economy," he said (Monastyrnaya, 2020). At least, three of the 10 main blockchain solutions developed by the company are directly related to the area of our analysis: electronic billing, distribution of prescriptions, and universal traceability (Ant Blockchain, n.d.).

19.3.6 Electronic Billing

The traditional smart medicine model requires patients to manually print off-line paper receipts after paying fees and mobile payments online. It greatly limits the development of smart health care, and it is inconvenient for patients. The blockchain billing model implements complete electronic and continuous invoice processing, ensuring the authenticity and uniqueness of invoice information and significantly increasing the efficiency of refunds, essentially becoming the last mile of process optimization.

The blockchain-based billing management platform implements the entire process of issuing electronic financial invoices, managing, transferring, requesting, storing, refunding, controlling, and reporting. Hospitals, financial departments, CHI authorities, insurance companies, and other parties are forming a consortium chain. Blockchain-based electronic invoices will be "stamped" throughout the entire process of creation, transmission, storage, and use.

From August 2, 2018, patients at Hangzhou, Taizhou, and Jinhua hospitals can use Alipay to pay registration fees, outpatient services, and hospitalization, and the corresponding e-invoices will be immediately sent to Alipay's Account Manager. Patients who pay in cash through a hospital app, health insurance card, etc., can simply scan the QR code of their e-invoice using their mobile phone. No need to go to the reception desk and stand in line for bills. There are fewer queues; service costs of a medical facility are lower; it is easier to conduct financial supervision.

Blockchain covers the entire process of creating, transferring, storing, and using electronic invoices. If an electronic invoice has been paid, then it is impossible to pay it a second time because it has a "paid" stamp in the blockchain, and these "stamps" are tracked, available for real-time viewing and cannot be forged.

19.3.7 Distribution of Prescriptions

The Ant Blockchain platform has allied with medical institutions, pharmacies, distributors, payment agents, and regulators as participants in the circulation of prescriptions and has solved the problem of protection against unauthorized access, timely status synchronization, full traceability, and the possibility to audit information.

On September 13, 2018, Huashan Hospital, part of Fudan University, has partnered with Ant Financial to launch the country's first blockchain-based electronic prescription. The patient just needs to open an Alipay Huashan Hospital Life Account to see the doctor online; the doctor writes useful prescriptions remotely, and the patient stays at home, waiting for the medication to be delivered.

"Stamping" begins from the moment when the drug is prescribed. Online prescription, online dispensing, delivery, and receipt of medicines will be consistently stamped. It is impossible to interfere with these "stamps," but they can be mutually checked and tracked throughout the entire process.

Moreover, the prescription authenticity is also guaranteed because once the prescription is stamped as "delivered," it cannot be reissued.

The problem of re-issuing prescriptions without a face-to-face visit of the patient to a medical institution is also being solved.

19.3.8 Universal Traceability

Unscrupulous suppliers exploit loopholes and information asymmetries at every link in the supply chain to produce counterfeit and substandard goods, causing great damage to the national economy, product brands, and consumer health.

The technical capabilities of Ant Blockchain, together with the IoT technology, make it possible to uniquely identify products using anti-counterfeiting labels or chips. All process information is recorded. It includes raw material procurement, processing, manufacturing, quality control, logistics, distributors, retailers, and consumers. At the same time, such problems of the industry as fragmentation, insufficient and non-transparent information, and inefficiency of the supply chain are addressed.

A "private key" is used to digitally sign and write the timestamp to the blockchain. Consumers or regulators will be able to verify all information about the turnover process from the blockchain. Blockchain technology will allow building a relationship of trust between brand owners, distributors, retailers, consumers, regulators, and supervisory authorities. The benefits of the service are product safety, effective supervision, supply chain coordination, quick access and inspection, and personalized marketing.

In August 2018, the Wuchang Municipal Government of Heilongjiang Province and Tmall, Cainiao, Alibaba Cloud, and Ant Financial reached a cooperation agreement. Since September 30, 2018, every bag of rice sold at the Wuchang Rice Tmall flagship store has had an exclusive ID card. Consumers can open Alipay and scan it to see the specific location where the rice was cultivated, as well as the data stored on the Ant Financial blockchain about the seeds, fertilizers, and logistics. They are verified by the Wuchang City Quality Control Department.

The transparency and immutability of supply chain records on the blockchain ensure the traceability of defective goods, making it easier to recall them.

One notable example of blockchain use for the supply chain is IBM's Food Trust (IBM, n.d.). Global food giants such as Walmart, Nestle, Unilever, and Carrefour also signed up for it. IBM has its blockchain platform, a public cloud service for building various blockchain networks. It is based on Hyperledger Fabric, an open-source collaborative blockchain project hosted by the Linux Foundation.

In 2018, 210 people in 36 different states were infected with E. coli from a tainted batch of lettuce. The FDA investigation lasted more than two months, and the Centers for Disease Control advised people to throw away lettuce that was grown in Yuma, Arizona. After that, Walmart decided to take part in the Food Trust, arguing that blockchain technology could be used to track the path of every shipment from farms to markets.

On November 6, 2020, the FDA recalled a single-head lettuce brand due to possible contamination with E. Coli, and the Michigan Department of Agriculture and Rural Development (MDARD) announced that a sample of the lettuce from Walmart had tested positive for the bacteria. Walmart announced that it took only a few seconds to track the path of a product from the Walmart Store to its source using blockchain.

19.3.9 Charity Projects

The following projects should be mentioned here:

- the crypto against COVID campaign organized by the Binance cryptocurrency exchange to raise funds in cryptocurrency for medical PPE and medicines for covid-infected patients in China, Italy, Germany, and the United States;
- charitable projects of the blockchain platform Helperbit, the crypto-platform Giving Block, the Chinese blockchain company Krypital;
- a major donation from Ripple Labs to the Silicon Valley Coronavirus Foundation;
- free provision of computing power to the Folding at Home project of the University of Washington (for the research of various viruses and the development of pharmaceuticals) by Bitfury, Cardano, CoreWeave, Golem Tezos, etc.

19.3.10 Blockchain and the Fight Against the Coronavirus Pandemic

The main damaging factors of the crisis caused by the outbreak in 2020–2021 pandemic coronavirus COVID-19 (CV) are aimed at transport and logistics chains and human resources (Genkin & Mikheev, 2021).

Special tasks of blockchain systems during the pandemic are tracking vaccine supply chains; tracing infections and patient contacts; aggregation of data required to monitor the epidemic (including data from medical gadgets).

Starting in spring 2020, the pandemic restrictions have led to discussions on the introduction of various formats of "immunity passports" for travel and flights by persons who are immune to the coronavirus.

A consortium involving large technology companies (including Microsoft, Oracle, and Salesforce) has developed a covid passport (an individual digital document on vaccination status) as part of the so-called Vaccination Credential Initiative (VCI). The project also involved two healthcare networks, medical software developers, and a number of NGOs. Air passengers of Cathay Pacific and United Airlines were the first to test the new "covid passport" in October 2020, Russians did it two months later.

The blockchain is helping to address the black market of fake vaccination certificates. People will be able to access and share their vaccination information to verify their covid status without disclosing other personal information and keeping the data secure and controlled. The technology will help to return to normal life (work, study, travel, etc.) while keeping people healthy and protecting their personal data. Without the option to trust vaccination data stored in the system, many countries would have to continue lockdowns and restrict the movement of their citizens until the virus is completely eradicated (Genkin, 2021a).

IBM is developing Digital Health Pass on its blockchain. This pass will allow people to provide proof of vaccination or negative covid test to access their jobs, hotels, flights, and concerts. Based on the holder's data, the application will generate a QR code that an inspector can read at checkpoints.

We will also mention the Excelsior Pass project, developed by IBM for the state of New York within a 3-year contract. Once you are identified in this mobile application, it will contact the medical facility and verify that you have been vaccinated in New York State, providing a QR code.

The Electronic Frontier Foundation (EFF), in its article Vaccine Passports: A Stamp of Inequity (Hancock & Tsukayama, 2020) noted that many vaccine passport projects use blockchain technology as a means of exchanging data. One of the qualities of blockchain is immutability: personal health information cannot be changed.

Confidentiality, the EFF concludes, is not only the absence of data leaks or tampering. Temporary measures can engrain in our lives because the blockchain-based databases of personal data are permanent, and they are unlikely to be inactivated after the crisis.

The New York Civil Liberties Union has proposed a bill to ban law enforcement and immigration authorities from accessing data collected in a covid passport application.

19.3.11 Drug and Vaccine Supply Chain

As mentioned, the pandemic has disrupted global supply chains. Many factories are closing due to safety and hygiene concerns, while demand for anti-epidemic drugs and medical supplies is unprecedented. Long supply chains entail unnecessary uncertainty, making inventory estimation and planning impossible (Khubrani & Alam, 2021).

Blockchain can be effectively used to support the supply chain of medical supplies; it deals with such issues as fake vaccines, overpricing, and over-stockpiling. It also helps to reduce processing and delivery times, costs, operational risks, and speed up settlement.

In this regard, we will mention the blockchain solution Watson Health Analytics from IBM for data collection and analytics, which helps to streamline vaccine stocks, and the solution from Macro-Eyes using machine learning to predict the readiness of medical facilities to ensure safe vaccine storage.

There are several other interesting use cases for blockchain in the fight against the pandemic. For example, two UK hospitals in Stratford-upon-Avon and Warwick are using IoT technology and Everyware's Hedera Hashgraph blockchain to monitor the storage and supply of temperature-sensitive covid vaccines.

Contact tracing with AI and GIS tools can slow the transmission of infection, while blockchain improves the quality and reliability of data when tracking patient activity. IOTA and Enigma announced plans to launch similar projects.

Collaborative Charter Services have implemented a blockchain system to track infections among teachers, staff, and students in California public schools. The basis of the system is the Team.Care Network application from Solve.Care (Genkin, 2021b).

MDS Mexico has launched a blockchain platform in Mexico to authenticate real-time covid tests using a QR code. This will help to prevent falsification of the results, especially since the signature of the doctor who checked the test result is also uploaded to the blockchain.

Agenzia Nazionale Stampa Associata (ANSA, Italy), together with the global auditing company Ernst & Young, developed and implemented the ANSA check blockchain deployed on the Ethereum platform to address the problem of fake news about the pandemic. Any reader can check any information and trace the entire history of its publications by the hash code.

19.4 Conclusions

We have reviewed over 30 examples of best practices for the effective use of blockchain technology to solve various kinds of problems in ecology and health care. The most effective were the solutions in supply chain management, electronic billing and electronic document management, creation of trusted databases with citizens' personal data, as well as the fight against the pandemic and its consequences. All these areas, apart from economic, are socially important. The main positive results achieved through the use of blockchain technology are multifactorial and include increased transparency, reduced costs, increased security of storage, and circulation of personal data. We can confidently predict a further expansion and active implementation of blockchain-based solutions in the areas under consideration.

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Chapter 20
Insufficiency of the Material Base for Implementing the Environmental Agenda of Industry 4.0

Elena B. Zavyalova and Tatyana G. Krotova

20.1 Introduction

The fourth industrial revolution, or the digital economy, is built based on the information economy. Accordingly, the information economy is the technical basis for digital transformation and building a new environmentally friendly information society (Bazarbaeva et al., 2021).

The environmental agenda is currently at the forefront of all world summits. Environmental, viral disease, economic, and inequality issues are closely linked and must be addressed together.

Global warming leads to an increase in destructive natural disasters and outbreaks of dangerous viral and infectious diseases. Together, these factors lead to a halt in production, the closure of borders, and impoverishment and stratification of the population.

It is believed that the transition to green energy sources without greenhouse gas emissions, which are the leading cause of global warming, is the key to a new future. Is the "old" technological and resource base enough for the world's transition to a green economy?

E. B. Zavyalova (✉) · T. G. Krotova
MGIMO University, Moscow, Russia
e-mail: e.zavyalova@inno.mgimo.ru

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20.2 Methodology

The authors implemented a statistical research method, as well as empirical and analytical methods for analyzing official statistics for outlining the current global tendencies. The inductive method used by the authors for analyzing the strategies for the introduction of green technologies in the transport and production process in the EU, the USA, and China proves the lack of sufficient resource base for the full green transition at the current moment.

20.3 Results

Let us start with the greening of transport and the transition to electric vehicles.

In accordance with the Green Deal, China, France, the UK, Norway, Germany, United Arab Emirates, Saudi Arabia, and Japan intend to completely switch to cars with electric motors by 2040 (Justinas, 2017).

Switching to electric vehicles is a key White House strategy to combat climate change. According to it, by 2030, half of the cars in the USA should be equipped with electric motors. Transportation emissions account for the largest portion of greenhouse gas emissions in the USA.

The market for electric vehicles in China is already the largest in the world, with more than half a million electric vehicles sold in 2016 alone. This is facilitated by government policy, which gives many privileges to the owners of such cars. By 2025, China aims to produce at least seven million electric vehicles a year.

According to Bloomberg forecasts, by 2040, the US, EU, and China will account for more than 60% of electric vehicles.

How much energy is required to charge so many cars?

Charging 1 million electric vehicles, depending on the charger used, will require from 3.5 to 24 GW of grid power. That is, it will take from 24.5 to 168 GW of power grid capacity to charge 7 million cars annually produced in China.

Under the terms of the Green Deal, the EU plans to reduce the amount of carbon dioxide emissions by 90% and bring the number of cars with electric motors on the roads of the EU to 13 million units by 2025 (General Electric, 2020).

According to experts, the EU car market, seeking to be completely replaced by electric vehicles, consisted of 242.7 million cars in 2019. If they were all equipped with electric motors, then it would take from 849.45 to 5824.8 GW to charge them. According to the CIA World Factbook (2022), the installed capacity of the global electricity generation equals about 6300 GW. It is clear that these cars will not be charged simultaneously, but we are only talking about the European ambition of eliminating internal combustion engines and the Chinese plan for the annual production of cars with electric motors.

Currently, the share of environmentally friendly cars in the EU is only 4.6%, of which 2.7% consume natural gas as fuel. The largest percentage of electric cars is observed in Norway—9.4% of the total number of cars (as of 2019).

In Russia, it is also planned to create electric vehicles to preserve the automotive industry and reduce imports of electric cars in the future. By 2030, when the EU plans to switch to electric vehicles completely, the market in Russia will not exceed 10%.

Experts believe that for the growing electric transport market, it is quite enough to increase the existing energy generation by 60% over the next 30 years, i.e., on average, by 2% per year, which is currently provided by the growing renewable energy market (e.g., solar panels and wind turbines). As we considered above, such an increase in a generation is insufficient. Moreover, this is an increase to the current generation, which is based on traditional energy sources, the shutdown of which is planned as part of the concept of zero greenhouse gas emissions.

Now, let us turn to the creation of green infrastructure. Electric vehicles require a considerable number of charging stations on city streets and along highways (Fig. 20.1). The creation and functioning of charging stations will require much energy. The creation of solar panels and wind turbines also requires huge energy costs, which cannot be obtained only from the final product. Recall how old coal mines were reopened in Germany to power the production of wind turbines.

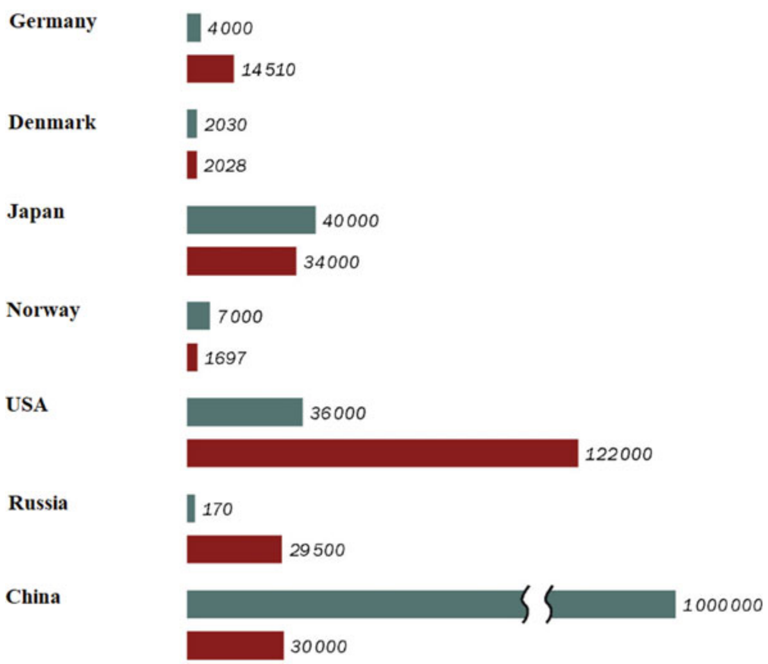

Fig. 20.1 Number of electric car chargers to be launched. *Source* Compiled by the authors based on (Olkhovskaya, 2021)

Add to this, the costs of using solar panels, namely large areas of fields where nothing grows and wind turbines, which also occupy vast areas, change the direction of airflow and make noise.

According to experts, to generate 1 GW of energy, 1.1 hectares of solar panels are needed (Energy, 2018). Thus, to generate from 849.45 to 5824.8 GW, it will take from 934.4 to 6407.3 ha (9.34–64.07 km^2) of flat land to install solar panels. The land area of Germany is 35,758 ha (357,578 km^2), the area of the EU is 423 million ha (4,233,000 km^2). This means that up to a fifth of the territory of Germany must be taken under the fields of solar panels. This is only for the generation of energy for electric transport, without production, heating, street lighting, and home heating.

Let us add to this the unresolved issue of utilization of these renewable energy sources. As a result, we will get comparable harm to the environment with the situation of using traditional energy sources. The press published data on large-scale dumps of electric vehicles in France and China (Ecology of Russia, 2021). These cars come with the batteries removed, which costs more than half the cost of a new car to replace and is completely unreasonable. The service life of a lithium battery for a car is 5–8 years, and it is halved when using "fast charging" (Virtustec, 2021). The battery weight of a passenger car is currently 700 kg, while the weight of an electric bus battery is 2000 kg. The damage caused to the environment by used lithium batteries is no less than that of nuclear waste. Lithium from batteries must be removed and properly disposed of. This is a very time-consuming and unprofitable process.

The only way to avoid a global environmental catastrophe is to establish a process for recycling and reusing such batteries. The leader in this matter is the Volkswagen concern; they managed to recycle 53% of old batteries. The planned capacity of the recycling plant is 3000 batteries per year. Currently, more than two million electric cars are registered in the EU. Given the green energy policy of the EU, their number will only grow, and, according to forecasts, the number of electric cars in the eurozone will reach 5–8 million by 2025. Consequently, a single processing plant of this kind is not enough. The problem of recycling conventional batteries has been solved for more than thirty years. So far, we have only reached a complete ban on throwing away batteries from household waste. According to the law of the EU, the solution to the problem of disposal of batteries of electric vehicles is solved by the manufacturers of electric vehicles. Currently, manufacturers of electric cars have figured out how to extend the life of electric car batteries. For example, BMW uses used i3 batteries to store energy at the manufacturing plant. Nevertheless, this is only a delay, not a solution to the problem. Even worse is the recycling of used batteries in China, the leader in the growth of electric vehicles and the largest manufacturer of electric cars. Manufacturers of electric vehicles are also responsible for the disposal of used batteries in China. However, only 10% of these batteries are currently recycled or reused.

The President of the USA, Joe Biden, set the goal of significantly increasing the share of electric cars in the USA and a complete transition to electric transport by 2040. There is a significant investment in lithium battery recycling startups. However, only three countries currently prohibit the disposal of used batteries (Earthworks Journal, 2021).

The utilization of wind turbines is no less of a challenge. In wind turbines, 90% of the entire structure is subject to processing. However, 10% are blades made from composite materials and not recyclable. Currently, most of these blades are reused. They are simply transported to poorer European countries. However, due to the wind energy renewal program, Europe will need to replace 5700 wind turbines by 2030; there is simply no room for so many blades. The length of one blade is 40 m, and the weight is seven tons. So far, the blade has been recycled by 43%, and these are experimental productions. Almost all blades that have not been recycled and not burned (which is not environmentally friendly in itself) are buried in landfills. This waste is not toxic, unlike lithium batteries, but this directly contradicts the concept of sustainable development (assuming full recycling of waste) and requires the creation of new large-scale landfills.

The readiness of today's energy system to move to a green standard is evidenced by several energy crises that have affected the USA, EU, and China over the past year.

Let us look at the cost of electricity and the structure of the energy balance in Germany, the leader of the Green Deal in the EU.

In the first half of 2020, the share of renewable energy sources in electricity production in Germany exceeded 50%. However, such indicators cannot be presented as a breakthrough toward a green economy. These indicators have only been achieved due to the confluence of circumstances, namely a general decrease in electricity consumption due to the closure of production during the lockdown period caused by the COVID-19 pandemic and the policy of Germany and the EU, which provides priority access to electricity from renewable energy sources. The very first cold weather reduced this share of RES in the country's energy balance to 20%.

The revival of the economy in Germany in 2021 led to a reduction in the share of renewable energy in the country's energy balance. With an increase in energy consumption by 4.3%, the share of renewable sources decreased by 12%. This is despite the fact that the number of "green" energy sources has increased over the year. When it was necessary to provide more energy with the restoration of the work of enterprises, "green" energy sources were not enough due to the strong instability of their work. Calmness in the North Sea and cooling lead to the shutdown of wind turbine blades and a sharp shortage of energy in the networks. Energy-intensive industries (e.g., the steel and processing industries) will be the first to suffer from this lack of electricity.

Currently, gas occupies the first place (30.6%) in the energy balance of Germany striving to "turn green," the second is fuel oil (28.6%), renewable energy (16.8%), and coal (16.6%). Simultaneously, with the onset of 2022, Germany has closed three out of six nuclear power plants, whose CO_2 emissions are significantly less than from coal-fired plants, of which 18 are currently operating in Germany.

Such investments and lobbying for green energy are very expensive for consumers. The first jumps in electricity prices in Germany were recorded with the arrival of cold weather and the stopping of windmills in the fall of 2020. In 2021, the situation worsened. Political contradictions and excessive reliance on renewable energy led to an increase in gas prices. Peak prices for blue fuel reached two thousand USD per cubic meter of fuel. These are exorbitant prices for energy suppliers in Germany, many of which were closed these days, and the load was redistributed to other suppliers (Polyakova, 2022).

The tightening of environmental legislation in China has caused the shutdown of enterprises in different parts of the world.

As part of its environmental agenda, China must become carbon neutral by 2060. In July 2021, China implemented a new carbon trading system, and even before that, hundreds of coal mines were closed because mining companies could not renew their expired licenses, and the rest had exceeded quotas.

The rise in the price of a ton of thermal coal at the Zhengzhou exchange amounted to 40% ($192.4 per ton). This is a record high for eight years. Electricity prices in China are regulated by the state, so businesses have become unable to cover their costs. Such a coincidence of shocks, restrictions on the supply of thermal coal from abroad, and cold and calm weather, making wind turbines useless, led to the fact that electricity was not supplied to residential buildings, traffic lights did not work, and the work of enterprises was partially or completely stopped.

Note that coal-fired power plants account for approximately 56% of China's 2.28 billion kilowatt-hours of electricity.

Restrictions on electricity consumption were introduced in 20 provinces, including Guangdong, which provides 10% of China's total output.

Among other things, the power cuts severely affected enterprises producing industrial magnesium, which is used to produce automotive and aircraft steel and microcircuits. As a result, 35 out of 50 industrial enterprises producing this metal are closed. China is the main supplier of industrial magnesium to the European market: 95% of the supply of this material to Europe comes from China. The sharply increased shortage of this product led to an increase in its price on the European exchange. A ton of industrial magnesium, which cost $2000 before the energy crisis, became almost instantly worth $10,000–$14,000. This threatens a partial or complete stoppage of car production in Europe, already hard hit by the lack of chips and the energy crisis.

Additionally, due to the shortage of electricity in China, the supply of aluminum, copper, and zinc, also widely used in the production of cars and aircraft, has also decreased.

European producers are afraid of a complete shutdown of their enterprises due to a shortage of these metals. Such a considerable shortage and price increase will cause a rise in the cost of cars (which have already risen in price due to a shortage of microcircuits) and the closure of a number of enterprises in the automotive and related industries that provide hundreds of thousands of jobs.

20.4 Conclusion

What alternative can be offered?

First, it is nuclear energy. The President of France, Emmanuel Macron, is lobbying for the recognition of nuclear energy as green in the European Commission. He also announced the resumption of the construction of nuclear power plants in France (Becker et al. 2022). He has a good reason for doing so. Electricity prices in France rose slightly, even with the advent of cold weather, because 70% of the country's energy balance is occupied by nuclear energy. Additionally, the European Commission may recognize gas as a green energy source as early as January 18, 2022. Recall that the carbon footprint of pipeline gas is much smaller than that of liquefied gas delivered by tankers (Polyakova, 2022).

Second, attention should be paid not to clean energy sources but to reducing the amount of greenhouse gas emissions into the atmosphere. First of all, we are interested in transport and industry. In this case, we return to the issues of filtration and recycling. The improvement and installation of advanced cleaning systems in the exhaust system of cars is several orders of magnitude cheaper than the introduction of a full cycle of production-consumption-disposal of electric vehicles. The same applies to industrial enterprises. Modernizing cleaning systems and creating waste-free production cycles are much cheaper than switching to unstable green energy sources.

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Part III
Industry-Specific Sustainability Features of Environmentally Responsible Business Practices in Support of the Fight Against Climate Change

Chapter 21
Formation of a Balanced Financing Model as the Basis for Sustainable Development of the Social Insurance System Against Unemployment in the Russian Federation

Anatolii V. Kholkin, Anastasia A. Sozinova, and Olesya A. Meteleva

21.1 Introduction

Unemployment is an integral phenomenon inherent in the market economy of every economically developed country. Since the unemployed person has no source of income from employment or entrepreneurial activity, many civilized countries pay benefits to unemployed people. To assign and pay benefits, there are appropriate state and public institutions and bodies, that is, a social insurance system. This system of assistance to the unemployed involves the payment of benefits, assistance in finding a job, professional retraining, and other measures. It is necessary to provide this system with sufficient funding for its functioning. Simultaneously, implementing financing diverts funds from the economy and is not associated with creating new value. Therefore, it is important to economically justify the amount of funds needed to divert funds from the economy. On the one hand, this amount should be necessary and sufficient to finance the unemployment insurance system. On the other hand, it should not be burdensome for the economy and not lead to negative consequences for the economy in general. Simultaneously, it is necessary to form a financing model in such a way that it is sustainable in terms of funding sources, which would be, to a small extent, dependent on political and economic risks.

The solution to this problem is possible based on building a balanced model for financing the social insurance system against unemployment. Therefore, this research is relevant and important for ensuring the sustainable development of the system of social insurance against unemployment and the country's economy as a whole.

A. V. Kholkin · A. A. Sozinova (✉) · O. A. Meteleva
Vyatka State University, Kirov, Russia
e-mail: aa_sozinova@vyatsu.ru

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The paper aims to form a model for financing the social insurance system in the Russian Federation based on the definition of the basic postulates and principles of building a balanced model.

To achieve the research goal, the authors had to solve the following tasks:

- To formulate the principles (postulates) and assumptions underlying the formation of a balanced financing model;
- To justify these principles (postulates) and assumptions;
- To draw up a balanced model for financing the social insurance system in the conditions of the Russian Federation and its justification.

The scientific novelty of this research lies in developing principles for building a balanced model and forming a balanced model of compulsory social insurance against unemployment in the Russian Federation. The scientific significance is the development of principles (postulates) and assumptions, which are the theoretical basis for developing balanced financing models. The practical significance of the research is forming a balanced model of social insurance financing in the Russian Federation, which provides the system with guaranteed sources of financing for its sustainable existence and development.

21.2 Methodology

The solution of the tasks was carried out using the following methods: analysis, synthesis, deduction, induction, modeling methods, tabular method, and graphical method. The materials and sources of the research were scientific publications of various authors, official statistics, and regulations and information from government agencies. In particular, the authors analyzed publications by such authors as Auray et al. (2019), Boadway and Cuff (2018), Devos and Rahman (2018), Ganong et al. (2020), Givens (2021), Hsu et al. (2018), Johnston (2021), Johnston and Mas (2018), Lachowska et al. (2020), Landais and Spinnewijn (2021), Landais et al. (2018), Le Barbanchon et al. (2019), Lechthaler and Ring (2021), Marinescu and Skandalis (2021), Miller and Pavosevich (2019), Osiander et al. (2021), Pavosevich (Pavosevich, 2020), Popkova et al. (2021), Renahy et al. (2018), Raifman and Venkataramani (2021), and Sozinova et al. (2021).

According to scientific articles, contemporary science has not paid enough attention to building a balanced model for financing the system of compulsory social insurance against unemployment in terms of determining the principles (postulates) and assumptions and in terms of creating and describing the model.

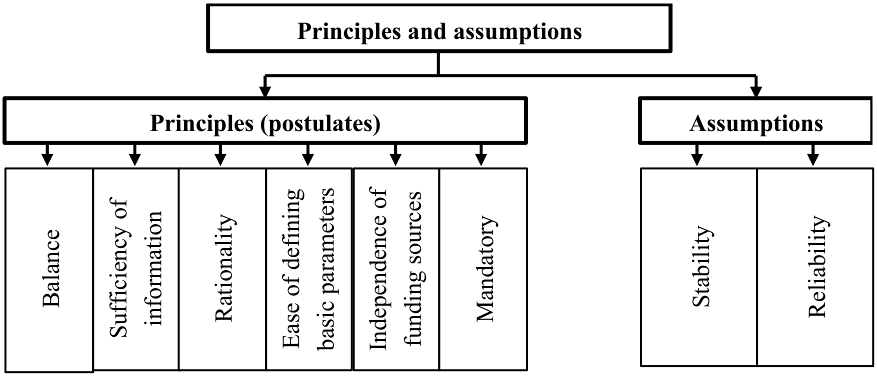

Fig. 21.1 Principles and assumptions of model formation. *Source* Compiled by the authors

21.3 Results

As a result of solving the research tasks, the authors obtained the following results.

First, the authors formulated principles (postulates) and assumptions, on the basis of which they developed a balanced model of financing the system of compulsory social insurance against unemployment. The diagram in Fig. 21.1 illustrates the composition of the principles (postulates) and assumptions.

Second, the authors justified principles (postulates) and assumptions underlying the development of a balanced model for financing compulsory social insurance against unemployment. The rationale for the principles is given in Table 21.1.

Third, on the basis of the principles, the authors developed a balanced model for financing the system of compulsory unemployment insurance in the Russian Federation. The diagram in Fig. 21.2 illustrates this model.

21.4 Discussion

The development of a balanced model for financing compulsory social insurance against unemployment should be based on the following principles (postulates): (1) balance, (2) availability of information, (3) rationality, (4) ease of determining the main parameters, (5) independence of funding sources, and (6) obligation. Assumptions underlying the creation of the model are (1) stability and (2) reliability.

The principle of balance is that the revenues coming into the system must fully cover all costs of the system, including the costs of ensuring the functioning of the system and its development. In this regard, it is necessary to strive for the income of the system to be arithmetically equal or slightly exceed the costs of the system.

The principle of information security provides that when determining the factors affecting the parameters of the system functioning, we must consider that the factors

Table 21.1 Rationale for principles and assumptions

Principles and assumptions	Rationale for use
Principles	
1. Balance	The equality of income and expenditure of the system contributes to the optimal functioning of the system and allows withdrawing the necessary and sufficient amount of funds from the economy
2. Availability of information	There is no need to build additional information systems and create additional information flows and additional resource costs
3. Rationality	It ensures the effective functioning of the system
4. Easy to determine the main parameters	It is necessary, and it ensures the implementation of the principle of rationality
5. Independence of funding sources	It provides self-financing, risk reduction, and sustainable existence and development of the system
6. Obligation	It gives the system legitimacy
Assumptions	
1. Stability	Calculation and forecasting of parameters are possible only in conditions of stability of the main macroeconomic parameters
2. Reliability	It is only on the basis of reliable data that we can determine the influence of factors and make predictions

Source Compiled by the authors

should be reflected in the relevant sources of information, reporting forms and, if possible, published in open sources of information.

The principle of rationality implies that the costs of creating the elements of the model, its implementation, and functioning should be rational, that is, give a greater effect, considering the need for the sustainable functioning of the system.

The principle of simplicity in determining the main parameters follows from the principle of rationality and suggests that the main parameters of the system should be determined simply, without the use of complex mathematical apparatus.

The principle of independence of funding sources is that when determining the sources of funding for the functioning of the system, it is necessary to strive to ensure that the source is independent of budgetary funds (this is associated with fiscal risks and risks of the budgetary system), and that the sources are independent of the influence of economic and commercial risks.

The principle of obligation implies that, in terms of sources of revenue, the system establishes mandatory contributions for economic actors. In terms of expenditure of funds, there is an obligation to use the funds received strictly for their intended purpose, without the possibility of using them for any maneuver in executing budgetary obligations by public authorities.

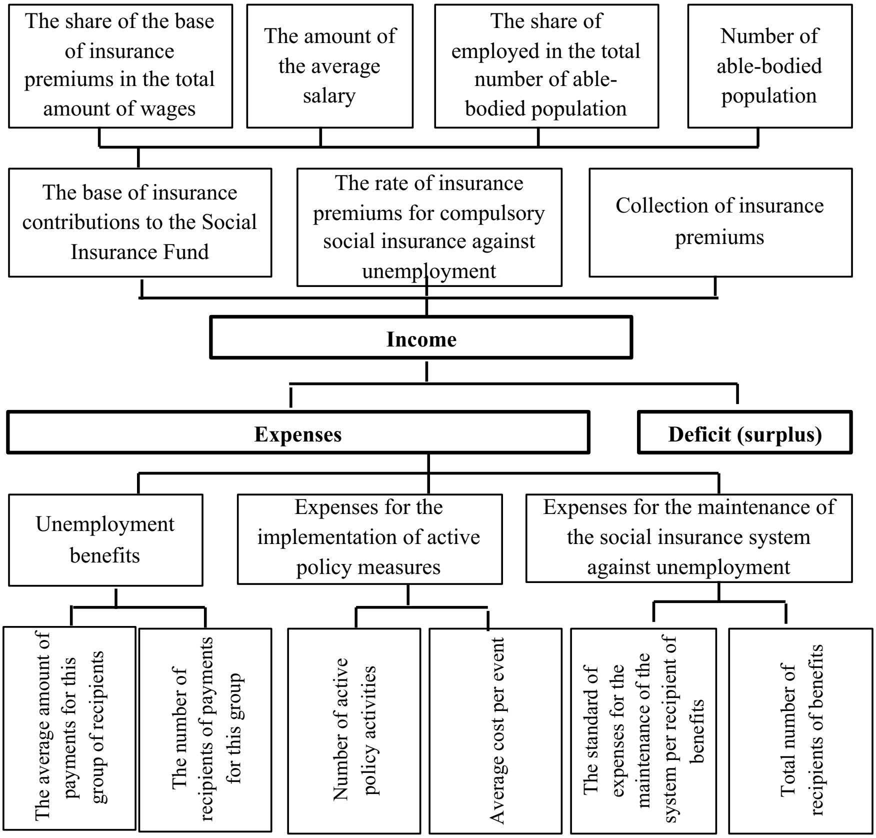

Fig. 21.2 Balanced model for financing the system of mandatory unemployment insurance. *Source* Compiled by the authors

The assumption of stability assumes that the economic and legal conditions of the system will not change significantly over a period of time. The reliability assumption provides that the information used in the system is obtained from reliable sources and does not contain intentional distortions and errors.

Guided by these principles and assumptions, the authors obtained the following balanced model based on the following equality and the principle of balance:

$$I_{sus} = E_{sus} \pm \Delta_{sus} \quad (21.1)$$

where

I_{sus}—revenues of the compulsory unemployment insurance system;
E_{sus}—expenses of the compulsory unemployment insurance system;
Δ_{sus}—surplus (+) or deficit (-) of system revenues to cover costs.

The following model can describe the income of the system of compulsory social insurance against unemployment:

$$I_{sus} = B_{fss} \times P_{sus} \tag{21.2}$$

where

B_{fss}—the base of insurance premiums deducted to the Social Insurance Fund;

P_{sus}—the rate of insurance premiums deducted to the system of compulsory social insurance against unemployment.

The base of insurance contributions to the Social Insurance Fund was chosen as the basis for calculating the income of the compulsory unemployment insurance system. This indicator is determined and controlled when drawing up the budget of the Social Insurance Fund; its value is open information and does not require additional costs for determination, which corresponds to the principle of rationality. The rate of insurance premiums when making a forecast is a variable parameter, which, in fact, is the balancing parameter of the entire system. Therefore, the problem lies in the correct definition of this value, its justification, and legalization.

However, despite the high efficiency of the tax control system in the Russian Federation, it is not always possible to collect the entire amount of any tax. This rule also applies to contributions. Taking into account the collection rate, the income of the system can be determined by the following model:

$$I_{sus} = B_{fss} \times P_{sus} \times C \tag{21.3}$$

where

C—collection of insurance premiums.

In the future, using the extension method in relation to multiplicative models, we can obtain the following model as the base for calculating insurance premiums:

$$B_{fss} = S_{fss} \times Z \times S_e \times N \tag{21.4}$$

where

S_{fss}—the share of the base of insurance premiums in the total amount of wages;

Z–the average wage;

S_e—the share of employed in the total working-age population;

N—working-age population.

In turn, using the extension method for additive models, the amount of social insurance costs can be calculated using the following model:

$$E_{sus} = U_b + A_p + M_p \tag{21.5}$$

where

U_b—unemployment benefits and other payments to the unemployed;

A_p—expenses on active policy measures;

M_p—costs of maintaining the social insurance system against unemployment.

Using the extension method for multiplicative models, we can obtain the following models to calculate the various components of the system costs.

With regard to payments in favor of the unemployed, the following model was obtained:

$$U_{\mathrm{b}} = \sum_{i=1}^{k} \overline{V_i} \times N_i \tag{21.6}$$

where

V_i—the average amount of payments for this group of recipients;

N_i—the number of recipients of payments for this group;

k—the number of beneficiary groups.

Groups of recipients are identified based on the analysis of the provisions of the current legislation, which determines the procedure for assigning, calculating, and paying benefits and other types of assistance to the unemployed.

In terms of spending on the implementation of active policy measures:

$$A_{\mathrm{p}} = Q_{\mathrm{m}} \times P_{\mathrm{m}} = U_{\mathrm{p}} \times S_{\mathrm{ap}} \tag{21.7}$$

where

Q_{m}—the number of active policy measures;

P_{m}—the average cost per event;

S_{ap}—the share of spending on active measures in relation to the amount of unemployment benefits.

The costs of maintaining the social insurance system against unemployment can be calculated according to the following models:

$$M_{\mathrm{p}} = P_{\mathrm{p}} \times \sum_{i=1}^{k} N_i = U_{\mathrm{b}} \times S_{\mathrm{mp}} \tag{21.8}$$

where

P_{p}—system maintenance cost per beneficiary;

S_{mp}—the share of costs of maintaining the system in relation to the number of benefits.

All factors can be determined based on sources of information available to the authorities obtained through statistical and budget reporting.

21.5 Conclusion

The authors of this research developed a balanced model of financing the system of compulsory social insurance against unemployment in the Russian Federation, aimed at achieving sustainable functioning of the social insurance system and the country's economy as a whole.

To create a model, the authors determined the principles and assumptions of the system formation. In particular, they underlined the need to consider the following principles: (1) balance, (2) availability of information, (3) rationality, (4) ease of determining the main parameters, (5) independence of funding sources, and (6) obligation. Besides, the formation of the model is based on the following assumptions: (1) stability and (2) reliability.

Using these principles and assumptions, the authors have developed a model that assumes and ensures equality of income and expenses, which is also necessary to achieve a balance of interests of all participants in relations arising in the processes of social insurance against unemployment.

Using these models, it is possible to determine the values of individual system parameters and determine and economically justify the size of the deduction rate, which is the main balancing parameter of the entire system. Simultaneously, the values of all factors included in the models can be determined based on open sources, where information is available both to the authorities and other people.

The introduction of this model will lead to an increase in the stability of the system of social insurance against unemployment because it involves the formation of independent income.

The direct introduction of these models into practice requires the creation of additional organizational and legal mechanisms within the framework of the social insurance system, which will result in the development and implementation of new regulations. However, the development of these acts is an independent research topic, which can be based on the results obtained in this research.

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Chapter 22
Analysis of Organizational and Individual Values Congruence in the Implementation of the Bank's ESG Strategy

Alim B. Fiapshev

22.1 Introduction

The issues of social orientation of business have been in the focus of management science research for decades. The adoption of social obligations by businesses was seen as a necessity due to a combination of circumstances. Among these circumstances were the limited capacity of the country to solve social problems, the awareness of the business of its special social mission, etc. This awareness occurred as businesses recognized the dependence of their strategic prospects on the measure of their participation in current social problems. The set of the latter gradually expanded, and, subsequently, one of the central places in it was occupied by environmental problems, the number and nature of which were directly linked to the activities of the business. As a result, these issues of the current socio-environmental agenda took shape in ESG principles, which are now an integral part of the strategic guidelines of business community activities. Achieving sustainable development goals is associated with implementing these principles, possible in full with an active government position in the relevant area.

The present study focuses on the issues of social interaction within organizations, the productivity of which is directly reflected in the indicators of motivation and labor productivity. Maintaining the high quality of such interaction in the interests of individuals—members of production teams and the entire organization—is the most important position in the number of social obligations of today's organizations and the toolkit of their HR management. Moreover, these tools are focused on fulfilling these obligations, which is considered the most important condition for the provision of target indicators of management activity efficiency. In this case, economic performance is not achieved at any cost, which for a long time was one of the most important

A. B. Fiapshev (✉)
Financial University Under the Government of the Russian Federation, Moscow, Russia
e-mail: fiapshev@rambler.ru

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characteristics of the capitalist paradigm and embodied all its vices, but through the solution of social problems, including those born within organizations. Nowadays, this increased social burden, expressed in the need to create conditions for effective industrial interaction and maintaining a healthy intra-organizational climate, implemented through a subsystem of HR management, has merged and become an integral part of the ESG missions developed and implemented by companies. Finding ways for such an effective interaction is the most important research subject of numerous theories of motivation. This is a vast subject area, and this paper will limit to a separate but most visible slice of the problem. These are both organizational or corporate and individual values. The former values are usually fixed in local organizational acts, such as corporate codes. The latter should be identified, which requires some management effort. Many organizations often do not bother to do this so that the necessary level of correspondence or consistency of individual and corporate values is not achieved, which dulls the motivation of employees and affects the efficiency of the whole organization. In parallel, social contradictions in the team are exacerbated, often resulting in the loss of work, transferring these contradictions to another, higher level when social tensions go beyond the organization and affect local communities. Therefore, the problem of identifying the conditions and factors for ensuring a high level of conformity of organizational and individual values is relevant, not so much to solve the current economic problems of organizations as to prevent the emergence of conflicts and contradictions and the growth of social tensions. This goal is an important and organic part of the contemporary agenda implemented by the business community based on ESG standards.

Nowadays, when ESG standards are actively and widely implemented in corporate codes, compliance with the benchmarks associated with them (including those related to the need to maintain a high degree of consistency of different values) is also the key to ensuring sustainable development.

Most Russian organizations are still in the early stages of incorporating high social standards into management practices. In this sense, banks are the furthest along among Russian organizations. Unlike employees in other sectors of the economy, their employees are somewhat more prone to introducing changes and accomplishing goals. Raising the level of consistency between organizational values and those of the employees is particularly important for the banking industry for this reason, as well as due to the way banks are positioned in the economy and the decision-making they are responsible for.

22.2 Materials and Methods

The use of person–organization (P-O) fit models originates in Argyris' theoretical works concerning job enlargement and participatory management (Argyris, 1957). In recent decades, the issue of value congruence and its implications has become an active area of research. The P-O fit construct was analyzed and discussed by chief theorists and intellectuals. Cable and Judge (Cable & Judge, 1996, 1997), Chatman

(Chatman, 1989, 1991), Chatman and Goncalo (2015), Kristof (1996), Kristof et al. (2002), O'Reilly and Chatman (1996), O'Reilly et al. (1991), and Schneider et al. (1995) defined P-O fit as a congruence between the individual and organizational values.

The inception of P-O fit research is associated with Schneider's Attraction–Selection–Attrition (ASA) model (Schneider et al., 1995), which is frequently regarded as a milestone in this domain. Schneider suggested that, drawing on underlying values, people can choose congruent roles, occupations, and even organizations. The ASA framework implies that individuals may be attracted to organizations where values are similar to their own. In turn, companies tend to select candidates who share values similar to the organizational ones (Attraction). The next step involves hiring employees who match the attributes that an organization desires (Selection). Once individuals become part of the organization but find it challenging to socialize and assimilate (because they do not fit the organization), they tend to leave (Attrition).

Thus, value congruence is seen as an essential factor of organizational efficacy. In this connection, Westerman and Vanka (2005) noted that the basic principle underpinning P-O fit implies that work attitudes and behavior outcomes stem not from the individual or the work environment in isolation from one another but rather from the interaction between the two. The meta-analytical review of Kristof et al. (2002) indicates that P-O fit exhibits high correlations with job satisfaction and organizational commitment and a more moderate relationship with intention to leave the organization. Many scholars came to similar conclusions, stating that the level of P-O fit affects important behavioral outcomes, such as job satisfaction, organizational commitment, and turnover intention.

A moderating P-O fit effect of the relationship between organizational commitment, job satisfaction, and turnover was shown by Alniasik et al. (2013). However, this effect was identified in relation to educational institutions. At the same time, organizations that actively implement digital technologies and replace human resources with these technologies have their own peculiarities. Banks are an example of such organizations. Therefore, it is interesting to see how these connections manifest themselves in these organizations, using the already methods that have already been shown to be effective.

The problem of the value congruence in relation to the nature of the banks' activities and the characteristics of the human resources practices used in this sector has remained insufficiently studied until recently. In this vein, it is worth highlighting the results of studies obtained in the cross-cultural analysis of the banks' activities in different countries (Fiapshev & Fiapsheva, 2020). The results obtained by comparing management practices allowed identifying the dominant behavioral attitudes of bank employees in different countries and revealing the national aspects impact of the organizational commitment, turnover intention, and job satisfaction on the consistency of organizational and individual values. Considering the dynamics of the development of the financial sector, active digitalization of business processes, and the pace of staff reduction in banks, these results are no longer so relevant. The values of bank employees and their behavioral attitudes are likely to change under the influence of these processes. Therefore, additional research is required to identify the level of consistency of individual and organizational values of bank employees, as well as to measure the impact that various factors have on it.

The sample of the current research is comprised of 114 employees from five Russian banks, two of which are regarded as systemically important credit institutions. The respondents were asked to keep in mind while ranking the items that they might vary depending on whether they were describing their own preferences or the culture of a focal organization. Thus, to measure the individual value profile, employees were asked to rank the values that correspond to their image of an ideal organization. To build an organizational value profile, senior employees who were familiar with the company's culture were instructed to answer the question "To what extent is your organization recognized for its…" in relation to each of the 28 OCP value items using a five-point Likert-type scale, where 1—not at all, 2—minimally, 3—moderately, 4—considerably, and 5—very much (amending the original Q-sort procedure to a normative scale). This procedure implies that the two different groups of people describe an organization's values and individual preferences. Person–organization fit is then assessed by comparing the organization profile to the individual profiles.

Consistent with previous research, the actual fit was calculated with the use of the sum of absolute differences by subtracting each respondent's score for each of the 28 value statements in the "organizational profile" from the value item in the "individual profile".

After considering the techniques used by the management of the researched organizations, the importance of values from individual and organizational levels was tested utilizing the OCP technique. The value profiles were analyzed, and the means were calculated for each item at each level—individual and organizational. The value discrepancy (e.g., misfit) was computed by subtracting the organizational level scores from that of the individual-level estimates.

The most important values reported at the individual level are (3) being distinctive—being different from others; (4) being competitive; (6) having a good reputation; (11) being people-oriented; (16) taking individual responsibility; (19) high pay for good performance; (22) enthusiasm for the job.

At the organizational level, the key perceived values are as follows: (2) an emphasis on quality; (6) having a good reputation; (8) having a clear guiding philosophy; (9) high pay for good performance; (20) praise for good performance (22); enthusiasm for the job (27); security of employment.

The overlap for individuals and the organization shows such values as (3) being distinctive—being different from others; (9) high pay for good performance; (20) praise for good performance; (18) opportunities for career growth. On the other hand, the largest discrepancy between individual and organizational levels displays values such as (5) being reflective and (12) collaboration.

Further, job satisfaction was measured using the "Global Job Satisfaction Scale" advanced by Quinn and Shepard (1974, pp. 33–56). An example of the question is "All things considered, I like my job." Organizational Commitment was assessed using the "Organizational Commitment Scale," developed by Meyer et al. (1993). Finally, to estimate intent to quit, the four-item intention-to-leave-the-organization scale was adopted from Angle and Perry (1981) and Jenkins (1993). Bank employees who participated in the survey were asked to indicate the extent to which they agreed with the statements on the questionnaire. This measure ranged from (1)—strong disagreement—to (5)—full agreement.

22.3 Results

The survey data were further used to identify the measure of dependence between the assessed variables. The results of the correlation analysis are presented in Table 22.1. In general, the correlation between the estimated variables was quite significant.

The author considers a high level of correspondence between individual and organizational values as an important condition of providing a socially oriented policy for the bank, a high level of job satisfaction, and minimization of risks that influence labor productivity. To confirm this hypothesis, the author carried out a regression analysis. Its first stage identified the most significant factors influencing the high level of compliance with these values and determined how this level is reflected in the state of other variables. These relationships seem important for management practices focused not only on economic but also on social goals that are part of the bank's ESG strategy. First, it was determined which of the variables (organizational commitment or P-O fit) had a greater impact on bank turnover. The regression analysis supported the conclusion that there was a significant negative relationship between turnover and job satisfaction. Simultaneously, the influence of the values matching variable appeared to be weak in this relationship. That is, the desire to leave the organization and change jobs is determined to a greater extent by dissatisfaction

Table 22.1 Results of correlation analysis

		Organizational commitment	Job satisfaction	Turnover intention	Person–organization fit
Organizational commitment	Pearson's correlation	1	0.957**	−0.921**	0.885**
	(bilateral)		0.000	0.000	0.000
Job satisfaction	Pearson's correlation	0.957**	1	−0.928**	0.824**
	(bilateral)	0.000		0.000	0.000
Turnover intention	Pearson's correlation	−0.921**	−0.928**	1	−0.847**
	(bilateral)	0.000	0.000		0.000
Person–organization fit	Pearson's correlation	0.885**	0.824**	−0.847**	1
	(bilateral)	0.000	0.000	0.000	

Source Calculated by the author

with the current job. The high level of this dissatisfaction can be caused by hygienic and motivating factors in the definition of the known theories of motivation.

After that, the effect of the P-O fit variable and the turnover variable on job satisfaction was assessed. A high level of consistency between individual and organizational values of bank employees appeared to have a weak direct effect on job satisfaction. Organizational commitment has a considerably more significant effect on job satisfaction.

However, organizational commitment is a controversial phenomenon. A high level of organizational commitment can be caused by factors that negatively characterize the social subsystem of organizations. In this regard, it was necessary to determine how a high level of correspondence between organizational and individual values is reflected in organizational commitment. The analysis results revealed the significance of the influence of the P-O fit variable on organizational commitment ($R2 = 0.680$). Thus, a mediated relationship was found that supports our hypothesis about the importance of maintaining a high level of alignment between individual and organizational values in the organization. P-O fit through organizational commitment affects job satisfaction, which is the most important motivation factor.

Additionally, it was found that there is a high level of correlation between the studied parameters. It turned out to be higher than in the research conducted 4–5 years ago. This growth can be explained by increased competition in the labor market. This competition is caused by the active implementation of digital technologies in the business processes carried out by banks.

We see the value of these results in the specific quantitative assessments of these interactions in relation to the characteristics of Russian banks. Moreover, the relationship between these parameters strengthens over time, which determines the necessity of introducing managerial practices aimed at the development of the corporate climate of Russian banks. Bank employees are often dissatisfied with their life in the present and evaluate their career path as average. This phenomenon is especially pronounced among highly qualified employees (the majority of employees of the Russian banking sector). Future orientation makes them, even with a small degree of dissatisfaction with their work, look for new places of application of their forces and qualification. This phenomenon persists today despite the increasing competition between people looking for work in the financial sector of the economy. Management practices in banks should focus on increasing the alignment of organizational and individual values. A high level of this alignment is the key to increasing the effectiveness of a bank's ESG strategy. While most of the attitudes in this strategy relate to a focus on solving problems external to the bank, in particular lending to environmental and social projects, intra-organizational social problems remain relevant.

22.4 Conclusion

The problem of consistency between individual and organizational values has been the subject of numerous studies, mostly by non-Russian scholars. Their results contain conclusions about the main factors that determine the possibility of such alignment, and about the impact of the latter on the efficiency of the organization. Based on these studies, we hypothesized that there is a significant relationship between P-O fit (value congruence), organizational commitment, employee job satisfaction, and the intention to leave the organization in a Russian company. Russian banks were chosen as the research object.

The studied banks have an extensive regulatory framework for personnel management, the most important component of which are provisions on corporate values and ethical standards that form the basis of their ESG strategies. During the research, surveys of employees were conducted, which revealed the dominant attitudes in people's behavior and values. Comparison of the latter with organizational values allowed identifying generally minor and fragmentary deviations. Simultaneously, when the organizational values are shared by the majority of respondents, there is a decrease in the effectiveness of the material reward mechanism, which we consider a threat to the entire system of effective interaction in banks, and a negative impact on the internal corporate climate.

The findings revealed an indirect relationship between P-O fit and bank employees' job satisfaction through organizational commitment. A comparison of the obtained results with the results of the previous studies confirmed that the strength of the relationship between these parameters increases with time.

This determines the need to develop management practices aimed at increasing the level of organizational commitment, which involves not only the maintenance of an effective system of material remuneration but also the comprehensive development of the social subsystem of the organization from the implementation of a wide range of social guarantees to the fullest possible identification and consideration of the value orientations of employees. Solutions in this direction minimize the risks associated with the implementation of the bank's ESG strategy and contribute to the achievement of sustainable development goals.

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Chapter 23
Solving Environmental Problems as a Priority for "Young" Companies Conducting IPOs Amid Global Economic Uncertainty

Ekaterina Yu. Voronova and Yulia A. Lukina

23.1 Introduction

In 2020, the world community has collided with a pandemic that has acquired tremendous dimensions and becomes a serious threat to the global economy. Many companies experienced negative dynamics in key economic indicators of profitability and efficiency. The impact of the pandemic on the real sector of the economy was mostly negative; the same cannot be said of its influence on the stock market (Mazumder & Saha, 2021). The most favorable dynamics of the stock market was formed in 2020, which was reflected in the growth of the main stock market indicators: Dow Jones, S&P 500, Nasdaq, Russell 2000. A sharp drop in all key indices was recorded in March 2020, but after that, there was an equally dramatic and stable growth, new historical highs were reached in December 2020. Nowadays, most of the indices have maintained positive dynamics, although the growth rates have significantly decreased compared to late 2020 and early 2021.

The main reason for such a sharp surge of activity in the stock market lies in a set of preventive measures to counter the spread of COVID-19. Many developed countries have resorted to financial assistance and other incentives to support companies and citizens. The quantitative easing policy, which was also adopted in some countries, led to a decrease in the key rate. "Additional" money and a lower interest rate on deposits resulted in an influx of new investors into the stock market in search of higher profitability. The increased interest in the stock market prompted many companies to conduct an initial issue of shares, and they considered the period of the global pandemic, which, at first glance, caused significant damage to the world economy,

E. Y. Voronova (✉) · Y. A. Lukina
MGIMO University, Moscow, Russia
e-mail: voronovaeu@inno.mgimo.ru

Y. A. Lukina
e-mail: starovaya.yu.a@my.mgimo.ru

E. G. Popkova and B. S. Sergi (eds.), *Current Problems of the Global Environmental Economy Under the Conditions of Climate Change and the Perspectives of Sustainable Development*, Advances in Global Change Research 73, https://doi.org/10.1007/978-3-031-19979-0_23

as the most favorable moment for entering the stock market. An increase in the number of IPOs was observed both on foreign stock exchanges and on Russian ones.

The situation in the real sector of the economy has always predetermined the dynamics in the stock market to some extent. Throughout the history of financial markets, there have been dozens of meltdowns, the most significant of which led to larger financial losses for investors, distrust in stock market mechanisms and tighter state control of the market. Thus, the financial crisis of 2007–2009 adjusted the dynamics of the IPO market in quantitative and qualitative terms. The number of IPOs decreased, but some of them were quite significant and had particular importance for the market as a whole.

The research is focused on the concept of a "young" company as one of the fundamental terms. "Young" companies are those companies that have carried out an IPO during the current year. Entering the stock market is an important phase of a company's life cycle, some companies conduct their IPO at an earlier stage, while others have been operating as private enterprises for decades, but an IPO is a kind of indicator of a company's "maturity". The IPO process involves a wide range of commercial and management costs, so when a company manages to implement environmental programs during its IPO, solving environmental problems can indeed be considered one of the key priorities for the company. Many stable and well-established on the stock market companies launch environmental programs, pursuing various goals from the desire of employees to contribute to solving environmental problems to improving their image in front of potential investors. "Young" companies sometimes have fewer financial resources than public ones and invest their capital for environmental programs in the pre-IPO stage, which highlights the serious attitude toward environmental issues.

Environmental problems are very acute in modern conditions, more-and-more summits and conferences dedicated to combating climate change, environmental pollution, the extermination of animals and plants, etc., are held. The United Nations Climate Change Conference (COP26) is planned for November 2021 in Glasgow; at COP26, countries will set a new higher level of emission reductions under the Paris Agreement. According to the International Energy Agency, the current level of investment to reduce CO_2 levels is not sufficient. An additional $48 trillion will need to be invested to combat climate change for the period 2020–2035 (Carnevali et al., 2021). Moreover, the current political and economic system cannot provide sustainable development due to imperfect institutional mechanisms; the transformation of indigenous political and economic institutions will be required for the sustainable development of society (Vatn, 2020).

The problem also lies in the attitude of people toward global warming and environmental problems in general, including water resources (Senerpont Domis & Teurlincx, 2020). Environmental problems cannot be solved by individual companies or states; all the challenges of global warming, pollution, etc., can be met only through joint efforts by all countries, companies and the international community as a whole. The key element should be the promotion of an environmentally friendly lifestyle, so companies that have a direct impact on consumers will play an important role in conveying environmental ideas to the world's population, and the activity of non-governmental organizations in social networks can also have a strong impact (Li et. al., 2021). Furthermore, according to ongoing empirical studies, other social factors can have a beneficial effect on solving environmental issues, for instance, the extension of school education can reduce ineffective plastic sorting by 44%, and a reduction in corruption in the country will lead to a decrease in the same indicator by 28% (Cordier et. al., 2021).

The chronological framework of the study will include two stages: the financial crisis of 2007–2009, as well as the crisis caused by the global pandemic, which began in March 2020, when the World Health Organization declared the spread of the SARS-CoV-2 virus as a pandemic and continues up to now. It seems most interesting in terms of geographical aspect to consider the environmental programs of "young" companies in two countries, namely the United States and Russia. These countries were selected by the authors, as they came to the ideas of environmental friendliness in different periods. The United States can be called the main driving force in combating climate change: The headquarters of many "green" organizations are located in the United States, and many innovative companies were established in this country. Russia, on the other hand, is on the path toward accepting environmental problems, various initiatives aimed at improving the environmental situation are gradually emerging, but these actions still cannot be regarded as large scale.

23.2 Methodology

Environmental problems require immediate intervention and concerted action from all economic entities: from individuals to governments. The urgency of combating global warming and other problems confirms the relevance of this research. The purpose of the study is to identify the contribution of "young" companies in Russia and the United States to solving environmental issues in quantitative terms. The following tasks of the research were formulated by the authors: firstly, to assess the effectiveness of solving environmental problems by "young" companies, taking into account the peculiarities of geography and external factors; secondly, to assess the role of "young" companies in "green" agenda over time; thirdly, to identify the main motives of companies when hastening investment in technology solutions to environmental problems; fourthly, to identify possible ways of increasing the interest of companies in green finance and find out the most effective mechanisms for financial support of such companies, taking into account the wide world experience.

The theoretical part of the study is based on scientific researches of domestic and foreign specialists in the field of international finance, ecology and nature management, as well as public administration and taxation. The article builds on ecological monetary thorium, in the framework of which money acts as social relations, evaluated in monetary units (Ament, 2020). The methodological and theoretical basis of the study include the methods of grouping, comparative and statistical analysis, comparison of time series and the expert assessment method.

The study conducted by the authors is scientifically novel, most experts assess the role of individual states in solving the issue of climate change and other environmental problems, and the central object of the study is environmental taxation in most cases (Hochman & Zilberman, 2021). A few pieces of research are devoted to evaluating the impact of individual companies on the environment. The object of this particular research is a narrow group of companies that carried out IPOs amid unfavorable dynamics of the real sector of the economy and global economic uncertainty, which implies scientific novelty.

23.3 Results

The global pandemic and the government policy aimed at containing the spread of the virus were a real catalyst for the rapid development of the global IPO market, which is confirmed by the dynamics shown in Fig. 23.1. Over 28,000, IPOs were carried out around the world from the beginning of the twenty-first century to the present time. One of the least successful years for initial public offerings was 2008, only 769 companies decided on an initial issue of shares amid the global financial crisis, a subsequent downward trend was recorded in 2009, and the number of companies that carried out IPOs dropped to 577 companies. The dynamics of the IPO market in the context of the crisis caused by the global pandemic turned out to be opposite. Over 1300, IPOs were conducted in 2020, which was a remarkably positive indicator in the context of the crisis, and the number of IPOs in 2021 significantly exceeds the indicator of 2020. As of October 2021, there have already been 1635 IPOs in the world.

The scale and structure of the IPO have undergone dramatic changes over the years. As part of the research devoted to the environmental orientation of companies, the largest IPOs will be considered at two stages of global economic uncertainty: the global economic crisis, which erupted in the United States in 2007 and ended in 2009, and the crisis provoked by the global pandemic, which lasts from 2020 to this day.

One of the most ambitious IPOs of 2007–2009 was Visa's IPO, which took place on March 18, 2008. It should be noted that Visa decided to conduct an IPO in the

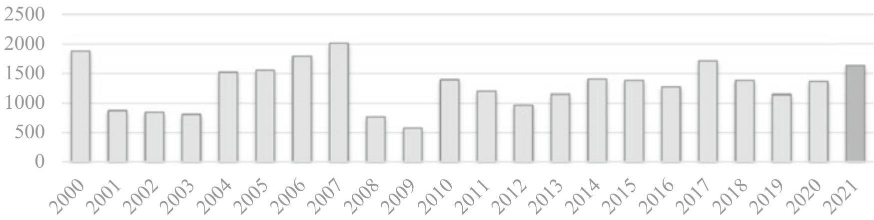

Fig. 23.1 Dynamics of the global IPO market in the period from 2000 to 2021. *Source* Compiled by the authors based on Ernst & Young Global Limited (2021)

most unfavorable conditions when Wall Street investors were shocked by the deal between JPMorgan Chase (JPM) and Bear Stearns, but everything turned out well for Visa. Investors appreciated the company, which at that time operated the world's largest payment system and owned approximately 13,000 financial institutions. The value of the company's shares increased by 28% on its first day of trading. As a result of the IPO, the company raised $17.9 billion, which is one of the most striking examples of a successful IPO during the crisis.

The period of world pandemic is characterized by a great variety and colossal scale of the IPO market. Airbnb, which conducted an IPO on December 9, 2020, is considered to be one of the most interesting companies in the context of ecology and nature management. Airbnb's initial public offering was priced at $68; the company's shares soared to $165 on the very first day of trading, which is significantly higher by 142.6% than the initial price. The share price was $169 in October 2021.

The Russian IPO market, the dynamics of which is shown in Fig. 23.2, has always been inferior in scale to European and American ones for quite obvious reasons, including a younger market, less developed financial mechanisms. The number of companies that have conducted IPOs and the value of transactions have always been at a relatively low level. A notable exception was 2007, when the largest number of initial public offerings, which amounted to 22 companies, took place; moreover, there were a number of very significant IPOs in value terms. The largest initial public offerings of that period can be considered the IPO of VTB and Sberbank. The latter is well-known for its ESG policy; therefore, it is the statistical indicators of Sberbank that will be used in the research for further comparison.

The clearly expressed upward tendency that emerged in 2020 should be noted. Six Russian companies conducted IPOs at once in 2020, and even more public offerings are to be carried out in 2021. Eleven companies will go public this year, seven companies have already completed their IPOs and estimated the number of funds raised, while the IPO closing date has not yet been set for others.

The seven most ambitious IPOs of Russian companies during the global pandemic are contained in Table 23.1. Almost all of these companies are involved in the process of resolving environmental issues to some extent. The Fix Price and OZON trading platforms are engaged in the sale of environmentally friendly products, and the transport company Sovcomflot regularly updates its fleet of ships, which allows them to

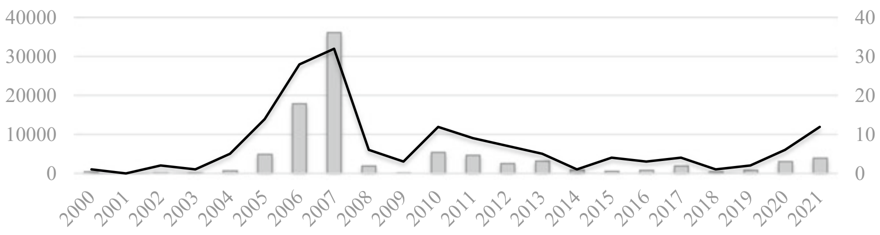

Fig. 23.2 Dynamics of the IPO market in the context of Russian companies in the period from 2000 to 2021. *Source* Compiled by the authors based on PREQVECA (2021)

Table 23.1 Russian companies conducting IPOs amid global economic uncertainty caused by the pandemic

No	IPO	Stock exchange	Amount of funds raised, USD million	IPO closing date
1.	Fix price	London stock exchange, MOEX	1740	09.03.2021
2.	OZON	NASDAQ	1140	24.11.2020
3.	Kaspi.kz	London stock exchange	1000	14.10.2020
4.	Sovcomflot	MOEX	550	07.10.2020
5.	European medical center (EMC)	MOEX	500	15.07.2021
6.	Segezha group	MOEX	411	28.04.2021
7.	Softline	London stock exchange	400	27.10.2021

Source Compiled by the authors based on PREQVECA (2021)

meet the highest environmental standards. Other companies, including Kaspi.kz, Segezha Group, Softline, also pursue complex environmental policies, participate in environmental campaigns, support initiatives to preserve and restore natural objects and so on. The Segezha Group is one of few organizations that publicly publish environmental spending as part of the company's annual financial statement. Moreover, the company is included in the rating of the 30 most environmentally friendly companies in Russia according to the Forbes rating, therefore statistical data of Segezha Group will be used in the course of further research.

Thus, more than 85% of companies that conducted IPOs during the pandemic take part in solving environmental problems, which is significantly higher than the same indicator for 2007–2009. The company's increased involvement in solving environmental issues can be attributed to many factors, including an absolutely sincere desire to neutralize the negative impact on nature or an attempt to increase its popularity among investors. It is often the second factor that turns out to be decisive. Nowadays, more-and-more investors are approaching the choice of investment objects responsibly, guided by the ESG rating, investors prefer more environmentally friendly and socially-oriented companies, even if they have lower rates of return. The EGS rating allows determining to what extent the business decisions taken by the company are focused on the ideas of sustainable development in the environmental, social and economic fields. The following criteria are taken into account when assessing the environmental factor: environmental policy, the impact of the company's activities on the atmosphere, water and land, waste management and "green" projects.

The EGS rating for Visa is 16.1, which is a low-risk value for the company. The company has been working to reduce carbon dioxide emissions into the atmosphere for more than ten years, the first significant reduction took place in 2015, and this

Table 23.2 Airbnb "green" hosting structure, 2017

	Europe (%)	North America (%)
Implementing environmentally friendly business practices	94	94
Provision of waste treatment services	62	75
Informing about the public transport schedule	69	59
Using "green" cleaning products	37	50

Source Compiled by the authors based on Airbnb (2017)

positive trend continued in subsequent years. In addition, the company's annual financial report provided statistics on water consumption; the amount of water consumed by the company also has a downward trend.

Visa is actively involved in the fight against climate change, and the company has achieved carbon neutrality of all its operations by moving to 100% renewable energy sources since 2020. The company aims to achieve zero emissions by 2040. In addition, last year, the company issued its first "green" bonds worth $500, maturing in 2027. The money received from these bonds will be allocated to finance "green" projects, including the development of renewable energy, increasing the efficiency of water consumption, etc.

Airbnb scored 25.2 on the ESG rating, indicating medium risk for the company. It should be pointed out that the company is not only involved in solving environmental issues but also participates in resolving a set of pressing social problems like social justice and equality. The company was engaged in reducing its environmental impact even before the IPO; Table 23.2 shows the results of its activities at the end of 2017 when the company's environmental indicators were already very positive.

The company has started to pay even more attention to environmental issues since the IPO in 2020 because its ESG policy directly affects the company's image in the eyes of potential investors, which in turn influences the share price and capitalization of Airbnb. Nowadays, 88% of Airbnb hotels worldwide are developing "green" hosting, which implies using "green" cleaning products, recycling or composting waste, using public transportation, providing bicycles and installing solar panels.

Sberbank, which is one of the largest and most prominent Russian companies, received 21.7 points in the ESG rating, while the Forbes rating agency named Sberbank, the second most environmentally friendly company in Russia. The company is reducing its environmental impact by declining the amount of consumed energy and generated waste.

The company sets some goals to improve the environmental situation at the present stage: to develop the concept of a "green" office, to reduce paper consumption, to increase the share of waste for recycling to 40% by 2023, to increase the share of green energy to 30% by 2023, to reduce carbon company footprint, to implement 100% purchases according to ESG criteria. A company can achieve a reduction in its carbon footprint through the optimization of transport services (Gaigné et al., 2020), which can be very effective. In addition, the company supports "green" initiatives, projects and conferences in every possible way; for instance, many environmental forums are held based on Sberbank.

Moreover, the company also actively invests in the "green" industry. The Sberbank's contribution to scientific research and environmental protection amounted to 1922 million rubles in 2019, while the total amount of charity expenditures is over 5362 million rubles. The company's environmental expenditures have increased significantly since its IPO in 2007 that was the pre-crisis year for the Russian economy, which may be explained by the growing interest of society in solving environmental issues and the increasing "consciousness" of investors. Investor demand for responsible for nature and society companies has led to the emergence of such companies, and now even small firm develops ESG strategy to be competitive at the stage of entering the stock market.

Sezegha Group is one of the largest companies in the paper and woodworking industry in Russia. Although the industry of the company cannot be regarded as environmentally friendly, the ESG rating for Sezegha Group is very high 21.4, in addition, the company was included in the 30 most environmentally friendly companies in Russia according to the rating agency Forbes. The company occupies such a high place among Russian companies due to its high expenses for environmental protection and its active participation in environmental projects. The company is to spend 11 billion rubles on the modernization of the existing production in the next three years according to the company's management, and 1 billion rubles of this amount will be spent on solving environmental issues.

The latest example of a "green" project in which Segezha has been taken part is the release of fry in the Yenisei. Segezha Group with the Federal Agency for Fisheries let 201.8 thousand grayling and 92.4 thousand sturgeons go into the Yenisei on October 22, 2021. The event was a part of a compensatory ecological program for the reproduction of aquatic fauna, the total costs of the project amounted to 18 million rubles. It should be noted that this project is not unique; the company often supports and initiates such events.

The company adheres to the environmental agenda not only at public events but also establishes a "green" office concept, following global trends. Sezegha Group described the following range of goals in the annual report in 2019: reduction of paper document turnover per year by 30%; an increase in recyclable waste to 40%; an increase in "green" energy to 30%. Furthermore, any corporate procurement of the company must comply with the ES principles.

Companies entering the stock market face a greater responsibility, now every wrong decision can be severely punished by the unanimous impulse of investors, which will affect the value of the company's shares and its capitalization. Any scandal or crime against nature and society, whether it is oil spilt in the ocean or a refusal to support an environmental initiative, will lead to an instant drop in the company's shares. An IPO is not just a way to attract additional financial resources in modern realities but also the need to be attractive and significant in the eyes of investors. Creating an image of an environmentally friendly and socially-oriented company will be one of the main priorities for enterprises represented on the stock market shortly.

23.4 Conclusions

Societal trends predetermine the behavior of companies, which are still focused on increasing profits, and in order to achieve their ultimate goals, companies need to maintain a reputation and stay ecologically-oriented.

A number of conclusions can be drawn based on the results of the study. Firstly, the geographical factor and other externalities have a direct impact on the environmental friendliness of a company, for instance, many Western corporations have been preoccupied with environmental issues for a long time. They started to introduce the concept of "green" activity earlier and for example, Visa has already switched to renewable energy sources, while Sberbank is only striving for this. Despite the fact that Russian companies are still lagging behind foreign corporations, they are moving in the right direction, increasing environmental costs and optimizing resource consumption.

Secondly, a clear tendency can be observed in the research that more-and-more "young" companies are involved in solving environmental problems over time. Nowadays, companies at the IPO stage are much greener than companies, which held IPOs between 2007 and 2009, which can be attributed to the greater public interest in environmental issues at present than ten years ago during the global economic crisis.

Thirdly, the main motive of companies investing in sustainability is to create a reputation for being environmentally friendly and socially-oriented. Nowadays, investors are extremely selective in the choice of investment targets; they take into account the environmental friendliness of companies and consider rating indicators evaluated by various agencies. ESG rating can be essential for "young" companies that are entering the stock market and must take into consideration all the factors that affect the value of shares.

Finally, the "green" trends currently observed in the market are extremely favorable; therefore, the priority for governments should be to maintain such dynamics through the introduction of financial incentives, including environmental taxation (Daigneault et al., 2020). However, it is worth mentioning that the stock market itself is a kind of mechanism for regulating corporate environmental responsibility, because any actions of companies affect the value of their shares.

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Chapter 24
Transnational Corporations, Climate Change and Human Rights ("Milieudefensie Versus Royal Dutch Shell", 2021)

Alexander M. Solntsev and Salikhat G. Magomedova

24.1 Introduction

On the 26th of May 2021, the Hague District Court delivered a judgement about recognizing obligations of Transnational Corporation *Royal Dutch Shell* in mitigating the consequences of climate change. Shell was ordered to reduce the volume of CO_2 emissions, produced as a result of its global operations by 45% by 2030 in comparison with 2019. The Court appeared to charge the corporation with a rather broad obligation to mitigate the consequences of climate change. Moreover, the Court ruled that Shell is also responsible for carbon emissions produced by their customers while using the energy products, for example, to drive their cars, power their businesses and heat their homes. The company is responsible for over 90% of the emissions produced by the products they sell.

RDS is also free to determine whether or not to make additional investments in exploration and fossil fuels, according to the Court. While the Court does not go so far as to order RDS to take this course of action, it appears that refraining from new fossil-fuel investments is vital to reach the mandatory reduction target.

24.2 Materials and Method

The topic of transnational corporations and their impact on climate change is studied in the works of: Buosso (2021); Baazil and Lombrana (2021); Dolmans et al. (2021); Gershinkova (2021); Maacchi and van Zeben (2021); Malloch (2021); Mougeolle (2021); Setzer and Higham (2021); Solntsev (2020); Zhang (2020).

A. M. Solntsev (✉) · S. G. Magomedova
Peoples' Friendship University (RUDN University), Moscow, Russia
e-mail: a.solntsew@gmail.com

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The method of comparative analysis had been used for determining the character of lawsuits against the transnational corporations, against states and appliance of national and international law.

24.3 Results

Going back to the Hague District Court's ruling regarding the *Royal Dutch Shell*, there is body evidence of the decision that it was based on the Dutch tort law, international law in the sphere of human rights protection, and conservation of climate.

First of all, a parallel can be drawn to the well-known decision of the Dutch Court *"Urgenda v. the Netherlands",* delivered six years ago, while the same Court has ruled that: *"the government of the Netherlands is obliged to reduce the greenhouse gas emissions by 25% by 2020 in comparison with 1990"* (Maacchi & van Zeben, 2021).

The decision of the district court in the *Urgenda* case was based on the tort law (opposed to the next one delivered by the Supreme Court of the Netherlands, which was based on the European Convention of human rights (Maacchi & van Zeben, 2021)).

Looking backwards at the *Urgenda* case, we understand that it is not so difficult to prove the states' obligations in the sphere of countering climate change, as it results from international climate agreements, agreements about human rights (and also, international custom). It is more difficult to muster an argument against profitable transnational corporations, working in a competitive environment (even if they account for a significant proportion of global CO_2 emissions).

The examined collective action was filed by 7 non-profit organizations and 17,379 private individuals. The Court refused to satisfy the claims of individual plaintiffs, appealing they don't have "fairly specific individual interest" (§4.2.7 of the decision). It recognized the collective action of 6 NPO, but only for representing the interests of citizens of the Netherlands. Such an approach of the Court did not allow the seventh NPO to intervene in the case (Action Aid), which strained after representing the interests of the population of other states. The Court considered that taking part in this NPO would unite various interests, because "there are big differences in time and methods of influence of global warming on population in different regions of the world" (§4.2.3 of the decision).

The Court found that the Dutch legislation is applicable following the EU Regulation "Rome II" as "the law of the country in which an event that led to [ecological] harm occurred". The Court justified it by pointing to political decisions adopted by Shell (in its headquarters in Hague), that belongs to those events which led to Shell's global operations and connected to the CO_2 emissions (§4.3.6 of the decision). The assertation of applying the Dutch legislation as *lex loci commissi delicti* in some degree is incompatible with the territorial limitations of the collective action, which rather means that the Dutch law is applied as *lex loci damni.*

The essential part of the judgement is based on the obligation to exercise care ("duty of care"). In accordance with the Dutch Civil Code, this obligation should be interpreted in the light of "what, according to an unwritten law, should be considered as appropriate public behaviour" (§4.4.1 of the decision). The Court refers to the international conventional protection of the right to life, the right for private and family life as an indication of this standard of care, although these international treaties do not establish obligations for transnational corporations (Articles 2 and 8 of the European Convention for the Protection of Human Rights and Fundamental Freedoms (ECHR) and Articles 6 and 17 of the International Covenant on Civil and Political Rights (ICCPR)).

Trying to define "appropriate public behaviour" of a petroleum company, the Court refers to the goal of the Paris Agreement—"to keep the growing global average temperature rise well below 2 °C above pre-industrial levels and to make efforts to limit temperature rise to 1.5 °C, recognizing that this would significantly reduce the risks and impacts of climate change" (Art. 2.1(a)).

The Hague District Court notes that the "global" reduction responsibility, which impacts the entire Shell group's policy, allows RDS far more flexibility than a reduction obligation limited to a single area or a single business unit or units. At the same time, it has potentially far-reaching repercussions, in that the decision of a case brought under Dutch law to protect the rights of Dutch people may prompt policy changes by the group, with the potential to have long-reaching consequences far beyond the forum state's jurisdiction.

The Court considers that this goal results from the reports of the Intergovernmental Panel on Climate Change (IPCC) (§4.4.27), even though it is completely opposite—the scientifical method cannot impose evaluative mentioning that is necessary for defining the right balance between expenses and advantages of mitigating the consequences. Therefore, the Court considers target temperature values as something that should be achieved while the state agreed with it only as a goal.

Interpretation of the Shell obligations by the Court does not constitute the limited territorial coverage of the case, which is adjudicated. As mentioned above, the Court examined the advantages of mitigative measures only within the Netherlands. The target temperatures mean the compromise between the global expenses and global profits from climate change mitigative actions. If the Court examines only the limited part of consequences of the climate change within one state, could it truly assume the same target temperature values?

One must also observe another case against Shell's subsidiary that was initiated by Nigerian citizens in 2015 (Solntsev, 2020). They stated that RDS owed them a duty of care since Shell exercised reasonable control over its subsidiaries and hence is liable in negligence of oil outflow. At that moment, the company also did not recognize its fault arguing that it is not responsible for its subsidiary's way of operating. Also, the High Court concluded that "*there is nothing performed by RDS by way of supervisory direction, specialist activities or knowledge, that would put RDS in any different position than would be expected of an ultimate parent company*", as well as that "*there is simply no evidence that SPDC ever did rely upon RDS*" (Setzer & Higham, 2021) in terms of guidance for its operations in Nigeria. But the claimants presumed upon RDS's internal documents that prove its allied companies are not eligible to make any decisions. On 12 February 2021, the UK Supreme Court overturned the decisions of the courts of lower jurisdiction and granted applicants' claim of owing them a duty of care (Zhang, 2020).

It should be mentioned that the Court extensively avoids relative uncertainties of the target temperature (for example, 1.5° or 2 °C?). It chooses the way of mitigating the impact of IPCC which supposes the reduction of global CO_2 emissions by 45% by 2030 in comparison with 2010 (Tench et al., 2021a, 2021b), underlining that this prediction "gives 50% chance to limit the global warming to 1.5°°C and 85% chance to limit the global warming to 2 °C" (§4.4.29 of the decision). Nevertheless, the Court does not explain why it chooses exactly this path, which brings in line with some believable interpretations of the target temperature values. For example, another IPCC path connected to 66% of probability of achieving the 2 °C goal supposes just 25% reduction of global CO_2 emissions by 2030 (Tench et al., 2021a, 2021b).

The Court also noted that Shell should reduce emissions from its global operations at the same time as the global CO_2 emissions (§4.4.38). De facto, the reductions of emissions inevitable proceed at different paces in different sections of the world economy. Most short-term global results on mitigating the consequences would be the result of reducing the coal consumption—sometimes due to the changeover to natural gas, which requires much less CO_2 emissions. As a result, the prediction of the International Energy Agency (IEA) regarding the way corresponding to a 50% probability of limiting the global warming to 1.5 °C, supposes reducing the coal consumption by 53% in the period from 2010 to 2030, but only by 20% and 11%, accordingly, of petroleum and gas consumption (Judgement 24–06–2015). Even taking into account the capture and storage of carbon, the IEA does not predict the CO_2 emissions from petroleum and gas as fast as the Court supposes.

While interpreting the obligation to exercise care that requires reducing the emissions by 45% by 2030 in comparison with 2010, the Court for unclear reasons decides that the basic level for Shell should be 2019 but not 2010. Insofar Shell emissions increased in the 2010s, and then the basic level of 2019 allows the company to produce more than following the basic level of 2010. For this purpose, the Court's postulation, therefore, raises the question that the basic level of 2019 "sufficiently corresponds broadly approved consensus that limited global warming to 1.5 °C requires net reduction of global CO_2 emissions by 45% by 2030 in comparison with 2010 (§4.4.38).

Alongside that, we understand that any reduction of Shell operations would be directly used by its competitors. The Court refers to the golden rule principle according to which Shell should regulate CO_2 emissions hoping that other companies would do the same or would be forced out to do the same (§4.4.49). the standard of care applied following the tort law presumably could be interpreted not only based on global goals but also regarding what companies do in similar circumstances, i.e. what can be substantively expected from the defendant.

The Court in detail examined the appliance of UN Guiding Principles on Business and Human Rights (4.4.11.–4.4.21). Among other things it pointed out that these guidelines appear as undisputed and approved on the international level, instrument of "soft law", which includes obligations of governments and business in the sphere of human rights, it does not create any other new rights and does not create legal obligations but corresponds the content of other broadly recognized instruments of soft law, such as "principles" of UN Global Agreement and Guiding Principles of Organization for Economic Co-operation and Development (OECD) for multinational enterprises.

The Hague Court applied the standard concluded from political goals and a scientific research despite it is not recognized by petroleum companies.

Why specifically Shell? What about the situation with other TNCs? Is Shell doing worse or better than other companies? Is it rightly using its power in a complex market to promote cleaner energy sources, such as developing gas rather than oil, reducing flaring and methane leaks, and enabling its customers to renegotiate long-term purchase agreements? Is her behaviour consistent with best practices? These are issues that the Court did not consider. It seems that they should have led to a decision that could place responsibility on the corporation in the light of more legitimate public expectations.

A similar case to the Shell is the case of the French company Total, filed in 2019 by 6 civil organizations to protect the park in Uganda. This case was initiated based on the French Duty of Vigilance Law and Art. 1252 of the French Civil Code, which states that the judge "can prescribe the reasonable measures suitable to prevent or put an end to the damage". In the beginning, the case was filed to the Nanterre Court, but later it was handled to the Versailles Court of appeal due to its incompetence. In October 2020, the Versailles Court remanded it to the commercial court, and the case was not considered on merits (Business and Human Rights Recourse Centre, 2015).

The most interesting fact is that even though Ben van Beurden, the CEO of Royal Dutch Shell, admits the company's fault, he is going to appeal against this decision stating that the Paris Agreement was signed by countries, not companies. It should be noted that the appeal of *Urgenda* lasted for more than four years; it was far more likely that this case would be similar.

Eventually, a corporate company will want to ensure its subsidiaries with proper administration. It is difficult to understand how a corporate company can significantly protect itself from the consequences of its subsidiary's operations.

24.4 Conclusion

Summarizing, transnational corporations' participation in the programs of international organizations, as well as in the implementation of obligations of corporate and social responsibility, is the result of the realization that they must help find solutions to the problems of global governance, as well as contribute to the implementation of solutions. Over the past decades, the power and influence of the private sector have grown exponentially, but at the same time, multinational corporations faced new risks and the need to assume new responsibilities. The spread of fatal diseases and environmental degradation have impacted the business environment. It is more profitable for a business to be involved in solving a problem, rather than being the cause of problems.

In the absence of effective government policies, courts have become a more common means of enforcing stricter climate mitigation requirements on both public and private players. The desire to impose these responsibilities on private actors is not new, and it can be traced back to cases like *Kivalina v Exxon.*

The impact of these lawsuits on international climate change discussions under the UN Framework Convention on Climate Change, which specifically emphasizes the necessity for "non-party stakeholders" to act inside the Paris Agreement, remains an unanswered subject.

Milieudefensie v. RDS, like *Urgenda*, can be thought of as a tool for expediting and implementing the UNFCCC's stipulated responsibilities.

While judicial acknowledgement of climate change interests may be perceived as a positive step in the right direction, it is more likely to erode trust in and relevance of internationally negotiated solutions than reinforce them.

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Chapter 25
Implementation of Sustainable Development Principles into Corporate Risk Management

Capitolina E. Tourbina

25.1 Introduction

Corporate governance is a tool for achieving strategic development goals of the companies, while the most important for the mature corporate risk management system is given priority to identify internal and external risks critical for sustainable development, assessing them and finding optimal ways to minimize, retain and transfer if necessary. Such corporate governance policies and practices may be based on international risk management standards, such as COSO or ISO, specified for various sectors of the economy and types of risks, or adopted by national regulatory authorities in the industries most significant for the national economy. In Russia, such tools are among the requirements ensuring industrial safety, GOST standards, and not the least also, following the acceleration of the trends in the transition to sustainable development, the regulatory leadership of the Bank of Russia.

The influence of regulatory rhetoric, recommendations and finally, various regulations adopted by the Bank of Russia is certainly becoming mandatory for financial organizations under supervisory functions of the Central Bank. However, the Bank of Russia sets the tone in the regulatory impact on public joint-stock companies and creates corporate governance standards, largely determining the requirements for listing such companies on the Russian stock exchange.

The purpose of this paper is to compile different approaches to how climate risks and ESG management can be incorporated into the general governance of the companies.

C. E. Tourbina (✉)
MGIMO University, Moscow, Russia
e-mail: ctourbi@yandex.ru

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25.2 Methodology and Materials

At the current stage, very few native publications on the issue can be found within the Russian scientific landscape as the issue is very new on the corporate and regulatory agenda. This is why our research focuses on the study of regulatory initiatives of the Bank of Russia and recommendations of international public institutions such as COSO and Task Force on Climate-related Financial Disclosures. As in many cases, most of the required changes are still considered as the recommendations in the used materials (Information Letter of the Bank of Russia, 2021; Information letter on recommendations…, 2021; COSO, 2018; Recommendations of the Task Force on Climate-related Financial Disclosures, 2017; The Bank of Russia, 2020).

Climate risks impact quite often requires assessment of the new risks, which in most cases increase corporate exposure to environmental pollution. In ESG strategy, it should be considered as one of the key risks and mitigation of the consequences by buying pollution insurance which can be the easiest and most efficient solution. Necessary facts and illustrations of the problem are based on the research of the Skolkovo task force (Moscow School of Management SKOLKOVO, 2020) and the Russian statistic database (Federal State Statistics Service (Rosstat), 2020).

25.3 Results

The Bank of Russia was one of the first among Russian regulatory bodies in formulating the need to consider the threats of the climate risks to the Russian economy and their influence on the sustainability of economic agents, releasing for public discussion in May 2020 the position paper "The Impact of Climate Risks and the Sustainable Development of the Financial Sector of the Russian Federation" (The Bank of Russia, 2020). For the first time in the Russian Federation, a discussion on the problem of the impact of the climate risks on the short and medium-term sustainability of economic entities within the framework of the Goal 17 of the UN Sustainable Development Goals, "Combating climate change" was initiated. Climate risks in the mentioned position paper, following the understanding of the international non-governmental organizations (Recommendations of the Task Force on Climate-related Financial Disclosures, 2017), are understood as the risks associated with natural disasters and these affecting business organizations:

– physical risks (physical risks: emergency and systemic).
– transitional risks: risks of transition to a low-carbon economy, including political, legal, technological, market and reputational.

Climate risks are caused by global warming, recorded in the observations since the mid-70 s of the last century, and most scientists associate this phenomenon with an increase in greenhouse gas emissions as a result of human activity. This provokes the acceleration of adverse weather events, such as floods, hurricanes, heatwaves, wildfires, up to the melting of the polar ice and permafrost. In total, according to experts, the damage caused can be estimated at more than 5 trillion US dollars within the last 20 years (Moscow School of Management SKOLKOVO, 2020).

For the Russian economy, such a long-term climate change can have a significant negative impact on the main players in the oil and gas, mining industries, the perpetuation of bioresources and ecosystems in the Far North, and not only, sustainability of the industrial facilities and leaving houses in these territories, the food security for the country population due to the increase in the duration of dry periods in the southern territories of Russia, and, as a consequence, on all other economic agents.

Subsequently, the Bank of Russia adopted further recommendations aimed at the managing of the climate and green transition risks in the corporate governance, in particular in the Recommendations of the Bank of Russia on Disclosure of Non-financial Information dated July 12, 2021 (Information letter on recommendations…, 2021), and the Information Letter of the Bank of Russia (2021).

Corporate governance usually develops based on two compulsions. The first compulsion is external, that is, arising out of the requirements of regulatory authorities. The second is those voluntary priorities that the economic agent sets for himself and implements through corporate policies. Adherence to a certain strategy, including the risk management strategy for the climate and environmental, social and governance (ESG) risks, is driven not only by the certain already formed regulatory pressure from the Bank of Russia but also by tectonic changes in the global economy. As the result of growing awareness of the need for the so-called “green transition” to a low-carbon economy, the need to reduce CO_2 gas emissions and the responsible economic behaviour of the agents in the global economy.

Main ESG factors impacting corporate governance require adopting a long-term development strategy including the achievement of Sustainable Development Goals. The second is the assessment of the climate risk exposure. The third is the assessment of environmental and social risks. All together these components should be combined in the Corporate Governance Code approved by the Board of Directors. For effective corporate governance, it is of utmost necessity that the Board of Directors designates the ESG agenda as a priority, appoint responsible persons engaged in developing the ESG strategy, monitoring the implementation of goals in the activity of all divisions and at all levels of the company (“tone from the top” in COSO standards (COSO, 2018)). Many economic agents are already noting the need for special ESG compliance procedures to achieve these goals, the creation of special units coordinating ESG policies and practices and the nomination of a special ESG-officer (Moscow School of Management SKOLKOVO, 2020) (Fig. 25.1).

At the same time, the company annual report, in addition to the financial statement, should disclose the provisions and metrics adopted to measure implementation of the ESG strategy, within non-financial reporting. However, all the priorities to achieve Sustainable Development Goals, ultimately, must have a material dimension.

The target metrics of the corporate strategy should be specific and achievable based on the global corporate governance and corporate risk management system (Table 25.1).

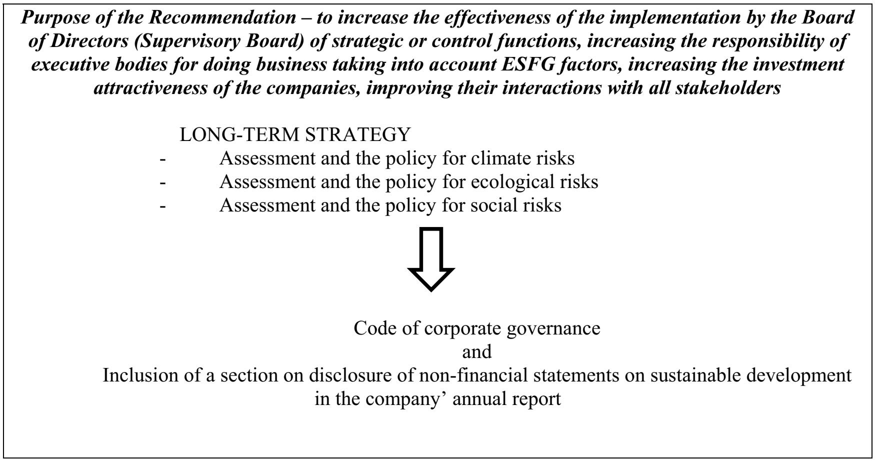

Fig. 25.1 Corporate governance code structure reflecting ESG impact. *Source* compiled by the author based on the publication of the Bank of Russia

Table 25.1 Structure and content of the non-financial report

<table>
<tr><td colspan="2">Composition of non-financial statement on sustainable development in the company' annual report
• Information about the sustainable development strategy
• Information about corporate governance
• Information about the business model
• Information about policies and procedures, indicators (metrics) and their achievement
• Information about the main risks and opportunities</td></tr>
<tr><td colspan="2">Sustainable development issues in the company corporate strategy, target metrics to reach, including Metrics from Paris agreement national strategical goals in ecology, social aspects and economy</td></tr>
<tr><td colspan="2">Information of corporate management in the company</td></tr>
<tr><td colspan="2">Business model</td></tr>
<tr><td colspan="2">Disclosure of substantial Information</td></tr>
<tr><td>Description of substantial topics</td><td rowspan="5">Disclosure of the information for all relevant topics subject to the report structure</td></tr>
<tr><td>Policies and procedures</td></tr>
<tr><td>Results of the implementation of policies and procedures</td></tr>
<tr><td>New risks description and risk management of these risks and opportunities</td></tr>
<tr><td>Key indicators of corporate efficiency</td></tr>
</table>

Source Compiled by the author based on the publication of the Bank of Russia

The current stage of ESG management development assumes that the Board of Directors and top management of the company should develop and implement an assessment of ESG factors significant for achieving corporate goals in all three ESG components—the company itself, its suppliers and finally, consumers of the company production. When the first component reflects the company's own "carbon footprint" (or S1 as in the accepted international vocabulary (Recommendations of the Task…., 2017)), the next two (S2 and S3) require close cooperation with suppliers and consumers to access their carbon impact, and at the same time, these risks/exposures should be a part of operational and compliance risk management procedures.

The second direction of the corporate action, especially important at the present stage of the green transition in Russia, is education and implementation into the mentality and practical day-to-day activity of the employees' importance of the ESG agenda and its priority in the strategic development of the company.

It is customary in the risk management guides to distinguish two levels of the implementation of ESG principles. The first one, at the inner level, includes the internal rules of the company's activities and metrics, including electricity consumption, workplace ergonomics, employee behaviour, and so on. The second component includes the principles of the "foreign" policy in order to achieve ESG metrics. In the insurance, for example, it can also be divided into two parts: first, green insurance products, fast claim settlement, easy process to sign the insurance and pay the claims, and secondly, investment strategy as the insurers is one of the main players in the long-term financial markets, and with "green appetite" can strongly change the availability of the resources for the green transition.

Sustainable insurance as an important element of ESG risk management of economic agents significantly expands an offer of specially designed programmes to ensure a green transition in agribusiness, aviation, maritime transportation, transportation of dangerous goods, cyber security risks, and pollution insurance.

Let us consider in more detail the factor of the pollution insurance in case of industrial incidents or other sudden adverse events in the climate risks mitigation. The connection of the climate risks with a possible increase in the frequency of such incidents is considered as a consequence of the changes in the natural environment. As it was shown above, the melting of permafrost in the Arctic can lead to a change in the state of the soils on which large industrial facilities are built, which can entail the occurrence of emergencies with an increased number of cases of environmental pollution. Similarly, in the other regions, a change in the usual natural environment can trigger dangerous incidents, for example, overheating of equipment or oil storage facilities in the absence of additional cooling can lead to the explosions of fuel or lubricants and environmental pollution.

Only in 2020, Rosprirodnadzor initiated 632 cases of environmental damage of 234.7 billion rubles, and only 0.01% was paid by the harm-causing enterprises voluntarily, the remaining amounts are recovering in court. The average amount of the claim was 231 million rubles. However, the available examples show that the actual damage caused can significantly exceed the average values. When dams were breached and the Vilyu River was polluted in 2018, environmental damage amounted to 27 billion rubles. During oil spills in Yugra due to the deterioration of the pipeline infrastructure in 2019, almost 2.7 thousand hectares of the land were contaminated with petroleum products and the amount of damage caused was more than 7 billion rubles. The fuel spill at the production facility of "Norilsk-Taimyr Energy Company" in 2020 caused damage to the environment in the amount of 148 billion rubles, according to Rosprirodnadzor. Ministry of Natural Resources reported that Russia loses 4–6% of GDP annually from environmental disasters, an increase in morbidity and mortality of the population. According to the experts, direct and indirect economic damage from emergencies caused by abnormal hydrometeorological and man-made catastrophes in the whole country on average is higher than 60 billion rubles per year (Federal State Statistics Service (Rosstat), 2020).

Insurance allows building a source to compensate damage or harm caused, independent of the financial state of the harm-doer or to compensate the harm-doer himself for the costs incurred in clearing contaminated areas, water or to finance the costs of restoring biological resources. The use of insurance can significantly reduce one-time costs for environmental restoration, and for this reason, the use of environmental insurance in climate risk management should be considered positively by ESG rating agencies.

Traditionally, pollution insurance involves the following types of compensation (payments of insurance compensation to the insured or payments to the owners of the nature protected objects and facilities):

– direct environmental damage (or restoration costs);
– expenses for clearing of the polluted territories, water, forests, etc.;
– payments for causing bodily injuries;
– payments in case of the business interruption for the period of the recovery after the incident and clean-up works;
– costs of biodiversity restoration.
– damage caused during the transportation of dangerous goods.
– expenses for the legal protection of the policyholder in court when suing state environmental authorities.

In the Russian specific case, the possibility of introducing mandatory environmental insurance as a form of ensuring the payment of the damage in the event of an industrial incident is being actively discussed. It must be recognized that in a country such as the USA or most European countries, which account for more than 60% of the global insurance premium and have a developed insurance market offering a variety of insurance products, where standards of corporate risk management are quite high, there is no need to consider the introduction of mandatory pollution insurance. Economic agents independently build their risk management systems considering the need for risk transfer in a case when risk appetite to keep pollution costs is low. On the contrary, for developing markets where legal practices for the recovery of the damages have not been fully formed, in countries such as Brazil, China and Russia, the topic of mandatory environmental insurance is being seriously discussed with the purpose to adopt limits of the insurance cover high enough to protect the interest of society in restoring damage caused to the environment.

Finally, the main concerns of the Bank of Russia are related to the impact of climate risks, if they can put significant pressure on the financial stability of financial institutions, both increasing its liabilities and reducing the asset value of the investments, which can suffer from the exposure to physical risks and risks of the green transition. The same leitmotif is presented in the latest study of the International Association of Insurance Supervisors and banks regulatory community. The tools for assessing the impact of such risks are scenario modelling, stress test modelling, and with this help, it is possible to prove to both the regulator and other stakeholders on how ESG factors affect the sustainability of the financial market players. The approbation and adaptation of such models to the specific environment of the economic agent should also be considered as an element of the corporate model for climate and ESG risks management.

25.4 Conclusion

We proved in the study that the traditional model of corporate management is under strong pressure by changing climate and ESG risks and regulatory pressure. These changes require logical changes in the corporate management practice following recommendations from international institutions such as COSO and Task Force on Climate-related Financial Disclosures and Russian Central Bank as well. Homework for the changes should include climate risks assessment and modelling of the potential damages to the environment. Role of the pollution insurance increase in the metrics of the management efficiency.

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Chapter 26
World Experience of Developing Entrepreneurial Competencies in the Context of the Sustainable Development Paradigm

Dmitriy N. Panteleev, Alexey V. Sysolyatin, and Anastasia A. Sozinova

26.1 Introduction

The main characteristic feature of entrepreneurship is the implementation of management based on innovation and risk, which is the essence of forming and developing students' entrepreneurial competence.

The system of higher education is undergoing considerable organizational adjustments. Universities have been transformed into universities of the third generation: project-oriented, innovative, and entrepreneurial.

Entrepreneurship training varies greatly in its content and methodological approach in different countries and different universities. The institutional base is still underdeveloped even in today's prestigious universities of "entrepreneurial education". It confirms the importance and relevance of developing methodological recommendations regarding the content of courses and entrepreneurship training programs, including the expected results in the form of skills and experience, a system for evaluating the effectiveness of training, requirements for teachers, etc.

The paper aims to determine the principles of sustainable development based on the concept of "entrepreneurial spirit", the main problems in this area, and factors of intensifying entrepreneurial competencies, including at the regional level.

The sustainable development of economic entities ensures stable growth of indicators in the long term in the environmental, social, and economic spheres (Kataeva et al., 2021).

The problems of assessing the development of entrepreneurial systems were considered by Bogoviz et al. (2018); Inshakova et al. (2021); Kataeva et al. (2017);

D. N. Panteleev · A. V. Sysolyatin · A. A. Sozinova (✉)
Vyatka State University, Kirov, Russia
e-mail: aa_sozinova@vyatsu.ru

A. V. Sysolyatin
e-mail: usr09158@vyatsu.ru

E. G. Popkova and B. S. Sergi (eds.), *Current Problems of the Global Environmental Economy Under the Conditions of Climate Change and the Perspectives of Sustainable Development*, Advances in Global Change Research 73, https://doi.org/10.1007/978-3-031-19979-0_26

Pirogova et al. (2020); Saveleva et al. (2017); and Sozinova et al. (2017, 2021a, 2021b).

These authors have revealed in detail the essence and role of entrepreneurship. However, it is necessary to supplement theoretical concepts considering the complex nature of the conditions for forming the spirit of entrepreneurship as a factor in sustainable development. It also requires a deep study of methodological approaches and practice-oriented support for developing entrepreneurial competencies at universities, including the participation of industrial partners.

26.2 Methodology

The methodological basis of the research is the provisions of micro- and macroeconomics, the relationship between their elements based on the use of current achievements, and innovative approaches to the development of an entrepreneurial type of thinking to form and expand the reproduction of an entrepreneurial ecosystem.

The authors justify the main provisions of the work concerning the process of activating entrepreneurial competencies and tools for developing the spirit of entrepreneurship to launch the sustainable development mechanism using the methods of deduction and induction, systematic, and integrated approaches. The empirical part of the research is based on the use of monographic methods of information analysis.

26.3 Results

Entrepreneurial competencies are a set of personal qualities, knowledge, skills, and abilities that allow successfully solving various business problems and achieving high-performance results.

There is currently no common view on the list of entrepreneurial competencies in European countries.

According to Bengt Johannisson, there are five important competencies for an entrepreneur. In his opinion, it is necessary to understand the reasons for entrepreneurship, the ability to implement and organize it, understand with whom to communicate and develop partnerships, and have entrepreneurial intuition and an entrepreneurial education (Andreeva & Shishkin, 2017; Tereshchenko et al., 2017a).

Since the end of the twentieth century, the European Union has been searching for methods to develop entrepreneurship education and instill entrepreneurial thinking in students. In 2006, the EU Parliament issued a recommendation entitled "European framework of core competencies for lifelong learning", where entrepreneurial competence (namely "the spirit of initiative and entrepreneurship") was one of the eight significant competencies. The globalization of the economic system has intensified the need for economic entities to increase competitiveness and introduce innovations. This requires creative and entrepreneurial people who can be more active and quickly move from an idea to its implementation. Entrepreneurial competence includes a willingness to innovate, creativity, and the ability to plan and manage projects to achieve the goal and take responsibility and risk (European Parliament and the Council of the European Union (2008); Komarkova et al., 2015).

Contemporary entrepreneurial education is characterized by a large practical orientation and a lesser degree of theoretical training. The role of the teacher in this process changes from teacher to mentor. The development of personal skills, a practice-oriented approach, and flexibility in constructing the curriculum is of particular importance (Tereshchenko et al., 2017b).

The universities that have chosen an entrepreneurial model to develop an innovation ecosystem achieve the highest results. A special role in the transformation belongs to the process of changing the composition of the required competencies of teachers, practitioners, and students. Training systems for specialists for innovation should be built on competencies in interdisciplinary areas, including entrepreneurship (Afanasiev (n.d.)).

According to Taiwanese analysts in the field of entrepreneurial competencies, the main list includes the following:

- Search, discovery, and assessment of the prospects of new business opportunities;
- Initiative as the ability to work faster, more, and beyond prescriptions and restrictions;
- Decision-making and responsibility for their consequences;
- Definition of the essence and solution of problems;
- Ability to think in an innovative way;
- Effectiveness of communication with different partners;
- Conclusion of effective deals;
- Creation of business and work networks from various participants.

It is important to understand that entrepreneurial competencies in university education can be formed within the framework of classroom work while implementing various types of project activities, in the process of creating interfaculty initiatives, performing team-building tasks, and forming personal growth trajectories (Aldoshina, 2019).

Currently, there are several popular practices designed to shape the entrepreneurial approach. A number of American business professors (R. Smilor, M. Morris, M. Shindehut, and S. Donk) offer several techniques for teaching entrepreneurial competencies. They recognize the Kolb model as the most effective one. They have proposed a set of effective practices for mastering entrepreneurial skills using a dynamic learning model:

- Performance of the practitioner in front of the students;
- Using a well-known entrepreneur as a mentor;
- Analysis of mini-cases;

- Game and simulation models;
- Development of a business plan with verification by experts;
- Structured projects and exercises;
- Keeping educational diaries to fix experience and reflection;
- Empirical tests—experiments and practical application of new entrepreneurial skills;
- Using theatrical methods, images, and technologies from the world of art.

It is very promising to use smart technologies to develop entrepreneurial competencies. They can have a delayed effect in the form of economic growth and management of the cyclical economy (Popkova, 2021; Sozinova et al., 2022).

The Moscow State University uses such teaching technologies as the "design thinking" method, the creation of a learning atmosphere—a lean environment, and the "flipped class" method of obtaining information. Entrepreneurship training at the Henry Ford Academy is built on interactive, hands-on activities. Mentoring and internships for the exchange of experience are also actively used.

This practice is used in the leading universities of Russia, such as the MSUT "Stankin", the Moscow Polytechnic Institute, and the NUST "MISiS". Disciplines on technological entrepreneurship are introduced starting from the first courses, accelerators are opened for further commercialization of projects, and successful business people are actively attracted as teachers.

The organization of practice based on elements of competition, which contributes to increasing the students' entrepreneurial spirit, is of decisive importance.

Exploring the foreign experience of creating entrepreneurial universities, it is necessary to note some features of their development (Table 26.1) (Mikhailov, 2014).

To analyze the international experience of teaching entrepreneurship and the requirements for the characteristics of teachers, the authors have analyzed 88 materials presenting empirical and theoretical studies on this issue.

Based on its results, they have identified entrepreneurship training practices with proven effectiveness:

- Group reflection in the format of teamwork;
- Use of the "brainstorming" format;
- Public presentation of a project in front of a group;
- Role-playing games on the topic of entrepreneurship;
- Invitation of lecturers from the business environment.

The important characteristics of teachers for successful student learning include the following:

- A term of teaching the subject;
- Having practical experience in a particular field;
- Teaching skills;
- Availability of basic education in the field of entrepreneurship;
- Organizational and managerial skills (Sorokin et al., 2020).

Table 26.1 Foreign experience in creating an entrepreneurial type university

University	Features of the development of entrepreneurial universities
University of Nottingham, UK	The university has structural divisions; their direct functions are the commercialization of the results of scientific research
University of Warwick, UK	The university has built a system of project activities. The tasks of managers are assistance to teachers in the development of project proposals, fundraising, development of interdisciplinary projects with the participation of several scientific and educational departments of the university, etc.
Technical University of Munich, Germany	There are centers for entrepreneurship, knowledge sharing, promotion of research funding and technology exchange, and a patent and licensing bureau
Jagiellonian University, Poland	The structure of the university has a center for innovation, technology transfer, and university development
University of Beijing, China	There is a department for patenting and rewards, a department for technology exchange and licensing, and science parks

Source Compiled by the authors based on (Mikhailov, 2014)

P. G. Shchedrovitsky, in his speech at the Vyatka State University, identified the key factor in the development of higher education as "the formation of new competencies through the cultivation of entrepreneurs creating new development institutions, "coormpetition" (competencies + cooperation of education, students, employers), the introduction of advanced training" (Internet Newspaper of VyatSU, 2016).

This recommendation should be kept as the main guideline in building a model for developing entrepreneurial and innovative competencies at the Vyatka State University (VyatSU).

Since the end of 2021, the VyatSU has launched an ambitious project together with the Center for the Development of Universal Competencies of the Ural Federal University. The project will be implemented in several stages. The first step is the development and implementation of an educational "core"—a system of interrelated disciplines and modules. The second step includes forming and training a team of teachers, then the teachers of the professional unit will master advanced educational technologies. Entrepreneurial competencies are also important in this endeavor.

26.4 Conclusion

In current conditions, the role of small and medium-sized businesses is increasing. As a result of a review of the role and importance of entrepreneurial competencies in third-generation universities, we have concluded that contemporary Russian universities should transfer knowledge, skills, and abilities to students in the field of entrepreneurship, stimulating the development of entrepreneurial initiatives among graduates through the assistance of the university while implementing these initiatives. There must be a revolution in the entire system of higher education and a restructuring of the organizational structure of universities in the direction of third-generation universities, characterized by a project-oriented approach, innovation, and a high level of entrepreneurial culture. In this regard, we agree with scientists who propose solving the identified problem and forming a high level of entrepreneurial competencies by implementing the interaction of competency-based, contextual, problem-based, and student-centered approaches to learning in the educational process of the university (Ronel et al., 2017).

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Chapter 27
Comprehensive Assessment of the Sustainable Development of an Industrial Enterprise

Ekaterina P. Garina, Natalia S. Andryashina, Elena P. Kozlova, Zhanna V. Smirnova, and Olga T. Cherney

27.1 Introduction

The outcome of a sustainability assessment often boils down to economic returns and profit calculation, while profit is critical to the success of a company, but it is very limited when assessing a set of subject areas. Alternative criteria for assessing sustainable development are technological, logistical and quality-related indicators that can be used integrated and in separate positions (Andrianov, 2016; Andryashina & Garin, 2016). At the same time, it is often not taken into account how risky it is to introduce a new product into the corresponding production process or how mature the technology is. Also, the flexibility of processes is often not taken into account when differentiating the assortment policy and related product changes (Kuznetsov et al., 2015, 2019). When making an investment decision, it is necessary to take into account the costs of acquisition and development, but they are often not enough for the initial and even for subsequent evaluation. A practice-oriented general method, such as comparative costing, should be included in the process model for selecting manufacturing processes. However, cost estimates alone are not enough. On this basis, a complete assessment of the sustainable development of an industrial enterprise is impossible, and it is necessary to determine priority areas for development.

E. P. Garina (✉) · N. S. Andryashina · E. P. Kozlova · Z. V. Smirnova · O. T. Cherney
Minin Nizhny Novgorod State Pedagogical University, Nizhny Novgorod, Russia
e-mail: e.p.garina@mail.ru

N. S. Andryashina
e-mail: natali_andr@bk.ru

Z. V. Smirnova
e-mail: z.v.smirnova@mininuniver.ru

E. G. Popkova and B. S. Sergi (eds.), *Current Problems of the Global Environmental Economy Under the Conditions of Climate Change and the Perspectives of Sustainable Development*, Advances in Global Change Research 73, https://doi.org/10.1007/978-3-031-19979-0_27

27.2 Methodology

The classical methods for assessing the sustainable development of an industrial enterprise by scientists include (Shushkin et al., 2016; Tolstykh & Shkarupeta, 2020; Usmanov, 2020):

1. Manufacturing cost calculation used when comparing alternative multi-stage manufacturing processes to determine manufacturing costs in the first stage of the life cycle and then subsequently the cost of prototyping, for serial and single production. Manufacturing costs include direct material costs, material overheads, as well as manufacturing costs, overhead costs and original direct production costs.
2. Accounting for planned, target costs is not a cost accounting system, but an aid in making strategic decisions, a method of cost control in development processes. The target cost estimate takes into account the price quoted by the customer or a price that is considered competitive. This «reverse calculation» determines how much it can cost to produce a product. The advantage lies in the ability to control costs in the early stages of product development, that is, in the process of the greatest possible impact. From a market-oriented cost management perspective, target costing can also be viewed as a special form of cost analysis. It can be considered a disadvantage that the cost of innovative products or production processes can only be estimated approximately.
3. Determining the hourly machine rate (= cost of a machine per hour of production) is an indicator that is often used in calculating production costs and for comparing different types of machines with each other. The following values are used for the calculation: purchase price, estimated useful life, depreciation, imputed interest (= acquisition costs/2 × interest rate (e.g. 12% of acquisition costs), space, energy, maintenance costs and number of hours worked.

In addition to the methods already discussed, business administration provides methods for evaluation and decision-making. Decision-making means consciously or unconsciously choosing one alternative from several. Evaluation serves to prepare constructive or conceptual solutions. The aim is to apply objective criteria and achieve comparability in order to avoid errors and uncertainties. The procedure is iterative and cascading. When making any decision, it is important to have a sufficient information base. The requirements and objectives («decision problem» and «target system»), as well as the criteria against which alternatives are to be evaluated or compared, should be clear. Evaluation and selection procedures are provided by decision technology or decision theory. Appropriate decision-making methods include (Garina et al., 2016):

1. Checklist procedure: Suitable for pre-selection from various options. If decisions like this have to be made over and over again in a company, checklists can be constantly optimized. Since the process is very easy to use, it is often used in practice.

2. Matrix of pairwise comparison of several options: A direct comparison of development options is carried out on the condition that the properties of the options are known qualitatively and not quantitatively.
3. SWOT-analysis (analysis of strengths and weaknesses): The purpose of which is a structured situation for a company, product or process. The goal is to capitalize on opportunities and strengths and minimize weaknesses and risks.
4. Feasibility study: According to VDI directive 2225 «Feasibility study», which offers support in «feasibility study for the design of finished technical products». Based on the analysis of utility value, the criteria are derived from the requirements, which are divided into technical and economic. The technical value X_j of option j is calculated using scores p and weights g_i:

$$X_j = \left[\frac{g_1 p_{1+} g_2 p_2 + \ldots + g_i p_i}{(g_1 + g_2 + \ldots + g_i) p_{\max}}\right] < 1 \tag{27.1}$$

The economic value Y is determined by relating the ideal planned costs to the actual costs:

$$Y_j = \left[\frac{\text{ideal planned costs } K_i}{\text{actual costs } K}\right] < 1 \tag{27.2}$$

For a general assessment, a chart is used that allows you to correlate the previously obtained values.
5. Benefit analysis and utility value (NWA): Benefit analysis belongs to the group of cost–benefit analyses. The goal is to find out how great the value of a particular activity or project (utility) is. Thanks to a hierarchical target structure and a clear definition of weights and scores, meaningful evaluation results can be reliably justified against a set of criteria.

27.3 Results

The results of the analysis of the methods show that the decision regarding the production process requires extensive knowledge and understanding of the production processes. However, the criteria underlying the choice of process may often be incomplete in terms of evaluation. For example, factors such as investment, operating costs, process quality, testing capabilities and efforts up to strategic considerations are not taken into account, or are not adequately taken into account in the methods for assessing the sustainability of an industrial enterprise. In addition, the growing complexity of processes, products and systems presents an ever-increasing problem: many companies cannot cope with the complexity of both products and processes. This can be seen in the drop in sales and profit per product, as well as in the growth of product portfolios of storage units (SKU, salable products and product options), in an increase in the number of process options (Garina, 2017). The central issue in this context is the assessment of the complexity of costs and benefits. This assessment assumes, among other things, an understanding of the interaction between complexity and performance drivers. By its very nature, complexity is often associated with negative effects in most areas of research. But there are positive effects that should never be ignored. A significant limitation, based on the current state of research, is the lack of understanding of the relationships between the complexity factors of various measurements and company performance (ElMaraghy et al., 2013). The existing approaches to measurement do not allow determining the consequences of actions for the company. This makes it difficult and prevents targeted complexity management. There is a need to develop indicators of complexity; there are no models for integral assessment and control of complexity. The need of companies for a consistent and holistic approach to assessing and controlling various aspects of complexity is obvious, and the scientific need exists.

The goal is to develop a cross-functional model for assessing the sustainable development of an industrial enterprise, which allows us to quantify the profitability and complexity effect in a company in order to improve the company's financial and operational performance. The results include the complexity index model and the methodology for its construction.

The process of assessing the sustainable development of an industrial enterprise, according to the researchers, is divided into two main stages of comparative assessment.

Stage 1. Creation of a sustainable development assessment model, where the starting point for the development of an assessment model is the formulation of the problem and the analysis of the knowledge base in selected areas of research in theory and practice. For example, the model can be considered from the position of managing the complexity of the product and processes using the technical and economic assessment of the VDI directive (Garina et al., 2016). Qualitative research methods can be used at this stage, from semi-structured to exploratory interviews. Data is then collected for the design under study to confirm it. An assessment model can be developed based on completed industrial projects, as well as information and knowledge obtained from open source sources. Then certain categories of the generated construct are analyzed to identify similarities and differences, as well as patterns. The valuation model and its assumptions are re-tested and adapted. For this purpose, expert interviews are conducted as part of a focus group. This procedure allows for progressive refinement and verification of the constructs and hence the evaluation model.

Step 2. Testing the scoring model in practice using a case study through systematic analysis, company data is first assessed on an individual basis in an iterative process between data collection and synthesis. The results of this final analysis, as part of the developed evaluation model, are used to further refine the model. For example, in the model, complexity management is to reduce excessive complexity to an absolutely necessary level so that the remaining complexity can be dealt with (Garina et al., 2016). The task of managing complexity is to form relationships between external and internal complexity.

27.4 Conclusion

An analysis of approaches to assessing sustainable development showed that:

1. An assessment-based approach should allow technology concepts to be classified in the course of technology development based on strategic goals as well as development-related goals and to initiate validation based on them.
2. With an assessment-based approach, in addition to the management and control of development objectives within technology development, the suitability of technology concepts should also be tested on the basis of a multidimensional assessment, in particular through a targeted combination and integration of qualitative and quantitative assessment methods.
3. The results of the suitability test should be accepted on the basis of an evaluation approach and used to perform specific actions, taking into account corporate resources.
4. The ability to assess the sustainable development of an industrial enterprise from the standpoint of a technological concept should be provided by comparing alternative technologies in their technical and functional context and checking their suitability at the component level.
5. The assessment-based approach should be used as a continuous assessment tool in the development of operational technology and should take into account the related areas of sustainable development management.

The benchmarking analysis proposed in the study provides a tool with which to holistically evaluate areas of development, place them in comparison with companies and purposefully improve. The developed model is adapted to the directions of development of mechanical engineering.

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Chapter 28
Formation of the Necessary Conditions for the Sustainable Development of Industrial Enterprises

Ekaterina P. Garina, Sergey D. Tsymbalov, Svetlana N. Kuznetsova, Natalia S. Andryashina, and Elena G. Kislova

28.1 Introduction

There are many different methods and models for the formation of the necessary conditions for the sustainable development of industrial enterprises, as well as many tools and technologies for evaluating products, projects and investment plans (Kuznetsov et al., 2019; Usmanov, 2020). It is not possible to obtain an economically and technically complete picture of the choice of production processes, which negatively affects user acceptability, design comparability and efficiency. The solution to these problems is possible through the implementation of the methodology of reproducible assessment and the choice of concepts, production processes and alternative courses of action. The methodology is based on utility analysis and supports the integration of different manufacturing processes and the relationship between product design and manufacturing process. As conceived by the authors, the preliminary selection is based on a detailed assessment of the production process through independent criteria, allowing comparing the technical and economic advantages and disadvantages of production processes and options.

E. P. Garina (✉) · S. D. Tsymbalov · S. N. Kuznetsova · N. S. Andryashina
Minin Nizhny Novgorod State Pedagogical University, Nizhny Novgorod, Russia
e-mail: e.p.garina@mail.ru

S. N. Kuznetsova
e-mail: dens@52.ru

N. S. Andryashina
e-mail: natali_andr@bk.ru

E. G. Kislova
Nizhny Novgorod Institute of Management—Branch of RANEPA, Nizhny Novgorod, Russia

E. G. Popkova and B. S. Sergi (eds.), *Current Problems of the Global Environmental Economy Under the Conditions of Climate Change and the Perspectives of Sustainable Development*, Advances in Global Change Research 73, https://doi.org/10.1007/978-3-031-19979-0_28

28.2 Methodology

The assessment of the existing scientific groundwork for the assessment of approaches, methods and tools to ensure the necessary conditions for the sustainable development of industrial enterprises was carried out in a number of areas (Garina, 2017; Kuznetsov et al., 2015):

- focus on the development of the corporate culture of the manufacturer;
- organizational structure for interdisciplinary project work;
- strategy of the market, technologies and cooperation;
- definition of a key product or core competency oriented to the market;
- effective interdisciplinary team work;
- structured innovation process and transparent «go/stop» decisions;
- use of integrated methods of product development and production;
- market-oriented cost and quality management;
- product prototyping.

One of the factors of sustainable development of enterprises is the approach to the development and production of complex components with high functional integration (Garina et al., 2016). Technical systems, playing an important role, are becoming more complex, so it is necessary to make long-term strategic decisions on the formation and maintenance of production processes. This gives rise to the need to develop and apply a methodology for assessing and selecting production processes through a comprehensive analysis of the procedures used in companies.

The study led to the conclusion that at present there are no combined and systematic methods and tools for the technical and economic selection of production processes, or they are not used in everyday work, which covers the entire complexity of the process chain (ElMaraghy et al., 2013). Therefore, there is no complete basis for making sustainable development decisions. There is also a need to develop practical methods and tools to facilitate early product development, product design and rapid evaluation and selection of the most appropriate manufacturing process. Estimated and cost-related aspects must also be taken into account.

An analysis of technically and economically oriented methods to ensure the necessary conditions for the sustainable development of industrial enterprises showed that the most widely used (Kuznetsov et al., 2019; Shushkin et al., 2016; Tolstykh & Shkarupeta, 2020):

1. Methodology for constructing VDI.
2. Process model for VDA product development.
3. Project management (PM).
4. Integrated product development—simultaneous product and process design.
5. Product and Quality Planning: In modern manufacturing, the focus of quality assurance has shifted from quality control to quality monitoring and further to quality planning through Quality Function Deployment (QFD), Error and Impact Analysis (FMEA), and Advanced Product Quality Planning (APQP).
6. Requirements management (requirements analysis).

The methods of production planning and technology management include:

1. Technological planning (manufacturability analysis).
2. Process development and production planning.

The listed methods are models that describe the overall processes and phase models of the project, represent command and organizational structures, and offer communication tools. But at the same time, there is no clear methodology for choosing production processes in the context of sustainable development of production. For example, manufacturability analysis is not process neutral.

Existing decision-making methods can support the process of selecting manufacturing processes and can be used during product and process development. There are methods that are very easy to implement, and there are procedures that are relatively complex but allow all relevant criteria to be taken into account. Most of the methods that form a differentiated basis for making sustainable development decisions, such as cost–benefit analysis or utility analysis, are rarely found in practice (Andrianov, 2016). This suggests that they are either too complex or time-consuming or too little known.

28.3 Results

Based on the experience of implementation and sustainability, used in companies today, there is a need to determine the requirements for methods for assessing and selecting production processes and systems integrated with them. It is also necessary to take into account customer requirements (requirements management), production issues (QFD, process planning, manufacturability analysis and maturity level planning). To arrive at a technical and economic assessment of sustainable development, often a domestic manufacturer lacks economic areas of competence (for example, strategic planning, evaluation, costing, procurement and logistics) (Andryashina & Garin, 2016; Garina et al., 2016; Tolstykh & Shkarupeta, 2020). As conceived by the authors, the methods discussed earlier should be reasonably combined with each other in practice, be built into the model of the product development and production process and be applied systematically. In addition to process-oriented methods of product development, process planning and production technologies, an integrated approach to managerial decision-making is required, which must be adapted to the specific criteria of the project under consideration, such as:

– taking into account all project criteria (technical, economic, strategic, logistical, etc.);
– cross-functional approach;
– realistic weighting of factors;
– the ability to adapt to the conditions of the company;
– improved understanding, cooperation and coordination of specialized departments in the development process;

- flexible use and the ability to adapt the results of implemented projects to other products and production processes;
- applicability of simple tools at the operational level;
- taking into account the dependencies between the product and the process technology, that is, between the requirements of the product and the performance of the product.

In addition to product planning, a sustainable development model should also consider process manufacturability, technology management issues (strategic aspects and technology planning) and business management factors (planning and investment calculation) and includes:

1. Embedding the method in the product development process. The actual product development takes place during the early stages of the product creation process. Production processes must develop in parallel. The decision on the production process should have been taken at the stage «Approval of the purchase of tools and systems». The overview, networking and parallelization of functional areas helps evaluate different scenarios and thus enables strategic decision-making.
2. Multifunctional approach, interdisciplinary team and integrated system. A multifunctional approach is necessary to select a manufacturing process with a sufficiently broad justification for the selected criteria, including those specific to the process.
3. General process model for the selection of production processes.
4. Integrated process model: In the integrated process model, the choice of alternatives is part of the analysis, design and pre-selection.

Working stages of the implementation of the sustainable development model:

1. Creation of a conceptual profile. Usually passed as request data from the manufacturer;
2. Formation of basic and mandatory requirements (data on the product and project, such as geometry, volume, and number of elements), definition of the first production concept;
3. Assessment of the existing backlog. Based on the basic requirements and the production concept, weight, cycle time, proportions of workpieces, availability of machines, capacities and productivity are evaluated;
4. Evaluation of investment alternatives based on cost comparison;
5. Primary product costing and production concepts (including material costs and prices, investment amount and personnel costs);
6. Evaluation of alternative production processes in accordance with the suitability of the process in relation to the required product and project criteria, determination of the average effect;
7. Determination of the average values of the compared indicators;
8. Evaluation of procedures, descriptive interpretation of results and derivation of procedures that are used for further consideration.

After a critical choice, it makes sense to partially include procedures that are in the limiting range in a detailed assessment, in particular, to form a list of requirements. It is recommended to check again whether a variant that only meets the mandatory criteria can still represent a reasonable and cost-effective solution for a product variant with an appropriate number of positions.

Examples of requirements from specialized areas (Shushkin et al., 2016):

- project management and production planning: possibility of implementation in the schedule, project risks, resource requirements, project costs, development, project priority and portfolio management;
- distribution: affordable market price, achievable sales volumes, customer purchasing power, substitution risk and competitive countermeasures;
- business administration and cost accounting: level of investment in tools and systems, profitability, positive assessment of the project, production cost, contribution margin, the possibility of raising capital, including possible financing programs;
- factory and production planning: flexibility and working conditions in the workplace (noise, dust and risk of accident), conversion difficulties, duration of the training process, use of existing facilities, personnel costs, space requirements, technology maturity level, experience with the required materials, use of special procedural knowledge, life expectancy and maintenance efforts;
- purchase: number of effective suppliers, reliability of supply, experience in the procurement market, price level and stability and options for purchasing materials;
- research and development (R&D): existing know-how and patents, acquisition of new patents, contribution to the development of other products and leading competition;
- quality management: quality objectives, percentages, deviation rates, quality assurance efforts and auditee management representative;
- logistics: routes, storage requirements, buffer zones, additional logistics, packaging, transport racks, delivery sequence and type of delivery (JIT, JIS, …).

How to work with lists of requirements and structure the target system:

- summarize all requirements, ensure completeness and take into account all interested parties. Assigning sorting criteria (iteration, multiple loops to find the right sorting criteria, re-sorting tables, forming groups, thinning, defining, etc., until a set of useful sorting criteria is found);
- evaluate whether the criterion is relevant for the desired assessment and selection—insert a filter and check again if there are uncertainties (here: relevance to compliance with the production process);
- elimination of duplication;
- a single basis for all requirements (and participants);
- formalized description (reduce/eliminate contradictions and redundancy);
- testable and resolvable requirements description;
- a clear separation between the task and the description of the solution;
- controlled configuration basis (change tracking);

- measurability of the criterion (either as a measurable technical, economic variable or as a question);
- sorting, grouping and weighting within groups (definition of ranking: paired comparison, single and sequential evaluation);
- determination of what measure, unit and scale can be used;
- checking for completeness (in a team) and checking whether all interests are sufficiently taken into account. Whether the correct criteria were used to evaluate the project;
- continuous review of grading criteria and evaluation criteria. Ensuring the complete filling of all criteria with sorting criteria;
- formation of a catalog of criteria, which specifies the requirements for components and processes for their manufacture.

28.4 Conclusion

The developed process model, requirement lists and tools, can support the manufacturing process selection process. A systematic approach using a process model makes complexity manageable and results in a well-founded estimate.

The multifunctional approach is presented in the form of a matrix of departmental activities and is implemented at all stages of the process. The process model is built into the strategic planning process. The list of requirements is structured at different levels, which ensures ease of use. The weighting and scaling performed for all criteria can also be adapted to the project and the company. Designed for the initial evaluation of manufacturing processes, the tool provides a quick and transparent statement of the significance of processes for specific applications and for more detailed study. The tabular tool, created for detailed assessment, is based on a complete list of product requirements and their manufacturing processes, including project-specific criteria. For specific use cases, you can create a rating with specific utility values. Weaknesses in product and production concepts can be identified through initial and detailed assessments. From this, optimization measures can be derived. The product manufacturing process matrix brings together disparate information about different technologies in a previously inaccessible completeness.

The methodology proposed in this paper can also be adapted to future requirements, such as being extended or applied to product related manufacturing processes. Further trends:

- there is an opportunity to reduce costs when standardizing product components, switching to expensive components;
- production processes should be easy to transfer and master. This justifies a deeper discussion of the topic of production in the future. The choice of the most suitable production process for new models will remain the task of machine builders and car manufacturers.

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Part IV
Carbon-Neutral and Clean Energy for Sustainable Development of the Global Environmental Economy in the Face of Climate Change

Chapter 29
Nanotech Innovations—The Basis of Efficient Energy Transfer

Olga B. Lomakina, Alexander I. Voinov, and Evgeny P. Torkanovskiy

29.1 Introduction

The contemporary world entered the newest *4.0* and *carbon-free* structure of development connected with elaborations and practical usage of scientific achievements in the sphere of nanotech. All of the nanotechnological improvements will in long-term perspective allow solving key problems of modern technogenic civilization: energetic, ecological, terrorism, life quality, education, public control, illnesses, etc. (Adamick & Morse, 2012; Brainard et al., 2014; Choi et al., 2018; Gauthier and Genet, 2014; Maine et al., 2012; Munari & Toschi, 2014). Nevertheless, the world community and UNO will have to take unprecedented measures to restrict the development of military nanobiotechnique, bringing it in a regime of limited access to military nanoequipment, to establish effective procedures of international control on which survival of humankind will directly depend in the twenty-first century. Elaboration and wide introduction of nanotechnologies in any developed country, as well as scientific and industrial branches connected with them, will allow low avoiding many of the important global challenges in the foreseeable future (Cacciatore et al., 2011; Campbell et al., 2012; Islam et al., 2020). Understanding of the key factor of

O. B. Lomakina (✉) · A. I. Voinov
MGIMO University, Moscow, Russia
e-mail: kafedra-rosneft@yandex.ru

A. I. Voinov
e-mail: vo_innov@mail.ru; a.voinov@odin.mgimo.ru

A. I. Voinov
International Institute of Energy Policy and Innovation Management, Odintsovo Branch, Odintsovo, Russia

Russian State Academy of Intellectual Property (RGAIS), Moscow, Russia

E. P. Torkanovskiy
Russian Academy of Sciences Institute of Economics, Moscow, Russia

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nanotechnologization in postindustrial economies brought to the implementation of comprehensive national programs concerning nanotech in the forms of public and public–private support. At the moment, more than 50 countries have governmental programs concerning the development of nanotechnologies (Kato, 2011; Cheng et al., 2019). In 2000, the United States was the first power to approve the priority long-term complex program *"National Nanotechnology Initiative" (NNI)* which is now considered as "an effective instrument for providing leadership of the USA in the first half of the century". The Nobel Prize in Physics was awarded in 2010 to Andre Geim (the Netherlands) and Konstantin Novoselov (United Kingdom) at the University of Manchester "for groundbreaking experiments regarding the 2-dimensional nanomaterial graphene". Also in 2016, the Nobel Prize in Chemistry was awarded to Jean-Pierre Sauvage (France), Bernard Feringa (the Netherlands), and James Fraser Stoddart (USA) for the development and creation of molecular machines. These Nobel Committee decisions show that the global nanotechnological trend remains at the core of Revolution 4.0.

The subject of the research is the resources of nanotech in Russia, which intensify the process of restructuring the real sector, as well as the resources of the world's nanotech in the field of oil and gas production.

The objects of research are the branches of the economy that are being modernized through the achievements of nanotechnology.

A research objective is to consider prospective resources for the nanotechnologization of the system of world economic relations and to find new points of growth of the real sector of the economy in transition to the sixth technological structure. The research problems include the analysis of innovative development of the branches of the economy based on the nanotech paradigm. Also, a theoretical and methodological basis of research are formed: system approach to the studied object and subject; scientific publications of domestic and foreign scholars based on problems of implementation of the nanotechnological improvements; the materials of international scientific conferences and seminars related to problems of global development of technologies.

29.2 Materials and Methods

According to the goal of the research, scientific methods such as analysis, synthesis, comparative analysis, and system approach are used. Institutional analysis let us describe market architecture of nanotechnologies. Statistical data of Lux Research (CORDIS), USPTO are used to show the tendencies of nanotech development including related ones with spending budgets and patents number.

29.3 Literature Review

Nanomanufacturing as a sector of the economy was researched by Adamick and Morse (2012); Brainard et al. (2014); Choi et al. (2018); Gauthier and Genet (2014); Maine et al. (2012), and Munari and Toschi (2014).

National and international problems of nanotech development were described in the famous researches of Arnaldi and Tyshenko (2014); Freund et al. (2020); Frolov et al. (2015), and Kato (2011). Due to the interdisciplinary nature of nanotechnology, it requires extensive multi-sector collaborations to foster more efficient development outcomes. The paper of Cheng et al. (2019) proposed a novel triple helix model to analyze the globalization of China's nanotechnology innovation.

Some problems of R&D activity's organization and risks were observed in the works of Cacciatore et al. (2011); Campbell et al. (2012); Islam et al. (2020). Very important problem of nanotech regulations and patent system was researched by Corley et al. (2013); Dolfsma and Leydesdorff (2011); Escoffier (2011), and Vare (2015).

The significant income of nanotechnologies from scientific publications is increasingly moving into the period of real application in the oil and gas industry, especially in the works of Gandomkar and Sharif (2020), and Du and Nojabaei (2020).

29.4 Results

To date, Russia has a substantial amount of master innovations in the sphere of nanotechnology and nanomaterials on the level of international achievements. In federal target programs and road maps were created the fundamentals of the nanoindustry development up to 2020 and beyond. In particular, the Nobel Prize in physics, awarded in 2000, to the academician Jores Alferov can be considered as the first step in an appreciation of Russian nanotech results. According to experts of "Kurchatovsky Institute", usage of nanotechnologies already in the nearest decade may lead to significant economic effects simultaneously in the high-tech and traditional industrial branches (Arnaldi & Tyshenko, 2014; Voinov, 2014).

In machinery construction: Replacement of common chrome coatings on metal-cutting and forming tools, various shafts, bearings, bushings on nanodiamond with an increase of their service life of at least 2 times without changing the design documentation; an increase of resources of cutting and machining tools with the inculcation of special coatings and emulsions; wide introduction of nanotechnological innovations for modernization of high-precision machines; methods of measurement and positioning elaborated with the use of nanotechnologies will ensure adaptive control of cutting instruments based on optic measurements of the treated surfaces of details and treating the surface of the tool directly during the technological process (such methods, in particular, will allow reducing treatment errors from 40 m km to hundreds of nanometers). In electronics: Expansion of the market for cables manufactured using polymer nanocomposite materials; quantum international communication channels in partnership with South Africa, China, and India; quantum long-distance communication lines and “quantum keys” for encryption of negotiations (20 billion rubles by 2024); broadening of possibilities of radio-location systems with the use of phase antenna grids with low-noise super high-frequency transistors on the basis of nanostructures and fiber-optic communication lines of high transmitting capacity due to photo-receivers and injection lasers based on structuring of quantum dots; industrial production of magnetoresistive random access memory; development of heat-vision observing-aiming systems with the spreading of matrix photo-receivers produced with nanotechnologies and characterized by high-temperature resolution; creation of powerful injection lasers on nanostructures, which are applied for pumping of solid-state lasers; 3-dimensional simulation of the light levels of the led sources and gradation of color temperature in a selective technological lighting process for the efficient functioning of operating areas, job sectors in the territories of oil and gas fields, railroad overpass, sectors when working gantry cranes, and replacement of lighting fixtures fuel installations draining the petroleum products. In artificial intelligence: The conceptual development of artificial cognitive systems consists in processing large amounts of data, finding acceptable solution options, identifying complex relationships, and dependencies on algorithms similar to human thinking; the interdisciplinary paradigm NanoBioInfoCognito allows using this technology in various segments of the national economy; the introduction of such breakthrough solutions ensuring their use in the transport infrastructure of the country and highly demanded complex of government measures on prevention of emergencies of natural and technogenic character, including in the power sector; the structures authorized by the state have already taken the first steps to apply these conceptual developments. In informatics: Multiple rises of production of the systems of transfer, treatment, and storage of information as well as the creation of new architecture of highly productive devices with possibilities of computing systems close to properties of natural living objects with hybrid elements of artificial intelligence. In energetics: Nanomaterials are inculcated for perfecting technologies of manufacturing fuel and construction elements, increasing efficacy of existing equipment, and forming alternative hydrogen energetics on the basis of carbon nanostructures; reduction of crude oil losses associated with its transportation, obsolescence of materials applied in the production of oil pipelines and pipeline connections, low quality of metals used in the manufacture of the most important connecting elements of oil pipelines—flanges and flange connections (in particular, through the development of methods of alloying of cast metals and fusions with the introduction of nanomaterials in the field of powder metallurgy); multiple rise of efficacy of sun-batteries based on the processes of accumulation and energy transfer in inorganic and organic materials with nanolayer and cluster-fractal structure; creating electrodes with developed surface for hydrogen energetics on the basis of track membranes; nanomaterials are introducted in heat-emitting and neutrino-consuming elements of nuclear reactors; nanodetectors ensure environmental control during storage and working over of depleted atomic fuel and monitoring of all technological procedures of installation and exploitation of atomic

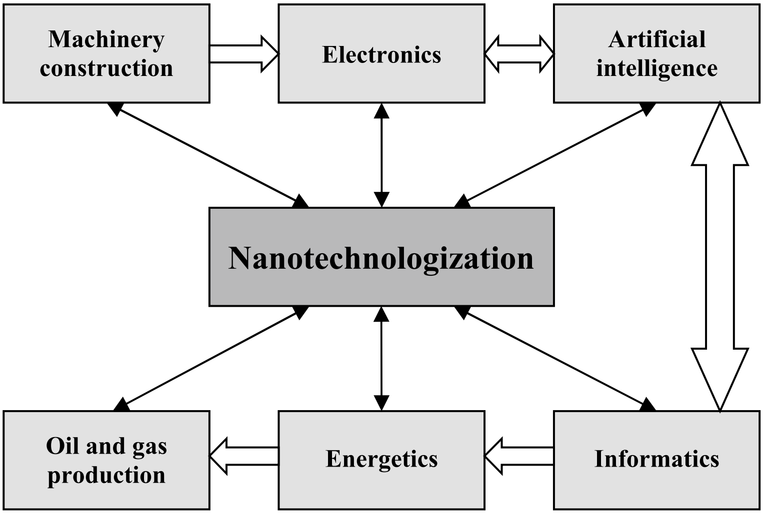

Fig. 29.1 Nanotechnologization in oil and gas production *Source* Compiled by the authors

reactors; nanofilters are used in separation of media during production and treatment of atomic fuel (Fig. 29.1).

The sphere of developments at the nanoscale is extremely wide—from oil extraction to nanocoatings and green energy of recuperation. No less relevant at present is the use of robotic nanomachines in the search for oil, as well as in improving the methods of its production and transportation (Gandomkar & Sharif, 2020; Du & Nojabaei, 2020).

To ensure high values of oil recovery, the features of its displacement from productive rocks are studied in-depth, first of all, at the nanoscale. The effectiveness of the process of oil displacement is determined by nanosizes: The surface of the pores has a nanometer roughness, and the wetting properties of rocks are determined by it. The regulation of the properties of oil and gas reservoirs at the level of electrical interactions, wetting, changes in the structure of minerals (the sizes of which are 20–40 nm) can be solved with the introduction of the created technologies of nanoscale control. Rational development of hydrocarbon deposits in petroleum science, which is a part of the Earth Sciences, is inherent to a specific object of research. This is the study of physicochemical nanoalloys in geological bodies, reservoir fluids, and field equipment, covering not only nanoalloys but also the ways of their taking into account geohydrodynamics and techno-economic calculations in the development and operation of oil and gas resources. The increase in oil recovery is produced by methods whose mechanisms are determined by nanoscale phenomena or directly by the application of nanoparticles. Primarily, these are the technologies of basic effects of temperature and physical fields, as well as a variety of biological effects. At the same time, it is a group of technologies based on the use of chemical and gas agents that have a nanoscale mechanism of impact on reservoir systems.

One of the leading corporations of the USA in the field of development and the organization of industrial introduction of nanotechnologies “Industrial Nanotech Inc.” to process pipelines of the Brazilian oil and gas giant “Petrobras” applies the Nansulate shield coating to avoid losses in the transportation of extracted oil and oil products. Nansulate shield is an anti-corrosion, anti-moldy, and thermal insulation coating of the latest generation based on the properties of nanoclusters. The coating is used for surface treatment of oil pipelines and parts of oil pipeline fasteners (flanges, plugs, transitions, tees), as well as various designs, devices, and installations exposed to aggressive environments. Pilot coatings of corporation “Industrial Nanotech Inc.” are commercialized in other oil and gas holdings, becoming industrial nanostandard.

In the Russian project to expand the production of high-effective oil extraction equipment for the manufacturing of submersible electric centrifugal pumps (ESP), special nanocoatings are applied for processing them by spraying radial bearings. Compared with tungsten hard alloys, traditionally used in the production of submersible pumps, its consumption during the application of such coatings is 40 times less. The technological novelty here is in the use of protective and functional nanostructured coatings based on tungsten carbide applying titanium oxide, aluminum oxide, chromium, and molybdenum, created by the group of companies “Novomet”.

Coatings are applied by the technology of gas-plasma spraying on the nodes subjected to the maximum load. The process of applying these coatings is controlled, and the grain size in the structure of spraying lies in the range of 5–100 nm. The use of nanotechnologies in the manufacturing of ESP allows primarily to reduce the friction coefficient of radial bearings by 1.4–1.7 times with an increase in their wear resistance by 1.5–2 times, to increase the corrosion and waterjet resistance of various parts of the pump installation, and to reduce energy consumption by 20–25%, as well as the size of the installation. Such submersible pumps are quite competitive in the world market for their reliability and energy consumption, especially when working in difficult fields and offshore.

Research and production company “RAM” has developed and established the manufacturing of unique spool valves applying nanotechnologies for the oil industry. Conducted based on “Rosneft” tests have shown that this innovative elaboration is able annually to bring global oil holdings in additional revenue over US$4.2 billion. The design of the “Norma” valve provides an increase in flow section more than 2 times and has no recognized world analogs. Compared with technically obsolete ball valves, its advantage is the nanodiamond chrome coating of the most worn parts of the valve. This technology of chromium plating can sufficiently improve the physical and chemical properties and reduce the thickness of the galvanic coating by applying the composite chromium-diamond layers using cluster nanodiamonds of detonation synthesis.

The created coating increases resistance to wear by 5.7 times, with the maximum operating time of the spool valve more than 1800 days, and the mean time between failures is significantly higher than the average of other competitors in the industry. In particular, “Tatneft” experts provided their test data on the increase in time between failures of their equipment by more than 180% with a simultaneous increase in the flow coefficient of at least 20%. The highest degree of wear resistance of valves is also evidenced by the results of tests conducted by the research organization in Dusseldorf. According to the calculations given by the General Director of "RAM" E. V. Ryzhov, based on the results of controlled operating valves, additional revenue for "Rosneft", in the case of re-equipment of the whole fleet to "Norma" valves, will be approximately US$33.9 million per year in the total upgrade costs about US$1.8 million. A similar analysis of the effectiveness of inculcation is conducted for other companies in the world sector of oil production.

Widespread in the fuel and energy industry method of displacement of oil–flooding. Special reagents, as shown by experimental research, preventing the nanoscale drop in permeability by swelling (dispersion) of clays, are able not only to maintain but also to restore the permeability after its reduction. During the tests of the technology, the increase in the ratio of intake capacity of wells reached an average of 27%. According to the results of field experiments, the clay stabilizers substantially (by 10–15 points) increase the oil displacement coefficient. Moreover, the extraction of oil significantly depends on the coefficient of reservoir clay content. Reducing the influence of clays on the permeability of layers leads to an increase in oil recovery. Due to nanotechnological solutions, the effect of water mineralization on permeability is reduced by regulating the behavior of clays, which provides an increase in the extraction coefficient to 0.40–0.45 even for low-permeable layers.

29.5 Discussions

1. According to the data of "*Lux Research*"—Community Research and Development Information Service (CORDIS), total world expenditure on all directions of nanoscience and nanotechnology (research and development, universities, manufacturing, etc.), already in 2001, was US$64 billion, in 2009—US$250 billion, and after 2015, the conservative forecast promised US$800 billion.

Meanwhile according to the study of "*MIT Technology Review*" (Tech trends, 2013; Drexler, 2015), if in 2013, nanotechnology was associated about 15% of production with a total cost of US$2.6 trillion, by 2020, with nanotechnologies will be connected 100% of world production, remaining in the core of the sixth techno-economic paradigm of global industries (Corley et al., 2013; Dolfsma & Leydesdorff, 2011; Escoffier, 2011; Vare, 2015). In the period 2013–2020, the statistics of The American patent and trademark office (USPTO) shows that the USA accounted for 35.528 nanotechnology patents and 45,155 published patent applications (78.7% registered), the share of the Republic of Korea—6724 and 9197, respectively (73.1% registered), the share of Japan—5938 and 6688 (88.8% registered) (Fig. 29.2). In total, the three flagships of the world nanotech for the considered time interval of transition between fifth and sixth techno-economic paradigms (Freund et al., 2020; Torkanovskiy, 2020) account for 48,190 patents, 61,040 published applications, of which 79.0% were registered.

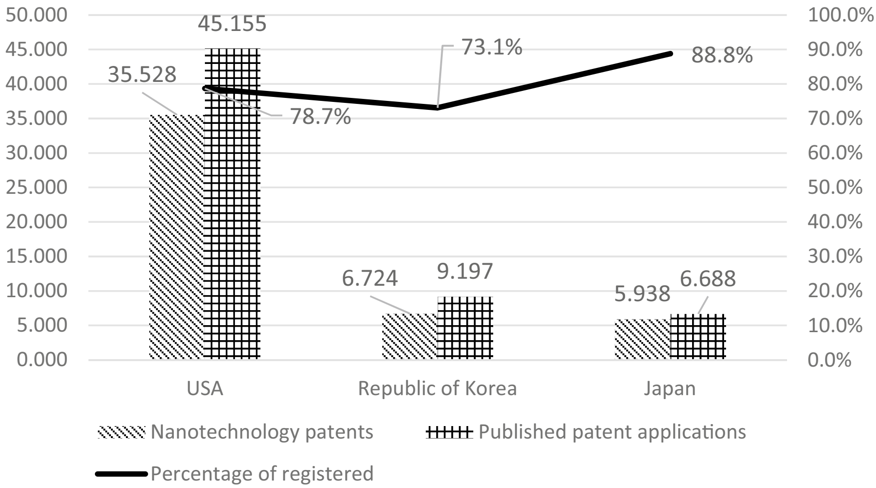

Fig. 29.2 Total amount of nanotechnology patents and published patent applications of the USA, Republic of Korea and Japan in 2013–2020 *Source* Compiled by the authors based on the data of Voinov et al. (2022)

2. Russia has a significant volume of scientific-technical groundwork in the field of nanotechnology and nanomaterials on the level of international contribution (Frolov et al., 2015; Voinov, 2016), also were created the fundamentals of the parity nanoindustry's development up to 2030. At present, time is the largely defining elaborations in machinery construction connected with national nanotechnology development—concrete improvements of the scientists. Here, the objective is to increase the resources of cutting and processing tools as well as wear-resistant parts of mechanisms, equipment, and oil pipeline structures with special strengthening coatings and materials. The program for the development of the "hydrogen economy" until 2024 and 2030 is also extremely important. Besides that, research in the interdisciplinary paradigm NanoBioInfoCognito allows to conduct conceptual expansion of artificial cognitive systems for processing large amounts of data, search for acceptable solutions, and identify set of relationships and dependencies on algorithms similar to human thinking (including a complex of government measures to prevent emergencies of natural and man-made character in the power sector). From 2013 to 2020 inclusive, according to the statistics of the USPTO, Russia managed to obtain only 54 nanotechnology patents in the presence of 90 patent applications (60.0% registered) (Voinov et al., 2022).
3. Global oil flagships spend huge budgets on searching for the newest opportunities in research already established raw material bases and methods of growth of oil extraction from available fields. Mining technologies of the fourth and the fifth innovation waves allowed recovering about 1/3 of the volume available underground. Even a relatively small increase in the volume of oil extracted

from open fields (if market participants receive at least 50% of the output of hydrocarbons instead of 35%) can double the global reserves of fossil energy resources, estimated today at 1.2 trillion barrels. Possible to prognosticate that it will take at least several decades of interdisciplinary research to reach this 50% mark. According to the estimates of the department of raw materials bases of the state oil company of Saudi Arabia "Saudi Aramco", the growth in the volume of energy resources raised from the underground by 10–15% should bring a 50-year increase in the period of satisfaction of world needs for hydrocarbons with existing volumes of consumption. About 4/5 of the global supply of crude oil is controlled by publicly-managed companies, and concerted actions by the oil-producing powers are required in the implementation of nanotechnologies in order to increase the recovery of fossil fuel.

29.6 Conclusions

A significant contribution was made by nanotechnological solutions implemented in such industries as machinery construction, electronics, artificial intelligence, informatics, energetics, oil, and gas production, the convergence of which can provide a combination of basic knowledge of 3 techno-economic paradigms at once. Patent dominance in the sphere of nanotech the economies of post industries as patent networks, who at this stage ahead of already retrofitted China, allows the US, the Republic of Korea and Japan to a certain superiority in the further development and intensification of the sixth structure, offering newest large-scale projects on the living arrangements of the future, and thereby confirming long-term competitive advantages. Japan, in turn, shows the highest level of patent activity, mediated by the number of registered nanotechnology patents. At the same time, only the indicator of the share of the current paradigm in the economies of the countries under consideration can determine their role and place in the system of international economic relations.

The points of growth of the real sector of the world economy and separation of its traditional branches in the new economic normality conditions lie in the modernization of these industries through the accumulated results of nanotechnology. Quite competitive and the works are deployed in this direction in Russia. In the era of open innovations in Industry 4.0, such nanotechnological solutions can become elaborations for prolonging sustainable development, in particular, of the traditional machinery: Replacement of common chrome coatings on metal-cutting and forming tools, various shafts, bearings, bushings on nanodiamond with an increase of their service life; an increase of resources of cutting and machining tools with the inculcation of special coatings and emulsions; wide introduction of nanotechnological innovations for modernization of high-precision machines; methods of measurement and positioning elaborated with the use of nanotechnologies will ensure adaptive control of cutting instruments based on optic measurements of the treated surfaces of details and treating the surface of the tool. Both nanosensors and artificial intelligence systems could make a meaningful return on productivity in this sector.

Against the background of the consequences of the COVID-19 pandemic, the serious innovative potential for implementation and commercialization of nanoelaborations remains in the fuel and energy complex in the transition period to the sixth technological structure. Nanomaterials are inculcated for increasing the efficacy of existing equipment and forming alternative hydrogen power for the foreseeable "green future" in the global environmental agenda based on carbon nanostructures. The possibilities of increasing sun-batteries CPA based on the processes of accumulation and energy transfer in inorganic and organic materials with nanolayer and cluster-fractal structure have not yet been fully explored. Also only partially solved the problems of reduction of crude oil losses associated with its transportation, obsolescence of materials applied in the production of oil pipelines and pipeline connections, low quality of metals used in the manufacture of the most important connecting elements of oil pipelines—flanges and flange connections, specifically, through the development of methods of alloying of cast metals and fusions with the introduction of nanomaterials in the sector of powder metallurgy. Another promising trend for global oil and gas production—special reagents, preventing the nanoscale drop in permeability by swelling (dispersion) of clays, are able not only to maintain but also to restore the permeability after its reduction and increase the ratio of intake capacity of wells. The clay stabilizers in such a technological process substantially increase the oil displacement coefficient. Moreover, the extraction of oil significantly depends on the coefficient of reservoir clay content. Reducing the influence of clays on the permeability of layers leads to an increase in oil recovery. Even a relatively small growth in the volume of oil extracted from open fields, if market participants receive at least 50% of the output of hydrocarbons instead of 35%, it can double the global reserves of fossil energy resources.

Directions for further research

National nanoindustry system of the USA and its expansion into the global technological space related to new opportunities for implementation of the results of nanotech activity in practice.

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Chapter 30
Sustainable Development of the Oil and Gas Sector in the Arctic Region

Igbal A. Guliyev, Vladislav I. Kiselev, and Victor V. Sorokin

30.1 Introduction

Russia, as one of the main exporters of hydrocarbons, needs to replenish its resource base to meet the expected growth in demand for oil and gas shortly. The oil reserves of the largest fields in Western Siberia are being consistently depleted every year, therefore, to further increase production; one has to create the technologies for developing hard-to-recover reserves (HTRR) and look for new deposits in the previously unexplored or poorly studied regions (Guliev et al., 2016). As for HTRR, this is a promising area, but at the same time, it cannot be a strategy for the near future, since science and technology still have a very long way to go to make the development of such reserves profitable and comparable in terms of the production potential with traditional reserves. The optimal option will be to search and explore new locations. It is the Arctic, in particular, the Arctic shelf zone that should become such a location in the foreseeable future (Figge & Hahn, 2004).

The Arctic is a region whose biological and ecological balance are extremely fragile. It is a region with a predominantly negative average annual temperature, so the slightest warming can jeopardize the existence of many species. Besides, the changes taking place in the Arctic affect not only the Arctic itself but almost the whole world (Krajnc & Glavic, 2005). The melting of glaciers increases the level of the world's oceans, so huge territories may be flooded in the distant future. Therefore, if economic activity is carried out in this region, special attention should be paid to the environment. This issue is one of the components of the sustainable development policy.

I. A. Guliyev (✉)
International Institute of Energy Policy and Diplomacy, MGIMO University, Moscow, Russia
e-mail: guliyev@miep-mgimo.ru

V. I. Kiselev · V. V. Sorokin
MGIMO University, Moscow, Russia

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In the last decade, sustainable development has become a very important agenda for oil and gas companies as a result of global warming, the destruction of the ozone layer and major accidents related to the oil field (Hardtke & Prehn, 2001). The issue of sustainable development has come to define the relationship between oil companies and other key stakeholders, such as local populations and national governments. The question faced by researchers and stakeholders is how to assess to what extent companies, entire industries, or even states meet environmental criteria in order to conduct their activities in the Arctic region with the least harmful impact.

30.2 Methodology

30.2.1 Methods of Assessing Sustainable Development at the Business Level

Within the framework of assessing the effectiveness of the business in the field of sustainable development, it is important to choose adequate methods for quantifying compliance with the sustainable development criteria. The existing methods can be divided into two groups: those based on financial indicators and those that do not take them into account.

30.2.1.1 Sustainable Value Added (SVA)

Sustainable value added (SVA) was developed by Figge and Hahn (2004) as a method of economically assessing sustainability in the context of business and takes into account the efficiency and absolute level of resource efficiency of all three dimensions of sustainability simultaneously. SVA quantifies the value added created additionally if the overall degree of environmental and social impacts remains constant (International Energy Agency, 2020; Mackinnon & Gomersall, 2019).

Within the framework of this method, the concept of opportunity costs, as well as direct costs, is shifted to the assessment of the corporation's contribution to sustainable development. As a result, one deals only with those investments that not only cover the directly assigned costs but also exceed the return on potential alternative investments.

From the point of view of sustainability, this concept evaluates whether the use of a resource is consistent with the policy of sustainable development, on the one hand, and whether the resource creates optimal added value, on the other. The sustainable development indicator shows where and whether environmental and social resources should be used at all, as well as whether one should take into account external and opportunity costs. Assuming that the value added already includes internal and opportunity costs, the SVA can be calculated by subtracting external environmental and social costs from the value added and adding opportunity costs to the value added:

Absolute Sustainable Value Added = Value Added − External Environmental and Social Costs (external costs) + Relative Sustainable Value Added (opportunity costs).

Unlike investment decisions, one cannot estimate environmental and social costs in monetary terms. To simplify the definition of SVA, only the question of where the resource should be used is raised, since the relative SVA can also be calculated without taking external costs into account. This question can be answered by comparing the environmental and social indicators of various corporations. In this case, the relative SVA indicates which resource should be used to achieve the greatest contribution to sustainability. Thus, the SVA indicator quantifies the corporation's contribution to increasing stability in monetary units.

30.2.1.2 Composite Index of Sustainable Development

An alternative method of assessing sustainable development is the Index of Composite Sustainable Development (ICSD), which uses non-financial indicators. The concept of ICSD was developed by Krajnc and Glavic (2005) and provides for a chronological record of integrated information on economic, environmental, and social indicators of corporations. To do this, the contribution of individual indicators to the overall corporate sustainability is determined using the analytical hierarchy process (Fig. 30.1).

ICSD is calculated in several stages. The first stage includes the selection, grouping, and evaluation of the indicators' impact. At this stage, we select the performance indicators that reflect aspects of sustainability and can be grouped into three dimensions (Busch & Gimon, 2014; FT Platform, 2017). Next, it is determined whether an increase in an indicator's value has a positive or negative impact on the indicators of sustainable development. At the second stage, individual indicators are weighed using the paired comparison method. Since the indicators are measured

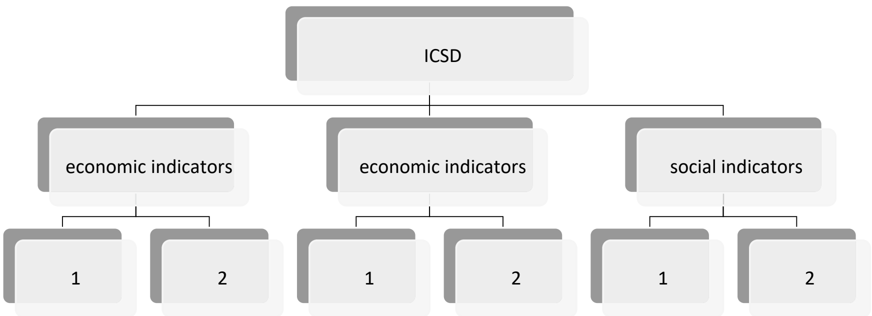

Fig. 30.1 Analytical hierarchy. *Source* Compiled by the authors

in different units, they require normalization. Two methods are recommended for normalization: either the indicator determined is relative to a realistic target value for a particular company, or the relative deviation of the actual value from the minimum or maximum value is calculated if we can use the data from more than one company. As a result, the indicators of individual aspects of sustainability can be calculated and aggregated in ICSD. The indicators can be determined by summing all weighted average products of the normalized indicator value.

The main advantage of assessing sustainable development using ICSD is that all three areas can be combined into one index, and therefore, one can critically evaluate the company. Thus, a company can use an additional management tool, which is an assistant for decision-making and participating in public discussions on sustainable development issues (Agiaye & Othman, 2015; Bacani et al., 2015). While the methods based on other indicators indirectly assess the industrial sector, ICSD uses raw data and provides transparent information about the company's sustainable development. Using normalized indicators, it allows one to compare different companies.

30.3 Results

Both the state and the public should be primarily interested in assessing the sustainable development of the energy sector. The considered methods of evaluating companies can be used directly or form the basis on which one can develop a new evaluation methodology, adjusted for the national policy or cultural and social factors.

30.4 Conclusion

When doing business in the Arctic region, it is really important to assess the companies' sustainable development. When selling license areas for exploring and producing oil and gas, the relevant authorities should take into account the company's policy in the field of sustainable development, in particular, its environmental aspect, since selling an asset to an unscrupulous subsoil user can provoke disastrous consequences.

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Chapter 31
Competitiveness of the Renewable Energy Sector in Russia and Prospects for a New Government Support Program Until 2035

Iman S. Magasheva and Olga B. Lomakina

31.1 Introduction

Nowadays, the global economy is undergoing an important stage of transformation. The world is on the track to achieve the Paris Climate Agreement goals, and decarbonization is the biggest trend in the economic and energy realms. The pandemic breakout has certainly enhanced this trend. There is a significant acceleration in the low-carbon energy transition. In particular, the increasing competitiveness of technologies based on renewable energy sources (RES) now is shifting the investment in power generation from conventional energy sources toward renewable in both developed and developing countries alike. In light of such circumstances, the Russian economy and energy sectors need to modernize and choose a pathway to rapidly decarbonize to maintain its position in the world market.

The market share of solar and wind in global electricity generation grew at a compound average annual growth rate of 15% from 2015 to 2020 (WRI, 2021). The role of renewable energy sources is especially significant in electricity generation. The share of wind and solar PV is growing to meet 56% of world electricity demand in 2050 (up from 9% today). Other renewables (including hydropower and nuclear energy) will provide a further 20%. This takes zero-carbon sources to 76% in 2050 (BNEF, 2020).

The world's leading countries' energy policies are changing. National governments set ambitious targets for the share of renewable energy in the energy mix from 20 to 50%, changing the structure of investments. At the same time, Russia is lagging in the process of the energy transition. Renewable energy is still often perceived in Russia as too expensive and cost ineffective. However, there is a growing number of studies that conclude that some renewable energy resources are already competitive

I. S. Magasheva (✉) · O. B. Lomakina
MGIMO University, Moscow, Russia
e-mail: magasheva.i@inno.mgimo.ru

E. G. Popkova and B. S. Sergi (eds.), *Current Problems of the Global Environmental Economy Under the Conditions of Climate Change and the Perspectives of Sustainable Development*, Advances in Global Change Research 73, https://doi.org/10.1007/978-3-031-19979-0_31

in many regions in Russia (Lanshina et al., 2018). So the purpose of this study is to identify the features of the state support mechanism for the renewable energy sector in Russia and assess the cost competitiveness of renewable energy technologies in the context of power generation.

31.2 Materials and Methods

According to the goal of the research, scientific methods such as analysis, synthesis, comparative analysis, and system approach are used. For comprehensive data research, data acquisition is an important step. International Renewable Energy Agency (IRENA), World Resources Institute (WRI), Bloomberg New Energy Finance (BNEF), International Energy Agency (IEA), BP, and relevant national statistical departments are selected as the data sources in this study because these sources are professionally devoted to the field.

To estimate costs of electricity generation from different energy sources, the levelized cost of electricity (LCOE) is calculated in this article. The LCOE is the average life cycle cost of every unit of produced energy over the lifetime of a power-generating system. The calculation of the unit cost of energy provides a useful comparative measure between different projects and technologies (Aldersey-Williams & Rubert, 2019).

31.3 Literature Review

Although there are a few analytical studies on the development of renewable energy in Russia and the first stage of national state support policy effectiveness for the period of 2013–2024, there are no studies on the new extended state support program for the period of 2024–2035 and no research based on the most relevant results of the competitive selection carried out under the new rules.

Boute (2012) studies the Russian support scheme based on a legislative act draft available at the time of his writing. He examines the challenges of capacity-based support in Russia and comes up with conclusions on the complex interaction between capacity markets and renewable energy.

Kozlova and Collan (2016) look over the Russian renewable energy legal framework and explore the effects of the state support program on the profitability of renewable energy investments.

Lanshina et al. (2018) give a review of the Russian renewable energy regulation to show that Russia is finally ready to gain core competencies in the renewable energy sector. Authors explore the potential competitiveness of renewable energy-based technologies against new conventional power plants.

Agyekum et al. (2021) examine the opportunities and challenges in Russia's renewable energy sector. By coupling both interviews and literature reviews, main opportunities (high export potential, high market potential locally, etc.), and key challenges (low attention to clean technologies from government, regulation and implementation uncertainties, etc.) were identified and discussed.

31.4 Results

The fundamental principles for the development of renewable energy and corresponding target indicators were first enshrined in Russian legislation in 2009 (Russian Government, 2009). However, the mechanism for stimulating investments in RES generation became fully operational with respect to the wholesale electricity and capacity market projects only in 2013 when the first target indicators for the volumes of commissioning of the installed capacity of generating facilities by types of renewable energy sources were adopted (Russian Government, 2013). The mechanism for stimulating investments in RES generation on the retail electricity markets was introduced two years later, in 2015 (Russian Government, 2015).

In most countries, the renewable support schemes used can be grouped into three types: feed-in tariffs (FIT), tender- or auction-based support schemes, renewable energy portfolio standards (RPS), or quota systems. In Russia, auction-based mechanism is adopted to support solar, wind, and small hydro (under 50 MW) in the wholesale electricity and capacity market. It takes a special place among the existing renewable energy policy types (Kozlova & Collan, 2016).

The mechanism for stimulating investments in RES generation is operating based on the capacity remuneration under Capacity Supply Agreements for renewable energy sources (CSA-RES). According to this scheme, competitive renewable investment project selections (hereinafter—competitive selections) are held every year, and the winning investors are given the right to conclude CSA-RES, guaranteeing a 12% return on investment (ROI) for 15 years to cover their expenditures on construction and installation of generating facilities.

The implementation of the CSA-RES support program is carried out in two stages: The first stage lasts until 2024, the second stage—until 2035. Competitive selections within the first stage have already been held. The parameters of the second stage were approved in 2021 by Government Resolution No.1446 (June 1, 2021). In September 2021, the first competitive selection was held under the updated rules.

Key differences of the second stage of the extended CSA-RES program are.

- there is no restriction on the volume of commissioning of the planned power plants, only the annual volume of monetary support is determined;
- the selection of projects is now carried out based on the index of effectiveness of the generating facility (a so-called one-part price), not on the level of capital expenditures;
- localization requirements have changed (transition to a scoring methodology and new target indicators);

- introduction of export requirements to stimulate an increase in the competitiveness of Russian generating equipment in the domestic and foreign markets.

The total installed capacity of renewable energy generating facilities in Russia, including the wholesale and retail markets, exceeds 3.5 GW, which is approximately 1.4% of the total installed capacity in the national grid of Russia and 0.5% of the electricity generation. By 2035, based on the results of two stages of CSA-RES programs, the installed capacity of renewable energy power plants may reach 15 GW.

An additional increase in the capacity of renewable energy sources in the amount of 3–5 GW may be provided through the development of projects on the retail markets and in the segment of microgeneration. Serious development of renewable energy generation may be stimulated by industrial enterprises to meet their own needs—this trend is especially relevant in the context of activation of the ESG principles and introduction of carbon border adjustment mechanism. So, by 2035, the share of renewable energy sources in the Russian electricity generation will be 5–6% which corresponds to the target indicated in the Resolution of the Russian Government of January 8, 2009, No.1-r.

Due to the growing competition between participants in the competitive selection of renewable energy projects in 2013–2021 on the wholesale electricity and capacity market, there is a decrease in the capital costs of solar, wind, and small hydroelectric power plants. Accordingly, the levelized cost of energy (LCOE) is also falling and approaching global indicators, which increase the competitiveness of the Russian renewable energy sector (Fig. 31.1).

The latest competitive selection of renewable energy projects, which took place in September 2021, showed the success of the Russian renewable energy sector. As a result of the selection under the new CSA-RES rules with commissioning in 2023–2028, the price of electricity announced by investors for individual wind generation projects turned out to be at the level of 2 thous. rub. per 1 MWh—this is lower than the current wholesale price for electricity in Russia. In solar energy, the declared cost of electricity has also significantly decreased and amounted to from 4.3 to 6.4

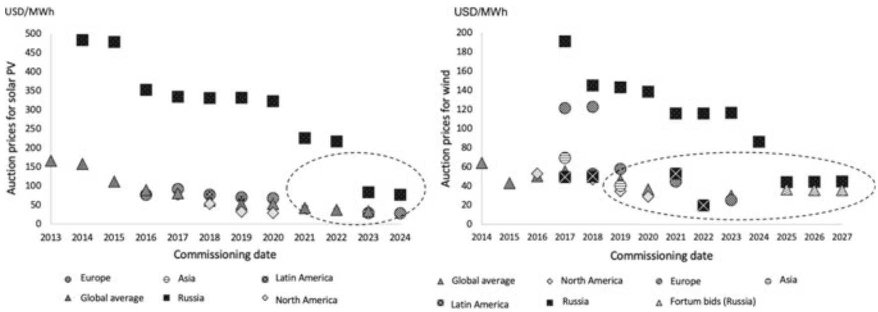

Fig. 31.1 Dynamics of average auction prices from solar and wind power plants based on competitive selection results. *Source* Authors' calculations based on IEA analysis

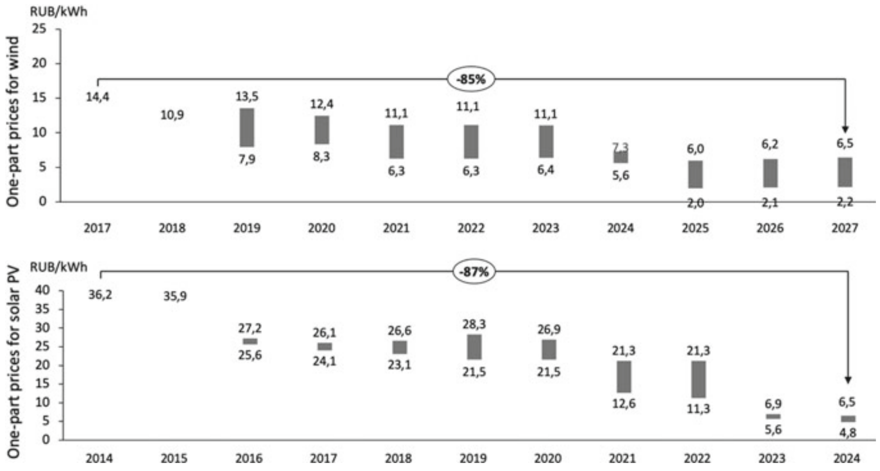

Fig. 31.2 Dynamics of one-part prices for wind and solar power plants based on the results of competitive selections in Russia. *Source* Authors' calculations

thous. rub. per 1 MWh. On the whole, prices for electricity from renewable energy generation in Russia will decrease by 85% by the time the projects are implemented in 2027 (Fig. 31.2).

Thus, renewable energy is becoming one of the cheapest sources in the Russian national grid. New solar and wind projects in Russia are increasingly undercutting even the cheapest and least sustainable of existing coal-fired power plants. The most efficient projects announced following the results of the last competitive selection already provide a cheaper generation than even combined cycle plants. Solar generation will catch up with the price indicators of combined cycle plants by 2027–2028.

A full-scale comprehensive renewable energy cluster has been created, including the green generation sector in the Russian energy market, industrial production of generating equipment for the renewable energy sector, as well as scientific and educational segment for the personnel training and research and development work. New production facilities were constructed in the segment of equipment for the renewable energy sector in Russia. Full-cycle plants for the production of photovoltaic modules are based in Russia, as well as blades, generators, nacelles, towers for wind turbines are localized in regions such as the Ulyanovsk Region, Nizhny Novgorod Region, the Republic of Mordovia, the Republic of Chuvashia, Rostov Region, Leningrad Region, and Saratov Region. Considering the ever-growing global demand for renewable energy generation equipment, the industrial cluster will play an important role in reformatting the Russian exports by increasing the share of innovative equipment with high added value.

In addition, the Russian renewable energy industry generates significant multiplier effects in the national economy. By 2025, as a result of the implementation of the first stage of CSA-RES program, 5.4 GW of renewable generation will be commissioned in Russia. By 2025, the implementation of the first stage CSA-RES program will provide an accumulated contribution to GDP growth in the amount of 1.01 trillion rub. The second stage of CSA-RES involves the commissioning of 7–8 GW of RES-based power plants. According to VYGON Consulting research, additional systemic effects will be formed by 2035:

- Investments in the production of localized high-tech and science-intensive products will amount to over RUB 50 billion. This leads to an increase in the annual projected capacity of equipment production for the renewable energy sector up to 1.9 GW.
- By 2035, the second stage CSA-RES program will provide an accumulated contribution to GDP growth in the amount of RUB 1.2 trillion.
- The CSA-RES program will provide revenues to the budgets of the Russian Federation at different levels until 2035 in the amount of RUB 310 billion.
- The minimum export volume until 2035 will amount to about RUB 50 billion, 40% of which are tough obligations under the CSA-RES program.
- New highly qualified jobs will be created in Russian renewable energy sector, which will provide direct employment for over 12 thousand people.
- The annual reduction in CO_2 emissions will be up to 8 million tonnes.

31.5 Discussions

With the large-scale introduction of renewable energy generation in the world, its price competitiveness is rapidly increasing. Some RES technologies have approached the threshold of competitiveness with conventional fossil fuel-based technologies. The competitiveness of renewable energy sources has especially increased in terms of costs. Since 2010, costs of RES generation have significantly fallen. The main drivers for cost reduction are improving technologies and developer experience, economies of scale, and competitive supply chains (IRENA, 2021). Costs for electricity from utility-scale solar PV fell 85% between 2010 and 2020, followed by onshore wind (56%) and offshore wind (48%).

The global weighted-average LCOE of utility-scale solar PV for newly commissioned projects fell by 85% between 2010 and 2020, from USD 0.381/kWh to USD 0.057/kWh (IRENA, 2021). For onshore wind projects, the global weighted-average cost of electricity between 2010 and 2020 fell by 56%, from USD 0.089/kWh to USD 0.039/kWh (IRENA, 2021).

Renewable energy projects are often cheaper today without financial support than any fossil fuel-based generation options. New solar and wind projects are increasingly undercutting even the cheapest and least sustainable of existing coal-fired power plants (IRENA, 2021). For example, now the most expensive new solar or wind power plant (the upper limit of the LCOE interval for solar and wind is $54/MWh) is cheaper than the cheapest new coal plant (the lower limit of the LCOE interval for coal is $66/MWh). In other words, there is no economic sense in building a new coal power plant (IRENA, 2020).

Russia is following the trend's global trajectory toward reducing the costs of generating electricity from renewable energy sources. Since the launch of the CSA-RES support mechanism, the costs of Russian renewable energy projects had remained higher than world levels, mainly due to local content requirements (LCRs). But at the last competitive selection, which took place in September 2021, LCOEs of wind and solar projects have dropped to world peers. Thus, Russian RES-based projects are now considered to be competitive in the energy landscape.

The implementation of CSA-RES support mechanism helped to build RES industry from the ground up in Russia. But the industry will not yet be fully operational by the end of 2024 without further special investment guarantee mechanisms operating within the wholesale electricity and capacity market. Currently, there are no instruments within the framework of the Russian wholesale electricity and capacity market, except for CSA-RES program, which could be considered by market participants as investment incentives in the renewable energy sector in order to achieve the targets of localization set by the Government of the Russian Federation. The capacity of the domestic retail market (about 150 MW/year), taking into account LCRs, is not enough for the construction of new production facilities, but at the same time, it can ensure their complementary load by 20–30% above the volume of CSA-RES program. For a more systematic development of RES sector on retail electricity markets, it is important to make the competitive selection of renewable energy investment projects mandatory in all constituent entities of the Russian Federation (now the decision to conduct competitive selections at the regional level is made by the administration voluntarily). Taking into account the constantly growing interest of electricity consumers in renewable energy and the cost of renewable energy-based electricity is rapidly decreasing, it is important to envisage the possibility of concluding bilateral agreements between consumers and investors in RES generation within the framework of the wholesale electricity and capacity market. It will make the process of pricing for electricity more transparent for consumers and will become an additional incentive for the development of this segment outside the CSA-RES support mechanism.

31.6 Conclusions

The extension of the CSA-RES program was a positive message for the Russian market that contributed to the active growth of investments in renewable energy projects. To further increase the competitiveness of Russia renewable energy projects and the energy sector at all, some reserves can be used. Considering the significant price decline as a result of the competitive selection in 2021, which means that renewable energy sources have become the most affordable source of energy in Russia, completely new opportunities are opening up for energy transition in the Russian energy sector.

When the whole world economy meets the trend of decarbonization in all spheres, it is important to reflect as much as possible the need for the development of the carbon-free renewable energy sector in the strategic documents of the Russian Federation. Otherwise, the Russian energy sector will not be able to adapt to dynamically developing innovative renewable energy technologies, while the national economy risks losing its competitiveness in world markets in the long term, especially in terms of the introduction of cross-border carbon taxes and other restrictive measures.

To sum up renewable energy development and use in Russia is highly relevant for the following reasons: firstly, the country stands the chance to gain competitiveness in the world markets due to developing and exporting innovative technologies of renewable energy. Secondly, the expansion of RES-based facilities will open up new opportunities for the establishment of a green economy in Russia, which in turn will ensure the attraction of additional foreign investments from the companies in accordance with the principles of sustainable development. Thirdly, considering the rate of technologies' development with the simultaneous decrease of their costs due to CSA-RES mechanism in Russia, electricity based on the use of RES will soon become cheaper than the conventional energy-based generation. It is important to consistently adapt the rules of the energy markets for the most efficient integration of innovative technologies into the energy mix structure.

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Chapter 32
Sustainable Energy Development in the Russian Arctic. Prospects for Smart Solutions to Mitigate Climate Change

Igbal A. Guliyev and Petr A. Kruzhilin

32.1 Introduction

Nowadays, in an attempt to meet the skyrocketing demand of the global energy balance, mankind has faced the problem of an environmental crisis, in which the emissions of greenhouse gases (mainly carbon dioxide and methane) in the production of energy from classic fossil hydrocarbons (coal, oil, and natural gas) cause the problem of global warming. This article has an overview and analytical nature and is dedicated to the observation of promising smart solutions designed to mitigate climate change.

The prerequisites for the study were the climate agenda and the increasingly popular management concept of the circular economy, which can be organically extrapolated to the energy industry.

The relevance of this work is to show how smart solutions could be created and implemented in order to mitigate climate change cost-effectively, as well as to show the prospects for their development. A region of the Russian Arctic which has significant potential for the development of smart climate solutions was selected to achieve the goals and objectives of the study.

The main objectives of this study are a brief analysis of the current trends in sustainable development in the energy complex of the Russian Arctic; analysis of promising climate innovations that have the potential for effective work in the Arctic; and evaluation of the prospects for smart climate solutions to combat climate change. These objectives have been successfully accomplished by applying a systematic approach while selecting proper climate technologies and "modeling" an ideal scenario when synergy and "closed-loop" are achievable. Some calculations of

I. A. Guliyev (✉) · P. A. Kruzhilin
International Institute of Energy Policy and Diplomacy, MGIMO University, Moscow, Russia
e-mail: Guliyevia@mail.ru; guliyev@miep-mgimo.ru

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carbon dioxide emissions have also been carried out to assess the current trend of sustainable development in the Russian Arctic.

32.2 Methodology

In order to calculate the volume of carbon dioxide emissions, the authors turned to the recommendations for calculating those based on the 2006 IPCC guidelines. According to this data, a coefficient of 0.202 tones CO_2/MWh was taken to calculate CO_2 emissions for a thermal power plant (using natural gas as fuel) (IPCC Guidelines…, 2006). The total capacity of the floating nuclear power plant (hereinafter FNPP) is 70 MW of electricity (Rosenergoatom, 2019), and the installed capacity utilization factor (hereinafter ICUF) is 90%.

The formula for calculating the energy produced by the FNPP per year is as follows:

$$P * \text{ICUF} * 24\ \text{h} * 365\ \text{days}$$

The formula for calculating CO_2 emissions of thermal power plants with equal power capacity is as follows:

$$P * 24\ \text{h} * 365\ \text{days} * 0.202$$

Since the article is of an overview and analytical nature, the article further discusses promising smart solutions selected according to special criteria:

- addressing current climate challenges and local problems;
- ability to create value-added product chains;
- ability to integrate all climate solutions into a single system to achieve a synergistic effect in the long term.

Also, the article uses the SWOT analysis method for a visually convenient presentation of data in terms of analyzing the positive and negative features of the injection of supercritical CO_2 into the underground gas storage facilities (hereinafter UGSF).

32.2.1 Sustainable Development in the Arctic

Today in Russia, a large-scale national project "Northern Sea Route" is being implemented. Within the framework of this project, it is planned to revive and create a new coastal infrastructure to support the Northern Sea Route. The concept of coastal infrastructure includes seaports that have special-purpose vessels (for example, tugs of various capacities), meteorological stations, as well as everything necessary for people to live and work in the severe northern climate.

The possibility of delivering energy to these facilities on the Northern Sea Route, taking into account the fact that some port cities are cut off from the continental energy system and use autonomous sources of energy generation and heating, arises as a rational question. Apart from providing port infrastructure, geological exploration of oil and gas fields and deposits is currently underway on the Russian Arctic shelf. Industrial complexes for the processing of gas and oil also need additional energy capacity. In addition, there are some industrial complexes engaged in the extraction of metal ores and minerals in the coastline in the north of the country.

All this requires an increase in the electric power capacities in the region. And it is for this purpose that the FNPP—a floating nuclear power plant—was developed. FNPP is intended for year-round heat and power supply to remote regions of the Arctic and the Far East (Rosenergoatom, 2019).

Thus, we can say that this unique project in the world is an innovative breakthrough in the field of generation and distribution of electricity in the Arctic latitudes, and this project itself can already be classified as "smart" climate innovation. The NPP does not have emissions similar to TPP using hydrocarbons, and "thermal pollution", mainly water, is declined as hot water is used to heat industrial and residential facilities, which, in turn, is very important in the Arctic and subarctic climate.

If we turn to the figures, then 2 FNPP power units with a total power capacity of 70 MW (Rosenergoatom, 2019), having an ICUF of 90% produced per year:

$$70\ \text{MW} * 0.9 * \ 24\ \text{h a day} * 365\ \text{days} = 551,880\ \text{MWh of energy per year}$$

If we compare the same amount of energy produced by thermal power plants using natural gas as a fuel, the difference in CO_2 emissions will be very sufficient. With a factor of 0.202 tons CO_2/MWh (IPCC Guidelines…, 2006), the approximate amount of carbon dioxide emissions for the same amount of energy will be

$$70\ \text{MW} * 24\ \text{h} * 365\ \text{days} * 0.202 = 123,866.4\ \text{tons of}\ CO_2\ \text{per year}$$

Thus, sustainable development in the north of Russia is already being achieved through the commissioning of nuclear power plants on the Arctic coast of Russia. The further commissioning of several FNPPs means that in future, there will be a reduction in carbon dioxide emissions in the north of Russia. It is also worth adding that, in addition to the commissioning of nuclear power plants, in recent years, the fuel and energy giants of Russia have been actively mitigating the negative impact on the environment by reducing the share of flared associated gas and by measures taken to reduce the number of gas, oil, and oil product breakthroughs during production, processing, and their transportation. This can be evidenced by data published by companies in environmental reports and sustainability reports.

32.2.2 Promising Areas of Smart Climate Solutions

32.2.2.1 Carbon Capture and Storage

The problem of global warming is probably of the highest priority in the context of mitigating climate change. Among all measures to combat the greenhouse effect (the main cause of global warming), the greatest attention is paid to limiting the emissions of CO_2. Today, technologies for direct capturing CO_2 from the atmosphere already exist and become affordable.

Moreover, apart from contributing to achieving global sustainable development goals, such solutions are based on closed-loop technologies—reagents for separating CO_2 from the air are reused many times. As an example, Fig. 32.1 shows a process of direct carbon capture from the atmosphere, originally presented by the Canadian company "Carbon Engineering" (Carbon Engineering, Vancouver, B.C.).

The relevance of these technologies and projects in the Russian Arctic is due to the possibility of achieving a high economic effect by replacing part of the volume of buffer natural gas at huge gas fields in the Yamal Peninsula. Carbon dioxide in a.

supercritical state of aggregation can help solve three problems at once (Dorokhin, 2017):

- increase the volume of recoverable gas by replacing part of the CO_2 buffer gas or increase oil recovery in depleting fields;
- reduce the negative burden on the environment;
- minimize the cost of finding suitable UGS facilities for storing CO_2.

"Supercritical CO_2 has better compressibility" (Dorokhin, 2017) compared to other "buffer gases" (excluding methane); in addition, it "has a higher density and viscosity, exceeding methane by 6 and 4.2 times". (Dorokhin, 2017). As a result, it is possible to inject a large volume of CO_2 into the reservoir, having the opportunity

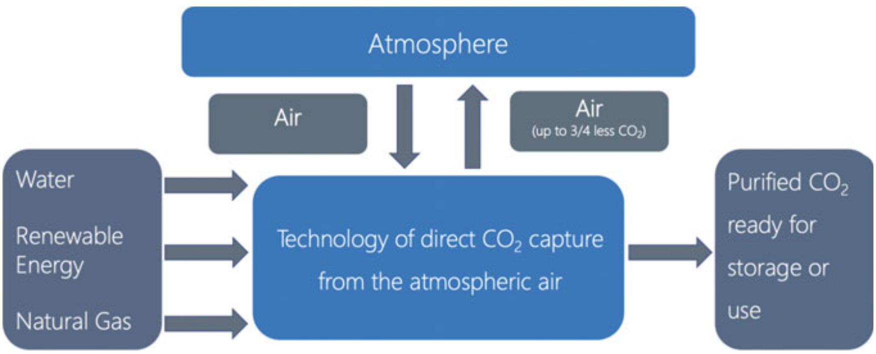

Fig. 32.1 Carbon capture technology; direct air capture scheme. *Source* Prepared by the authors based on data from the official Website of Carbon Engineering (Rosenergoatom, 2019)

Table 32.1 SWOT analysis of CCS projects in the Russian Arctic (supercritical CO_2 is used)

Strengths	Weaknesses
→ Climate change mitigation → Maintenance of the pressure within the reservoir → Enhance oil and gas production rates	→ Significant investment → Creation of new expensive infrastructure for CCUS projects implementation → Creation of infrastructure for additional preparation of CO_2 before storage
Opportunities	*Threats*
→ Opportunity of buffer gas replacement by CO_2 → Opportunity of using CO_2 as a "reagent" for the gas hydrates development → Improved conditions for the development of gas hydrates	→ Risk of project unprofitability → Risk of unpredictability on energy resources market → High final cost of natural gas produced from gas hydrates → Climate risks (CO_2 breakthrough)

Source Compiled by the authors based on Analytical Center for the Government of the Russian Federation (2013), Dorokhin (2017)

not to buy carbon credits following the Paris Climate Agreement, the prices of which are expected to rise over time.

To reach a clear and comprehensive understanding of the opportunities and limitations of CCS technologies to combat climate change, their strengths and weaknesses will be presented in the form of a brief SWOT analysis (Table 32.1).

Among the most promising prospects and strengths of this type of project, it is the ability to pump CO_2 for environmental reasons which are cost-effective at the same time. An experiment to replace part of the CO_2 gas buffer volume, carried out by Gazprom VNIIGAZ employees, showed that the active gas volume can be increased to 70% of the total gas volume in the storage, while the natural gas buffer volume (Dorokhin, 2017; Karvatsky, 1985) (the share in the reservoir is about 50–55% of the total volume of stored gas).

In addition, there is an opportunity for the use of CO_2 in the development of gas hydrates in the long term due to its ability to dissociate methane and water in gas hydrate compounds (Analytical Center for the Government of the Russian Federation, 2013).

It is also worth noticing that very significant capital investment in the infrastructure of CCS projects together with a group of technological, financial and even climate risks associated with changes in the cost of energy resources for the end-user are the most obvious drawbacks and threats for implementing the projects of such scale. There is also a potential financial risk linked with the mineral extraction tax regulations in Russia that can negatively affect potential revenues of CCS projects realization.

32.2.2.2 Integration of CCS and FNPP Projects in the Russian Arctic

This point represents an innovative approach rather than a definite technology; however, this link also plays a crucial role among the rest of smart solutions. The interaction of CCS and FNPP projects can lead to a synergistic effect because excess capacity from FNPP can be used to operate equipment for carbon capture and its injection into the reservoir. The energy required for CCS projects in the Arctic is purchased from a unified energy system, but at the same time, the presence of a nearby FNPP or renewable energy sources may, over time, contribute to a direct (reduction in the price of electricity) or indirect (subsidies for the use of "cleaner" nuclear energy) to reduce costs for the required energy.

The reactors of nuclear power plants are "clumsy", their maneuvering capabilities are limited, and if the power release can be done in a short time, the power up to the nominal parameters may take several days. So, CCS infrastructure can perform "rheostats" for FNPPs, especially if the power circuit is autonomous.

Today, this type of interaction is economically justified only in the regions of oil and gas production, however, with the development of the region, this type of interaction can become profitable over time. It is also permissible to use excess electricity from the FNPP for hydrogen production, which is also discussed in the IEA report (IEA Report, 2019).

32.2.2.3 Hydrogen Production

Nowadays, the trend toward the use of hydrogen as an energy resource is gaining more-and-more prominence and gravity in the world.

Last summer, in the interview to Handelsblatt newspaper, the executive director of Nord Stream 2 AG mentioned a possible option to convert the Nord Stream 2 gas pipeline to hydrogen instead of current natural gas in 10 years (Matthias Warnig interview, 2021). In this case, large deposits of natural gas and gas pipelines connected to them are combined in the region of the Yamal Peninsula, while the electricity needed to produce hydrogen in such volumes can, again, be provided by the FNPP. At the same time, part of the natural gas that is currently used to electrify the industrial regions of Yamal can be implemented more efficiently from an economic point of view.

Thus, in 10 years, hydrogen can be exported to other countries and used for energy needs within the country, while a by-product from the activity—oxygen is also commercially profitable while utilization in the industrial sector.

If hydrogen cannot be used for energy needs, there is still the possibility of its commercially profitable implementation in the industrial sector. Based on the data from the IEA report on the "future of hydrogen", we can expect an increase in the use of hydrogen in such industries as ferrous and non-ferrous metallurgy, construction, and mechanical engineering (IEA Report, 2019).

In the event of a transition to hydrogen energy, it is possible to achieve a synergistic effect when interacting with CCS projects. When choosing a technology for steam reforming of methane to produce hydrogen, carbon is still injected into the reservoir, extending the production period in the fields, which allows achieving a certain economic effect.

32.2.2.4 Converting Waste to Energy

Among the global climate issues, one can find another actual type of pollution—this is waste. In this case, it is worth considering solid municipal waste (hereinafter SMW) produced by the civilian population. Why is it important? The answer is simple—the conditions for the disposal of SMW in the Russian Arctic are in doubt today. Some of the main waste disposal methods are landfill, incineration, recycling, and composting. The minimum amount of soil and low temperatures do not allow composting and burial in landfills (for natural decomposition), while waste incineration is not cost-effective in small northern cities. In this case, plasma gasification of waste can be considered as a possible climatic solution on the scale of local settlements. Plasma gasification is a thermal process in which, with a small amount of oxygen, carbon-containing waste is converted into synthesis gas, which can then be used for energy needs (Alekseenko, 2020).

The process of plasma gasification is described in Fig. 32.2 and consists of the following stages: supply of waste to the combustion chamber, where the plasma torch with an "arc" temperature of 4000–6000 °C converts high-molecular compounds into synthesis gas (Alekseenko, 2020). By-products of the process: solid slag, recovered metal and sulfur could bring revenues (if realized on market) or are used for the local needs. At the next stage, synthesis gas is fed to a gas turbine, burned, thereby generating electricity or could be turned into bio-diesel. It is advisable to compress the extracted carbon dioxide and prepare it for transportation to disposal sites (for example, in oil/gas reservoirs), especially since maritime logistics is one of the main types of transport links on the coast of the Russian Arctic.

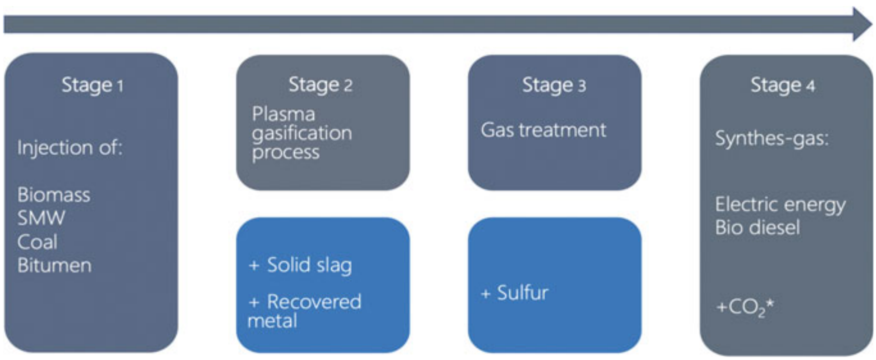

Fig. 32.2 Process of plasma gasification *Source* Prepared by the authors based on Alekseenko (2020)

It is also possible to improve the quality of synthesis gas in future by introducing a system of intelligent automatic selection and sorting of waste at the preparation stage.

Concluding the review of this climate solution, it should be said that plasma gasification of waste has good potential for the northern regions of the country, where it can be used as a local method of waste disposal with simultaneous generation of electricity.

32.2.2.5 Low Carbon Biofuel Synthesis

Another technology should be considered as a smart climate solution: the synthesis of low-carbon biofuels, the production of which is based on captured or taken carbon dioxide and water. The prospect of this technology lies in the cyclic use of fuel from carbon dioxide and water, as a result of which the same substances: Carbon dioxide and water are formed (Keith et al., 2018). This solution is dedicated to reusing CO_2 that already exist in the atmosphere. This smart solution is dedicated to reusing CO_2 that already exist in the atmosphere by means of cheap electric power and instant water access. Direct air capture technology helps to capture CO_2 from the atmosphere while water is converted into oxygen and hydrogen with the helping hand of electric power (through the electrolysis). As far as such equipment does not require UGSFs, it could instantly produce the required amount and type of fuel (from bio-diesel to jet fuel), which makes this solution flexible in terms of location. The Russian Arctic with FNPPs and unlimited water access is believed to be a proper place where this climate technology may well be implemented and developed.

32.3 Results

As a result of observation in this article, the authors have prepared an overview of prospects for smart solutions to mitigate climate change. Taking into account the current political, economic, ecological trends, and considering all the above-mentioned technologies and approaches, prospects have been divided into three parts, grouped by time.

32.3.1 Short-Term Prospects

Soon, it is probably difficult to expect the emergence of CCS projects, as well as a skyrocketing transition to hydrogen energy since the infrastructure in the country is not yet ready for such rapid and large-scale changes in these technological areas. However, such solutions as an increase in the number of FNPP on the Arctic coast and reduction of the negative impact on the environment by fuel and energy companies operating in the north of Russia.

32.3.2 Mid-Term Prospects

If the implementation of planned and tested solutions is expected in the coming years, then a little later, CCS project may begin to appear in the north of Russia. This is due to several factors that influence their appearance.

- Firstly, international and national tax regulations aimed at reducing the environmental burden of the fuel and energy complex can push the introduction of such technologies.
- Secondly, perhaps a more significant argument is that under a certain state, CO_2 can be used for the needs of the fuel and energy complex, as a strategically important resource, since it will increase oil and gas recovery in depleting fields, or it will make it possible to profitably replace part of the buffer natural gas, redundant in the UGSF.

Considering the rapid growth in the popularity and importance of hydrogen in the international energy mix, the energy transition to hydrogen energy may begin in the next 10 years, which allows hydrogen to be also classified as a medium-term perspective among smart climate solutions in the Russian Arctic.

32.3.3 Long-Term Prospects

Technologies for converting waste into energy (by the method of plasma gasification of waste), as well as for the synthesis of biofuels from CO_2, may be applied in practice a little later, in the long term. This is since the technologies themselves still need to be improved—today, they are not suitable for large-scale implementation due to their low profitability. It is equally important that both technologies are organically integrated into the structure of the energy complex when the infrastructure of CCS or waste selection projects has already been worked out and is functioning. Without them, it is expected that the viability of such projects significantly depends on the level of government support. Therefore, the synthesis of biofuels from CO_2 and gasification of waste in the Russian Arctic is possible only in the long term and only if the state creates favorable conditions for the development of these technologies.

32.4 Conclusion

All things considered, the role of floating nuclear power plants in the development of smart climate solutions is crucial. The FNPP network is capable of creating a chain of energy centers of affordable clean and relatively inexpensive energy in the Arctic region of Russia, so smart climate solutions may well benefit from that. FNPPs, being a part of the power system, are now replacing thermal power plants operating on the northern coast, which significantly reduces carbon dioxide emissions. Further development of nuclear energy technologies will be able to mitigate the negative impact on the environment in this region.

As for other smart solutions and promising technologies discussed in this article, their implementation will definitely have a positive effect on the environmental situation in the region and will contribute to the global fight against climate change. However, the accomplishment of high-efficiency indicators (by implementing solutions separately in each technological area or the form of a system of interconnected climate solutions) depends on the direct participation and interest of the state in the implementation of these initiatives (a clear result of such support is just the example with the FNPP chain along the Arctic coast of Russia).

Today, the government of the Russian Federation has approved a low-carbon development strategy. If the investment in the target scenario would amount to 1% of annual GDP from 2022 to 2030 and 1.5–2% of annual GDP from 2030 to 2060, then, with the effective management, the technologies discussed in the article not only would contribute to achieving carbon neutrality but also contribute to economic development in the Russian Arctic.

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Chapter 33
Adapting Innovation Strategy of Major International Oil and Gas Companies to the Evolving Climate Agenda

Yulia V. Solovova and Alisa O. Khubaeva

33.1 Introduction

A successful energy transition requires the timely development and scaling of renewable and alternative energy technologies. The IEA notes a significant mismatch between announced decarbonization goals and the current level of development of clean energy technologies, which are insufficient to achieve carbon neutrality (IEA, 2020). Much of the emissions come from sectors where technological options for reducing them are limited (e.g., shipping, trucks, aviation). Reducing carbon emissions from these sectors will require the development of new technologies that are currently in the early stages of development. About 35% of the cumulative CO_2 reductions needed to transition to a sustainable development pathway come from technologies that are currently at the prototype or demonstration stage; another 40% of the reduction depends on technologies that have not been commercially deployed on a mass scale.

33.2 Methodology

Innovation strategies determine the key directions of technological development of leading foreign oil and gas companies. Due to the mutual dependence of innovation strategy and general corporate business strategy, which in turn incorporates key trends in the development of the oil and gas industry and the energy sector as a whole,

Y. V. Solovova (✉) · A. O. Khubaeva
International Institute of Energy Policy and Diplomacy, MGIMO University, Moscow, Russia
e-mail: yu.solovova@inno.mgimo.ru

A. O. Khubaeva
e-mail: a.khubaeva@inno.mgimo.ru

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the innovation strategies of the oil and gas companies are considered in the context of global structural changes in the energy sector. Comparative analysis of innovation strategies of major international oil and gas companies has been conducted in the following areas: approaches to the organization of the management system of innovation activities; directions of technological development. Comparison of innovation management approaches was aimed at identifying best practices enabling efficient integration of clean energy technology projects in innovation portfolios to support decarbonization and diversification efforts. It has been focused on the main aspects throughout innovation development life cycle including strategic planning of innovation activities, technology forecasting system, elements of innovation ecosystem and role of open innovation, financing of innovation activity, commercialization of innovations. Directions of technological development have been identified based on the corporate documents, sustainability reports as well as the current structure of corporate capital venture arms portfolios. For the analysis, clean energy technologies have been broadly defined as technologies used at various stages of the energy chain that provide minimally or no carbon and pollutant emissions. The technological focus of oil and gas majors has been further analyzed.

33.3 Results

33.3.1 Adapting Innovation Strategy to the Climate Agenda

The general corporate strategy of vertically integrated companies is closely related to their innovation development strategy, and this relationship is two way. On the one hand, the general corporate strategy highlights the company's short-, medium- and long-term development directions, following which the company develops its innovation strategy and prioritizes the directions of R&D activities. On the other hand, the emergence and development of new promising technologies can make adjustments to the general corporate strategy, respectively, increasing the importance of such innovation function as identifying technological trends in a wide range of technological areas, assessing their possible impact on the company's business and transmitting relevant information to the level of the general corporate strategic planning function. In this regard, vertically integrated companies are beginning to introduce departments that track technologies in the oil and gas sector and related and non-oil and gas industries (e.g., the Technology Futures department of British Petroleum). The task of such departments is to take into account potential risks and prospects associated with the development of breakthrough technologies in the formation of the general corporate strategy of companies. Thus, there is a two-way relationship between the strategies of general corporate and innovative development of companies: as general corporate strategy affects the medium- and long-term directions of innovative development, so new technological trends lead to the need to adapt the strategy to the realities of the future.

Although forecasts published by international vertically integrated oil companies indicate a growing global demand for fossil fuels over the next two decades, many of them are actively taking steps to manage the risks associated with the climate agenda (Zhong & Bazilian, 2018). Given the need to maintain a competitive position in the context of energy transition trends, leading international oil companies seeking long-term sustainability are adopting innovative strategies, while their responses and strategic choices themselves can significantly affect the developments and dynamics of the low-carbon energy transition. Vertically integrated oil and gas companies are actively investing in the development of renewable, alternative energy and environmental technologies. Despite the low expected return on invested capital, renewable and alternative energy projects are an integral part of the long-term asset portfolio of vertically integrated oil and gas companies. Investments in the development of renewable and alternative energy technologies are linked to the diversification of oil and gas companies' asset portfolios due to the risks and prospects of the energy transition. Amid the will of regulators and society to reduce greenhouse gas emissions into the atmosphere and diversify energy systems in favor of low-carbon energy resources, international oil and gas companies are adding renewable and alternative energy projects to their portfolio of innovative assets.

Despite the recent announcement of emission reduction targets and participation in renewable energy projects, companies' actual investments in clean energy are still low compared to investments in fossil fuels. According to IEA statistics, oil and gas companies' investments in clean energy represent a small share of total capital expenditures, but since 2018, there has been a clear trend of steady growth (IRENA, 2021). A number of companies have indicated plans to significantly increase investment in clean energy in the short term. BP, for example, announced plans to increase its annual investment in clean energy from $500 million in 2019 to $5 billion per year by 2030, with an interim goal of $3–4 billion per year by 2025. Total announced that about $2.5 billion of its planned total investment of $12–13 billion in 2021 will be for renewables and electricity (including natural gas). Shell plans to increase its share of investments in clean energy to 25% by 2025. Eni's 2021–24 strategic plan calls for devoting 20% of its average annual capital investment of €7 billion to clean energy projects.

The strategies of major vertically integrated companies to adapt to the trends of the energy transition, driven by intensifying climate agenda, vary greatly. There is a strong linkage between the oil majors' proved reserves and their renewable energy strategies (Pickl, 2019). Major European companies are more active in implementing measures to transform their operations than their American counterparts (such as Chevron, ExxonMobil and ConocoPhillips), while national oil companies (such as Pemex and CNPC) are more limited in their ability to diversify, often because of the tighter government policies and regulatory framework within which they operate.

The diversity of initiatives can be categorized under the following strategic areas:

- Offsetting emissions: offsetting emissions from existing operations that do not involve a deep transformation of the operations themselves;

- Transformation of current operating activities: reduction of emission intensity through the transformation of operating activities (drilling; flaring of associated gas; leaks; refining);
- Product supply transformation: reducing the carbon footprint by offering new low-carbon products using existing resource base and delivery channels;
- Transformation of the business model: the fundamental transformation of the business model by focusing on new end-users and using new delivery channels.

Faced with increasing tax pressure to reduce greenhouse gas emissions as part of the goals set by international climate agreements, oil and gas companies are seeking to optimize their energy systems in ways that maintain or reduce CO_2 emissions. They are implementing initiatives aimed at improving efficiency and reducing emissions from existing oil and gas operations. Among the most cost-effective industry measures to address operational decarbonization are minimizing methane leaks throughout the hydrocarbon production chain, which have a 26–28 times greater negative impact on the climate than carbon dioxide, and managing emissions from decommissioned wells. Companies also pay great attention to operational and energy efficiency, which directly correlate with the level of greenhouse gas emissions. The oil and gas industry is a major producer of energy, but it is also one of the largest consumers of energy. It requires large amounts of energy to extract resources from the earth and to process, convert, transport and deliver them to end-users. Many major oil and gas companies have set emissions targets for their operations, and some (e.g., Shell) have tied employee remuneration policies to these targets. Internal operational changes are needed to address the challenges of the energy transition, including measures such as regular audits, implementation of energy management systems, equipment upgrades, process automation, leakage control, reduction of flared associated gas and expansion of cogeneration capacity.

An important area is the development of carbon capture, use and storage (CCUS) technologies. Chevron has invested more than $1 billion in CCUS projects in Australia. Chevron has invested $1 billion in CCUS projects in Australia and Canada. ExxonMobil is one of the leaders in CCUS technology development. CNPC has created a joint fund with OGCI that invests in CCUS projects and technologies being developed for China's needs.

The strategy, which focuses on optimizing the traditional business model, is more typical of US companies that focus on improving efficiency, increasing biofuel production and CCUS. ExxonMobil representatives outline the company's approach to the energy transition as based on the existing hydrocarbon and petrochemical business and not involving a radical transformation of the business model. CCUS projects, algae biofuels and new hydrocarbon-based materials to reduce emissions in construction and industry are key means to achieve this goal.

Some companies are implementing strategies focused directly on positioning their portfolios in the context of the low-carbon energy landscape. This strategic direction involves diversifying portfolios and expanding presence in alternative energy through:

- Direct acquisitions (M&A) in RES, energy storage, alternative transportation and power generation and distribution;
- Investments in the creation of electric generating assets based on RES;
- Investments in research and development in alternative energy;
- Venture investments in technological startups in the RE sphere.

Some vertically integrated oil companies have set up specialized divisions to develop alternative energy as part of their diversification strategies. Total, Equinor, Repsol, BP and Shell are actively increasing their renewable energy generation capacity by acquiring assets in electricity retailing and electric vehicle charging and by setting intermediate targets for increasing renewable energy capacity. The most common investments by oil and gas companies in the RES sector are in wind and solar projects, while very few have stakes in hydropower (e.g., Repsol) and geothermal (e.g., Shell, Chevron, Pemex and CNPC). The leaders in terms of installed RES-based power generation capacity are Total and BP. The Norwegian state-owned company Equinor is actively developing the wind power sector based on floating wind platforms. Companies that continue to focus primarily on the traditional oil and gas business, such as Chevron and Saudi Aramco, are also incorporating renewable energy projects into their strategies, although on a smaller scale and mainly for use at their production sites to reduce the carbon footprint of their products.

All these adaptation strategies imply the ability of the companies to develop and introduce a bride spectrum of new technologies in their operating activities and heavily depend on the efficiency of innovation management.

33.3.2 Innovation Ecosystem

International oil and gas companies have a well-developed innovation ecosystem, combining various mechanisms for different types of innovation projects. The incorporation of different mechanisms ensures a wide technological coverage with minimized risks and costs as well as an interdisciplinary approach, which enables the synthesis of knowledge from different scientific fields. The innovation ecosystem of leading international oil and gas companies typically combines in-house innovation with some so-called open innovation (OI) mechanisms (Fig. 33.1). The concept of OI implies the use of two knowledge streams—outgoing and incoming streams:

- The incoming flow, through which the company accumulates knowledge from external sources and enhances its ability to innovate;
- The outward flow, which implies that knowledge leaves the company and is then used by external participants. The company uses the outgoing flow of knowledge to obtain additional profit from the sale of its technologies; the sale of technologies that turned out to be irrelevant to the company during development but are important to external participants; and the formation of new business areas based on the developed technologies.

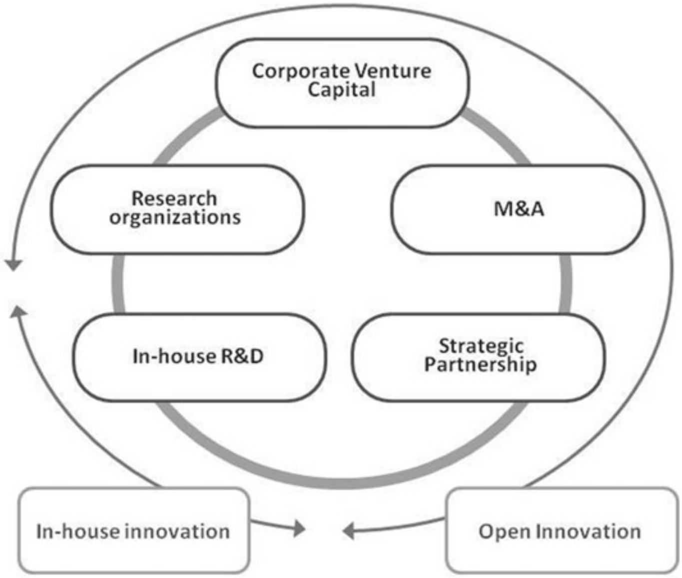

Fig. 33.1 Innovation ecosystem of oil and gas companies. *Source* Developed by the authors

Based on the analysis of forms of development of technologies in the field of low-carbon energy in foreign oil and gas companies, the tendency to strengthen the role of OI as a mechanism to reduce the risks and costs of development of long-term technology R&D projects at the early stages of TRL associated with a high degree of risk was revealed.

As a significant trend of innovative development in the field of low-carbon energy technologies, the increasing importance of corporate venture capital financing mechanisms (CVC) was identified. According to IEA statistics, a larger share of recent spending in new areas has come through M&A and venture activity, focused on renewables, grids and electrified services such as mobility (EIA, 2020). A significant advantage of CVC is the possibility of investing in breakthrough technologies, without involving significant internal resources of the company in research and development (IESE, 2017). In the context of regulatory and technological uncertainties, vertically integrated companies are increasingly using venture capital as part of their energy innovation strategies rather than allocating corporate R&D budgets for in-house development. Since many companies' carbon–neutral goals involve integrating new activities beyond their core competencies, companies are using CVC investment and acquisition of startups as ways to manage technological uncertainty. There is a trend toward a shift of venture financing objects toward technologies in the field of energy efficiency and the development of alternative energy sources, including renewables. Based on the analysis of startups in the portfolio of corporate venture funds of foreign vertically integrated companies, the following areas of investment in clean energy have been identified:

- Alternative energy: wind, sunlight, water power, storage, etc.
- Alternative materials: materials or products that could potentially replace petrochemical products.
- Environmental preservation: technologies that would avoid negative environmental effects associated with hydrocarbon burning—reduction of CO_2 emissions, household energy efficiency and reduction of automobile emissions.

Since 2005, the share of ecology oriented technologies in CVC portfolios has steadily grown (CFPro, 2019). Some oil and gas companies have refocused their CVC toward clean energy technologies, such as TotalEnergies Ventures, which is focused on finding, funding and fostering high-potential startups which will contribute to creating a low-carbon future. Other companies along with CVC arms investing in core technologies of exploration and production have created specialized funds, dedicated solely to clean energy.

Another important element of clean energy technology development is participating in multilateral international initiatives to develop and scale technologies that support the energy transition. The process of developing and improving technologies is capital intensive for a single vertically integrated oil and gas company. Participating in joint initiatives can facilitate and accelerate the development of these technologies. The analyzed oil and gas companies participate in bilateral and multilateral projects to develop and scale energy transition technologies. Vertically integrated oil and gas companies, including BP, Chevron, CNPC, Eni, Equinor, Exxon Mobil, Petrobras, Shell and Total, participate in the Oil and Gas Climate Initiative (OGCI). Companies participate in OGCI voluntarily. OGCI was established to coordinate the actions to achieve the set goals of sustainable development. OGCI implies joint efforts of vertically integrated oil and gas companies to develop technologies that will improve the environmental sustainability of companies along the entire value chain: from production to sales. OGCI's priority technologies include:

- Methane utilization;
- Reducing methane emissions;
- Low-carbon power;
- Operational safety;
- Operations optimization;
- Automation;
- Digitalization;
- Heat recovery;
- Productive and energy-efficient equipment.

One recent OGCI involving BP, Eni, Equinor, Shell and Total is the development of a full-cycle CCUS project, the Clean Gas Project, in the UK. It is assumed that natural gas will be used for generating electricity, and then the carbon will be captured and transported to the North Sea deposits by pipeline. Bilateral and multilateral projects not only accelerate the development of technologies for the energy transition but also create joint platforms for the development, testing and scaling of any technologies that are promising according to the vertically integrated oil and gas companies.

33.3.3 Directions of Technological Development

Against the background of the growing importance of energy transition trends and climate agenda, changes are taking place in the criteria for prioritizing technological areas and the aspects taken into account when making decisions on the implementation of individual innovative projects. Whereas previously the decision to invest in technological areas was based solely on factors of economic and operational efficiency, at present technologies are evaluated both from the perspective of economic and operational efficiency and from the perspective of environmental and operational safety. The important role of the environmental aspect in the innovative development of companies does not mean that oil and gas companies are engaged exclusively in the development of environmental technologies and technologies in the field of renewable and alternative energy, on the contrary, the main directions of research activities of companies remain technologies in the field of geological exploration, field development, production, refining, petrochemistry and gas chemistry. However, companies increasingly consider the degree of their environmental friendliness and relevance in the context of achieving decarbonization goals as a criterion for evaluating promising technologies.

An important factor, which has a strong influence on the technological focus of oil and gas companies, is government policy. Regulator policies aimed at stimulating the development and implementation of innovations in the energy sector, including renewable and alternative energy technologies, are implemented through incentive measures, such as support for technology programs, formation of national technology platforms, preferential taxation, as well as regulatory measures of a restrictive nature, such as the introduction of a tax on carbon emissions, the establishment of minimum mandatory biofuel content in fuels.

The analysis of the innovative development directions of leading foreign oil and gas companies permits us to conclude that the innovation programs include a range of technologies that are essential in the context of the energy transition, decarbonization trends and the development of a circular economy. The vertically integrated companies are actively investing in the development of renewable and alternative energy technologies and environmental protection technologies. The following key technology areas can be highlighted:

- Solar energy;
- Wind power;
- Energy of seas and oceans;
- Hydrogen;
- CO_2 emission reduction, capture and storage technologies;
- E-mobility and energy storage technologies;
- Fusion energy technologies with magnetic plasma confinement.

Hydrogen and biofuels are the main directions of product offer transformation based on the existing resource base and existing delivery channels. Increasing the production of biofuels (mainly biodiesel and bioethanol) is one of the key areas of diversification in the oil refining segment, as it involves the possibility of entering new low-carbon energy markets with a product more familiar to oil and gas companies and using their existing distribution infrastructure. Modernization of capacities for the production of biofuels is considered as an alternative to the closure of some outdated and inefficient refineries in Europe and the USA. Against the backdrop of regulatory actions in the USA and European Union, which impose mandatory first- and second-generation biofuel content in the total volume of fuel produced, most vertically integrated companies are developing, scaling up and commercializing first- and second-generation bioprocessing technologies. Some vertically integrated companies are also developing and scaling up third-generation bioprocessing technologies. ExxonMobil plans to increase biofuel production to 10,000 b/d by 2025 (according to the US Energy Information Administration, as of January 1, 2021, total US biofuels plant production capacity reached 21 billion gallons per year or 1.3 million barrels per day) (EIA, 2021).

At the moment, there is a new wave of interest in hydrogen. Eni is developing technologies to use hydrogen in transportation. In 2019, Eni and Toyota signed an agreement to expand hydrogen filling stations in Italy. BP is investing in joint projects on the use of "green" and "blue" hydrogen at refineries. Shell is implementing several projects to develop infrastructure for hydrogen refueling in Germany (with Total and Daimler—400 stations by 2023), the UK (with ITM Power) and the USA (with Honda and Toyota) and is also developing and licensing technologies for hydrogen production and marketing (Shell, 2020). Equinor is participating in a government-funded project to develop infrastructure for using hydrogen in commercial shipping. The direction of "green" hydrogen is actively developing. Equinor and Shell are jointly implementing the NortH2 project in the Netherlands, which plans to create a system consisting of offshore wind farms, electrolyzers, gas storage facilities and pipelines to convert offshore wind power into green hydrogen, which will then be stored and transported to industrial centers in northwest Europe.

Meanwhile, the resulting energy technology landscape supporting energy transition is highly uncertain due to the existence of a wide range of alternative technological options based on early-stage technologies (DNV, 2021).

33.4 Conclusion

Given the importance of technology both in maintaining competitiveness by improving operational efficiency, reducing the carbon footprint of traditional products and increasing profitability and in accelerating adaptation to changing market conditions by transforming the product offering, the development of innovation management competencies is particularly important. The energy transition creates significant risks and prospects for oil and gas companies, which need to maintain and develop flexible and evolving strategies that take into account the impact, development and implementation of promising technologies and allow them to remain competitive in any market conditions and under various development scenarios for the sector and the world economy as a whole. In this context, the present study analyzed the experience of foreign vertically integrated companies in incorporating new areas into their technological development strategies, as well as the application of modern tools for the development and implementation of new technologies.

Analysis of the organization of management of innovation development of leading oil and gas companies showed that the latter pay great attention to the need to coordinate the innovation strategy with the general corporate strategy. At the same time, it is worth noting that companies revise their technological directions regularly. The innovation strategies of the world's leading multinational vertically integrated oil and gas companies reflect the structural changes in the energy sector. Relevant R&D projects are implemented through a variety of mechanisms including in-house research and open innovation. Authors have revealed the increasing importance of corporate venture capital investments and multilateral technological partnerships for the development of clean energy technologies. The analysis of the innovative development directions of leading foreign oil and gas companies permits us to conclude that the innovation programs include a range of technologies that are essential in the context of the energy transition, decarbonization trends and the development of a circular economy.

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Chapter 34
Czech Energy Policy and Diplomacy in the Context of the Climate Agenda

Igbal A. Guliyev and Natalia V. Ushakova

34.1 Introduction

In recent years, environmental issues have become an essential factor in the transformation of the global energy sector, which has been greatly facilitated by the intensification of climate change manifestations amid the economic recovery after the pandemic, as well as aspects of economic competition and the strategic aspirations of many countries for energy and resource independence.

The global climate agenda, which is based on the ideology of “sustainable development” and supported by public structures and populations of different countries, is becoming global and turning into a serious tool for achieving geopolitical and economic goals.

The majority of countries are ready to unite to achieve a common goal of mitigating climate change and adapting to it. This is demonstrated by the 2015 UN Framework Convention on Climate Change (Paris Agreement), adopted by 196 countries at the 21st session of the Conference of the Parties (COP 21). The global challenges concerned with the interaction of mankind and nature are now taken seriously as a basis for practical actions both at the global and national levels. The public support for such initiatives in different countries is also growing. Nevertheless, different groups of countries often demonstrate adverse approaches to the formation of the most effective methods of practical human response to climate change. Mechanisms of multilateral diplomacy enable the adoption of an optimal universal approach to the conceptual transformation of energy consumption within the framework of an evolving new model of the global energy sector.

I. A. Guliyev (✉)
International Institute of Energy Policy and Diplomacy, MGIMO University, Moscow, Russia
e-mail: guliyev@miep-mgimo.ru

N. V. Ushakova
MGIMO University, Moscow, Russia

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Currently, aspects of the decarbonization of the global energy sector have gone beyond individual countries and become global. They determined the need to create a reliable system for providing net-carbon energy sources to the world economy based on respect for the environment and climate change mitigation. Over the past few decades, the role of international energy organizations in the transformation of the global energy sector has grown significantly. Such influential organizations as the UN, the IEA and the International Renewable Energy Agency (IRENA) have had a considerable impact on the development of the global energy system, its ongoing structural changes and the formation of the regulatory framework for international energy cooperation under the new conditions.

Renewable energy sources, that are currently experiencing a period of rapid growth, are one of the key components of the current energy transition associated with aspirations of the world community for net CO_2 emissions, energy independence and security. Advance in power generation technologies from renewable energy sources ensures the competitiveness of green energy in comparison with fossil fuels. Therefore, the development of renewable energy sources (RES) in many countries no longer needs governmental support measures.

However, the energy transition is a complex process and in addition to the large-scale use of renewable sources, it covers energy efficiency, decarbonization, electrification, distribution of generated energy, and digitalization. The energy paradigm shift is accompanied by the development of innovative breakthrough technologies in power generation, distribution, and consumption.

Thus, international energy cooperation, supported by multilateral diplomacy mechanisms, contributes to the coordination of energy strategies of individual countries, elimination of regional imbalances within the framework of decarbonization of the economy and energy transition, as well as the development of the most effective practical measures against climate change.

34.2 Methodology

Strategic aims of the Czech Republic's energy sector.

Currently, the main documents defining the energy policy of the Czech Republic are:

- The State Energy Concept of the Czech Republic 2015 (published on 21.12.2016);
- The Evaluation of the implementation of the State Energy Policy of the Czech Republic (published on 04.2021);
- The National Action Plan for Smart Grids (NAP SG) dated 04.03.2019. (last updated on 16.09.2019);
- The National Action Plan for Clean Mobility (NAP CM) dated 20.11.2015 (last updated on 27.04.2020);
- The National Action Plan for the Development of the Nuclear Energy Sector in the Czech Republic (NAP JE) dated 03.07.2015;

- The National Renewable Energy Action Plan of the Czech Republic (NAP RES) dated 25.01.2016 г. (after 2021 will be replaced by the National Energy and Climate Plan of the Czech Republic);
- The National Energy Efficiency Action Plan of the Czech Republic (NAP EE) (after 2021 will be replaced by the National Energy and Climate Plan of the Czech Republic).
- The State Energy Concept of the Czech Republic 2015 (published on December 21, 2016) is the current version.

In contrast to more ambitious plans of the EU related to greenhouse gas reduction, the Czech Republic aimed for 43% GHG reduction by 2030 compared to 2005 level in the economic sectors where EU ETS quotas are used, and by 30% (34% by 2050) in other sectors.

According to the current evaluation of the implementation of the State Energy Policy of the Czech Republic (dated 04.2021), the target is a 30% GHG reduction by 2030 compared to 2005, which will amount to 44 million tons of CO2. The share of renewables in total final energy consumption will account for 22% following the latest National Energy and Climate Plan of the Czech Republic, adopted on 13.01.2020 based on the State Energy Concept of the Czech Republic (2015) and then submitted to the European Commission (evaluation of the implementation of the State energy concept, 2021).

As for energy security, the plan is based on the State Energy Concept of the Czech Republic (2015) and above all provides for ensuring a reliable natural gas supply by achieving greater diversification of energy sources, maintaining electricity self-sufficiency, developing energy infrastructure and preventing greater dependence on external energy supply. At the same time, it is recognized that a gradually increasing dependence on external energy supplies is expected shortly due to the declining share of domestically produced brown and black coal.

However, there are still ongoing discussions in the Czech society regarding short and long-term energy policy goals. Therefore, the new National Energy and Climate Plan of the Czech Republic will be adopted after 2021.

The following SWOT—analysis of the energy sector in the Czech Republic is offered in Table 34.1.

Key points of the SWOT analysis have not lost their relevance at present. There is still a tendency to develop energy policy primarily at the EU level rather than at the level of the member states. Therefore, a weak point (or threat) remains the "excessive and frequently changing regulation at the EU level and then national level, creating an unstable environment for much greater investments" (Evaluation of the implementation of the State energy concept, 2021). This is partly due to enforcement of any binding EU climate and energy policy objectives in violation of technology neutrality. Risks can be complemented by the insufficient financial resources to achieve EU policy goals, as well as the risk of non-compliance with EU objectives and penalties arising from such non-compliance.

Table 34.1 SWOT-analysis of the energy sector in the Czech Republic

Strengths and opportunities	Weaknesses and threats
High quality and reliability of energy supply	Market distortion and shortcomings of the investment policy
Production base transformation of the electric power industry in order to secure its stability and sufficient capacity	Aging resource base and infrastructure of power grids
Public acceptance of nuclear power	Lack of highly qualified young professionals
Developed heat supply system	Limited potential to increase the share of renewable energy
Relatively low level of dependence on external energy supply	Frequent use of low-quality raw materials in certain regions
Electricity and heat self-sufficiency	Insufficient level of waste disposal and recycling in certain regions
Use of innovative technologies in the construction of complicated technological complexes	Lack of public understanding of the need to introduce high quality and reliability standards in the energy sector
The opportunity of electricity transit within Central and Eastern Europe	Forced adoption of commitments within the EU climate agenda while developing decarbonization measures which contradicts the principle of technological neutrality and creates an additional burden on the state budget and the whole economy
The opportunity of recycling and use of secondary materials	The threat of lack of legal regulation
The opportunity to use alternative energy sources (electricity, LNG, etc.) in urban and suburban rail transit	The threat of unilateral and uncoordinated introduction of mechanisms regulating the energy market within the EU, primarily in countries bordering on the Czech Republic
The opportunity of lower energy input into residential heat supply and higher energy efficiency of industrial-technological processes	The threat of limited available brown coal reserves and difficulties with residential heat supply
The opportunity of participation of the Czech research programs in international energy research programs	The threat of time-consuming and complicated construction of modern highly efficient resource capacities as a replacement for existing ones
The opportunity of expansion of technical school programs and use of intellectual resources of graduates in scientific and research programs	Threat to ensuring a safe and reliable energy supply with the gradual introduction of the emergency management system
Development of smart grids	The threat of deteriorating operational reliability of the energy system due to rapid growth of variable RES and no additional supporting measures
Restructuring of resource base by introducing modern highly efficient technologies and energy-efficient resources	Risk of non-compliance with Generation Adequacy metrics due to fossil fuel phase-out

(continued)

Table 34.1 (continued)

Strengths and opportunities	Weaknesses and threats
Development of unconventional methods of hydrocarbon production in the world and the EU	Threat to continuing rapid development of variable renewable energy in Europe amidst an insufficient expansion of network infrastructure

Source Developed and compiled by the authors based on Evaluation of the implementation of the State energy concept (2021)

As for investments in renewable energy sources, not supported by state and European funds, today they are not made at all. Taking into account stronger requirements for GHG reduction in Europe, soaring prices of EU ETS quotas, demands for replacing coal-based heating with green fuel in households and a significant allocation of public funds in this area, limited resources should not be viewed as a threat.

In general, the energy policy of the EU, and the Czech Republic as its member, is aimed at increasing consumers' participation in the production of electricity and other energy sources used directly in the EU.

New opportunities include the use of new technologies (hydrogen, modular nuclear reactors, etc.) as their development has recently gained momentum due to the EU requirements and global trends. The cost of key technologies has decreased internationally and approached market commercialization, although this has not yet happened in the Czech Republic.

The strategic goal of the 2015 State Energy Concept of the Czech Republic, indicated in Chap. 4.1 (2015), is to ensure a safe, competitive and sustainable energy supply. Safety is understood as an adequate power supply both during normal operation and in emergencies. Competitiveness implies maintaining final energy prices (electricity, gas, and oil products) for industrial consumers and households at an acceptable level compared to other EU countries, as well as securing the ability of energy companies to generate profit in the long term. Sustainability is viewed in terms of environmental impact, the sufficiency of financial, economic, human resources, possible social consequences, and features of energy resources. In the short term, an optimal ratio of these three components should be achieved.

The strategic goals of the State Energy Concept of the Czech Republic are shown in Table 34.2.

34.3 Results

Areas of implementation of energy policy priority directions are ensuring an optimal ratio of use of different types of energy resources, energy saving, increased efficiency of energy resources use, improved infrastructure and increasing the role of international cooperation, the introduction of innovative technologies, and ensuring energy security.

Table 34.2 Strategic goals of the state energy concept of the Czech Republic

Reliability	Competitiveness	Sustainability
Maintaining or increasing the existing emergency reserves	Maintaining the transmission capacity of power grids for both export and import at a minimum 30% level of its load	Decreasing energy intensity of GDP at the EU average level
Reducing and maintaining the diversification ratio of primary energy sources below 0.25 in the long term	Energy cost optimization	Reducing environmental impact on a permanent long-term basis in all directions
Reducing and maintaining the diversification ratio of total electricity generation below 0.35 in the long term	Maintaining energy prices at a minimum of 120% of the OECD level	Effective use of soil resources for energy purposes while sustaining food security
Reducing and maintaining the diversification ratio of imports below 0.30 in the long term	Reaching and maintaining consumer prices for electricity and gas below the EU-28 level	Continuous reduction of fossil fuel share in primary energy consumption
Reducing and maintaining import dependency at the EU-28 level in the long term	Reaching and maintaining the share of energy costs in total household spending below 10%	Reducing the energy intensity of gross value added at the EU-28 level
Ensuring the operation of the electrical system in compliance with guideline N-1 (guideline of operational safety)	Optimizing the share of the energy costs in gross value added	Reaching full and effective exploitation of renewable energy sources
Ensuring energy self-sufficiency at a minimum 90% level	Decreasing the share of energy imports in gross value added below 2010 level	Maintaining permanent electricity consumption per capita below the EU-28 level
Ensuring a capacity range of -5% to + 15% of the maximum load power consumption	Maintaining positive overall economic value added in the energy sector	Reaching 60% of the heat to be supplied through cogeneration using security systems and 20% through renewable energy sources
	Reducing the impact of energy imports on the balance of payments	

Source Developed and compiled by the authors based on State Energy Concept of the Czech Republic (2015)

Decarbonization is the main problem on the way to more balanced integration of the energy system of the Czech Republic into the pan-European one.

The Czech Republic is currently facing challenges in transforming its energy system in the context of the climate agenda.

In the early twenty-first century, almost half of the internal electricity was supplied from coal-fired power plants, and Czech energy companies were able to plan their long-term investment policy. However, everything changed since the EU took a long-term course toward phasing out fossil fuel sources, black, and brown coal above all.

In January 2020, the Assessment of the Fulfillment of the State Energy Policy of the Czech Republic was published, the same year the share of coal in total Czech electricity production (81 Twh) dropped significantly (the brown coal's share dropped by 17.3% and that of black coal by 10.9%) (Annual Report on the operation of the Electrical system, 2020). In addition, the market price for greenhouse gas emission permits within the European Union Emissions Trading Scheme (EU ETS) began to rise rapidly, and it is still rising today, although back in 2006 and even in 2018–2020 it fluctuated around €30 and below this level (it reached €59.82 as of 03.11.2021) (Price dynamics of permits, 2021). While the 2004 State Energy Concept of the Czech Republic, adopted before the country joined the EU, considered brown and black coal as one of the main energy sources for the country recommended to optimize the use of available domestic energy sources, along with coal and other sources of fossil fuels, the country had to change both its energy policy and diplomacy drastically after the Czech Republic joined the EU. This also required the Czech Republic's National Energy Concept to be updated.

On the one hand, the Czech Republic had to comply with the EU decision to limit greenhouse gas emissions due to the EU ETS and then achieve carbon neutrality in the long term. On the other hand, the Czech Republic initially received a significant amount of greenhouse gas emission permits free of charge, which also allowed selling some of them at market prices for large amounts of several billion crowns. Thus, in 2006 one of the leading Czech energy companies ČEZ sold emission permits for the amount of 3077 million crowns (1053 million crowns in 2005) (Report of the company ČEZ in 2006, 2006).

On July 30, 2019, a Coal Commission (Official website of the Coal Commission, 2021) was established which is responsible for determining the time needed and necessary measures to achieve carbon neutrality in the Czech Republic in the long term, and in early 2021 an active public debate about the most likely real-time for the country's transition away from coal as an energy source broke out. The point of disagreement still is the terms and ways of limiting coal production, especially that of brown coal. Many experts suggest continuing the operation of the three modernized coal-fired power plants-Tušimice 3, Prunéřov, Ledvice-for as long as possible (until 2030–2040) and closing down the other thermoelectric power plants at an earlier date would be an optimal solution (Official page of journal Chomutovsky delnik, 2021, Official page of Iuhli.cz, 2021, Official page of news channel idnes.cz, 2021).

However, whatever scenario is to be implemented in the coming years, the coal regions will have to deal with the problems of unemployment in the industry. This will mainly affect regions with developed brown coal mining, such as the Karlovy Vary Region, the Ustecký region, and also those producing black coal, like the Moravian-Silesian region, as it was seen in the regions which had already closed black coal mines-Ostrava, Karviná, Kladno. The unemployment rate in all of these regions is already higher than that in other regions of the Czech Republic (Official page of the Czech State department (2021). The success of solving these problems will also depend on the geographical location of coal exploitation sites within the Czech Republic (e.g., proximity to large cities would be a positive factor), and on the educational level of most of the population since substantial funds will be needed for retraining programs. The closure of mines and coal-fired power plants would cause expenses worth tens of billions of crowns.

At present, energy companies using fossil fuels are incurring losses due to the sharp rise in the current price for emission permits. They manage to maintain a sufficient profitability rate largely thanks to nuclear power.

In October 2021, several EU countries, including France, Slovenia, Slovakia, Bulgaria, Croatia, Poland, Hungary, the Czech Republic, Romania and Finland, asked the European Commission to recognize nuclear energy as low carbon. In their opinion, a positive decision would reduce energy dependence on export. In addition, it is stressed that there is no evidence of the negative impact of nuclear energy on the climate. In the Czech Republic, in particular, 37% of total energy is produced by nuclear power plants (Bilik, 2021).

Czech nuclear power plants are still using Russian technologies, mainly the Dukovany and Temelín nuclear power plants. The Temelín nuclear power plant was constructed in the 1980s, but it started to operate only in 2002. The plant's two reactors produce a total capacity of 2000 MW. The Dukovany is an older nuclear power plant, built and put into operation in Czechoslovakia. However, the Czech Republic rejected Rosatom's competitive export offer and excluded it from the tender for the construction of a new power unit at Dukovany due to the recent tension between Russia and the Czech Republic. After Russia's Rosatom and Chinese China General Nuclear Power were excluded, Westinghouse is bidding for the $6 billion contracts ("The Czech Republic has finally excluded Rosatom", 2021). Despite the high probability of an increase in the cost of the project, the Czech Republic has passed a law that disables Russian and Chinese companies to participate either in the construction of the new power unit or in its further operation.

The issue of whether the state supports the development of renewable sources of energy is still high on the agenda, especially in the context of the energy crisis that broke out in October 2021.

On 20.10.2021 the government of the Czech Republic approved an amendment to the law on measures to support households' electricity consumption, that provide for compensation of part of the costs to mitigate the impact of the rising energy prices on the population. Approximately, one-half of households' costs are covered by the regulated share set by the Energy Regulatory Authority (2021), and it is less than 1/3 for gas. The regulated share of the price for electricity includes transmission and distribution fees as well as investment in renewable energy sources. The remaining share of the price is determined by the energy suppliers themselves. The energy authority regularly announces its share of the price for the following year at the end of November.

The total annual payment to the so-called supported energy sources accounts for about 45 billion crowns, of which 27 billion crowns are paid by the state and the remaining 20 billion crowns are paid by households and companies in their payments. Since 2006 more than 430 billion crowns have been allocated to support these energy sources in the Czech Republic (Official page of oEnergetice.cz, 2021).

In November 2021 (06.11.21), the Senate of the Czech Republic partially approved the Fit for 55 European Climate Program proposed by the EU in July 2021 in the following areas: taxing energy products and electricity; developing alternative fuel infrastructure; tightening CO_2 standards for new cars and commercial passenger vehicles; promoting renewable sources of energy; improving energy efficiency; revising the EU ETS system and ensuring energy reserves, although the day before this meeting the senators had subjected to criticism the main provisions of the European Green Deal (Official page of fZone.cz, 2021).

The Senate's draft opinion on the EU Energy Products and Electricity Tax Directive, for example, says that "adopting such an ambitious European Green Deal plan in a situation when there is no known way to replace existing energy sources is irresponsible" (Official page of oEnergetice.cz, 2021). The European Senate committee gave a negative opinion on two provisions of the Green Deal, namely, the introduction of infrastructure for alternative fuels and the tightening of CO_2 emission standards (The Senate recommended to establish support for renewable resources by government decree, 2021). According to the committee, these proposals do not guarantee technological neutrality. At the same time, the Commission stated its intention to increase the share of energy from renewables to 40% by 2030, considering the target of 32% to be insufficient. Besides, it is stressed that the member states should determine their measures to achieve this goal. The Czech Republic will increase the share of renewables in the energy mix in the context of the climate agenda, but it is noted that the role of renewables will be limited and the country will rely primarily on the development of nuclear energy due to its geographical location (Official page of fZone.cz, 2021).

In recent years, significant resources have also been allocated in the Czech Republic for the development of solar and wind energy.

According to the Electricity Market Operator (OTE) (Official page of the Czech Electricity Market Operator, 2020), 29.1 billion crowns were allocated to support solar power plants in the Czech Republic in 2020. According to these data, 45.4 billion crowns were allocated in the Czech Republic (at the level of 2019) for the development of so-called "supported energy sources" (The concept of supported energy sources is based on Law No. 165/2012 Coll., 2021), which include biomass and biogas, photovoltaics, wind power, hydropower, secondary sources, biomethane, etc. Since 2006 more than 430 billion crowns have been allocated to support them in the Czech Republic. In 2019, 27 billion crowns were allocated. The use of solar power plants is seen as one of the alternatives on the path to carbon neutrality, for example, by carrying out the governmental "solar auctions" to purchase electricity from such plants in the areas where the coal mines are closed. In August 2021, the Senate also approved a proposal to support small hydropower plants upgraded after the 2002 floods for 30 years after their modernization (Official page of oEnergetice.cz, 2021).

European Union Trust Funds.

In order to address decarbonization, the Czech Republic relies primarily on three funds created by the European Union in the past two years.

The Next Generation EU (NGEU) is created from 2021 to 2027 to deal with the consequences of the pandemic in EU countries. Of the announced funds worth 750 billion euros, a significant part will be set aside for the implementation of measures under the Green Deal (Official page of lifegate.it, 2021). The Recovery and Resilience Framework (RRF) is the main part of the Fund. On its basis, the Czech Republic plans to attract about 172 billion crowns in grants and 20 billion crowns in loans in 2021–2026 as part of the National Recovery Plan (Czech Republic's reform and investment plan for overcoming the consequences of the pandemic) (Official page of the State Environmental Fund, 2021).

The Just Transition Fund was established in May 2021 and has a total amount of funds worth 17.5 billion euros (7.5 billion euros will come from the 2021–2027 EU budget and 10 billion euros from the Recovery and Resilience Facility (RRF). The Fund's resources will be intended mainly for countries and regions that intensively use fossil fuels (coal, brown coal, peat, and oil shale) (Official page of eureporter.co, 2021).

Modernizační fond (Modernization Fund) was created in 2020 specifically for such countries as the Czech Republic and some others (Bulgaria, Hungary, Latvia, Lithuania, Poland, Croatia, and Estonia) within the Next Generation EU to solve the problems of transition to a green economy in these countries (Official page of enovation.cz, 2021). The Czech Republic is one of the first EU countries to receive the Fund's resources to the amount of 150 billion crowns in the next few years, which will be allocated to Czech companies producing and distributing energy generated from renewable sources, as well as to companies building solar power plants and those optimizing energy consumption in operational and technological processes. In general, 9 programs are envisaged, ranging from modernization of lighting systems, purchase of electric buses, energy savings in buildings, emissions reduction in industry and energy, to the construction of photovoltaic power plants or wind turbines (Official page of the State Environmental Fund, 2021).

The EU Structural Funds also provide for the allocation of substantial funds for the implementation of the climate agenda (Official page of European Commision, 2021).

34.4 Conclusion

It is possible to conclude that the general strategic directions of energy policy and diplomacy of the Czech Republic remain decarbonization, reducing the role of solid fuels in the overall use of energy resources, further development of renewable energy technologies (especially solar and wind energy), development of technologies and systems of electricity storage, development of hydrogen technologies and small modular reactors, modernization of thermal plants, implementation of other EU recommendations in the context of the climate agenda. Despite the complexity of the decarbonization process due to objective historical and geographical reasons, the Czech Republic will not reject the implementation of the EU Green Deal. Though, it will try to get the maximum subsidies to mitigate the transformation of its energy in the context of the climate agenda, as well as ensure the longest possible operation of coal-fired power plants until a reliable base for renewable sources of energy is provided, or at least try to obtain permission from the European Commission to suspend the operation of the updated brown coal-fired power plants, and leave these mines as strategic reserves with the opportunity to use them when the produced power energy is insufficient (e.g., during winter period or in case of emergencies).

In addition, the Czech Republic will promote and support the construction of new nuclear power units, emphasizing that there is no direct negative impact of nuclear power on the environment.

The country will also strive to create maximum strategic natural gas and oil reserves shortly, cooperating primarily with Germany in this field and using its energy infrastructure whenever it is possible.

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Chapter 35
Green Energy of the BRICS Countries: The Driver of Inclusive Development

Viacheslav E. Zakharov and Marina D. Simonova

35.1 Introduction

Energy retains the status of a key industry in any economic system and its qualitative and quantitative characteristics determine the potential of economic development. The combination of modern risks caused by the growing "carbonization" of economies, uneven distribution of deposits of hydrocarbon fuels, multi-vector price volatility in world energy markets, and aggravation of environmental problems transforms the approach to sustainable development. Apparently, in the foreseeable future, the RES could become the most demanded tool used for the diversification of the global energy system as well as for the prevention of greenhouse gas emissions. The purpose of this study is to analyze the factors of the RES-development in the BRICS countries as well as to assess the effectiveness of the current models of the RES-market incentives.

35.2 Methodology

The theoretical basis of the paper is the scientific studies of Russian and foreign researchers. For instance, Podoba & Kryshneva, (2018) studied the energy balances of the BRICS countries, the dynamics of investments in the RES as well as the effectiveness of the mechanisms used to reduce greenhouse gas emissions. The current

V. E. Zakharov (✉)
Ministry of Foreign Affairs of the Russian Federation, Moscow, Russia
e-mail: vesy333@mail.ru

M. D. Simonova
MGIMO University, Moscow, Russia
e-mail: m.simonova@inno.mgimo.ru; rusinamar@mail.ru

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state, as well as the key directions of energy development in the BRICS countries, focused on the mechanisms for supporting "green" energy in Russia, revealing that the scale and speed of the introduction of the RES into the state energy system depends, first of all, on the effectiveness of the government support (Simonova et al., 2019).

The potential of the RES for "decorbanization" of the BRICS economies was studied by several researchers. For example, the performed analysis (Shen et al., 2021) proved the correctness of the hypothesis of the environmental Kuznets curve in favor of the BRICS countries and also revealed the negative impact of economic growth and globalization on the process of preventing carbon dioxide emissions. Sharma et al., (2021) evaluated features of the approaches of China and India regarding the RES-market regulation through the comparative analysis.

Numerous studies devoted to "green" energy focused on the importance of investments for RES development. The study (Zeng et al., 2017) showed the similar problems of the BRICS countries in financing matters of "green" energy. Among other things, the authors highlighted the lack of funding sources, insufficient presence of small and medium-sized businesses, systemic "failures" of a state policy.

Many papers study the mechanisms of the RES-market regulation in each country of the BRICS. For instance, F. Xia, X. Lu, F. Song found a direct correlation between the reduction of the "green" tariff and curtailment (Xia et al., 2020).

Maurício et al., (2021) revealed the peculiarities of the auctions for the selection of green power plant projects in Brazil as well as the influence of this mechanism on the RES implementation into the structure of power generation.

Olusola et al., (2021) studied the potential of renewable energy to reduce greenhouse gas emissions and assessed the economic impact of "greening" of the South African's power sector.

Eren et al., (2019) assessed the impact of economic growth on the dynamics and scale of "green" electricity's consumption in India.

The information basis for the study is the statistical data from the International Renewable Energy Agency (IRENA), the World Bank, the energy yearbooks "BP" and "Bloomberg". In addition, the latest information from the energy ministries and agencies of the BRICS countries was also used.

The authors used the methods of classification, comparison, economic and statistical analysis as well as factor analysis tools and expert assessments.

35.3 Results

35.3.1 *The State of the Energy Systems of the BRICS Countries*

Substantially differing in political systems, social structures, macroeconomic characteristics (Table 35.1) as well as resource potential, at the same time the BRICS countries unanimously share the opinion that further deepening of multilateral economic partnership within the framework of the association will give an additional impetus to development for each participant. The BRICS do not ignore such a strategic area of cooperation as energy, where in the last decade the importance of RES—the most dynamically developing sector of the world fuel and energy complex—has been clearly outlined. In this regard, "green" energyone of the pillars of a low-carbon and energy-efficient model of economic developmenthas a perfect potential to become an additional area of the further economic rapprochement of the BRICS countries.

Having studied the structure of consumption of primary energy sources in the BRICS countries as well as the dynamics of carbon dioxide emissions, the authors identified the trends characterizing the current state of their energy systems and also assessed the prospects of the RES development. As a tool, the authors used a derived analytical indicator of time series—the compound annual growth rate (CAGR).

It can be seen that the rate of consumption of primary energy sources is largely correlated with the dynamics of economic growth. In addition, renewable energy in the BRICS countries demonstrates the highest consumption dynamics among all primary energy sources. According to the data presented in Table 35.2, in the period 2010–2020, the compound annual growth rate of RES-consumption in Russia was 14.8%, Brazil-8.4%, China-26.0%, India-14.7%, and South Africa-27.0%. As a result, RES is gradually strengthening its position in the traditionally "carbon dominated" energy balances of the BRICS countries, while in Russia the share of RES in the structure of primary sources consumption is still insignificant-0.1%,

Table 35.1 Macroeconomic indicators of the BRICS countries in 2020

	GDP (2015 prices), USD trillion	GDP per capita (2015 prices), USD	Compound annual growth rate of GDP (2015 prices), 2010–2020, %	Trade balance, USD billion	Gross capital formation rate, % of GDP
Russia	1.416	11,786. 6	1.2	73.6	23.9
China	14.625	10,430.7	6.8	366.0	43.2
India	2.481	1797.7	4.9	46.4	28.4
Brazil	1.749	8228.8	0.2	41.2	15.4
S.Africa	0.303	5121.0	0.6	27.8	12.4

Source Compiled by the authors based on World Bank (2021)

China-5.3%, India-4.5%, South Africa-2.2%, and Brazil-16.7%. Such a high share of renewable energy sources in the Brazilian energy balance is explained by the fact that the country is not only actively developing “green” electricity but also pays significant attention to the introduction of biofuels (bioethanol and biodiesel) in transport.

In the context of the aggravating problem of climate change, caused, among other things, by the growing carbon dioxide emissions produced by thermal power plants (mainly coal-fired), it is important to note that the BRICS countries in the aggregate are the largest “polluter” of the planet-in 2020 the total share of the BRICS countries in the structure of the world carbon dioxide emissions made up almost 45.0%. Undoubtedly, the contribution of each country of association is different-for example, the share of China in the structure of world emissions has reached 30.6%, but Brazil-1.3%. In addition, Russia and South Africa managed to significantly slow down greenhouse gas emissions, while India and China, on the contrary, increased it due to the growing demand for electricity and motor fuel, which is contrary to the obligations undertaken by these countries under the Paris Agreement on climate.

The authors conducted the factor analysis to determine the role of the RES in the economy and energy consumption of the BRICS countries. The researchers developed the regression model of the dependence of the RES-share in the structure of primary energy consumption of the BRICS countries (in%) on the following indicators: annual investments of the BRICS countries in renewable energy, the RES-share in the structure of primary energy consumption of the BRICS countries, the total consumption of renewable energy in the BRICS countries, the total consumption of primary energy in the BRICS countries, GDP of the BRICS countries in current prices, GDP per capita (in current prices) in the BRICS countries, total installed power capacities based on RES in the BRICS countries (excluding hydroelectric power plants), total proved reserves of oil, natural gas, coal in the BRICS countries, the shares of imported oil, natural gas, coal in the structures of its consumption, the volume of CO_2 emissions in the BRICS countries, the volume of investments in R&D. The authors used bench-mark data for the period of 2010–2020 (excluding years without data). There was a sample of 53 indicators totally.

Factor analysis showed the following dependence on two indicators. With an increase in the total consumption of renewable energy in the BRICS countries by 1 million tons, the share of RES in the structure of primary energy consumption increases on average by 0.06%. With an increase in the share of imported coal in the structure of its consumption in the BRICS countries by 1%, the share of the RES in the structure of primary energy consumption increases on average by 0.12%. Thus, there is an inverse correlation between an increase in the share of the RES in the structure of consumption of primary energy resources and a decrease in the share of consumption of fossil fuels.

Table 35.2 Consumption of primary energy resources and carbon dioxide emissions by the BRICS countries, 2010–2020

	Compound annual growth rate of consumption, %					Consumption structure, %				
	2010–2020					2020				
	Russia	China	Brazil	India	S.Africa	Russia	China	Brazil	India	S.Africa
Primary energy	0.1	3.3	0.9	3.5	−0.7	100.0	100.0	100.0	100.0	100.0
Oil	1.0	4.1	0.1	3.1	−0.5	22.5	19.6	38.3	28.2	20.8
Natural gas	−0.3	11.7	1.6	1.4	0	52.3	8.1	9.6	6.7	3.0
Coal	−1.4	1.2	−0.5	3.7	−1.1	11.5	56.5	4.8	54.9	71.0
Nuclear power	1.8	16.6	0	6.1	0.7	6.7	2.2	1.1	1.2	2.8
Hydropower	1.9	5.6	−0.7	3.5	0	6.6	8.0	29.3	4.5	0.2
RES	14.8	26.0	8.4	14.7	27.0	0.1	5.3	16.7	4.5	2.2
	Compound annual growth rate of emissions, %					The share of the BRICS in the world emissions, %				
Carbon dioxide (CO_2)	−0.3	1.9	0.3	3.3	−0.8	4.6	30.6	1.3	7.1	1.3

Source Compiled by the authors based on BP Statistical Review of World Energy (2021)

35.3.2 Models of Support for "Green" Electricity in the BRICS Countries

The combination of the current economic, climatic, industrial and technological factors makes the BRICS countries look for new methods of energy supply, the implementation of which will diversify the structure of energy consumption as well as prevent the growth of greenhouse gas emissions. That is why the RES are dynamically integrated into the energy systems of the BRICS countries (Podoba & Kryshneva, 2018). For example, Russia has embarked on plans to "green" the power generation sector by introducing renewable energy plants on a utility scale. It is expected that the progressive RES development would contribute to the solution of such problems of the Russian fuel and energy complex as low energy efficiency, a critical level of physical deterioration of capacity at almost a third of Russian thermal power plants. In addition, the complication of the process of hydrocarbon's extraction due to the depletion of "mature" oil and gas fields leads to an increase in energy prices at the domestic market (Simonova et al., 2019).

Although hydrocarbons traditionally dominate the current structure of energy consumption, the first signs of the "emergence" of renewable energy are appearing in the Russian energy balance. In 2020, the RES-share in the structure of electricity production was only 0.3%, in the structure of installed capacities-1.1%. The installed capacity of "green" power plants increased from 0.1 GW in 2015 to 2.7 GW in 2020 and demonstrated the compound annual growth rate-93.3%. In the same period, the volume of electricity generated by RES-power plants increased from 13.4 million kWh up to 3.3 billion kWh-in average the production of "green" electricity grew by 200.0% per year (for comparison: in the period 2015–2020, the compound annual growth rate of electricity production at thermal power plants (TPP) made up 0.2%, the compound annual dynamics of installed TPP capacities-0.3%, for nuclear power plants-2.0% and 1.5%, for large hydroelectric power plants (over 25 MW)-2.0 and 0.8%, respectively) (Russian Power System Operator, 2021).

The main mechanism for RES-support in Russia is the program "Capacity supply agreement for RES" (abbreviated as "CSA RES"), which so far applies only to objects of the wholesale electricity market-power plants with a capacity of at least 5 MW, which have received the opportunity to sell two goods: electricity and power. "RES CSA" program covers only three types of RES power plants: photovoltaic solar, wind, small hydro (with a capacity of up to 25 MW), and its validity period is calculated until 2024. According to the target goal, the implementation of "RES CSA" should result in an increase in the share of RES in the structure of electricity production to the level of 4.5% (Official website of the Ministry of Energy of the Russian Federation, 2021).

The main selection criterion under that program is the level of declared capital expenditures (hereinafter capex) for the construction of 1 kW of installed capacity. The analysis of price bids at the past auctions allows saying about the growing competition of RES-plants. For example, in 2019, the capex announced during the auctions for photovoltaic solar plants decreased to a record level-49,800 RUB/kW (almost twice lower than the established indicator for 2019–105,200 RUB/kW). In the same year the declared capex for the construction of a 1 kW wind farm decreased to 64,800 RUB/kW against the established minimum threshold for this year-109,500 RUB/kW (Association for the Development of Renewable Energy, 2020). As a result, a decrease in capex included in the structure of support payments leads to a reduction in consumer's bills.

Obviously "RES CSA" program has allowed increasing the installed capacity of "green" generation facilities-from 0.1 GW in 2014 to 2.1 GW in 2020. Moreover, annual auctions for RES projects has intensified competition between developers and led to a reduction in the Levelized cost of "green" electricity. So, in the period 2014–2020, the average price of "green" electricity decreased by 3.5 times, entering the corridor of 6–11 RUB/kWh (Kommersant, 2020). In turn, the authors came to terms that to reach the final target of the program (4.5%) in 2024 is an extremely complicated task because it requires an increase in the total capacity of RES-plants by more than 14 times: from the current 2.1 to 30.0 GW. Nevertheless, the process of integrating RES into the wholesale electricity market has already been launched, and the growing competitiveness of "green" energy proves the real prospects of stable RES development.

Taking a course towards the building of "Xiaogang" (moderately prosperous) society, the Chinese government pays special attention to the problem of uninterrupted power supply amid the growing needs of the economy and population. That is why the modern agenda of China's energy policy is simultaneously aimed at the consistent modernization of the fuel and energy complex, reduction of dependence on imports of fossil fuels (for reference: in 2020, the share of imported oil in the structure of its consumption made up 70.6%, the share of natural gas-42.2%, and the share of coal-2.7%) as well as mitigation of the negative impact of the fuel and energy complex on the environment (BP Statistical, 2021).

According to the authors, these three goals broadly explain the current large-scale process of the RES introduction into the Chinese electricity generation sector. According to the Chinese leader S. Jinping, the state intends to achieve carbon neutrality by 2060, as well as to significantly reduce carbon emissions (Mamonova, 2021). Such high optimism of the Chinese government is a consequence of the already achieved results. So, in the period 2000–2020, the total installed capacity of solar and wind plants increased from 0.3 GW to 534.9 GW (almost 1783 times)-the compound annual dynamics of installed RES-plants was 45.3% (for reference: thermal-8.6%, large hydro-8.0%, and nuclear-17.1%). Accordingly, the share of the RES in the structure of installed power plants increased from 0.1% in 2000 to a record-24.3% in 2020. Wind plants occupy the leading position among other RES with 281.5 GW. Photovoltaic solar plants hold second place with 253.4 GW (China Energy Portal, 2021).

The rapid growth of the share of RES in the structure of energy production was a consequence of the impressive investment. So, in the period 2010–2020. China invested in "green" energy, mainly in solar and wind, 905.4 USD billion-the highest figure in the world (REN21, 2021). In addition, the constantly improving regulatory framework in the field of RES coupled with a unique planning system based on five-year development plans has allowed China to become a world leader in the RES-development for one decade as well as to take the position of the world's largest producer and exporter of RES-equipment (Shen et al., 2021).

The Chinese model of RES-support is based on "green" tariffs that consist of two parts: monthly payment of a grid company to an electricity supplier and a subsidy from the state fund of the RES development paid once a quarter or a year. Assessing the Chinese system of "green" tariff, the authors highlighted two features: the "zoning" of tariffs depending on the resource availability of the region as well as the consistent reduction of "green" tariffs. Thus, the program for optimization of tariffs in wind energy divided the country into four tariff zones, taking into account the potential of wind energy, and set for each zone a fixed rate of the "green" tariff: 1 zone-0.51 RMB/kWh, 2 zone-0.54 RMB/kWh, zone 30.58 RMB/kWh, and zone 4–0.61 RMB/kWh. In view of the reduction in capex of the construction of onshore wind farms in 2020, the "green" tariffs were significantly cut: 1 zone-0.29 RMB/kWh, 2 zone-0.34 RMB/kWh, 3 zone-0.38 RMB/kWh, and 4 zone_0.47 RMB/kWh (Xia et al., 2020).

The policy of the Chinese authorities of recent years has shown a willingness to focus more on the qualitative parameters of the RES-market development, which determines the starting transition from "green" tariff to auction as well as the testing of such support mechanisms as "green" certificates and bonds. The program of "green" certificates is designed so far only for ground wind plants and photovoltaic solar plants and is voluntary. Another mechanism, "green" bonds, is based on a responsible investment approach that has become widespread in Western countries (Zeng et al., 2017). In the first quarter of 2021 Chinese, predominantly state-owned companies (banks and large construction and energy companies) issued "green' bonds totaling 15.7 USD billion for environmental projects, including the construction of RES-plants, overtaking the "green" bonds market leader-the United States with 15.0 USD billion (China Energy Portal, 2021).

Among the BRICS countries, Brazil is the only country whose energy balance is dominated by a non-carbon resource-hydropower (for reference: in 2020, the share of large hydropower plants (over 30 MW) in the structure of electricity production was 66.0%) (US EIA, 2020). In turn, the increased dry seasons periodically cause a reduction in the generation of electricity from large hydropower plants, thereby undermining the reliability of the current energy system. That is why "green" energy has been chosen as one of the priorities of Brazil's modern energy policy. In 2020, the total capacity of installed RES power plants (excluding large hydro) made up 40.7 GW including wind-17.2 GW, biomass-15.2 GW, and photovoltaic solar-7.8 GW (IRENA, 2018).

Currently, the main support mechanism is an auction that allows selecting RES-projects by price criterion, thus forcing developers to reduce capex. A winner of an auction concludes a contract with the grid company for the supply of electricity, the duration of which depends on the type of RES: wind farms and biomass power plants-20 years, small hydropower plants-30 years. In addition, there are various auctions: A3-the power plant will be launched in 3 years after the auction (for wind, small hydro, and solar power plants), A5-in 5 years (for biomass plants). In 2017, auctions of A4 and A6 were introduced to heighten the flexibility of the mechanism. If a company has postponed the scheduled launch of a RES plant for more than a year, it will be fined (Hochberg & Poudineh, 2018).

Due to the growing competitiveness of the RES, the current system of auctions has the following features: firstly, RES-projects participate in these auctions together with thermal and large hydro plants; secondly, within the framework of one auction, the share of the selected RES-energy capacities began to exceed the same indicator for the selected projects of thermal and large hydro plants; thirdly, the developers of wind and solar plants already offer the price of electricity below the price offered by the developers of traditional power plants. For instance, the held in 2019 auction A-6 showed such a picture: the final price of solar projects was 20.5USD/MWh, for wind projects-24.0USD/MWh, for large hydro plants-38.2 USD/MWh, for power plants operating on biomass-45.7 USD/MWh, for gas turbine plants-45.9 USD/MWh, for small hydro plants-56.4 USD/MWh, while the share of renewable energy projects in the structure of selected capacities was 60.3% (Maurício et al., 2021).

India's rapid economic development along with the high growth of its population (for reference: in 2000–1.05 billion people, in 2020–1.38 billion people) have drastically exacerbated the problem of energy supply. The state retains the status of a net oil importer and natural gas (World Bank, 2021). In turn, impressive coal reserves allow the country to cope with the growing energy needs at the expense of the environment. As a result, the current energy situation has broadly stipulated the development of "green" energy. In the period 2010–2021 the share of the RES in the structure of installed capacities increased from 9.7% (15.5 GW) to 25.9% (100.6 GW) (Central Electricity Authority, 2021). In 2021, the structure of the RES is represented by photovoltaic solar plants with a total capacity of 46.2 GW, wind plants-39.8 GW, biomass power plants-10.5 GW, and hydroelectric plants (less than 25 MW)4.8 GW (National Power Portal, 2021). Such a high increase in RES capacity is explained by a large-scale inflow of investments. For instance, in the period of 2010–2020 the total investments in the RES reached the level of 90.0 USD billion (Frankfurt School-UNEP Centre/BNEF, 2021).

Having adopted the practice of most European countries that are successfully developing renewable electricity, India used a system of "green" tariffs amid the formation of the industry: for projects of wind power plants-from 2004 to 2017, for projects of solar power plants-from 2010 to 2013. The rate of the "green" tariffs was set by the Central Electricity Commission and depended on the type of RES and the resource potential of the state. At the same time, reduction in the cost of RES equipment along with an increase in its productivity as well as the development and adoption of effective state rules for the control and regulation of renewable energy led to the introduction of a new mechanism to support the industry -a reverse auction (the auction participant who offered the lowest price for the supply of electricity becomes its winner) (Eren et al., 2019).

By stimulating competition among developers of RES plants, auctions significantly reduced the cost of "green" electricity and in some cases helped to achieve price parity with electricity generated by coal-fired power plants. So, if in 2012 the minimum rate of tariff for electricity produced by the municipal solar plant was 10.9 INR/kWh, in 2020-its level dropped to 2.0 INR/kWh, while it should be noted that the cap of the auction's tariff differs across the Indian states and is largely determined by the resource potential of the region, the financial "health" of companies, the investment climate of the state. At the federal level auctions are conducted mainly by the Indian Solar Energy Corporation and the State Thermal Power Corporation, at the state level-by the state authorities (regional renewable energy development agencies).

In addition, one of the features of the Indian RES support system is the Renewable Purchase Obligation, according to which a certain group of electricity buyers, such as grid companies, are obliged to purchase a specified share of RES electricity as in the form of a real or nominal product- "green" certificates (for reference: 1 certificate = 1 MWh). Each state sets independently, but in coordination with the central authorities, its level of commitment, taking into account the economic conditions, the state of the energy system and the RES potential. If in 2019 the average size of the obligation across the country was 17%, in 2022 it should reach 21% (Sharma et al., 2021).

South Africa retains the status of the most developed state on the African continent, while in the last decade economic growth slowed down due to a two-fold devaluation of the national currency, growing frictional unemployment, falling demand for export goods in Asian countries as well as a decrease in world prices for the main export items of South Africa: platinum, gold, diamonds, coal, iron, and manganese ores. Economic stagnation has negatively affected the state energy sector, which periodically faces the problem of prolonged power outages-rolling blackouts (Sguazzin, 2021). A separate line is the question of the complete dependence of South Africa on imported oil and natural gas, while the level of consumption of these resources is relatively stable. In addition, the problem of the population's access to electricity remains relevant-according to the latest data, almost 15% of South African residents are deprived of access to electricity (World Bank, 2021).

The SA's energy policy of the last decade demonstrates the growing interest to develop the RES. The government plans to replace obsolete coal-fired power plants with "green" plants. In 2020, the share of green power plants in the structure of installed capacity in South Africa (totally 51.6 GW) reached 13.3% or 6.9 GW. In this context, it is worth mentioning the adoption in 2019 of the Comprehensive Resource Use Plan, which has become, in fact, a roadmap of the development of the South African energy sector until 2030. According to the plan, the total capacity of power plants of all types would increase to 77.8 GW in 2030, at the same time; the decommissioning of coal-fired thermal plants with a total capacity of 11.0 GW would also take place. It is planned to commission solar (photovoltaic and collector) plants-6.8 GW and wind plants-15.7 GW. Thus, in 2030 the total share of the RES in the structure of installed energy capacity would grow to 28.9%. In turn, the document does not provide for an increase in the capacity of small hydroelectric power plants (with a capacity of less than 10 MW) and power plants operating on biomass, which indicates that there is no prospect for the development of these areas (SA's Ministry of Energy, 2019).

The RES-support system is being improved taking into account global trends, the state of the South African economy, the needs and problems of the energy sector. The first support mechanism was a "green" tariff introduced in 2009. Then South African authorities ordered the vertically integrated "Eskom Group" to purchase "green" electricity from licensed producers, signing 20-year supply contracts with the latter. In turn, "Eskom' which has enormous political influence, was dissatisfied with the high rate of "green" tariff. That is why the company began to introduce its criteria for the selection of RES projects, thereby deliberately reducing the number of potential developers of RES power plants. For example, the company has determined that the capacity level of a power plant claiming a feed-in tariff must be at least 20 MW instead of the government-set 1 MW (Baker & Wlokas, 2015).

"Weak" legal elaboration of "green" tariff coupled with fierce resistance from "Eskom", did not allow the effective use of this mechanism and led to the emergence of an auction system. In 2011 the "Program for the Purchase of Renewable Energy Power Plants from Independent Producers" was adopted and opened up the opportunity to select the most cost-effective projects of RES-plants of a municipal scale. Participants must propose a tariff rate equal to or lower than the established threshold value, which varies depending on the type of RES and also provides a tender guarantee. The South African Department of Energy signs an agreement on the performance of the contract and "Eskom"-a long-term (20 years) contract for the supply of renewable energy with winners of an auction offered the minimum tariff rate (Olusola et al., 2021).

In turn, the contractors must launch the project no later than the period established in the contract of its performance, averaging 15–24 months. If a developer was unable to launch the object within the period specified in the contract, he is given an additional period of 180 days, after which the contract with him is terminated. It is also worth noting that the issue of connecting to the network, namely, connecting to the nearest substation, is the responsibility of a developer. There are also high fines if the developer does not comply with the undertaken socio-economic obligations such as employment of the black population. In addition, developers are required to obtain on average about 20 permits from various authorities ranging from civil aviation authorities to environmental and heritage committees (IRENA, 2021).

35.4 Conclusion

The study argues that renewable energy is the most important factor and driver of inclusive development. In the course of the conducted analysis of the state and support models of the "green" power sector in the BRICS countries, the authors could generalize the modern theoretical approaches to the RES market. In addition, the authors identify several similar trends of the RES development in the BRICS countries:

- regardless of the resource availability factor, in the period 2010–2020 renewable energy in the BRICS countries demonstrated the highest dynamics of consumption among other types of fuel and energy resources;
- among the factors affecting the RES-share in the structure of primary energy consumption of the BRICS countries, the authors detected two most important ones: the total volume of renewable energy consumption and the share of imported coal in the structure of its consumption (under the influence of China's energy system);
- the most promising RES-area in the BRICS countries is the power generation based on photovoltaic solar, ground wind, biomass power plants;
- the current RES support models in Russia, India, Brazil, South Africa are based on the mechanism of auctions-competitive bidding to select RES-projects, using usually two main criteria: the cost of electricity produced or the number of capital costs for the construction of 1 kW of a power plant (Russia). The last three countries initially used a system of "green" tariffs to support the RES, but the reduction in the cost of RES equipment along with an increase in its productivity forced India, Brazil, South Africa to adopt a new strategy of RES-support based on an action, stimulating the natural competition among "green" developers. China is still using a system of "green" tariffs, while there is its gradual reduction as well as testing of an auction system in some provinces. In addition, China, along with India, is using some "green" financing instruments, such as "green" certificates and bonds, as additional mechanisms to increase the investment attractiveness of the RES.

In the context of sustainable inclusive growth, the authors believe that renewable energy can become one of the full-fledged areas of cooperation between the BRICS countries. Moreover, the theme of renewable energy is increasingly frequently reflected in the joint BRICS documents: final declarations and action plans.

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Chapter 36
Prospects for Sustainable Development of the Green Energy Sector in the New Economic Environment

Sergey G. Tyaglov, Pavel A. Degtyarev, and Tatiana V. Miroshnichenko

36.1 Introduction

In today's environment, effective solutions are required to reduce CO_2 emissions into the atmosphere and, consequently, reduce the negative impact of conventional energy sources on the environment. Nowadays, many large companies include in their sustainability programs the task of decarbonizing their production facilities; some companies even include this issue in the formulation of their development strategies. By the end of 2021, energy efficiency and decarbonization were still very far from the target set by the Paris Climate Agreement.

One of the ways to achieve the established indicator can be a wider introduction and use of renewable energy sources (RES), which can improve energy and environmental efficiency and contribute to the strategic objectives of reducing the environmental load and optimizing the structure of the energy balance, reducing dependence on fossil fuel exports and ensuring long-term innovative energy development.

Simultaneously, the transition from traditional energy sources to renewable energy requires a significant amount of investment and additional costs, which is not always beneficial to the fuel and energy companies and the end consumer. However, it should be borne in mind that there will be cost savings, and the resulting social and environmental effects will exceed the financial cost of developing alternative energy sources.

S. G. Tyaglov (✉)
Rostov State University of Economics, Rostov on Don, Russia
e-mail: tyaglov-sg@rambler.ru

P. A. Degtyarev · T. V. Miroshnichenko
Sochi Institute (Branch) of the Peoples' Friendship University of Russia, Sochi, Russia
e-mail: degtiarev.pa@rudn-sochi.ru

T. V. Miroshnichenko
e-mail: miroshnichenko.tv@rudn-sochi.ru

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36.2 Methodology

It is necessary to use the energy projection methodology proposed by EnerFuture to determine long-term trends in energy consumption and CO_2 emissions to assess the likelihood of an accelerated transition to RES. According to this approach, the dynamics of CO_2 emissions into the atmosphere should be considered using the three scenarios presented in Fig. 36.1, where:

- The blue curve means the implementation of the scenario with the preservation of the existing energy efficiency policy and current unchanged trends. In fact, it reflects the state of the system where the implementation of green projects related to the improvement of the current environmental situation is in the stagnation phase;
- The red curve represents a scenario based on the successful achievement of the Nationally Determined Contributions (NDC) laid out in the Paris Climate Agreement;
- The green curve means a change in the emission situation in the case of a more stringent environmental scenario, involving the implementation of a strict energy policy and a clear commitment by countries to meet their obligations under the Paris Agreement, as well as a regular review of their emission targets toward their continuous reduction.

For each stage presented in Fig. 36.1, we can draw our own conclusions:

- Stage up to 2010—"zero." At this stage, there is an increase in emissions and accumulation of environmental damage;
- Stage up to 2020—"first." Zero trends persist, and fluctuating values in 2020–2021 can be called conjunctural rather than reflecting sustainable trends;
- Forecast scenario "2." As part of the implementation of this scenario, it is necessary to determine whether the long-term strategies of the countries are compatible with the laid-down goal of decarbonization to 1.5–2 °C. A sharp change in the

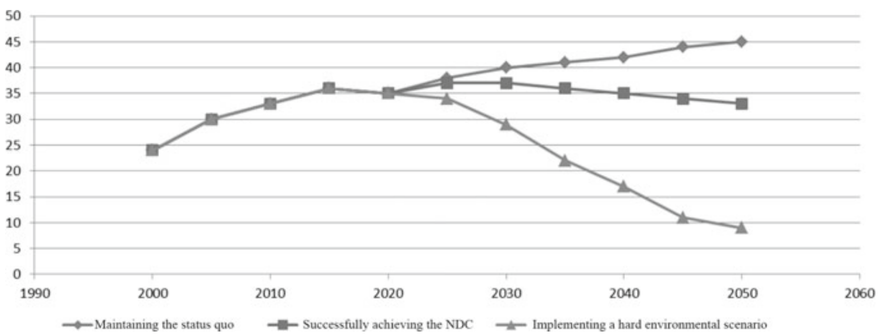

Fig. 36.1 Scenario approach to determining the dynamics of CO_2 emissions in the energy industry. *Source* Compiled by the authors based on (Enerdata, 2022)

geopolitical and economic conditions in 2022 has shown that in the near future, the transition of countries with even the most developed alternative energy market to renewable sources will be significantly hampered; many countries are not ready even to partially replace some of the commodity energy exports—on the contrary, the market began to notice a trend of increasing the volume of purchases of oil and gas (Vedomosti, 2022);
- Forecast scenario "3." In this scenario, it is necessary to answer the question of whether the goals for, for example, 2030 are correct in light of changed economic realities;
- Forecast scenario "4" assumes that the current situation will continue, and so far, in the short term, it seems the most realistic.

In this regard, it is necessary to identify those key indicators that need to be monitored in 2022–2023 to adjust the adopted environmental strategies.

36.3 Results

According to experts, although the sanctions imposed on Russia by Western countries have a noticeable impact on the development of the industry, they will not become a serious insurmountable obstacle to the further implementation of investment projects related to the renewable energy industry because the country already produces enough equipment in the domestic market, for example, for wind energy. For example, Ulyanovsk manufacturers can already provide turbine blades for wind farms, and the wind turbines themselves are of domestic origin and manufactured in Volgodonsk.

Additionally, the implementation of these projects is driven not only by the economic interests of investors but also by the following environmental macro-objectives:

- The need for further work on the ESG agenda, with the fight against climate change at the forefront;
- The need to implement the Paris Agreements and the President's instructions to achieve carbon neutrality by 2060;
- The logic of evolutionary development of large domestic industrial companies, for which ESG transformation became an organic continuation of strategic development and an opportunity to reach higher productivity and profitability.

A system of state support measures was developed to support the energy complex in the context of sanctions against Russia, including the following:

- A special regime for imposing penalties for delays in commissioning facilities under the program to modernize old TPPs and new renewable energy generation to prevent a sharp increase in penalties under the new economic conditions;

- Investment projects for renewable energy, which have already passed the competitive selection, can be adjusted in terms of changing the dates of launch of the project and the delivery of capacity;
- The possibility for power companies with state participation to prioritize the 2021 profits for implementing investment programs without paying dividends.

It is necessary to emphasize the importance of the gradual transition to renewable energy sources and the gradual increase in the share of alternative energy sources in their total volume. Currently, this figure varies greatly depending on country affiliation.

Simultaneously, neither the USA, the UK, nor Russia are among the leading countries in the use of renewable energy. Moreover, Germany, which uses almost 45% of its energy from renewables in the current environment, faces the need to restore those coal-fired power plants that have long been decommissioned. Similar processes can be seen in the USA: over the past decade, the coal mining industry has seen growth in production and sales. This trend intensified in 2022 after the outbreak of armed conflict in Ukraine and the imposition of unprecedented sanctions against Russia, which include attempts by European countries to refuse imports of domestic energy resources.

However, it is fair to say that these events were only the catalyst for the so-called "coal renaissance" that began in 2021 against the background of the energy crisis caused by the growing demand for electricity after the COVID-19 pandemic and the inability to ramp up generation in the short term. An equally important part was played by the prolonged windless weather with the simultaneous absence of reserves in Europe's gas storage facilities in case of supply problems and the slowdown of generation from renewables. Therefore, gas prices began to rise sharply by the fall of 2021, reaching $2200 per 1000 cubic meters in the EU by the end of the year. In March 2022, we saw higher values for gas, a historical record but at that time. Therefore, the use of cheaper but less environmentally friendly coal by power companies has become a near-unalternative option.

This situation has significantly altered the current green trends of the climate agenda. Despite the forecasts of the International Energy Agency, the use of coal in electricity generation has increased by 9%, exceeding the 10,000 TWh (Volobuev et al., 2020).

Further development of the alternative energy industry in Russia is determined by the basis established for implementing transformational ESG processes—goals of sustainable development were proclaimed, rules were created, and regulations, standards, and taxonomies were prepared. The ESG equity sector, created to finance social and environmental projects, grew rapidly. Within four years of its inception, it had four distinct segments, consisting of green bonds, social bonds, sustainability bonds, and national and adaptation projects. Currently, the largest volumes of green investment come from clean transport, which is due to large issues of Russian Railways and the Moscow government. The second place is taken by renewable energy projects, which is also mainly due to the placement of two companies—Sberbank and Atomenergoprom (Fig. 36.2).

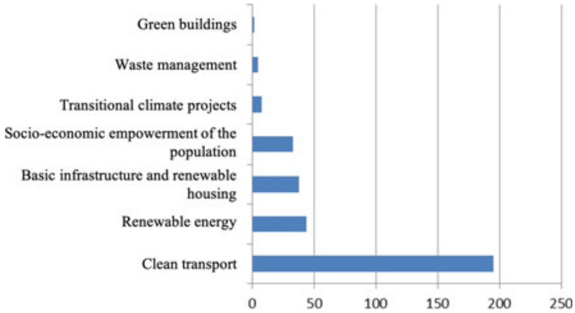

Fig. 36.2 Volumes of investment in the ESG segment of the Russian economy in 2021. *Source* Compiled by the authors

In three years, 33 issues of green, social, and other target bonds in the format of sustainable development of Russian issuers worth 418 billion rubles were held. The total volume of Russian issuers by the end of December 2021 amounted to 192.6 billion rubles.

Additionally, the first five rating agencies that have the right to verify green bonds appeared in Russia, an ESG alliance was created, and the Bank of Russia prepared special regulations that consider the basic principles and rules of international accounting standards. It is difficult to predict what will be the Russian ESG agenda in the future and whether it will be at all. However, it is safe to say that green energy and the entire economy are waiting for the structural transformation.

Russia was forced to respond to Western sanctions. Nevertheless, these actions resemble a backlash against the performance achieved. In particular, the government submitted to the State Duma of the Russian Federation an anti-sanctions package of laws aimed at a significant relaxation of the regulation of environmental activities of enterprises and the transfer of the expansion of the national project "Clean air" and the unified state register of timber accounting. It should be noted that environmentalists expressed some concern about loosening the stringency of environmental criteria, because it could have a negative impact on the environment.

Experts argue that despite the fact that access to international finance is closed for an indefinite period, the key rate of the Bank of Russia does not suggest active investment, and the complete abolition of investment in the green economy should not be expected, most likely, spot investments are waiting for green energy projects.

Investments in traditional areas will be cut back. Therefore, paying attention to alternative energy projects is necessary because the ESG agenda will be resuscitated over time. When the acute phase is over, energy companies will start looking for partners for ESG development in different directions. For example, for the project in Sakhalin, it is planned to involve partners in Asia. If there is a project on decarbonization, for example, in Kaliningrad, the orientation will be already on the European countries.

36.4 Conclusion

Thus, we can argue that despite geopolitical and related economic developments, climate policy and the energy transition have become a tool for advancing national interests and addressing global issues. Currently, the level of technological progress and the degree of scientific development in this area allow increasing the share of alternative energy in the world. However, a large-scale transition to alternative energy is constrained by economic reasons. This situation is largely due to systemic problems in the industry, such as a decrease in the output of wind power plants with a simultaneous lack of reserves in traditional sources of generation. It is also worth paying attention to the increase in green financing in the economies of many countries, indicating that the climate agenda has ceased to be solely an environmental or energy issue and has become a tool for managing global financial flows.

In all this, when introducing or developing green energy projects at the national level or at the level of a specific enterprise, it is necessary to realize that this direction of activity is not just following the public, political, or financial fashion, but the technological future of humankind and the possibility of optimal use of the renewable part of natural resources.

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Part V
Social Institutions, Government Regulation, and Infrastructure for Sustainable Development of the Economy and Combating Climate Change

Chapter 37
Novelties of Tax Regulation of Decarbonization in the Russian Federation

Alla V. Kiseleva and Yuriy A. Kolesnikov

37.1 Introduction

Russia needs to ensure sustainable development at a sufficiently high rate (it should be higher than the rates that are given to us by the structural heaviness of our economy). We need to use controlled technological changes, primarily related to the implementation of environmental legislation, with the introduction of the best available technologies; accelerated modernization of power economy, not only in the field of the "big energetics", but also in the heat generation in Housing Infrastructure. It is necessary to use accelerated gasification, usage of gas instead of coal and petroleum products. The possibility of using the technological advantages of the Russian Federation. There are a number of technologies in which the world lags behind us. For example, these are atomic and hydrogen technologies. There are very big opportunities. For example, the demand for hydrogen already now is about 120 million tons per year.

Much has already been done in terms of policy management in this area.

In the summer of 2014, the norms on Best Available Technologies were adopted. They can be considered as a main regulatory act that removes barriers to green investments; the Government of the Russian Federation has developed a draft roadmap on green financing (Decree of the Government of the Russian Federation No. 3052-r of 29.10.2021, 2021).

However, there is no unity and harmony of the concept in the adopted and developed acts. And, what is extremely important, there is no unity in understanding the mechanism of problem resolution among the world leaders.

A. V. Kiseleva (✉) · Y. A. Kolesnikov
Southern Federal University, Rostov-on-Don, Russia
e-mail: avkiseleva@sfedu.ru

Y. A. Kolesnikov
e-mail: yakolesnikov@sfedu.ru

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Modern fundamental research in the field of climatological changes has led the world community to realize the need for the fastest possible move towards the implementation of the energy transition and the transformation of the economy of all states in the world without exception. Although the ultimate goal of these processes is the survival of mankind, they cause a lot of controversies and have significant opponents from current energy companies to ordinary people. And this is quite understandable because everyone's life on the planet will change. IPCC's Report at the International Summit in Glasgow indicates that with an agreed energy transition, heating in winter in houses should not be 22–23 °C, and in summer 25% lower, the cars with an electric motor can be used 4 days a week.

Thus, we see that the green transformation will be fraught with obstacles everywhere. That is why progressive scientists in their field should identify threats and opportunities for global changes to conserve climate. And first of all, it is necessary to resolve the issues that the Russian Federation is currently facing in terms of preserving the firmness of the country's energy sovereignty.

The tax is a system-forming element of statehood. Traditionally, it is believed that the main function of the tax is fiscal. By means of taxes, the state apparatus is maintained and the task of the state to ensure the preservation of society is fulfilled. However, in historical retrospect, and especially at present, the regulatory function of taxes is extremely important. Thanks to this function, the balance in society is achieved, the balance of private and public interest, the balance of interests between social strata or classes, the balance of interest between the state and society, and the balance of interests of an individual and society as a whole (Federal Law No. 146 of 31.07.1998, 2021).

There is no doubt that the process of global transformations of public relations associated with green transformation and energy transition results not only in a change of political elites, shifts in international leadership, changes in the life of every person, but also important amendments to all branches of law and areas of legislation. Jumping ahead a bit, it can be noted that most likely shortly we will face completely new not only areas of legislation, but also branches of the law of green transformation, endowed with a special subject and a specific method.

Especially important in this area is an assessment of risks from the introduction of a new mechanism for taxation of hydrocarbons in Europe, and implementation of this mechanism in the legal frame of the Russian Federation and the identification of tools for harmonization of the tax system of several countries in relation to energy products and environment.

At the international level, there are a number of agreements on energy, for example, the United Nations Framework Convention on Climate Change of 1992; the Kyoto Protocol of 1997, the Paris Climate Agreement. Based on UNFCCC, the documents were adopted to reduce hydrocarbon gas in the atmosphere from 2020 and to keep the increase in average temperature below 2 °C. The leaders in the implementation of deterrent factors are Russia and the European Union. Meanwhile, China's greenhouse gas emission has increased three and a half times, and the US has remained at the same level. China and Russia have made a Statement on their intention to achieve carbon neutrality by the year 2060, and Europe by the year 2050, and Russia has reduced emissions by 30%.

According to many researchers, the introduction of so-called cross-border carbon regulation can serve as the main factors for achieving carbon neutrality. The world community intends to regulate carbon prices by interfering with the sovereign limits of regulatory control, including tax regulation. The main driver of this issue is the European Commission, which thus intends to force exporters of goods with a high share of greenhouse gas emissions during production to increase environmental friendliness and "greening" of production (The UN Sustainable Development Goals, 2021).

37.2 Methodology

In this research, the authors aim to study various measures, tools, and mechanisms that contribute through tax and other financial institutions to achieve a balance of interests of Russian producers and implementation of the tasks of maintaining the planet. First of all, we have subjected the mechanism of international carbon regulation and those financial instruments that the Russian Federation can use to preserve and maintain its sovereignty to the most intense influence.

In order to achieve this goal and ensure the scientific objectivity of the research results, a set of modern general scientific and special methods used in legal science has been selected. All methods were applied in interrelation, which ultimately contributed to ensuring the comprehensiveness, completeness and objectivity of the results of scientific research, and correctness and consistency of conclusions. The dialectical method of scientific cognition became the methodological basis of the study, with its help, reasonable conclusions and recommendations were obtained to determine the general characteristics of the application of tax regimes concerning hydrocarbons.

37.3 Results

First of all, it should be noted that the Paris Climate Agreement does not contain such a term as cross-border carbon regulation. Moreover, some countries have been using different lists of carbon taxes for about 30 years, with the aim of conservation of climate by minimizing the carbon footprint. However, the measures of national governments are clearly insufficient, and the Paris Agreement aims to unite the efforts of countries in terms of the climate agenda. Decarbonization should not serve unscrupulous political goals. In particular, the United Nations Framework Convention on Climate Change specifically states that measures to combat climate change should not serve as a means of unjustified discrimination or hidden restrictions on international trade. Paris Climate Agreement 2015 accumulates international efforts for sustainable development and gives impetus to the formation of new regulatory and market mechanisms and organizations.

At the same time, states do not rely on voluntary responsible behaviour of market participants and tighten tax and tariff policies on the carbon agenda. A number of studies have shown that the carbon tax is a more understandable and transparent tool in relation to, for example, carbon gas emissions trading approved by the Decree of the President of the Russian Federation of May 13, 2019, No. 216. It indicates that the challenges to the security of energy supply include discrimination of Russian fuel and energy complex organizations by changing the statutory regulation of the energy sector, including under the pretext of implementing climate and economic policies or diversifying sources of energy imports. At the same time, the Doctrine attributed the stability of tax policy to the tasks that make it possible to ensure Russian security of energy supply, taking into account the social responsibility of fuel and energy sector organizations. However, the introduction of carbon taxation at the interstate level is integrated into the national taxation system and hinders its stable development. To what extent is it possible, in principle, from the point of view of a sovereign state, to implement certain interethnic taxes into its legal tax system?

A year ago, there were 33 carbon tax projects in the world community, among which the EU initiative on CBT is one of the most developed and, at the same time, the most threatening to the security of the energy supply of the Russian Federation.

The European Commission assumes that the carbon boundaries adjustment mechanism (CBAM) will prevent greenhouse emissions. In its opinion, the United States and China will absolutely not suffer from the introduction of this tool, unlike Russia, which will suffer the most. However, CBAM will affect less than 20% of imports, since it will only apply to individual segments. A plus for the EU economy with the introduction of CBAM is the refusal to issue free permits for emissions within the carbon market of more than 15 billion Euro per year. As for producers from Europe dependent on exports, according to many, they may be at a disadvantage due to the need to pay CBAM. CBAM will be extended to such economic sectors as energy, fertilizers, steel, cement, and aluminium.

CBAM or Proposal for a mechanism for adjusting carbon boundaries was formulated within the framework of the "European Green Deal". The bottom line is that importers have to pay a certain cost for carbon at the border by purchasing a CBAM certificate. The cost is adequate to that paid by EU producers under the EU Emissions Trading Scheme (ETS). Until now, European manufacturers have been provided with benefits for ETS for free, and it is assumed that CBAM will be facilitated by the operation of market pricing mechanisms for carbon emissions. A phased introduction of CBAM is arranged. For the first three years, importers at the border will only provide information about the emissions produced by the supplier. Then, within 10 years from 2026 till 2035, payment will be introduced in stages, and EU producers will gradually lose 10% of their allowances from those they receive now.

EU producers, of course, find themselves in a more difficult situation because the cost of their products will be higher due to taxes than in countries with weaker climate regulation.

The CBAM Authority will control all this new taxation mechanism. Suppliers of goods to Europe will have to receive a certificate, the price of which will be calculated depending on the average auction price for EU and ETS quotas.

From the point of view of climate, the most worrying is multilateral diplomacy. Countries such as Brazil, South Africa, India, and China assuming that the EU CBAM will be enforced, the UNFCCC violates the general principles of differentiated responsibilities (according to which developed countries should play a leading role in combating climate change), and the spirit of the Paris Agreement determined at the national level. But many lower-income countries and those vulnerable to climate change—especially from Africa—are likely to be affected as well. As a recent analysis conducted by IEEP and others shows, although the exports of some of these countries may account for only a very small share of imports to the EU, the impact can nevertheless be significant in cases where the country has a relatively high dependence on exports to the EU and relatively high carbon intensity of production. Countries such as Mozambique, for which metal accounts for more than a fifth of exports, 87% of which are destined for the EU, Cameroon, and Ghana. For iron and steel, this means countries such as Zimbabwe, for which these products account 13% of exports, 25% of which are sold to the EU and Zambia. As for fertilizers, it will also significantly affect such North African countries as Algeria and Egypt, as well as Trinidad and Tobago, and Morocco, which is engaged in electricity.

As we have already indicated, Russia will suffer the most from such a taxation mechanism. The Russian Federation is currently creating an internal market for carbon units. The Federal Law "On Limiting Greenhouse Gas Emissions" became the regulatory basis.

At the same time, it should be noted that the biggest challenges for Russia are other regulatory mechanisms within the framework of the Green Deal, namely a significant increase in the share of GNP in the energy sector, decarbonization of transport, abandonment of internal combustion engines by the year 2035, and decrease in energy consumption almost by 40%.

37.4 Conclusions

Of course, the Russian Federation will not stay away from these processes and is trying to defend its sovereign position through diplomatic negotiations and the involvement of conciliation and judicial mechanisms of international procedures. The national carbon tax option is an excellent market-proven regulatory tool. Its development is planned for 1–1.5 years. The Russian government is currently considering three options. One of them is that enterprises will pay an increased fee for exceeding the threshold emission rate; the other option assumes, in our opinion, a somewhat inadequate and opaque mechanism for trading emissions quotas; or a certain combination of the first two is considered as the third option (Decree of the President of the Russian Federation No. 666 of 04.11.2020).

Of course, the introduction of national taxes should take into account the entire array of environmental factors. Moreover, the world community needs to take into account the unique ecosystems of the Russian Federation, due to which we can be donors to other countries in the field of decarbonization.

The peculiarity of CBAM is that the importer can refuse to pay it if he/she proves that the carbon tax has already been paid in another tax jurisdiction.

Experts in the field of taxation believe that the system of paid carbon quotas is wider than CBAM and will allow Russian producers to get rid of it completely. However, in our opinion, it is necessary to start not only by solving the narrow task of ridding the subjects of the Russian tax jurisdiction of taxes “imputed” to them by other jurisdictions. The issue of quotas or taxation directly and significantly affects the domestic tax system, which with great difficulty has acquired the features of harmony and stability by now. Therefore, researchers in the field of taxation, sustainable development, and “green” reporting very soon will have a lot of work to implement international norms, harmonize tax systems, and achieve a balance of interests of the entire world community.

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Chapter 38
Infrastructural Dimension of Sustainable Development, Climate Change and Environmental Governance

Oleg V. Ivanov

38.1 Introduction

Infrastructure is the backbone of the modern economy. Transport, energy, water supply, medical and educational institutions, telecommunications form necessary conditions for the production process, affect the quality of life of people and ensure public welfare. Numerous studies confirm close correlations between the state of infrastructure and its impact on various socio-economic processes in society (IMF, 2015), (McKinsey Global Institute, 2016), (VEB.RF /NCGCHP, 2021).

However, despite the public benefits that infrastructure brings, it often suffers from a lack of funding. Overcoming infrastructure gaps, therefore, act as the main imperative of infrastructure development. On the other hand, new challenges—growth of social problems (poverty, inequality, overpopulation), an increase in anthropogenic pressure on the environment and its large-scale pollution (about 60% of greenhouse gases emitted into the atmosphere are the result of the construction and operation of infrastructure (UNEP, 2019), climate change, pandemics and their consequences, etc.—call into question the ability of traditional infrastructure to meet these challenges. At the same time, environmental costs to which infrastructure makes the main contribution are significant. According to OECD estimates, the delay in actions to combat climate change is fraught with annual losses of 2% of their GDP for G20 countries by 2025, up to 3.3% by 2060 and up to 10% by the end of the century (official Website of the Government of the Russian Federation; OECD, 2017).

In light of this, new approaches to infrastructure development are required that could not only fill the "investment hunger" in this area but also increase the efficiency of investments in infrastructure projects by improving the quality of infrastructure

O. V. Ivanov (✉)
MGIMO University, Moscow, Russia
e-mail: ivanov_ov@mail.ru

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being created, ensuring its greater sustainability, social and environmental orientation, which society is increasingly in need today. More than 80% of senior corporate executives and investment specialists believe that it is an integrated approach to infrastructure investments, taking into account not only financial and economic but also social and environmental aspects, that will give a return in the form of greater shareholder value in the next five years and are inclined to invest in sustainable and high-quality projects (McKinsey, 2020).

For Russia, a country with a huge territory, the importance of infrastructure complex development goes beyond the purely economic framework. The country's leadership noted: "The scale of the country is such that in the twenty-first century, the lack of investment in infrastructure means degradation of the entire space of the state. This is a question of the existence of a single state" (official Website of the Government of the Russian Federation).

Although Russia has significantly moved up in the aggregated ranking of the World Economic Forum in terms of infrastructure quality in recent years, in many of its important components—the quality of road infrastructure, density of railway infrastructure, efficiency of air transport infrastructure, quality of electricity supplies, etc.—it is much inferior to the leading countries of the world. International assessments of the state of Russian infrastructure generally coincide with the opinion of domestic researchers: The unsatisfactory state of infrastructure in Russia covers all industries and is characteristic of all regions. Infrastructure provision in Russia is at the level of developing countries and is insufficient (InfraONE, 2019).

38.2 Methodology

In the last decade, a change of worldview is taking place in the world—the idea of continuous improvement of well-being and increasing consumption of natural resources is being replaced by a more balanced view, according to which the satisfaction of the needs of humanity should be carried out "without prejudice to the ecosystem and future generations". In economic sciences and practices, new concepts and approaches to infrastructure development are becoming increasingly widespread, including the concepts of "sustainable infrastructure", "quality infrastructure", "responsible investment in infrastructure", build back better, green, resilient and inclusive development (GRID), etc. (Ivanov & Shamanina, 2020).

The concept of sustainable infrastructure is closely related to the concept of sustainable development (SD), which was formulated in the late 1980s by the UN Commission on Environment and Development (United Nations World Commission on Environment and Development, 1987). The World Bank's Sustainable Infrastructure Action Plan defines economic and financial sustainability, social sustainability and environmental sustainability as key elements of sustainable infrastructure based on effective governance (World Bank Group, 2008). The 2030 Agenda for Sustainable Development, adopted in 2015, formulated a spectrum of 17 Sustainable Development Goals and 169 targets (United Nations. Addis Ababa Action Agenda …; United Nations.

Transforming our world …). Infrastructure plays a key role in achieving sustainable development and has a direct or indirect impact on the achievement of all Sustainable Development Goals and 92% of all targets (Thacker et al., 2018).

The above-mentioned conceptual documents formed the basis of the concept of sustainable infrastructure, which is understood as "infrastructure projects that are planned, designed, constructed, operated and decommissioned in a manner to ensure economic and financial, social, environmental (including climate resilience) and institutional sustainability over the entire life cycle of the project" (IDB, 2018).

The concept of quality infrastructure was put forward to develop and complement the concept of sustainable infrastructure. G7 and G20 play an active role in the theoretical and practical promotion of this concept. In 2019, G20 adopted the Principles of Quality Infrastructure Investment (QII), which take into account environmental, social and economic aspects of infrastructure to achieve the quality and sustainability of facilities (G20, 2019).

The concept of responsible investment or investment based on ESG-factors (ESG—environmental, social and governance) is based on the same principles like the concept of sustainable development with an emphasis on the corporate level. It is used by investors to evaluate companies on three aspects: environment, social development and governance. The environmental aspect takes into account the impact of the company's activities on the environment. The social aspect includes the well-being of employees and local communities, and the governance factor takes into account such components as corruption, business ethics, gender composition, remuneration of top managers, etc. Investing in infrastructure taking into account ESG-factors allows managing environmental and social risks, improving management efficiency and ultimately improving the quality of infrastructure investments and ensuring long-term profitability for investors.

In 2021, The World Bank announced the promotion of a new approach to infrastructure investment called green, sustainable and inclusive development (GRID). The priority of environment-friendly products, clean jobs, low-carbon technologies and intelligent risk management systems, overcoming inequality in opportunities and results through inclusiveness at all levels, is becoming increasingly important for infrastructure projects. Such a transformation requires clear policies, legislative and fiscal incentives, as well as the introduction of specific regulatory requirements (World Bank Group, 2021).

Another brick in the conceptual foundation of new approaches to infrastructure development is the building back better (BBB) initiative ("building better than it was"). This initiative was adopted in 2015 by the UN Member States as one of the four priorities of the Sendai Framework Program for Disaster Recovery, Risk Reduction and Sustainable Development (UNISDR, 2015). The essence of the BBB approach, the leitmotif of which sounds like "build better, faster, more inclusive", is to minimize the overall impact of natural disasters on the affected population, to restore infrastructure faster and better and to provide all conditions for support after natural disasters to reach all victims. BBB applies to all aspects and sectors of disaster recovery—communications, education, energy, healthcare, housing, transportation, water supply and sanitation.

Despite all the differences between the new concepts and approaches, they have a "common denominator": Maximum synergy can be achieved only through an integrated approach that takes into account the interrelationships and interactions in space and time between the public and private sectors, between different industries and sectors of the economy, between institutions, institutions, organizations and various segments of society, as well as the interrelationships between different phases of the infrastructure life cycle (UNEP, 2019).

38.3 Results

In recent years, new theoretical and conceptual approaches to the development and modernization of infrastructure have been embodied in some areas of practical activity, which, taking into account their scale, can be considered as key trends in global infrastructure practices. The following can be distinguished as the main ones.

38.3.1 Long-Term Planning of Infrastructure Development with an Emphasis on "Green" Infrastructure

In recent years, there have been a growing number of countries that are switching in their economic policy to long-term planning of infrastructure development. This phenomenon reflects the growing desire of states and governments, taking into account bitter lessons of global economic and financial crises, to form a clearer vision of the vector of infrastructure development, calculate quantitative and qualitative parameters of this development and build guidelines for sources of financing.

Examples of systemic long-term infrastructure development planning are provided by the United Kingdom (HM Treasury, 2016; HM Treasury, 2020; National Infrastructure Commission, 2018), Australia (Australian Government, 2016), Canada (Infrastructure Canada, 2018), Japan, India, etc. It is noteworthy that the principles of green infrastructure have already been included in the national strategic documents of most G20 countries.

For example, Japan has adopted a Basic National Sustainability Plan. The infrastructure plan in Canada is focused on increasing resilience to climate change and accelerating the transition to a clean growth economy. It uses a "climate lens"—a screening mechanism for climate-related green infrastructure projects. Saudi Arabia has included provisions on "green infrastructure" in the National Spatial Strategy, the National Strategic Plan for Integrated Infrastructure and the National Transport Strategy. Following the roadmap for a closed-loop economy, France is moving toward a new type of economy where consumption is moderate, products have a longer service life, and waste is limited and can be converted into new resources.

Long-term planning of infrastructure development is gradually becoming one of the important tools of public administration of the infrastructure sector in Russia. Recently, several important state strategic planning documents have been adopted, outlining strategic contours and building sectorial and regional priorities for infrastructure development:

- the Spatial Development Strategy of the Russian Federation for the period up to 2025 provides, among other things, "the elimination of infrastructure restrictions of federal significance and improving the availability and quality of the main transport, energy and information and telecommunications infrastructure";
- 13 national projects covering transport, education, ecology, demography, housing, etc., are the most important strategic documents based on which the country's infrastructure will be developed in the coming years;
- equally important is the comprehensive plan for modernization and expansion of the core infrastructure until 2024, which provides for the implementation of projects for the construction of high-speed highways (HSR), the reconstruction of more than 60 airports, the development of transport hubs, ports of the Azov-Black Sea basin, the reconstruction of major highways, transport bypasses of a large number of large cities, the creation of hub transport and logistics centers, etc. (InfraONE, 2020).

38.3.2 Improving the Quality of Infrastructure Projects

In recent years, both public authorities and the private sector have become increasingly aware of the need to provide quality infrastructure. The concept of quality infrastructure implies that investments in infrastructure are no longer viewed through a purely financial and economic prism and become an instrument for comprehensive development, working, among other things, to reduce social tension and to preserve a healthy and safe environment.

The transformation of the paradigm of modern business is expressed in "responsible investment", or "approach based on ESG-factors". According to the Global Alliance for Sustainable Investments (GSIA), both the total global sustainable investment and its share in total assets under management ($35.3 trillion and 35.9% in 2020 accordingly) are steadily growing in the world in recent years (GSIA, 2021). Judging by numerous polls of the "captains" of modern business, private entrepreneurship's attention to ESG-factors continues to grow, and ESG is increasingly viewed by them as an important component of corporate policy in the long run (McKinsey, 2020; OECD, 2017).

In Russia, the "ESG transformation" is still at the very beginning. As the RAEX-Europe agency ranking showed, as of March 2021, there were about 80 companies and 20 banks in Russia that had implemented the principles of sustainable development. In 2020, several Russian companies and banks received green loans or loans linked to ESG-factors (INFRAGREEN, 2021). In September 2021, Sberbank took the initiative to create an ESG alliance in Russia, which met the understanding and support of some leading companies and banks.

However, these individual positive steps are not yet "making the weather" nationwide. The ideas of sustainable development and quality infrastructure have yet to take hold of the minds of Russian businesses, as shown by the results of a recent survey of participants of the infrastructure market. Almost all the companies surveyed (92%) agreed that most of the infrastructure projects implemented in Russia do not comply with the best practices in the field of quality. About half of the companies (48%) believe that the share of quality projects is less than 25%. The majority of respondents acknowledged that at the moment, the focus on the economic efficiency of projects dominates in the Russian infrastructure market (54%), social aspects are in second place (32%), and ecological aspects and environmental protection are considered a priority by only 6% of respondents (VEB.RF/NCGCHP, 2021).

38.3.3 Development of Tools for Assessing the Sustainability of Infrastructure Projects

In order to comply with the principles of quality infrastructure in practice, many countries have created and successfully operate systems for assessing and certifying the quality of infrastructure projects, which provide investors and financing organizations with comprehensive information for making investment decisions. More than 50 tools have been developed worldwide aimed at implementing sustainable development approaches and helping investors evaluate financial, economic, environmental, social, managerial, and other aspects of infrastructure projects CEEQUAL, Envision, Infrastructure Sustainability and Greenroads have become the most widespread in world practice.

Russia has also started moving in this direction. For practical implementation of the QII principles in Russia, VEB.RF State Development Corporation and the National PPP Center developed in 2020 a National System for Assessing the Quality and Sustainability of Infrastructure Projects—Impact and Responsible Investing for Infrastructure Sustainability (IRIIS). The system is designed to help investors and banks correctly calculate the risks of entering infrastructure projects in Russia. The peculiarity of this tool is a comprehensive assessment of the risks of an infrastructure project, including economic, social and environmental aspects (VEB.RF/NCGCHP/AECOM, 2020). The IRIIS system is currently running in test mode and is expected to enter full service in 2022.

38.3.4 Development of Digital and Platform Solutions in the Field of Infrastructure Investments

One of the notable trends of the infrastructure market is the active development of digital and platform solutions to support the implementation of infrastructure projects both at the international and national levels. Many countries are already using digital platforms to improve the quality of preparation of investment projects and build effective interaction between participants of the infrastructure investment market.

Among the key digital products, operating internationally and contributing to global infrastructure development are the Global Infrastructure Hub (GIH) portal, World Bank's PPP Project Database, IJ Global Platform, Infrappnet portal, etc.

National products typically offer data relating to the rules and practices of a particular country. Their task is to promote the development of the market and attract investment. At least, a third of G20 countries have and use databases of infrastructure projects, and some have already switched to the introduction of integrated infrastructure platforms.

Since 2019, the ROSINFRA Infrastructure Project Support Platform—a unique digital solution for the preparation and implementation of infrastructure projects—has been operating in Russia. Its main mission is to overcome such "bottlenecks" of the Russian infrastructure market as a lack of data on the current state and trends of infrastructure development, lack of experience of public and private entities, difficulties and high cost of attracting qualified specialists, etc.

The Digital Project Office service enables regional and municipal authorities to work together online to launch investment projects, including with the involvement of external experts, investors and financing organizations. In 2020, based on ROSINFRA Platform, VEB.RF and National PPP Center have launched a regional anti-crisis support program aimed at assisting in the preparation and launch of PPP projects implemented at the regional and municipal levels. 53 regions have already joined the program.

38.3.5 Development of New Infrastructure Financing Mechanisms

The relevance of sustainable development and interest in sustainable investments has formed new trends in the financial market, including the development of new financial instruments. In response to changing conditions, new mechanisms of sustainable investment have emerged—transitional, green, social, blue, sustainable bonds—that allow investors to direct capital into projects which solve environmental and social problems.

The market of sustainable financial instruments is growing rapidly. At the beginning of 2020, issues of green, social and sustainable bonds amounted to over $320 billion, which is almost twice as much as in 2017. At the same time, green bonds remain the most attractive stable financial instruments—78% (Environmental Finance, 2020).

Green finance has appeared in Russia quite recently. At the end of 2018, the country's first issue of green bonds of the KhMAO Resource Saving Company was placed on the Moscow Stock Exchange. Over the past few years, the green finance system in Russia has made some progress: New issues of green and social bonds have appeared in the country, as well as examples of trust management of assets, which are based on ESG-strategies and principles of responsible investment. Moscow Stock Exchange, development institutions and the state have actively joined the process of market formation. As of the end of 2020, the Register of Green and Social Bonds of Russian Issuers (INFRAGREEN) included 20 issues of green and social bonds of seven Russian issuers worth more than 216 billion rubles (INFRAGREEN, 2021).

However, a stable framework of the domestic system of green finance in Russia has not yet been formed. The authorities plan to launch the green finance market on the horizon of three years. To that end, the government is preparing to launch a system of financing green projects and initiatives in the field of sustainable development. The decree defining the goals and main directions of its functioning was signed by the Prime Minister in July 2021. Financing will be carried out at the expense of green or adaptive financial instruments (special bonds or loans). With their help, businesses will be able to attract extra-budgetary funds on favorable terms. The document also defines the areas of green financing—energy, construction, industry, waste management, transport, agriculture, water supply and sanitation.

38.3.6 Institutional Aspects of State Environmental Governance

A number of recent initiatives indicate that after many years of ignoring, the Russian government is beginning to seriously turn around toward the issue of climate change.

In his April 2021 address to the Federal Assembly, the President for the first time identified ecology and climate as one of the priorities of the country's development. During his speech at the climate summit, President Putin called for broad international cooperation in the fight against climate change. In accordance with the instructions of the President of the Russian Federation, the Government of the Russian Federation in October 2021 approved the Strategy of Socio-economic Development of the Russian Federation with low greenhouse gas emissions until 2050, the purpose of which is to adapt the economy to the global energy transition, reduce greenhouse gas emissions and achieve carbon neutrality by 2060.

There are already some positive initiatives in this area in Russia: the creation of pilot territories to reduce carbon footprint (Carbon Free Zone) in three Russian regions, the transfer of solid municipal waste treatment to a closed cycle in seven Russian regions, the decision of the Moscow government to issue "green" bonds of 70 billion rubles to increase the share of electric transport in the Moscow agglomeration, the agreement between BP and Rosneft on moving toward carbon neutrality, as well as the plans of individual companies (LUKOIL, X5Retail Group, En+, etc.) to achieve carbon neutrality.

Thus, Russia continues to implement reforms, state programs and other measures which can be conditionally combined with the term "green modernization". At the same time, environmental policy in Russia continues to remain largely ineffective. This is reflected in the following, in particular:

- low (the worst among all national projects!)—the quality of execution of the national project "ecology" only 26.1% of the planned budget assignments, according to the Ministry of Finance of the Russian Federation, as of August 2021;
- the share of consolidated budget expenditures on environmental protection remains extremely small (less than 0.7% in 2019). The share of "green" energy in the total generation is also very low (0.2%) (InfraONE, 2021);
- being one of the ten largest emitters of greenhouse gases (about 5% of global CO2 emissions, which per capita is twice as high as the average in G20 countries), Russia ranks only 52nd among 61 countries in the aggregated Climate Change Performance Index for 2021 (Climate Change Performance Index, 2021).

Fragmentation and disunity can be named among institutional defects of the state environmental governance in Russia. Governance of natural resources is combined with the powers of nature protection in the Ministry of Natural Resources and Ecology. This should not happen a priori, since environmental functions—especially in a country whose economy has been developing for many decades due to an extensive increase in extraction of natural resources—will inevitably fade into the background, which is what happens in practice.

Environmental pollution issues are handled by the Ministry of Natural Resources and Ecology, but climate change issues (not only emissions reduction but also adaptation to it), as well as "green" financing, are regulated by the Ministry of Economic Development. At the same time, although more than 80% of greenhouse gas emissions in Russia are due to the burning of fossil fuels, the Ministry of Energy is only indirectly involved in their regulation. Climate change issues are almost not mentioned in Russia's Energy Strategy until 2035, approved by the Government in 2020.

38.4 Conclusion

1. A profound transformation of conceptual and practical approaches to infrastructure development based on the paradigm of sustainable development is gaining momentum in the world today. The purpose of the transformation is the transition from traditional facilities to sustainable ones that take into account economic, social and environmental aspects. International initiatives are being developed to promote sustainable infrastructure, as well as standards for assessing

its quality, and new instruments for financing infrastructure projects are being formed. Investors are increasingly taking ESG-factors into account when making decisions.

2. Russia is part of the global system and cannot ignore the trends of the infrastructure market. Much is being done in the country to "be in the trend" and not to remain on the sidelines of the dominant phenomena in world infrastructure practices. Infrastructure development is beginning to acquire an increasingly systematic character—a long-term planned basis is being put under it, sustainability aspects are taken into account in the national development goals until 2030, initiatives that take into account the best world practices are being launched to assess the sustainability of infrastructure projects, the process of forming the green finance market and its tools have begun.
3. At the same time, serious infrastructural changes are taking place in Russia unevenly, and sometimes inconsistently. At the largest infrastructure forum "Russian PPP Week-2020", serious barriers to infrastructure development were noted, the key of which are

    - problems with strategic planning, the ambiguity of the authorities' plans regarding projects with the expected participation of extra-budgetary funds;
    - lack of transparency in decision-making on federal budget support for infrastructure PPP projects in most industries. Lack of guarantees for the timely launch of projects and the provision of funding from the federal budget;
    - an "arrhythmia" in the execution of budget assignments for infrastructure projects. According to the Accounts Chamber of the Russian Federation, federal budget expenditures for the implementation of a comprehensive plan for the modernization of the core infrastructure were fulfilled only by 38.1% as of August 2021;
    - regulatory instability, unsystematic improvement of the regulatory framework, introduction of new regulatory barriers;
    - shortage of the "long money" flow into infrastructure, insufficient use of the potential of pension and insurance funds;
    - the need to improve the quality of project preparation by unifying processes and requirements, as well as transferring the interaction of participants to the maximum digital format;
    - the inertia of officials in the regions, the lack of real incentives to choose more complex PPP mechanisms for the implementation of infrastructure projects instead of the "conventional" mechanism of public procurement.

4. The principle of responsible investment (ESG) is just starting to work in the Russian market. ESG is gradually ceasing to be exclusively an image characteristic, and tougher approaches from foreign regulators and investors are forcing Russian players to deal with this issue more substantively. The government and the Central Bank are increasingly involved in this issue along with interested companies and banks, but the trend is only gaining momentum, and it is still premature to talk about the sustainability of demand for ESG-strategies.

5. Significant problems remain in the field of environmental governance. The general systemic greening of the economy is poorly visible, the fragmentation and disunity of public administration remain, and control over budgetary environmental expenditures remains insufficient. In this regard, it can be considered expedient to create a Ministry of the Environment that would consolidate the development of the environmental agenda in the country.
6. The removal of the above barriers could give a significant impetus to infrastructure development in the country; improve its quality and efficiency, which would be fully consistent with the objectives of achieving the Sustainable Development Goals.

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Chapter 39
Public–Private Partnerships and Green Financing of Infrastructure Projects

Ellina A. Shamanina

39.1 Introduction

Today, it is difficult to overestimate the role and impact of infrastructure on the economy and the general well-being of the world's population. An increasing impact on infrastructure began to be exerted not only by various political, technological, economic changes but also by problems directly related to the 2015 Agenda for Sustainable Development until 2030, which became an updated roadmap in the field of implementation of the concept of sustainable development. For example, population growth, natural disasters and man-made disasters as well as climate change issues negatively affect the ability to existing infrastructure to meet the growing needs of modern society and withstand new threats (Bazarbaeva et al. 2021).

Thus, a dualism arises in the development of the infrastructure complex: on the one hand, infrastructure can have a negative impact on the environment (e.g., about 60% of greenhouse gas emissions occur as a result of the construction and further operation of infrastructure facilities (IDB Invest, 2018), and on the other hand, it is also one of the key factors of economic development and a tool for achieving the UN SDGs. One of the 17 Sustainable Development Goals (UN SDGs) included in the UN Global Agenda directly relates to the development of the infrastructure complex—Goal 9 "Industrialization, Innovation and Infrastructure". Moreover, being inseparable from each other, other goals directly intersect with infrastructure.

Unfortunately, the existing infrastructure with a high level of wear and tear is not able to meet the growing demands of the population and cannot cope with the emerging socio-ecological problems of our time. The Global Infrastructure Hub has estimated that 11 countries already have an infrastructure deficit of approximately US $10.3 trillion. And to achieve the global sustainable development goals and the

E. A. Shamanina (✉)
MGIMO University, Moscow, Russia
e-mail: e.shamanina@inno.mgimo.ru

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implementation of the climate agenda from the current period to 2030, investments in infrastructure amounting to $6.9 trillion are required (UN Environment Program, 2020). Closing the infrastructure gap requires not only investing more in infrastructure projects but also transforming the way the infrastructure is planned, developed and operated.

The need to revise approaches to creating a new infrastructure that takes into account the criteria of sustainability is caused by the pandemic of a new coronavirus infection that has engulfed the whole world, which has accentuated the uneven nature of achieving the UN SDGs and also exposed the problems of existing infrastructure. Infrastructure deficit, expressed as a shortage of medical institutions and the services they provide, a lack of water and electricity supply, has a negative impact not only on overcoming impacts of COVID-19 but also threatens the progress made in recent years in the field of sustainable development (United Nations Statistic Division, 2020).

It is worth noting that even the world's largest economies are facing a deficit in infrastructure investment. The countries with the largest deficits include the United States, with a total of $3.8 trillion, and China, whose investment needs are $1.9 trillion. Moreover, without proper measures, the infrastructure deficit will expand on almost all continents—in Europe, North and South America, Asia and Africa (Global Infrastructure Hub, Infrastructure Outlook, 2021).

For modern Russia, the lack of investment in infrastructure, along with the obsolescence of fixed assets and the lack of high-quality, sustainable infrastructure facilities that can meet the growing needs of the population, is an urgent problem. According to the Global Infrastructure Hub, by 2040 Russia will need to attract investments of USD 1.8 trillion to cover the infrastructure deficit and achieve the UN SDGs (Global Infrastructure Hub, Infrastructure Outlook, 2021).

The purpose of this study is to identify trends and prospects for the development of public infrastructure in the context of achieving the UN Sustainable Development Goals. In particular, the author of the article analyzes the possibilities of international and Russian practice for the development of sustainable infrastructure through public–private partnership (PPP) mechanisms, along with the formation of a market for sustainable financing instruments and their application in relation to the implementation of infrastructure projects.

39.2 Materials and Methodology

The research methodology is based on a theoretical and statistical analysis of the features of infrastructure complex development within the framework of the implementation of global sustainable development agenda. Based on expert methods and comparative analysis, the mechanisms of sustainable financing, the practice of implementing project initiatives to create objects of high-quality (sustainable) financing, the practice of implementing infrastructure on the principles of public–private partnership (PPP) as well as the prospects for using PPP mechanisms in the context of green financing of sustainable infrastructure in Russia are considered.

The reliability and completeness of the research results are ensured by the use of both a systematic approach and other scientific methods of cognition, such as the method of grouping, generalization, classification, analogy, comparison and formalization. The study also used descriptive methods based on the collection and study of practical examples of the implementation of projects with an environmental solution in a PPP format in Russia and abroad.

To gain the necessary understanding of the development of sustainable infrastructure and green investment mechanisms, including the implementation of environmentally friendly projects based on PPP principles, foreign sources like research articles, reports from regulatory bodies and development institutions were analyzed. Their analysis served as the basis for revealing the structural changes that have occurred in the PPP mechanisms, in particular, in the Russian infrastructure market and the institutional and legal field over time. The statistical data presented in the study were collected and analyzed based on statistical observations using the relevant international and Russian databases, in particular, materials from the World Bank, McKinsey consulting agency, Inter-American Development Bank, UNEP, Global Infrastructure Hub agency, National Center for PPP as well as the Russian platform for supporting infrastructure projects ROSINFRA and analytical materials from the Russian independent investment company InfraONE (UNEP Finance Initiative, 2018). The methodological foundation of the work was also formed by regulatory documents, international standards, guidelines concerning the regulation for the development of high-quality infrastructure, the sustainable investment market, the development of PPP mechanisms, specifically in Russia.

39.3 Results

Considering the relevance of the concept of sustainable development and the ESG agenda[1] demand for sustainable infrastructure[2] and responsible investments will continue to expand, creating new trends in investing. The response to the emerging new "sustainable reality" in the financial sector has become a model of green financing, involving investments in projects related to solving environmental problems and providing environmental benefits. Within the framework of this model, the first financial instruments were green bonds, first issued in 2007 by the European

[1] Sustainable and responsible investing is based on ESG-standards (E-environmental, S-social and G-governance), which investors use to evaluate a company's compliance with the concept of sustainable development.

[2] Sustainable infrastructure is defined as infrastructure that is planned, designed, built and operated with the four basic sustainability criteria (economic and financial; social; environmental (including resilience to climate change) and institutional) achieved all through the project life cycle (IDB Invest, 2018).

Investment Bank (EIB). In 2008, the initiative was taken up by the World Bank, which directed the proceeds from the green bonds it issued to combat the effects of climate change.

According to Environmental Finance, among the leading countries in the placement of green bonds, the USA (approximately 59 billion US dollars in 2019), China (27 billion US dollars in 2019) as well as EU countries, in particular, France (31.3 billion US dollars in 2019), Germany (22.5 billion US dollars in 2019) and the Netherlands (approximately 16 billion US dollars in 2019). Among international institutions, the green bond market is also developing; the largest issuer here is the International Bank for Reconstruction and Development (groups of The World Bank) with a volume of 4 billion US dollars (Environmental Finance, 2020).

Accounting for about 80% of the total number of sustainable investment mechanisms, green bonds in the financial market is also an attractive instrument for financing sustainable infrastructure facilities. The European countries participating in the climate agenda are actively engaged in the development of green infrastructure through the issue of green bonds. In particular, the Netherlands, which issued government green bonds in 2019, was able to attract investments of $6.68 billion US$ for the implementation of major projects under the climate change adaptation program, to support the development of renewable energy as well as railway infrastructure (National Center for PPP, 2021).

Other sustainable investment mechanisms include transitional and blue bonds, which are aimed at stimulating the transition to a low-carbon economy and the implementation of projects for the protection of oceans and coastal waters. In 2018, the world's first sovereign blue bonds were issued by the Republic of Seychelles, raising about $15 million for the development of the blue economy of this small island state. In the same year, Morgan Stanley, together with the World Bank, carried out the sale of blue bonds of $10 million to solve the problem of ocean pollution (Ahmed, 2019). Thus, infrastructure development projects occupy a significant position in the list of investments with sustainable financial instruments. The elimination of the infrastructure deficit and the development of sustainable infrastructure increasingly requires expansion in the use of alternative traditional public financing methods.

Among the effective instruments for financing the development of the infrastructure complex, public–private partnership (PPP) can be singled out. PPP plays a significant role as a tool for replenishing budget resources, as well as solving the problem of infrastructure deficit. According to a McKinsey study, PPP mechanisms play an essential role in mobilizing capital for the implementation of sustainable infrastructure projects in countries with different income levels. For example, in middle-income countries, PPP accounts for 22% of the total financing of infrastructure development projects (McKinsey Center for Business and Environment, 2016).

The pooling of the resource potential of the public and private partners, as well as the additional attraction of various other sources of financing within the framework of the PPP model, determines the possibility of using green bonds, including other sustainable financing instruments when launching PPP projects. At the present stage of world practice, there is still no accurate statistical data that would provide an estimate of the share of green bonds issued for financing PPP projects. Nevertheless, some examples do exist. For example, in 2014, Canada launched the first green bond issue under a PPP project to create North Island hospitals in Vancouver. The project, with a total cost of CAD 606.2 million and a duration of 33 years, will build and maintain hospitals that meet sustainability criteria, in particular, in terms of energy efficiency and greenhouse gas emissions targets. The Tandem Health Partners consortium participating in the project has issued green bonds of CAD 231.5 million companies, fund managers, etc. (Investinfra, 2018).

The market for green financial instruments in Russia is still at the initial stage of its development. Nevertheless, it can be noted that among the mechanisms of sustainable investment, green bonds are the leaders. In 2020, there were 15 issues of green bonds, worth more than 50 billion rubles. And by the end of 2021, the expansion of the green investment market is predicted. According to the experts of the Expert RA agency, at least ten issues of green bonds are expected, which will lead to an increase in the market volume to 250 billion rubles (Gazeta RG.RU, 2021). In 2019, the Government of the Russian Federation approved a decree providing for the provision of subsidies for organizations (including for those that have a significant negative impact on the environment, e.g., producers of coke and petroleum products, oil and gas companies, metallurgical production, etc.), issuing bonds for financing projects to introduce the best available technologies (BAT) in order to reduce the negative impact on the environment (The Russian Government, 2019). And in 2020, the Bank of Russia introduced the concept of "green bonds" into the standards for issuing securities, according to which funds from the placement of such bonds should be used to fund environmental protection projects. The funds received from the emission of green bonds, as a rule, are used to fund projects in the field of transport (in particular, rail infrastructure) and energy, as well as for the implementation of project initiatives in the areas of housing and communal services, management of solid waste and green construction. And, despite a certain immaturity of the Russian market for sustainable financing instruments, in particular, green bonds (compared to the total volume of the bond market of about RUB 27 trillion, green bonds account for only RUB 13.4 billion), an increase in the number of PPP initiatives using green investment tools is predicted (InfraONE, 2020).

Over the past decades, the Russian PPP Institute has passed a major landmark in its development: from the implementation of individual projects to the formation of a complex market covering a large number of players and infrastructure sectors. It is worth noting that the progressive movement of development was facilitated by the strengthening of the legal framework. In 2015, the Federal Law FZ-224 "On Public–Private Partnership, Municipal-Private Partnership in the Russian Federation" (Federal Law No. 224-FZ) designed not only to consolidate the conceptual apparatus but also to expand the possibilities of structuring and launching project initiatives through the use of various contractual models. In addition, the current Federal Law No. 115 "On Concession Agreements" (Federal law No. 115-FZ, 2005) has been repeatedly adjusted since 2014 in order to improve the effectiveness of the use of the concession form, as well as to ensure the legal protection of the rights of a private investor. The consequence of the changes made was an increase in the number of concession projects in various infrastructure sectors. Due to investment and financial stability, as well as the already accumulated experience in structuring infrastructure projects in the format of concessions (under 115-FZ) and PPP agreements (under 224-FZ), some Russian regions may well resolve their environmental problems and implement appropriate initiatives through partnership tools.

At the beginning of 2021, at various stages of implementation, there were about 3900 projects with a total investment volume of more than 3 trillion rubles. Along with the growth in the number of project initiatives, the industry range of application of partnership mechanisms is also expanding. The practice of implementing PPP tools, established in traditional industries such as transport, energy and housing, has spread to the sectors of agriculture, IT infrastructure, social sphere as well as areas where the implementation of projects fully corresponds to the "green" agenda: *the treatment of MSW, the development of urban transport and alternative energy.*

Today, in Russian practice, the sphere of solid waste management is promising for the implementation of PPP in the format of concessions. According to the "InfraONE" agency, by the end of 2020, 38 projects for the creation of MSW treatment facilities totaling 45.7 billion rubles were launched under the concession. Moreover, the demand for the creation of such objects is only increasing. This trend is due to a very urgent problem related to the reduction in the capacity to neutralize the current volumes of MSW (according to forecasts, in 32 Russian regions, the capacity of landfills will last only until 2024 (Finanz.ru, 2020)), as well as the continuous underfunding of this industry. In addition, the innovative development of the MSW management sector is accompanied by environmental benefits. For example, due to the growth of recycling, the amount of waste placed in landfills will decrease, which in turn will lead to a reduction in greenhouse gas emissions in the amount of 269 million tons of CO2 equivalent (IFC, World Bank Group, 2018).

One well-developed area of implementation of project initiatives in PPP formats in the world is public transport. Today in Russia, the market for PPP projects in relation to the development of public transport is still quite limited, including only a few concession projects for the construction of tram lines in St. Petersburg and projects for the creation of a cable car in Moscow.

Nevertheless, experts note that this direction has significant prospects for its implementation in the PPP format. On the one hand, public transport infrastructure development projects are often capital intensive, which explains the need for public authorities to attract additional sources of funding. On the other hand, the business involved in the implementation of such PPP initiatives is interested in efficient construction and high-quality operation of facilities on which the passenger traffic and the payback of the entire project depends.

It should be noted that the financing of the implementation of PPP projects in the areas of waste management and construction of rail transport is most suitable for the global standards of "green" projects with the use of green financing tools. In Russia, there are already PPP projects in the framework of which the issuance of green bonds is carried out. For example, in 2018, the company (concessionaire) Resource Saving of the Khanty-Mansi Autonomous Okrug placed green bonds on the Moscow Exchange for a total of RUB 1.1 billion. The proceeds from the bond issue were directed to the implementation of the concession initiative for the construction of an "integrated inter-municipal landfill for the placement, disposal and treatment of MSW in the Nefteyugansk region of the Khanty-Mansiysk Autonomous Okrug". Another concession project, which is financed through the placement of green bonds by the Transport Concession Company, is a project to create a tram network in the Krasnogvardeisky district of St. Petersburg (National Center for PPP, 2021).

PPP mechanisms have not bypassed the field of alternative energy. Such projects are not uncommon in the world. So far, Russia has one project in the format of a concession for the construction of a wind farm in the Chukotka autonomous region. Despite such low indicators, in the long term, the potential for the implementation of PPP projects in this area, for the creation of solar and wind energy facilities, is quite high. This mechanism is especially relevant in the context of the implementation of the program to support the improvement of the energy efficiency of the electric power industry based on the use of renewable energy sources until 2035 (The order of the Government of the Russian Federation of 08.01.2009 N 1-r, 2021) and may well be its reasonable complement. To create renewable energy facilities, the form of PPP agreements operating in the framework of 224-FZ may be more in demand. The opportunity for investors to obtain the right to dispose of the objects of the PPP agreement is an important factor in the participation of a private partner who can operate a generating facility without any time limits, while the public side does not relieve itself of the need to maintain and operate the facility after the agreement is completed.

Undoubtedly, the potential for private sector involvement is not limited to the areas discussed above, and many environmental projects can be implemented through the use of partnership mechanisms. Among other promising areas that have not yet received such a wide propagation in Russia, or abroad is the development of urban landscaping and greening, projects for the preservation of biodiversity and ecotourism. In essence, any infrastructure project implemented in a PPP format can be considered environmental if it complies with the basic principles of sustainable development and is structured in accordance with "green" standards, i.e., with key ESG requirements. And in the current macroeconomic conditions, the development of the infrastructure complex requires not only the study of issues of attracting additional funding but also the sustainability (quality) of the launched project initiatives.

Of course, at the moment, Russia is lagging behind countries with a developed PPP institute in many ways. Nevertheless, one cannot deny significant progress in the implementation of PPP mechanisms, as evidenced by the strengthening of the institutional and legal framework and the expansion of the sectoral spectrum of the partnership. Moreover, the contribution that the PPP format can make in the creation of high-quality infrastructure facilities and the promotion of sustainable development principles cannot be underestimated.

39.4 Conclusion

Today, improving the well-being of the population and protecting our planet are increasingly at the top of the international agenda. In this regard, the goals developed within the framework of the concept of sustainable development are an acceptance of existing problems and a call for decisive action by states. Undoubtedly, the development of the infrastructure complex cannot run counter to the global agenda. As one of the key factors for stable economic development, infrastructure plays a significant role in achieving the UN SDGs, and the world community cannot ignore such a problem as the widening of the infrastructure deficit. In this regard, the world market is developing mechanisms of sustainable financing like green, social and transitional bonds. When financing infrastructure projects, investors begin to increasingly take into account non-financial risks, as well as make decisions based on the ESG approach.

International practice demonstrates that the improvement of the infrastructure complex requires additional resources, including financial resources. The search for investments is not limited only to budget sources, and for the implementation of infrastructure projects, business funds are actively attracted on the principles of public–private partnerships (PPP), which contributes to the development of infrastructure facilities at an accelerated pace, and also leads to economic growth in the long term. It is important to understand that the PPP institute has both significant advantages and disadvantages and the results of its work will fully depend on a consistently and competently built institutional and legal environment, as well as strict adherence to the key principles of this mechanism. Nevertheless, as practice shows, the PPP toolkit contributes to resolving the problem of funding shortfalls and also becomes an effective mechanism for creating sustainable infrastructure facilities.

As a part of the global system, Russia is systematically working to transform its infrastructure market, taking into account key economic, managerial, environmental and social aspects when structuring project initiatives. There is no doubt that Russian infrastructure also needs funding to meet existing and future needs. The PPP Institute in Russia has come to a long distance and is characterized by positive dynamics in its development. Due to investment and financial stability, as well as the already accumulated experience in structuring infrastructure projects in the PPP format, Russia may well implement its environmental initiatives through partnership tools. Projects in the areas of solid waste management, the development of public green transport as well as alternative energy are already being implemented in the country. Moreover, the market for sustainable financing instruments is developing, including an increase in the number of green bond issues. Initiatives are being launched to assess the sustainability of infrastructure projects that take into account the best international practices of sustainable development. All this provides the necessary conditions for the further implementation of the principles of sustainable development when structuring projects to create public infrastructure facilities that meet the criteria of sustainability and in the long term is aimed at achieving positive economic, social and environmental effects.

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Chapter 40
EAEU Industrial Development Under SDG-9: Challenges and Possibilities

Maria A. Maksakova and Angelina A. Kolomeytseva

40.1 Introduction

The Green Agenda implementation in various areas is becoming one of the leading trends in modern economic development both at the global, regional, and country levels within the UN Sustainable Development Goals (SDG). The 2030 Agenda for Sustainable Development, adopted in 2015, reflects a more comprehensive view of the transformation of societies, where economic, social, and environmental goals are balanced (UN, 2015). Problems of transition to green industry to support the country's high levels of competitiveness in the context of Industry 4.0, as well as the practice of using industrial policy instruments by countries of different levels of development to stimulate environmentally friendly industries are currently becoming of high significance. In 2011, the United Nations Industrial Development Organization (UNIDO) advocated for the introduction of green industrial policy instruments to tackle environmental disruption following the global financial crisis. As a means of implementing this policy, UNIDO proposed attracting investments in ecological production, environmentally friendly technologies, and training specialists in this area.

There is no uniform and generally agreed definition of "industrial policy" and "green industrial policy" (Warwick, 2013), but still, the term encompasses sets of measures that governments use to influence a country's economic structure in the pursuit of the desired objective. Until very recently, this desired objective was first and foremost to enhance the productivity and competitiveness that in turn would allow for economic growth and higher incomes. In the same way, UNIDO and OECD defined

M. A. Maksakova (✉) · A. A. Kolomeytseva
MGIMO University, Moscow, Russia
e-mail: m.maksakova@inno.mgimo.ru

M. A. Maksakova
Institute of Economics of the Russian Academy of Sciences, Moscow, Russia

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industrial policy. The green industrial policy aims to stimulate long-term trends in technology and markets, primarily taking into account environmental considerations that affect the future direction of economic development. Green industrial policy is considered as any government action aimed at accelerating the structural transformation of the economy toward a "low-carbon and resource-saving" economy, which also contributes to increased productivity in the economy. Green industrial policy is necessary at this stage of development, as green industry producers face high costs and risks; therefore, government support through various industrial policy instruments is needed until green innovations become commercially viable. By 2030, one of the priority goals for UNIDO is SDG-9 implementation in the context of creating sustainable infrastructure, promoting inclusive, and sustainable industrialization and stimulating innovation. This goal calls for governments to increase the industrial share of employment and GDP by 2030 through applying clean and environmentally friendly technologies in the industrial production process by stimulating public and private spending on R&D. Thus, the process of reindustrialization and the initiatives of international organizations lead to an increase in the share of industrial production. Another feature of Industry 4.0 is the transition to a neo-industrial development model that calls for the introduction of high-tech standards using high-environmental technologies in the industrial production process. Nowadays, the international competitiveness of a country or a region is partly determined by the level of green technologies implementation in the process of industrial production.

Almost all developed and some developing countries (China, Brazil, and India) were able to gain new competitive advantages as a result of industrial policies aimed at developing green industries. Even in the absence of opportunities for introducing innovations into production, the potential for adapting the best available technologies remains and such a policy contributes to increasing employment and product exports. The effective result of the introduction of green technologies in the production process is examined by Altenburg & Assmann, (2017), who concluded that almost all developing countries received a competitive advantage due to the emergence of new green jobs.

The idea of transition to a green economy and, namely, the industry began to form quite recently, but there are many studies on this issue, including foreign and Russian ones. Some of the specialists offer a profound analysis of the different theoretical and empirical aspects of the sustainable development concept, namely current environmental problems, the building of green economies, climate policies, specifics of international interaction in the sphere of sustainable development, the role of civil society and characteristics of national models of sustainable development (Danilov-Danilyan & Piskulova, 2018), consider prerequisites for the further development of foreign economic relations in the environmental sphere within the EAEU, including the development of industrial cooperation and mutual investments, the movement of green FDI, and scientific and technological exchanges (Piskulova & Pak, 2017). Other researchers thoroughly describe the negative consequences of the transition to Industry 4.0 for the environment and the related obstacles in fighting climate change that allows outlining the key directions of state regulation of the digital economy for environment protection, as well as provide a detailed case overview of Russia and other countries (Zavyalova & Popkova, 2021).

Altenburg (2017) and Rodrik (2014) sum up the experience gained from decades of industrial policy research and reveal fundamental principles of smart policymaking that boost the government's capacity to cope with market failures while minimizing the potential risks.

At the moment, the subject of industrial development in terms of environmentally sustainable development within the integration unions, namely the Eurasian Economic Union has not been sufficiently developed in academia. In the previous papers, the authors of this research considered different aspects and directions of regional cooperation within the EAEU concerning trade and energy aspects of integration (Gurova et al., 2018; Kolomeytseva & Maksakova, 2019), the main issues of the Union's digitalisation process (Platonova & Maksakova, 2022) but did not pay enough attention to the environmental agenda and its impact on the industrial development in the EAEU. To fill this gap, the authors in this study turn to the topic of the EAEU industrial development and performance in terms of sustainable agenda.

The goals and objectives of EAEU economic development largely correspond with the ones of the UN SDG Agenda for the period up to 2030. Integration contributes to the achievement of SDG and becomes an additional tool for maintaining high-quality and sustainable growth of member states of the Union. The activities of the main supranational institution of the EAEU—Eurasian Economic Commission, in the context of contributing to the achievement of the sustainable goals are focused on the following directions: implementation of the SDGs in the system of regulatory mechanisms of the EAEU; monitoring of the SDGs achievement by the EAEU member states; assessment of the impact of integration on the achievement of the SDGs by the EAEU countries; development of new areas and technologies that will intensify the achievement of the SDGs. The main directions of the Eurasian Economic Union's economic development up to 2030 were put forward in October 2015 and also include sustainable use of resources and energy efficiency improvements (EAEU, 2015). The historic Paris Agreement signed by more than 190 countries entered into force in 2016, opened a new stage in world climate policy. Today, only two countries of the EAEU—Kazakhstan and Russia, have pledged to achieve net-zero carbon emissions by 2050 and 2060, respectively. The EAEU member states have serious environmental problems that have not yet become a priority in the work of the Union. The EAEU Treaty does not have a special section regulating environmental relations between the countries, there is only an Agreement on cooperation in the field of ecology and environmental protection. At the same time, all countries of the Union have their national programs aimed at energy efficiency improvement and a shift toward alternative energy sources. And the Union members have also declared their intention to develop mutual economic cooperation in terms of climate agenda, including the Paris Agreement goals and the UN SDG, and the formation of the necessary approaches and mechanisms based on the principles of the functioning of the single market of the EAEU.

40.2 Methodology

The study considers industrial development within the integration union in the Eurasian space using the index method and comparative analysis instruments. Based on UNIDO Industry Index, the authors rank and assess the industrial performance on SDG-9 of the EAEU countries. According to SDG-9, a country should create sustainable infrastructure, promote inclusive and sustainable industrialization, and stimulate innovation that can unleash dynamic and competitive economic forces that create jobs and income. They play a fundamental role in introducing and promoting know-how and new technologies, accelerating international trade, and enabling the efficient use of resources.

UNIDO's role in SDG-9 monitoring is to be a custodian agency of six SDG-9 Industry-related indicators. UNIDO is responsible for the collection, compilation, and dissemination of timely, internationally comparable statistics to support member states in the formulation of their development plan and programs in the context of ISID. The SDG-9 Industry covers all 3 dimensions of sustainable development: advancing economic competitiveness; creating shared prosperity; safeguarding the environment. According to the EAEU among the main objectives of industrial cooperation within the Union, we can define the following: acceleration and improvement of the sustainability of industrial development, modernization (technical re-equipment) of existing production facilities, stimulation of mutually beneficial industrial cooperation to create highly technological, and innovative and competitive products. Thus, for the purpose of this research, the authors use 4 of the above-mentioned indicators (9.2.1, 9.b.1, 9.2.2, and 9.4.1).

40.3 Results

40.3.1 SDG-9 Monitoring in the EAEU

In this part of the study, the authors analyze data for indicators related to the 9th Sustainable Development Goal «Industry, Innovation, and Infrastructure». SDG-9 comprises 8 Targets and 12 Indicators. But only three of these targets represent the scope of our analysis. *SDGs target 9.2* addresses the promotion of inclusive and sustainable industrialization, calling for countries to raise significantly the industry's share of employment and gross domestic product (GDP). SDG indicator 9.2.1 is "manufacturing value added (MVA) as a proportion of GDP and per capita" (United Nations, 2015). MVA is a widely used indicator to access the level of a country's industrialization. It measures the manufacturing sector's contribution to a country's total GDP. Belarus and Kyrgyzstan have their MVA share of GDP exceeding the world average level—21.5 and 17%, while the rest three countries merely exceed 12% each. In the medium-term period 2015–2020, there was noticed a positive dynamics of this indicator in the whole EAEU, especially in Kyrgyzstan which managed to exceed

Table 40.1 Manufacturing value added per capita in the EAEU (constant 2015 USD), annual growth rates (%)

Country	2015	2016	2017	2018	2019	2020	2015–2019	2015–2020
Armenia	332	368	410	455	493	503	10.3	8.7
Belarus	1235	1231	1315	1382	1398	1397	3.1	2.5
Kazakhstan	1078	1082	1132	1167	1220	1153	3.1	1.4
Kyrgyzstan	158	164	171	177	188	152	4.4	−0.8
Russia	1173	1205	1216	1235	1255	1195	1.7	0.4
World	1657	1677	1732	1777	1807	1667	2.2	0.1

Source Compiled by the authors based on UNIDO SDG-9 (2021b)

the world average in 2019 for the first time since 2016. As a country industrializes, its share of MVA in GDP rises.

Another important indicator is MVA per capita. It is the fundamental indicator of a country's level of industrialization adjusted for the size of its economy. In 2020, the global MVA per capita reached only USD 1667 compared with USD 1657 in 2015. Such an extremely low growth was a result of the COVID-19 pandemic, which broke the positive trend. The global average growth rate amounted to 2.2% within the pre-pandemic period 2015–2019 and plummeted in 2020. There was a 7.7% decline. As for the countries of the Eurasian Economic Union, there was noticed a positive medium-term dynamics up to 2019 strongly hit in 2020 as a result of global lockdown. Armenia was the only country with MVA per capita growth even in 2020. As a country industrializes, its MVA per capita increases. According to Table 40.1 data, Belarus is the leader in MVA per capita among the countries of the Union. It amounted to USD 1397 with an annual growth rate of 2.5% in 2015–2020. Russia ranks second, followed by Kazakhstan. Armenia and Kyrgyzstan have the lowest MVA per capita within the Union. Nevertheless, Armenia demonstrates the highest growth rates within the EAEU due to the low base effect.

SDG indicator 9.2.2 is "manufacturing employment as a proportion of total employment" (UN, 2015). Manufacturing can create jobs that offer higher wages as a result of higher levels of productivity. Hence, the manufacturing sector plays an important role in economic growth, particularly when countries are at a relatively low-income level. UNIDO classifies countries by global income groups. Under this classification, the five EAEU countries represent various groups depending on their GDP per capita:

1. Industrialized economies: Upper Middle Income (Belarus, Russia)
2. Emerging industrial economies: Upper Middle Income (Kazakhstan)
3. Other developing economies: Upper Middle Income (Armenia) and Lower Middle Income (Kyrgyzstan).

Industrialized and developing economies display wide differences in the way manufacturing drives economic growth. In developing countries, contributions to output growth mainly derive from capital investments and natural resources and energy; in industrialized countries, they come from productivity. High-income countries typically use labor and resource-saving technology that permits them to extend output not increasing considerably factor inputs. Thus, the share of manufacturing employment in total employment, and therefore, the absolute number of manufacturing jobs typically fall in high-income countries (Kolomeytseva et al. 2020).

In 2019, only 13.7% of the world's working population was employed in manufacturing. As the country industrializes, its share of manufacturing employment increases. The world's manufacturing employment share in total employment has fallen from 14.4 to 13.7% within 2015–2019. In 2019, the indicator exceeded the global average only in two countries of the Union—Belarus and Russia (17.4 and 14.3%, respectively). Despite the general upcoming trend, the situation in Belarus corresponded with the global reality, and there was a decrease of 3.1%. At the same time, manufacturing employment's share in total employment raised significantly in Armenia and Kyrgyzstan by 2.0 and 4.4%, respectively. Kazakhstan is the only country in the Union with the lowest share (6.8%).

SDGs target 9.4 addresses the environmental sustainability of industrial development, calling for industries to cause less damage to the environment due to higher resource-use efficiency and greater adoption of eco-friendly technologies and industrial processes. SDG indicator 9.4.1 is "CO_2 emissions per unit of value-added" (United Nations, 2015). This indicator measures carbon intensity. It reports the quantity of carbon dioxide emissions generated per unit of value-added. Manufacturing industries gradually reduce their emissions as countries industrialize. At the subsector level, the production of chemicals and chemical products, basic metals, and non-metallic mineral products usually lead to a high volume of emissions. To minimize CO_2 emissions in manufacturing, it is necessary to make structural changes and diversify the product (UNIDO, 2021a, UNIDO, 2021b).

Most of the countries of the former Soviet Union are characterized by the high energy intensity of their economies and cannot boast a low level of greenhouse gas emissions. According to Fig. 40.1 data, Kazakhstan and Russia have the highest CO_2 emissions within the EAEU. Belarus outperforms the above-mentioned countries. At first glance, it seems that the countries with a smaller role of industrial production in economic development (Armenia and Kyrgyzstan) have better performance on this indicator. However, the figures show the insufficient level of industrial development rather than success in the field of energy efficiency in these countries. Nevertheless, as an MVA share in Kyrgyzstan's GDP is growing, its carbon footprint is increasing too.

SDG Indicator 9.B.1 is the proportion of "medium and high-tech value-added in total value-added" (United Nations, 2015). It assesses the share of a country's manufacturing value-added derived from medium to high-tech industry outputs. In 2018, Belarus had the highest share of medium and high-tech industry in MVA (40%). Nevertheless, the indicator was still less than the world's average (45.13%). Russia ranked second with 30.49%. The figures show that the industrial sector in Kazakhstan (14.51%), and especially in Armenia (4.84%) and Kyrgyzstan (2.80%), is not focused on high-tech and innovative products. And this is a typical problem for

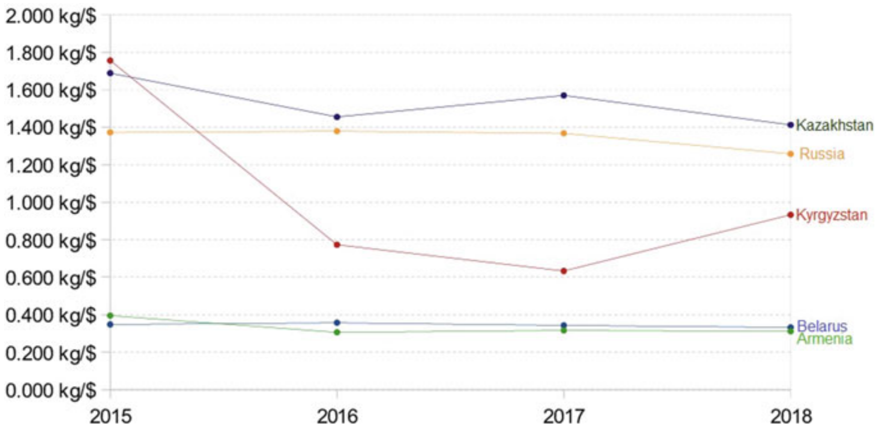

Fig. 40.1 Carbon dioxide emissions per unit of manufacturing value-added (kilograms of CO_2 per constant 2015 USD). 2021b *Source* Compiled by the authors based on UNIDO SDG-9

the whole Union. Labor- and capital-intensive industries (food and beverages, fuels, and basic metals) remain the leading industries in the Union. Fuels and basic metals account for 40% of MVA, food, beverages, and tobacco—15.3%, chemicals—14.8%, while machinery and appliances; office equipment—for only 4.9%. The countries of the Union have all the necessary production factors and should develop mutual technological cooperation to become less dependent on the foreign medium and high-tech products and much more competitive on both foreign and common markets.

40.3.2 *Inclusive and Sustainable Industrialization of the EAEU Countries*

UNIDO has developed the SDG-9 Industry Index—a tool for assessing 128 countries' performance in terms of their achievement of the industry-related targets of the UN SDG-9. Its values are normalized between 0 (bottom) and 1 (top), with an inverse normalization for CO_2 efficiency, as reductions in CO_2 are desirable. The country with the highest level of manufacturing CO_2 intensity is appointed a value of 0, and the one with the lowest, a value of 1. The Index can be used for analyzing the inclusive and sustainable industrial development at a country level.

In 2018, the highest score was achieved by China, Taiwan Province. It had the highest scores in value-added (1.0), employment (1.0), CO_2 efficiency (0.97), made substantial progress in technology (0.86), and relatively fair in value-added per capita (0.33). The province's MVA share of GDP amounted to 32.5%, and MVA per capita—to USD 7951. The share of manufacturing employment in total employment reached 27.7%. Despite its positive contribution in 2018, the performance has deteriorated since 2000, and there has been a decline of 1.5%. The share of medium- and high-tech manufacturing value-added in total MVA reached 69.5% much higher than in industrialized economy's average (50.7%). China, Taiwan Province is followed by Ireland, Switzerland, Republic of Korea, Germany, and Singapore.

It is important to mention that industrialized economies used to outperform developing economies in terms of sustainable development, as they use energy efficiency technologies and also renewable sources of energy. So, the EAEU countries perform differently SDG-9 Industrial Index. According to the latest available data, in 2018, industrialized Belarus and Russia outperformed the rest three countries (Table 40.2). In general, only Armenia, Belarus, and Kazakhstan improved their positions compared with 2000.

According to UNIDO, Belarus has the highest position in terms of inclusive and sustainable industrialization within the EAEU. In 2018, it achieved the following scores in the components of the SDG-9 Industry Index: CO_2 efficiency (0.94), value added (0.86), employment (0.62), technology (0.50), and value-added per capita (0.06). Since 2000, the country has made respectable progress in all indicators, except employment and technology. Although the share of manufacturing employment has fallen, still it is the highest within the Union, and above the average level of industrialized economies. Despite its decline by 2.0% since 2000, the share of medium- and high-tech manufacturing value-added in total MVA (40%) is much higher than in the EAEU (29.3%) but lower than in the industrialized economy's average (50.7%).

Russia has made not much progress toward the SDG-9 Industry targets since 2000. In 2018, it achieved the following scores in the components of the SDG-9 Industry Index: CO_2 efficiency (0.77), employment (0.49), technology (0.38), value added (0.37), and value-added per capita (0.05). The country's performance in all the five indicators was insignificant (or even negative) and far below the industrialized economy's average level. For instance, the average MVA per capita in this country group exceeds USD 5,463, i.e., almost 5 times higher than in Russia, as well as the average CO_2 emissions from manufacturing amounting to 0.22 kg per USD in industrialized economies, which is much less than 1.37 kg per USD in Russia. Russia's performance in the following three indicators has deteriorated since 2000: value-added, employment, and technology. In general, Russia's ranks correspond to the average estimates for the EAEU (Fig. 40.2).

Kazakhstan, representing a group of emerging industrial economies, has demonstrated much moderate progress in terms of sustainable industrial development since 2000. In 2018, it achieved the following scores in the components of the SDG-9 Industry Index: CO_2 efficiency (0.74), value added (0.30), employment (0.20), technology (0.18), and value-added per capita (0.05). The country has made respectable progress in CO_2 emissions from manufacturing amounting to 1.41 kg per USD. Nevertheless, it has to improve the situation in the future, as the indicator is two times higher than in the emerging economy's average (as well as than in the EAEU). Besides, the country managed to improve its positions in MVA per capita which has doubled since 2000, amounting approximately to the emerging economy's average of USD 1352. Kazakhstan also has made substantial progress in technology, but still, it has to continue the progress at the current pace to narrow the gap with other

Table 40.2 SDG-9 Industry Index in the EAEU

	Armenia		Belarus		Kazakhstan		Kyrgyzstan		Russia	
	2000	2018	2000	2018	2000	2018	2000	2018	2000	2018
Rank	106	102	41	28	93	83	97	109	44	49
Value-added										
MVA (% of GDP)	9.8	11.2	16.3	22.4	12.8	10.6	24.2	14.7	14.8	12.6
MVA per capita (constant 2015 USD)	124	455	431	1382	566	1167	173	177	792	1235
Employment										
Manufacturing employment (% of total employment)	8.0	9.9	26.5	17.6	7.8	6.7	6.4	11.8	19.5	14.1
CO_2 efficiency										
CO_2 emissions from manufacturing per unit of MVA (kg per constant 2015 USD)	1.90	0.31	0.68	0.33	2.18	1.41	0.99	0.93	1.39	1.26
Technology										
Medium- and high-tech MVA (% of value added)	9.5	4.8	42.0	40.0	5.2	14.5	5.9	2.8	32.7	30.5

Source Compiled by the authors based on UNIDO, (2021a, 2021b)

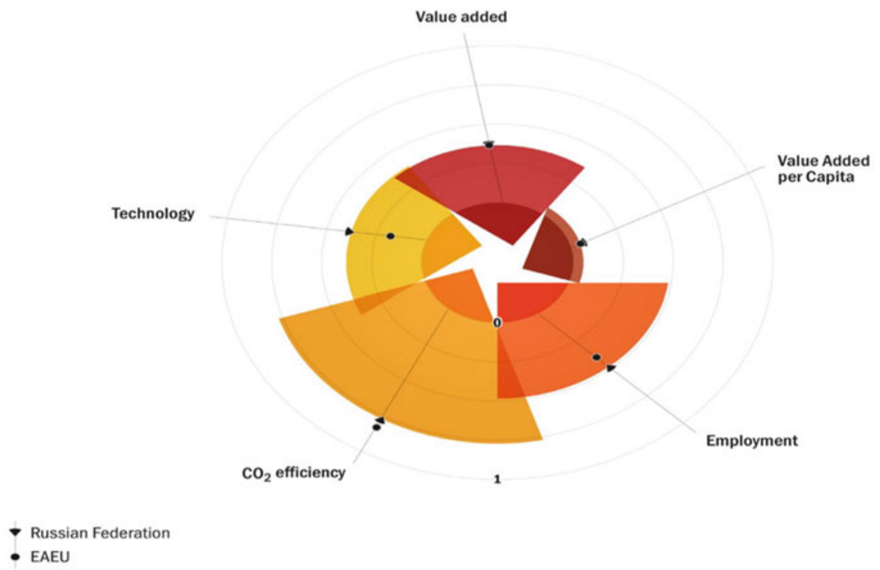

Fig. 40.2 SDG-9 Industry Index, the performance of Russia, and the EAEU, 2018. (2021a, 2021b *Source:* Compiled by the authors based on UNIDO)

emerging industrial economies and countries of the EAEU. The following indicators have deteriorated since 2000: MVA's share of GDP and the share of manufacturing employment. There is a serious gap between Kazakhstan and other emerging industrial economies (and also countries of the EAEU) on these two indicators.

Armenia and Kyrgyzstan represent other developing countries group. In 2018, Armenia achieved the following scores in the components of the SDG-9 Industry Index: CO_2 efficiency (0.94), employment (0.33), value added (0.32), technology (0.06), and value-added per capita (0.02). Armenia has the highest score in CO_2 efficiency within the EAEU. Besides, there has been substantial progress in manufacturing employment since 2000. Nevertheless, this indicator is lower both in other developing economies (10.7%) and in the EAEU (13.4%). Armenia has made respectable progress in both value-added indicators, while its performance has deteriorated in technology since 2000. The share of medium- and high-tech manufacturing value-added in total MVA has fallen to 4.8% which is five times lower than in other developing economies' average (20.5%) and six times lower than in the EAEU (29.3%).

In 2018, Kyrgyzstan achieved the following scores in the components of the SDG-9 Industry Index: CO_2 efficiency (0.83), value added (0.43), employment (0.40), technology (0.03), and value-added per capita (0.01). Kyrgyzstan has also made substantial progress in manufacturing employment since 2000 and has increased its scores in CO_2 efficiency. Besides, there has been insignificant progress in MVA per capita, which is still less than in other developing economies (USD 300) and is the least within the EAEU. Despite its positive contribution in 2018, the MVA's share of

GDP has deteriorated since 2000. The share of medium- and high-tech manufacturing value-added in total MVA has fallen to 2.8% which is seven times lower than in other developing economies' average and ten times lower than in the EAEU. Armenia and Kyrgyzstan both have to reverse their negative trends to succeed in their progress toward the SDG-9 Industry targets.

Figure 40.2 presents the comparative performance of Russia and the whole EAEU in the SDG-9 Industry Index. A closer examination of the underlying indicators comprised in the SDG-9 Industry Index helps to reveal some areas for potential improvement of their industrial performance in terms of environmentally sustainable development such as manufacturing value-added, technology, and employment.

Within the framework of green industrial policy in Russia, special attention is paid to such instruments as the introduction of technologies of high-environmental standards in industrial production, as well as green certification as a way to minimize environmental risks and maximize the quality of life. One of the main strategies of the national project "Ecology" for the period 2019–2024 is the introduction of environmental technologies at industrial enterprises to increase economic competitiveness and investment attractiveness.

40.4 Conclusion

In terms of environmentally sustainable development, the current condition of the manufacturing industry in the EAEU is far from favorable performance. Members of the Union have serious environmental problems that have not yet become priority tasks in the work of the EAEU. At the supranational level, we can see only the first steps of the EAEU toward implementation of SDG principles in the main official documents, regulating the integration process. According to the UNIDO classification, the EAEU countries represent different groups depending on their GDP per capita: industrialized economies (Belarus, Russia), emerging industrial economies (Kazakhstan), and other developing economies (Armenia, Kyrgyzstan). Industrialized and developing economies display wide differences in the way manufacturing drives economic growth.

The analysis shows that the EAEU industrial sector plays an important role in economic growth and integration development, but it is not focused on high-tech and innovation products, some figures show the insufficient level of industrial development rather than success in the field of energy efficiency, many indicators are still less than the world's average, and most of the EAEU members are characterized by high energy intensity of their economies and cannot boast a low level of greenhouse gas emissions.

Based on UNIDO's SDG-9 Industry Index, which is used for analyzing the inclusive and sustainable industrial development at a country level and consists of five indicators, assigned to the industry-related targets across four main dimensions: value-added, employment, CO_2 efficiency, and technology, and the authors may conclude that the EAEU states perform differently. Among all the EAEU members, Belarus has the highest positions in terms of inclusive and sustainable industrialization within the EAEU, Russia's ranks correspond to the average estimates for the EAEU and make not much progress in terms of sustainable industrial development, Kazakhstan also demonstrates moderate progress, showing improvement in some of the SDG-9 Industry Index components (CO_2 efficiency, MVA per capita and technology), and Armenia and Kyrgyzstan also show modest progress and both have to reverse their negative trends to succeed in their progress toward the SDG-9 Industry targets.

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Chapter 41
From Scientific and Technical to Socio-Ecological revolution–A Step into the Future

Olga I. Ostrovskaya, Galina M. Golobokova, and Matvey G. Chertovskikh

41.1 Introduction

The paper is devoted to the most pressing issues related to rapid environmental changes. Unfortunately, many of these changes are dramatic and force urgent action. The question is–what exactly needs to be done. Understanding this is an extremely challenging task that is unlikely to be undertaken for one person or a single group of scientists. Currently, it is only apparent that local, point changes, or separate actions are drowning in a sea of growing problems.

Let us pay attention to the very authoritative forecast of Bank of America Merrill Lynch, made by the bank for its investors in 2019. The conclusions of this forecast are replete with pessimistic expectations in the global economy, with the most ambiguous and most negative conclusions concerning, among other things, the environment: “By the end of the decade, the world’s population will increase by almost 1 billion people. An increase in population will overload the planet’s limited resources, but it can also exhaust the remaining carbon budget, accelerating the pace of global warming and raising temperatures above the critical point, which will have devastating economic, social, and political consequences”.

However, is everything so hopeless? Is it worth talking about ecology, predicting an inevitable catastrophe? Perhaps, it is necessary to consider the salvation resources

O. I. Ostrovskaya (✉)
Moscow Polytechnic University, Moscow, Russia
e-mail: oostr2009@yandex.ru

G. M. Golobokova
Republican Scientific Research Institute of Intellectual Property, Moscow, Russia
e-mail: golobokova@rniiis.ru

M. G. Chertovskikh
MGIMO University, Moscow, Russia
e-mail: Matt780@mail.ru

E. G. Popkova and B. S. Sergi (eds.), *Current Problems of the Global Environmental Economy Under the Conditions of Climate Change and the Perspectives of Sustainable Development*, Advances in Global Change Research 73, https://doi.org/10.1007/978-3-031-19979-0_41

that humanity can attract by changing the settings of its collective mind from negative to constructive-positive and, based on positive expectations, move on to systematic smart multifaceted measures to improve their own habitat and, as a direct consequence, to save nature.

Can we assume that the main cause of environmental problems is population growth? Does not it seem that such ideas are far from new? Back at the turn of the eighteenth–nineteenth centuries, Thomas Robert Malthus believed that the world was in danger of overpopulation and famine in the nearest future. However, he could not consider one important factor that nullified all his forecasts–he did not consider scientific and technological progress. Nowadays, such ideas are unacceptable from ethical and humane positions, as well as from the standpoint of historical experience, which has shown that such a development factor as "intellect" should be considered and actively used to solve such a problem.

We believe that the alarming environmental situation is caused not by the growing population but by the environmental irresponsibility of economic and business entities. To make actions for saving the environment effective, it is necessary to transform key economic, political, and social channels and management mechanisms.

41.2 Methodology

The research aims to initiate a discussion on the issues of the "green economy", in particular, on the development of mechanisms to stimulate economic entities to be environmentally and socially responsible through "green" monetary and financial instruments.

How do we do this? In which direction should we move? What are the forces that can help carry out this transformation? What resources should be connected, and which technologies should be implemented? Who will have the courage and make responsible decisions? This is only part of the issues that now concern environmentalists and common people.

If it were not for the linguistics section of derivatology, we might not have known that the concepts of "economics" and "ecology" have a common root and a close origin. Their lexical core is the Greek word οἶκος ("house"). In the word "economy", the suffix νμμειν means "management", "household management", or "management of resources". In turn, λγγια at the end of the word "ecology" means "study". Since immemorial times, people have perceived the world around them as an extension of their own home. Nevertheless, ecology and economics turned out to be on different sides over time. These two concepts will become a dialectical pair in a little longer, turning from a single common root into an absolute dialectical opposite. This change will mean that a direct rigid inverse relationship will be established between the development of the economy and the state of the environment: the economy is growing–the ecology is being destroyed.

What happened to a civilization where the economy and ecology stood on opposite sides?

Nowadays, the connection between economics and ecology remains inextricable, not yet unambiguous. However, the economy increasingly harms the environment and "cleans up after itself" less and less.

More resources are required for the development of the economy, which, in turn, must be renewed with increasing speed and intensity or, in case of exhaustion, replaced with alternative ones. The recycling problem–the reverse effect of resource consumption–is becoming increasingly acute. This problem is growing exponentially because economic growth and income growth are currently spurred by aggressive advertising cultivation of overconsumption, the introduction into the consumer's consciousness of the possibility of receiving system discounts, cashback, easy consumer loans, etc., and various banking tricks, stimulating consumers to buy new items.

It seems that some irresponsible business leaders with the right to make important decisions actively launch an "information virus" that only a billion inhabitants should remain on the planet, that everything is bad and hopeless to such an extent that it is time for people to come to terms with the rapidly deteriorating ecology because it is people's fault that there are too many of them, and soon, they will exhaust resources and will not be able to feed themselves. Thus, these business leaders shy away from solving pressing problems, particularly environmental problems (Kontinent 4V, 2008; Overpopulation). This position leads to the introjection of the idea into the consciousness of consumers that irreversible climate changes are coming, it is time to forget about earth and look at the prospects of Mars colonization, etc. Moreover, there is an active purposeful primitivization of the population's consciousness, which contributes to the launch of such myths (Information Agency "Regnum", 2021).

The only environmental problem that cannot be localized and that causes noticeable material damage to global business and the entire human civilization is global climate change. Perhaps, this problem remains in the top trend just for this reason. According to the European Commission, from 2007 to 2016, economic losses from extreme weather conditions increased worldwide by 86% and amounted to €117 billion in 2016 (Delbeke & Vis, 2016; National Center for Public Private Partnership, 2021; Sorokin, 2011).

Global warming is not an independent problem. It is an integral problem, derived, among other things, from the predatory attitude toward nature in all areas of nature management and irrational use of resources by contemporary civilization. To think about global warming without raising all causes of its occurrence is an overgeneralization.

As mentioned earlier, the functioning of economic entities (including consumers) is one of the main causes of global environmental problems, including the following:

- emissions into atmospheric air;
- discharges into the water;
- land pollution, impoverishment, and desertification;
- destruction of forests;
- waste generation;
- effects of toxic and dangerous substances on humans and wildlife;

- loss of non-renewable natural resources;
- other forms of pollution (noise, smell, visual effects, light pollution, vibration, electromagnetic radiation, radiation, infectious agents, etc.).

Corporations realize their commercial or other goals, and, following a normal healthy logic, they should be responsible for their contribution to the overall deterioration of the environmental situation. The responsibility should be shared, regardless of whether they work in environmentally hazardous or manufacturing industries or simply engage in office activities because they are all interconnected in economic turnover and are participants in common supply chains. Therefore, reducing the ecological footprint is the task of each organization, regardless of the nature of its main activity.

41.3 Results

We will deliberately not delve into specific areas of ecology, discussing only the "ecological footprint" of an ordinary office company. Considering the issue from this angle will only strengthen the impression of the scale of environmental problems because the most numerous office companies in the world believe that they are poorly involved in causing environmental damage.

Offices are quite large consumers of heat and energy resources. Water and transport are required to ensure their work. Moreover, offices purchase various types of inventories. Up to 20% of the electricity and up to 45% of the generated thermal energy is consumed for municipal needs. The energy sector, whose consumers are offices, accounts for more than one-third of total CO_2 emissions, which is the main source of greenhouse gases. Water consumption in offices is associated exclusively with municipal needs. Nevertheless, this does not remove from them the urgency of the problems of pollution of reservoirs and lack of freshwater. The reserves of freshwater, the need for which is especially great for people, are insignificant and exhaustible. There is an acute shortage of freshwater in many places on the planet. According to today's science, freshwater accounts for approximately 2.5% of the world's reserves. If we consider that about 75% of freshwater is frozen, about 24% is underground in the form of groundwater, and 0.5% is soil moisture, then freshwater accounts for slightly more than 0.01% of the world's water reserves. It should be noted that 80% of all diseases worldwide are associated with poor quality of drinking water and violations of sanitary and hygienic standards of water supply (Water Science School, 2018). It should also be noted that the property located in the office (including electricity and water resources) does not belong to employees, and the necessary culture of handling "shared" resources is most often not formed.

The use of transport is associated with the primary and economic activities of any organization, and offices are no exception. It has a very significant impact on the atmosphere through CO_2 emissions, leaving a carbon footprint, ultimately contributing to global warming. The harmful effects of transport do not end with CO_2 emissions. The use of transport entails emissions of exhaust gases into the atmosphere, leading to an excess of permissible concentrations of toxic substances and carcinogens in the air and smog formation. The greatest danger is nitrogen oxides. When using sulfurous gasoline, sulfur oxides may enter the exhaust gases when using leaded gasoline – lead (tetraethyl lead), bromine, chlorine, and their compounds.

A great challenge for the environment is the use of various types of inventory items in the administrative and economic activities of office organizations; these are paper, office and household appliances, lighting equipment, stationery and household products made of plastic, metal, and wood, detergents, and antiseptics.

These inventory items are products of many manufacturing industries: petrochemical and chemical (the most unfavorable in terms of environmental impact), paper pulp and wood processing, instrumentation manufacturing industry, and other industries that consume resources and lead to various pollutions and carbon emissions.

Offices are key consumers of paper. For its production, wood is required, obtained mainly due to deforestation of natural origin. Approximately 20–25 trees need to be cut down to produce 1 ton of paper (Department of Nature Management & Environmental Protection of the City of Moscow, 2010). Deforestation leads to the destruction of ecosystems, disruption of carbon exchange, mechanical pollution of territories, and irreversible climate changes, including the formation of vortex flows leading to tornadoes and hurricanes. The most dangerous toxins used in paper production are dioxins, furans, sulfates, phenols, etc.

Housings and many electronics and electrical engineering components are made from gas and petrochemical products. Plastics are now produced mainly from natural gas or gas condensate. The production of synthetic plastics is based on polymerization and polycondensation reactions of low molecular weight starting substances extracted from coal, oil, or natural gas, such as benzene, ethylene, phenol, acetylene, and other monomers.

Toxic substances are widely used in producing materials for the manufacture of furniture: phenol (carbolic acid) and formaldehyde, which are poisonous and flammable. Formaldehyde has a high carcinogenic effect.

According to the researchers of the Waste Electrical and Electronic Equipment (WEEE) Forum, in 2021, people were expected to throw out 57.4 million tons of such garbage (Antoshchenko, 2021). The Great Wall of China weighs less, and it is the heaviest artificial object on the planet, writes the Independent (Cockburn, 2021).

The environmental situation in Russia is not the worst yet. Russia ranks 58th in the international rating of the Environmental Performance Index, 2020 of the Yale Center for Environmental Law and Policy (Yale Center for Environmental Law & Policy, 2020). If we compare it with the leaders of environmental indifference: Liberia, Myanmar, and Afghanistan, occupying 180, 179, and 178 positions, respectively, it seems that everything is not so bad. If we pay attention to the countries at the top of the rating, we see that these are our closest neighbors: Finland–7th place, Sweden–8th, Norway–9th, Estonia–30th, Lithuania–35th, Latvia–36th, and Poland–37th place, having either common borders with us or located in close regional proximity. After that, Russia's 58th place no longer seems to be a reason to remain calm.

The speed of climate change in Russia is of particular concern. According to observations of Russian weather stations, the average annual air temperature in Russia has increased by 1°C over the past century (which is significantly higher than the global average), of which 0.4°C–only in the last decade of the twentieth century and by 0.47°C in a decade (from 2008 to 2018). Simultaneously, the average temperature of the entire planet increases by 0.17–0.18°C per decade. This means that global warming in Russia is 2.5 times faster than worldwide (Smirnova, 2019).

When we study global statistics, it seems that office companies can do nothing for the environment, and climate change is hardly under their control. It is difficult to disagree with this. However, about ten years ago, we hoped that the concept of corporate social responsibility (CSR), which came to Russia from abroad, would work a miracle. In Russia, the corresponding ISO standard was put into effect in the form of the National Standard of the Russian Federation "GOST R ISO 26000–2012" (International Organization for Standardization, 2010).

In 2012, it seemed that the idea of CSR was rational and quite promising for Russia. Indeed, some Russian organizations have taken a risk and made some progress along this path, but there are only a few of them. For example, VEB.RF adopted a Corporate Social Responsibility Strategy, recognizing that it, as a development institution, can contribute to environmentally oriented economic growth, introduce environmentally efficient technologies, reduce environmental impact, apply environmentally sound waste management, and form an ecological culture. The company began to implement this strategy following the standard (Vnesheconombank, 2011). However, it should be noted that VEB.RF is not an ordinary commercial structure but a state development corporation.

M. Porter and M. Kramer considered two models of CSR development: responsive and strategic (Porter & Kramer, 2006). Responsive CSR aims to solve the company's problems and eliminate negative consequences from its activities. The strategic model provides for embedding the idea of social responsibility into the overall strategy of the company to create long-term competitive advantages.

The initiators of CSR abroad were large corporations, especially those seeking to increase their goodwill. According to the results of achievements in the field of CSR, companies should publish special reports. There are about eight major systems of corporate social responsibility in the world. Corporations join and fulfill the conditions of one or more standards; the minimum of them for a set of requirements, perhaps, is the UN Global Compact with its own rules, which companies undertake to comply with. There is no liability for violation of the obligations assumed by the company. In fact, the UN Global Compact is a kind of elite club, inaccessible to either small or medium-sized businesses.

The practice of CSR is the subject of numerous disputes. The "stumbling block" of these disputes is the question: "Is there a real economic feasibility of expensive measures related to corporate social responsibility?".

The content of these disputes is as follows. Defenders believe that CSR is an economically sound choice of a corporation, and it will receive long-term strategic advantages, not short-term benefits in the form of profit. Critics argue that CSR is an embellishment of reality that takes business away from its "fundamental economic role".

Analyzing the content of the dispute, we see that CSR supporters have complex long-term tasks of sustainable business development on one side of the scale and short-term benefits on the other. The structure of the opponents' arguments is different; they worry about the "fundamental economic role of business", which socially responsible companies promise to perform properly.

That is, the dispute develops in at least two different planes. Having made a decomposition of this controversy, we will highlight the problematic issues arising from this dispute:

1. What is currently happening with the concept of long-term and sustainable development?
2. Why has the choice in favor of momentary benefits become possible and popular? What contributes to this?
3. What is the "fundamental economic role" of the companies, and why do the opponents of CSR find contradictions with this concept and sustainable development pursuits?
4. Where did the idea come from that a commercial organization has a fundamental role in acting only in the field of the economy?

41.4 Conclusion

Let us analyze these provisions.

If we talk about sustainable development, to which the topic of CSR invariably leads, then we see that the subjects of sustainable development are exclusively global corporations that discover new economic opportunities in adjusting the course of their business according to the green vector. Once again, we meet members of the "elite club" who are engaged in those topics of sustainable development that promise them super-profits. Nevertheless, environmental and nature restoration, social, educational, and similar functions are performed by states, and the customers of green infrastructure projects are also states, but not all of them can afford it.

In response to the question about the essence of the current state of the concept of sustainable development, we will say the following. In the linguistic sense of this word, we do not observe sustainable development as a phenomenon indicating the sustainability of life, especially in the last 3–4 years.

However, the concept of sustainable development exists. It exists in the international business, but only in the form in which it was adopted by global companies specializing in promising projects in the field of alternative energy and alternative transport. Here, they are exactly the "backbone" of the subjects of the concept of sustainable development. Additionally, global companies that increase their moral capital with the help of green and sustainable ratings fit into this concept, along with global financial regulators of green finance and exchange operators.

Why are more and more companies forced to choose short-term solutions and short-term benefits? When international corporations are contriving to create futuristic projects, national business, especially small and medium-sized, serves vital needs of the population at the local level and gives the maximum number of jobs for ordinary citizens. The management with planning, competent management processes, qualified staff with the necessary functionality, etc., has nothing to do with the organization of the work of most local companies. In the production, these are "hangar" workshops; in the non-production sphere, these are offices with an incomplete set of personnel who randomly do any work that the manager assigns to them.

These companies permanently exist in conditions of a shortage of financing of current activities. They do not have funds for development and sustainable development. Their solutions (goods, services, works, and processes) are built on momentary opportunities. For them, the formula "money is more expensive today than money tomorrow" has been brought to the formula "money is today, what will happen tomorrow is unknown". They live from crisis to crisis.

Their marginality decreases after each round of the crisis or the next fiscal blow. The state "releases" another portion of unsecured money to partially dampen the new blow. However, they only partially cover the inflationary growth, as a result of which the purchasing power of the population once again decreases, and companies, reacting to a reduction in effective demand, raise prices. In such a high degree of uncertainty, companies, as a rule, do not have a balanced budget and live by the principle: incomes came–debts were closed–the rest was spent to restore turnover assets until prices rose–and it is good if there is a little money left for wages. Such "development" does not fit the definition of sustainability because, after each economic crisis, local economic entities return to an even worse state than before the crisis.

The next question is related to the origin of the idea that the fundamental role of a business organization is economical. The idea that the purpose of a commercial company is profit was formed in the economic teaching of the classics of political economy in the period from the second half of the seventeenth century to the first half of the nineteenth century. At that time, commercial activity began to be defined through profit, primarily to give it the main distinguishing feature from other non-commercial activities, which was later reflected in civil law.

In the first half of the twentieth century, the famous economist Peter Drucker reasonably questioned this interpretation of the purpose of the company's existence. He reflected that a company could operate without profit but still perform its function. A firm makes an offer to the market in the form of products, works, or services, and if, at the same time, it makes up for costs (reimbursement of material costs and wages) and invests in development, then such a firm can exist and offer a useful product to the market for as long as it wants; it does not cease to be a commercial company, even if it does not have a net profit and does not set this as its main goal. Based on the real experience of companies, P. Drucker suggested that the company's main goal is to consider its survival, striving for which the company pursues several "survival goals" based on "survival functions". Herbert Simon, the Nobel Prize winner in economics, was of the same opinion. He concludes that profit maximization cannot be a goal because it is only a means to achieve the main goals of the company.

As a result of the development of the idea of the fundamental purpose of a commercial company, four main trends have formed:

1. The goal of the company is profit.
2. The goal of the company is the survival of the business.
3. The goal of the company is to capitalize or increase the value of the business.
4. The company has a system of goals (economic, investment, marketing, production, social, and strategy selection).

It is important to note that the first four approaches are formed from the firm's position. If we move to an independent position (metaposition) and look at the firm from its consumer's perspective, we will see that for consumers and society, the main goal of business is to satisfy needs with the help of goods (utilities). This means that the company, on the part of its consumers, has at least one more goal that is no less important than profit–the offer of a high-quality and in-demand product. This task cannot be attributed simply to the company's economic role. It simultaneously manifests a social role, expressed in the need to bring public benefit.

The fact that commercial companies primarily serve public interests often goes out of the spotlight of economists and ordinary citizens. The existence of a particular business is justified precisely because a particular product is in demand by society. Consequently, the company's main function is not economical at all (economic function is a second order) but bringing public benefit, serving people's interests, and meeting their needs. For this reason, society, in the person of individuals, experiences the corresponding need and pays the company for its goods or services. The free consent of the consumer to purchase the goods offered by the company is the source of its income and profit. Thus, business exists only because people buy what it offers.

What is the main conclusion arising from the first part that will help us move on to the second part of the article, in particular, to the issue of green money? The knot of economic and social contradictions that hinder the solution of environmental problems, at first glance, seems very confusing. However, if we look at it from the outside, it becomes apparent: To stop the environmental crisis, it should be "overtaken", which means going to the steps and activities that give a quick effect. From our experience, we all know that such an effect is provided by material incentives that are clear, understandable, and attractive to all participants in economic turnover. These incentives should work on the principle of money that can be earned only by making a green contribution to all systems of human civilization: economy, politics, culture, education, etc.

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Chapter 42
Formation of Competencies for the Sustainable Development of Future Teachers of Mathematics

Meilihan A. Altybaeva, Kaukhar A. Sooronbaeva, Elnura T. Avazova, and Raykhan Zh. Turganbaeva

There is no certainty in the sciences where one of the mathematical sciences cannot be applied, or which are not in relation with these mathematics.

(Leonardo da Vinci)

42.1 Introduction

At the World Summit on Sustainable Development, the leaders of the participating countries assumed joint responsibility for the development and strengthening of economic growth, social development, and environmental protection at all levels, which are integral components of sustainable development. It is clear to everyone that to build a prosperous, global world and solve the sustainability tasks outlined in the sustainable development goals (SDGs), people must be able to make changes and transformations for sustainability (Korotenko et al., 2003, 2014; Movement & "BIOM"., 2022).

The fundamental document of the Kyrgyz Republic on education notes that "… the priority of school education will be to improve the quality of education in the context of education formation for sustainable development" (Ministry of Economy of the Kyrgyz Republic, 2018).

The content of education in the SDGs will increasingly include not only issues related to environmental safety, economic development, and overcoming poverty but also comprehensive solutions to these problems (Bobylev & Zakharov, 2011).

M. A. Altybaeva (✉) · K. A. Sooronbaeva · E. T. Avazova · R. Z. Turganbaeva
Osh State University, Osh, Kyrgyzstan
e-mail: meilihan1950@gmail.com

R. Z. Turganbaeva
e-mail: turganbaeva.1955@mail.ru

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To implement the SDGs, as a full member of the UN, the Kyrgyz Republic adopted the National Strategy for Sustainable Development for 2013–2017, and then, the "National Strategy of the Kyrgyz Republic for 2018–2040" was approved by the Decree of the President of the Kyrgyz Republic. These fundamental documents outline measures to achieve the SDGs in the country and its regions, the implementation of which will lead to real results (Ministry of Economy of the Kyrgyz Republic, 2018; United Nations in Kyrgyz Republic, 2022).

It is indisputable that education plays a key role in development; without education, there can be no development in any production branch.

Therefore, all educational organizations, including general education schools, should organize the educational process so that students can expand their knowledge, form attitudes, and develop competencies that they will need throughout their lives and professional careers to solve problems in the field of sustainable development. Thus, SDG issues should become an integral part of the methodology and teaching of all subjects taught in secondary schools.

As the primary academic discipline in school, mathematics has ample opportunities to implement the SDGs. It contributes to developing special knowledge, skills, and abilities necessary to achieve specific sustainable development goals.

The learning objectives, the methods used, and the system for evaluating learning outcomes must be closely linked and complement each other (Altybaeva & Attokurova, 2017; Altybayeva, 2018).

Teachers are a real driving force for change, capable of contributing to implementing the SDGs through education. Their knowledge and professional experience are crucial in revising the educational process and transferring schools to the rails of sustainable development (Korotenko, 2021; Korotenko & Marchenko, 2013; Pavlova, 2009).

To do this, it is necessary to introduce the principles of sustainable development into the teacher training system.

The authors of the research set the following tasks:

- To analyze the current curricula and programs of disciplines of the professional cycle of physical and mathematical education (PhME) to find out how much and what content of educational material they relate to sustainable development;
- To clarify the awareness of mathematics teachers on sustainable development issues;
- To define the competence of a mathematics teacher necessary to promote sustainable development;
- To revise the content of the course "Practical course on solving mathematical problems (PCSMP)" for undergraduates of the PhME, considering the problems of sustainable development;
- To develop a new course program "Methods of teaching mathematics in a comprehensive school focused on sustainable development".

42.2 Materials and Methods

Osh State University (OshSU) has been training mathematics teachers since 1951. By the Decree of the Government of the Kyrgyz Republic, since 2012, the Republic has switched to two-level training of specialists. Since that time, the curriculum and the basic educational program (BEP) of physics and mathematics education have been revised almost every year since the State Higher Education Institution established only the competencies of future specialists, and the corresponding content, learning technologies, and others are determined by the university independently (Ministry of Education & Science of the Kyrgyz Republic, 2021).

For the last time, the BEP of "Physics and Mathematics Education" (Bachelor's degree) has been revised to integrate SDG issues. It is clear that there cannot be a separate academic discipline devoted to all sustainable development issues, and there is no need for this. The analysis of the BEP showed that the cycle of professional disciplines has no topics in any course that relate to the problems of the SDGs.

In this regard, we have chosen a practical course on solving mathematical problems with the same volume (6 credits). The course programs include tasks, the plots of which contain information related to the problems of sustainable development.

Most of these tasks are compiled by the authors based on such digital data as population size, products and consumption, land and water resources of the Kyrgyz Republic and their use, production, consumption, and saving of electricity, ecology and environment, etc.

To clarify the competencies of sustainable development of mathematics teachers, the authors conducted a survey among teachers of Osh, Karasu, Naukat, Alay, and Aravan districts of the Osh Region and Tash-Kumyr, Jalal-Abad Region.

The survey involved 218 teachers with work experience from 1 to 35 years. The survey showed that teachers are mainly guided by textbooks when teaching mathematics, being limited to the fact that they are included in educational and methodological complexes. The exercises and plot tasks in these textbooks rarely contain tasks that include the content of sustainable development. Moreover, even such tasks are not used by teachers in the SDGs. The reason for this is that teachers note unpreparedness in the walls of the educational institution.

The results of the survey of teachers and the analysis of the BEP "Physical and Mathematical education" showed the need to revise the results of the training program and the set of competencies according to the state educational standard "Physical and Mathematical Education" (Bachelor's degree level). When reviewing these documents, the main emphasis is placed on the fact that mathematics teachers focus on the formation of key, core competencies of students. Key competencies are the necessary competencies for all students of the world, regardless of their age. Such competencies are considered to be over-subject and transversal. The core competencies in the field of SDGs include systems thinking, forecasting, integrated problem solving, teamwork, strategic vision, etc.

Mathematics has a wide opportunity for the formation of each of these competencies. What does it take to be a math teacher? A math teacher must be competent in solving problems:

- To help students realize that understanding sustainable development is important for every person;
- Actively involve students in the discussion of sustainable development problems;
- Teach to analyze problems from different positions;
- Support and stimulate students' reflection on sustainable development problems not only in the classroom but also outside the formal education system.

Education plays an invaluable role in achieving SDGs. Education for sustainable development is based on broad interdisciplinary knowledge based on an integrated approach to the development of society, the economy, and the environment.

This study examines the formation of competencies related to the SDGs in mathematics teachers in the process of studying at a pedagogical university. The authors analyze the orientation of the content of the educational and methodological complexes of the disciplines of the curriculum "Physics and Mathematics education" on the SDGs, as well as on the content of the competencies of the Bachelor of Physics and Mathematics education (profile "Mathematics") included in the state educational standard of higher professional education of the Kyrgyz Republic (Ministry of Education & Science of the Kyrgyz Republic, 2021). The analysis results show that the competencies (5 universal and 21 professional) cover all areas of the future teacher's activity (Ministry of Education & Science of the Kyrgyz Republic, 2021).

The formation of a teacher's competence "at the exit" should demonstrate the possession of life skills (to cope with personal problems, manage time, draw up business documentation, etc.), supra-subject skills (to be able to defend their point of view, generalize and systematize information of various kinds, be able to find non-standard solutions, etc.), general pedagogical competencies (to study independently, improve qualifications, assess personal capability and various situations, make decisions and take responsibility for them, adapt to rapidly changing living and working conditions, etc.), and general subjects (knowledge of contemporary teaching technologies, the culture of communication, working with information and transmitting it, etc.) (Altybaeva, 2015; Altybaeva & Turdubaeva, 2012; Pavlova, 2009).

Future math teachers should have knowledge and experience in drawing up tasks that reflect the real environmental problems of the region, the problems of preserving the natural and cultural heritage of their native land, with the involvement of the students themselves. Let us look at some examples of tasks for grade 6 that meet rational consumption:

1. The cost of granulated sugar at retail in a store is 102 soms per 1 kg, and a bag of sugar (50 kg) costs 4800 soms. What is the best way to buy sugar: retail or wholesale (by bags)? How do you buy sugar in your family?
2. What kind of packaging of washing powder is more profitable for the hostess to buy if it is known that a package weighing 2 kg 400 g costs 450 soms, and a package weighing 450 g costs 102 soms. How much money will she save?

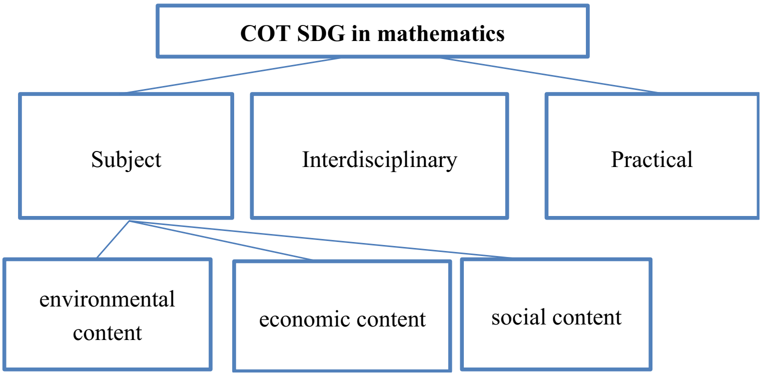

Fig. 42.1 Classification of competence-oriented tasks in mathematics related to the SDGs. *Source* Compiled by the authors based on (Shekhonin et al., 2014)

3. A young family saves 1500 soms every month to buy a refrigerator. How long will it take for her to buy a refrigerator if it costs 28000 soms?

The classification of competence-oriented mathematical tasks (COT) related to the SDGs can be presented in the following form (Fig. 42.1). This scheme was finalized by the authors based on a textbook by a team of authors on competence-oriented tasks (Shekhonin et al., 2014).

Let us give an example of compiling a COT of environmental content for grade 6 on the topic "Proportions":

- Stimulus: The healing power of the sea has been known since ancient times. Sea salt contains a huge amount of trace elements necessary for health.
- Task formulation: The saltiest of all the seas of the globe, the Dead Sea, contains up to 300 g of salt per 1 kg of water. Find out how many grams of salt are contained in 200 g of seawater. Learn about the benefits of seawater for human health. What should be done to protect seawater from pollution? Find information on the content of salt in Issyk-Kul Lake, "Dead Lake" near Issyk-Kul.
- Source: 1 kg = 1000 g. The main property of the proportion is if a:b = c:d.

42.3 Results and Discussion

The authors are confident that in the conditions of VUCA (volatility, uncertainty, complexity, and ambiguity), it is impossible to build long-term strategies and career prospects. Thus, the need to continuously rebuild a set of competencies, the competencies of the future, including competencies related to sustainable development, will be in demand in the labor market. This is due to globalization, the introduction of environmental principles in people's lives, the introduction of digital technologies in various spheres of life and production, the acceleration of technological progress, and demographic changes (Abdullah et al., 2017; Shukurov, 2009, 2016).

42.4 Conclusion

The concept of sustainable development is closely related to the state of consciousness and worldview of people. Since there is no universal model of sustainable development, each country should define its own action programs and specific goals and objectives based on local environmental, social, and economic conditions and outline optimal solutions.

At the meetings of the permanent seminar "Actual Problems of Teaching Mathematics" at the Department of Technology in Teaching Mathematics and Informatics, the participants discuss the ways to help teachers include ideas and problems of sustainable development in the curriculum of the school mathematics course.

As Academician Moiseev correctly notes, "a new civilization should begin not with a new economy but with new scientific knowledge and new educational programs … New moral principles should enter into the flesh and blood of man" (Moiseev, 2000). It is indisputable that, according to the great scientist A. Einstein, the further development of humankind will depend on its moral foundations and not on the level of technical achievements (Mirkin & Naumova, 2006).

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Chapter 43
The Instruments, Necessary for the Transition from the Scientific and Technological Revolution to the Socio-Ecological One

Irina A. Koroleva, Natalia V. Avtionova, and Olga V. Balandina

43.1 Introduction

For the first time, the term "green economy" appeared in the economy about 30 years ago (UN General Assembly, 2000). There are many definitions of the green economy; their authors proceed from different approaches. It is advisable to bring the definitions to a "single denominator".

Let us consider the conclusion proposed by experts on the green economy, which consists in the fact that in defining the term "green economy", it is necessary to proceed from the synthesis of general economic, sectoral, technological, and civilizational approaches, according to which it is possible to define the green economy as an economy of environmentally friendly industries and resource conservation, in which economic development and ecological culture are stimulated by state environmental and economic policy (Vukovic, 2018).

In our opinion, the synthesized approach described above is reflected to a certain extent in the following definition. The green economy is a system of economic activity associated with the production, distribution, and consumption of goods and services that lead to an improvement in people's well-being in the long term, without

I. A. Koroleva · N. V. Avtionova
A. S. Griboyedov Institute of International Law and Economics, Moscow, Russia
e-mail: ter_ira@mail.ru

N. V. Avtionova
e-mail: nataly-anv@mail.ru

O. V. Balandina (✉)
Academy of Labor and Social Relations, Moscow, Russia
e-mail: Bionik01@yandex.ru

I. A. Koroleva
Institute of modern art, Moscow, Russia

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exposing future generations to significant environmental risks and environmental deficits (Puzanova, 2010).

Currently, the definition given in the United Nations Environment Program (UNEP) is one of the most commonly used: green economy–an economy that leads to "improved human well-being and social equality, significantly reducing environmental risks and environmental deficits" (UNEP, 2011).

It should be noted that the global trend determining the sustainability of development is the transition from the traditional model of economic growth to the green economy. The green economy has great chances to become the economy of the future (Vukovic, 2018).

In June 2009, 34 countries signed the Green Growth Declaration, stating that they would "strengthen their efforts to implement green growth strategies within the framework of their measures to overcome the crisis and beyond, recognizing that the concepts of 'green' and 'growth' can be inextricably linked" (Green encyclopedia).

The opinion of experts, discussions in political circles, and speeches by activists have not yet produced tangible changes and results, most likely because the implementation of the new scenario largely contradicts everything that is characteristic of the model of unstable or economocentric development, which has begun with the transition of humankind to a productive economy and has long demonstrated environmental failure.

The aspiration and transition to the green economy involve the gradual restoration of natural ecosystems to a level that ensures the sustainability of the environment, and in which there is a real possibility of a healthy existence of future generations of people, meeting their vital needs and interests.

The synthesis of approaches to the concept of the green economy is justified because, like any economy, the green economy consists of many different economic subsystems and types of economic entities that must meet the green criteria. This means that resources, land use, technology, production, jobs, households, and recycling should be green. The green economy also presupposes the rational use of natural resources (this already correlates with production efficiency issues); it should also ensure the return of end-use products to a new production cycle.

43.2 Methodology

The result of the interaction of these subsystems (its tip) is a green product that must meet the following criteria:

- Environmental safety at all stages of the life cycle.
- Ecological utility (the product serves to improve the ecology and quality of the human environment).

As a result, through the disclosure of the essence of the concept of "green product" as an environmentally safe and environmentally useful product, we reach the main goal of the green economy–it should be aimed at producing an environmentally safe and environmentally useful product, and all its elements (subsystems) should participate in this, contributing to this and, in turn, meeting the criteria of environmental safety and environmental utility.

For our economy to become green, the following universal mechanisms should be incorporated into it.

1. Environmental impact assessment and monitoring and environmental utility assessment.

Before introducing any elements (raw materials, processes, products, etc.) into an economic turnover, an environmental impact assessment should be carried out. Then, their monitoring is carried out through the entire life cycle, followed by the use of the assessment results as baseline indicators and to measure the green value-added, which contributes to the environment and increases the "green capital" of a particular economic entity.

This approach will create a "filter" for the admission of any element of the green economy into economic turnover, as well as a clearly measurable system of criteria, indicators, and characteristics for environmental monitoring.

The system of environmental monitoring and assessment should be initially automated and is also mandatory as a financial and economic assessment of the activities of economic and business entities (green accounting, environmental statements, accounts, reports, audits, etc.). Simultaneously, environmental points can be accrued, which, during the input assessment and monitoring, should become the basis for strengthening the "green reputation" and accumulation of "green capital" of an economic or business entity.

2. Sustainable procurement.

Environmental and ethical characteristics of purchased products or services throughout their life cycle should be incorporated into the procurement system of any economic and business entity.

This approach will allow switching to the use of environmentally appropriate goods or services in a fairly short time and will encourage suppliers to behave in an environmentally responsible manner. The spread of sustainable procurement practices will be facilitated by an assessment and monitoring system that will make the environmental properties of any purchased product or service transparent and ensure their green assessment.

The management of environmental efficiency of procurement has been called the green procurement policy. It is an effective tool for direct and indirect impact (through the supply chain) on environmental efficiency. It is carried out in the following directions:

- Formation of a list of universal environmental requirements for purchased goods, works, and services and criteria for environmental friendliness. The work in this direction consists in the development of mandatory environmental requirements for the types of purchased products, the definition of a list of criteria for environmental friendliness, the conditions of their application, etc.

- Presentation of environmental requirements to suppliers in the course of procurement activities.

3. Environmental education, training, and awareness-raising of citizens.

Many people began to realize that for a person to survive, it is necessary to radically transform all areas of their activity to reduce pressure on the biosphere significantly–almost by an order of magnitude; and also to change themselves. The great difficulty lies in changing the value system, which should reflect the interests and needs of the current and future generations. People accustomed to a certain level of comfort and quality of life are often not ready to act differently, not because of extreme selfishness but because of habits, ignorance, and the lack of incentives.

It is necessary to consistently form an ecological culture through environmental education, training, and information to solve this problem. Environmental education and training should be comprehensive (all groups of the population should go through it), continuous (starting from preschool education and ending with on-the-job training), and end-to-end (pass sequentially from topic to topic, from practice to practice through all stages of training). It is necessary to start educating on ecological culture from early childhood and carry out this education through the whole life of a person. Only then will civilization cope with the task of forming an ecological person instead of an economic person.

It should be noted that the role of the human factor in achieving environmental goals is key in the green economy. It is impossible to achieve green behavior and green thinking only through directives, punishments, and compulsions. It is necessary to create social conditions, encourage and popularize examples of personal environmental responsibility, apply green incentives, and launch "green social elevators".

4. The formation of green jobs.

The information and communication revolution allowed changing the paradigm of labor organization that had developed at an early stage of the industrial economy.

The ways of solving environmental and economic problems, both at home and abroad, are often connected with each other. The assumption that the creation of green jobs can improve the environment and increase employment has contributed to the growth of the green economy in the USA and other countries.

The initiative to create green jobs was supported by the International Labour Organization (ILO), the International Organization of Employers (IOE), and the International Trade Union Confederation (ITUC).

The ILO defines green jobs as decent jobs that contribute to preserving or restoring the environment, whether in traditional sectors such as manufacturing and construction or in new, developing green sectors.

Green jobs contribute to the following:

- Improving the efficiency of energy and raw materials use.
- Limiting greenhouse gas emissions.

- Minimizing waste and pollution.
- Protecting and restoring ecosystems.
- Supporting adaptation to the effects of climate change (Trifonov, 2015).

An important element of this approach is that, among other things, green workplaces should comply with the principles of decent work: productive employment, appropriate income, social protection, and respect for the rights of workers, granting them the right to participate in decisions affecting their lives.

This approach reflects three aspects of sustainable development. Green jobs are decent work that significantly reduces the negative impact of economic activity on the environment and ultimately leads to the creation of viable enterprises and a sustainable economy.

At the enterprise level, green jobs can produce goods or provide services that benefit the environment, such as clean transportation.

However, green products and services are not always based on environmentally friendly production processes and technologies. Therefore, such workplaces can also be distinguished due to their contribution to more environmentally friendly processes. For example, green workplaces can reduce water consumption or improve recycling systems. However, green jobs defined in the manufacturing process do not necessarily produce environmental goods or services.

Nevertheless, there is still disagreement about which jobs should be classified as green.

The United Nations Environment Programme (UNEP) report states that “not all green places are equally green”. The authors insist that the bar in determining which jobs can be classified as green should be set at a high level. From an economic point of view, the accuracy of the definition plays a key role. Nowadays, government subsidies for green employment are widely used in many countries. Thus, many employers declare their company as green, although it is not.

The impact of the creation of green jobs on employment in the country has not been studied so far. There is an opinion that the costs of creating such places are much higher than usual, i.e., conditionally, instead of one green workplace, three ordinary ones can be created.

It is worth noting that the development of green jobs is also possible in the form of hybrid offices and remote employment in the so-called turquoise human-centered organizations. Some companies consider an employee not just as a cog that should effectively work and produce a certain result but look at the employee as a person. The results of a person, including production, highly depend on his or her physical and psychological state, relationships in the family, and the presence of personal problems.

5. Application of environmentally sound technologies and practices.

Green technologies are technical solutions, inventions, utility models, methods of using technical means, substances, components, materials, and production processes, methods of storage, transportation, disposal, and supply chains that meet the criteria of environmental safety and environmental utility.

Green technologies are divided into three categories:

- Environmentally friendly technologies (contribute to the environment);

All technologies that are originally designed to solve environmental problems fall into this category of technologies, such as waste disposal systems, water purification, air filtration, restoration of lands, forests, reservoirs. An example of such technologies can be systems of oxygen-free waste incineration with zero CO_2 emission and the production of an environmentally friendly product, for example, activated carbons, or algae used to clean reservoirs.

Additionally, the same category includes various production technologies and technologies for the production of works and the provision of services, which, in addition to the useful (consumer) cost, have an additional environmental effect. One of the examples of such technologies is technologies for growing plantation fast-growing wood for woodworking, wood processing, and house construction. Such a technological solution provides an environmentally positive product (eco-friendly building materials, eco-friendly raw materials for industry); moreover, landscaping and CO_2 neutralization occur as an additional environmental effect, because trees absorb it.

- Environmentally neutral technologies (do not harm the environment and human health).

Environmentally neutral technologies should not lead to environmental degradation. They may have a slight negative short-term effect, which is subject to rapid neutralization. An example is farming with the use of biological fertilizers.

- Technologies with justified environmental risks (significantly less harmful compared to those technologies that currently prevail in industries).

This group includes technologies in which the maximum minimization of environmental risks is achieved, in the case when these risks are unavoidable. An example is the production of the chemical industry, energy, and others that use harmful components or dangerous factors in their work but apply solutions to partially or completely neutralize these harmful effects.

Green technologies and practices are the main tools of the green economy. For inventors to focus their attention on the environmental properties of technologies, they must have an order for this from technology users.

Economic and business entities must bear additional costs to switch from traditional technologies to green technologies. Simultaneously, having introduced green technologies and practices, they begin to work in a new status, namely together with the economic added value, they begin to produce a green added product. This is worthy of material encouragement, which will aim to reimburse the costs of the ecological transition and stimulate further functioning in the green status.

Following this simple logic, the apparent conclusion is that without green monetary and financial mechanisms, there can be no question of forming a full-scale global green economy.

43.3 Results

As an economical category, money acts as a means of paying for goods, works, and services, participates in measuring their value, and also has the property of preserving its value for a certain period of time.

The concept of "finance" is not equivalent to the concept of "money". Finance is defined as a set of economic relations arising in the process of formation, distribution, and use of centralized and decentralized funds (Prokhorov, 1977; Reisberg et al., 2006).

The composition and formulations of finance functions differ significantly among themselves and depend on whether the proposed formulation is Russian or foreign. In Russia, the concept of "finance" is associated primarily with budgetary and tax relations. In international interpretation, the concept of "finance" is associated with the state, corporate, and global finance.

The difference between money and finance is apparent. In simple words, it can be explained as follows: if an issue or phenomenon is considered in the plane of commodity-money relations, then it will be about money and its functions, and if the angle of attention turns into the plane of relations related to funds, budgets, and the movement and distribution of cash flows, then this is finance.

The differences in concepts are important, first, to show the current state of development of green monetary and financial mechanisms, and second, to see the essence of green money, which is not the equivalent of green finance.

The first known financial mechanism for attracting capital to finance green projects was green bonds, which were issued in 2008 by the World Bank.

Interest in green finance is currently steadily growing. The growing interest in ESG (ecology, social policy, and corporate governance) confirms the statistics of regulators. In 2021, the market for sustainable public financing had grown more than six times (Makarova, 2021).

In this regard, a significant event was the congress "ESG–(P) Evolution", held by RBC on October 14, 2021. The main conclusion of the congress is that business has changed its attitude to ESG practices and tools and is now ready to apply them. Moreover, the main changes have occurred over the past year.

Even though the term "green economy" appeared more than 30 years ago, there is still no single definition of green finance.

Most often, they mean funds allocated to finance environmental projects. These include, in particular, investments in alternative energy, alternative transport, and environmental management programs, in the creation of environmental technologies, the waste management system, in the elimination of the consequences of oil spills, in the development of low-carbon technologies, etc.

To highlight the controversy around the concept of "green finance" and reveal their essence, we will give the opinion of specialists who have prepared a specialized textbook on green finance. They believe that it is too early to talk about green finance as a reality, the system has not yet developed, so there is no generally accepted definition yet. Some experts believe that green finance is synonymous with investments in environmentally sustainable development projects and the production of environmental goods and services, including investments in reducing greenhouse gas emissions. Another part considers them from the perspective of the banking sector as a kind of financial services and products.

The authors of the manual offer three different approaches to determining green finance.

The first approach consists of a narrow interpretation, in which green finance is understood as a set of financial products and services, the development, production, and use of which leads to a reduction in environmental and climate risks (Porfiryev, 2018).

The second approach represents a broad interpretation of green finance, which, in addition to the above, includes mechanisms for financing alternative energy projects, for example, special grid tariffs (FIT) for electricity from renewable sources (RES) and financial, specializing in green investments (e.g., carbon exchanges, which implement quotas for greenhouse gas emissions; funds such as Green Climate Fund), as well as financing or hedging instruments for such investments (Porfiryev, 2018).

The third approach considers green finance from a purely theoretical standpoint, as an example of a "metalanguage" that describes and characterizes the interdisciplinary use of various knowledge about the flow of funds in the process of environmental management (Porfiryev, 2018).

The last theoretical formulation shows that green finance is currently more a metaphor than an independent economic category. In fact, these are the same finances but directed to environmental projects or green financial and stock instruments. They are not connected with the flows of green money.

43.4 Conclusion

The authors have already mentioned that corporate social responsibility practices are inaccessible and unattractive for many local commercial companies and organizations, which, as a rule, use outdated technologies and equipment that do not meet even the minimum environmental requirements. The population, as a rule, is also not included in the green processes.

In this regard, it should be noted that in recent years there has been a visible trend of increasing the role of fiscal policy, which is manifested in measures that increase tax collection and in the increase in the amount of taxes. As a result, the increased fiscal burden slows down the economic development of companies and does not contribute to the financing of environmental measures. Together with the fiscal burden, as a rule, the burden of fines increases. In the light of these trends, it is impractical to apply harsh measures and penalties to stimulate the socially responsible behavior of local economic entities and citizens. Such an approach will lead to a negative attitude toward environmental measures rather than to a positive effect.

If local subjects and citizens remain outside the processes of environmental and social responsibility, then we will not be able to build a green economy. To involve them in the green economic turnover, economic incentives that increase interest are needed.

Such incentives can be based on such an economic category as green value-added, which is an assessment of the environmental contribution of an economic entity.

It is proposed to begin work on the formation of the concept of such a tool that could serve as an economic stimulator of green development in the form of green money.

The main question that arises about the development of the concept of green money is: "What mechanisms and forms can be used for them?" In an attempt to get closer to the answer to this question, the following question arises: "Are there analogues of such stimuli?".

Definitely, analogs have been and exist in our time. These are not complete analogs but only some elements similar to green money.

Historically, all socially oriented states paid attention to environmental problems in one way or another and looked for ways to solve them, including through the creation of systems and mechanisms that would allow the maximum number of subjects (enterprises and citizens) to be involved in solving environmental problems.

There is also a worthy example in the history of Russia. In the USSR, a full-scale consumer network was created to receive recyclables from organizations and the population (delivery of waste paper, glass containers, scrap metal, etc.), covering the territory of the whole country. Thus, the mechanisms of interaction with citizens included additional incentives that were very attractive at that time. The reception points bought secondary raw materials from the population, paying according to the price list for the quantity or weight of raw materials, and, as an additional incentive and a reinforcement for money, they issued special coupons, called coupons at that time. The number of coupons issued depended on the type and weight of the delivered raw materials. With these coupons, it was possible to get the right to buy scarce types of goods directly at reception points or in stores. The price of each scarce product was set both in rubles and in the number of coupons. Coupons had free circulation and could be transferred and accumulated; they were accepted at any recycling point or in stores that worked with this system. Coupons have formed a "market" value. They could be freely transferred to other citizens in exchange for money.

These coupons, by right, can be called a kind of prototype of "green money". The system was very popular with the population and worked effectively until the collapse of the USSR.

In today's world, environmental incentives are used to switch to eco-friendly transport or green energy. For example, in Japan, there is a law on the purchase by electric grid operators of only the energy that they received from renewable sources, as well as a green surcharge to the usual electricity tariff. In France, residents can receive monthly compensation up to €200 if they refuse a car (Investlab, 2019).

In our opinion, special attention should be paid to the experience of South Korea. Namely, this country is currently as close as possible to the introduction of economic stimulus measures that are close in essence to green money. With the help of green payment cards, which earn points for purchases of goods made with environmental innovations, residents can pay for housing and communal services, direct them to environmental and social projects, charity, etc. (Investlab, 2019).

Green electronic money can, for example, be issued in proportion to the amount of green value-added calculated based on green accounts and then be credited, in the form of environmental points earned by companies or citizens, to a bank card or sold through a specially created electronic platform.

It is difficult to say which state, foundation, organization, or association will be the initiator and organizer of such a system. The main thing here is something else–now, with the current level of development of information and communication technologies and smart systems, it has become technically possible. Within this system, even an international green currency can exist and develop, supplemented by elements.

The beginning can be laid by creating such incentives for citizens, for example, a system for organizing the collection of recyclables supplemented with bonuses for the purchase of environmentally friendly goods and services (green packaging, energy-efficient residential buildings, the transition to eco-transport and green energy, the purchase of wastewater treatment systems, etc.). Additionally, one can include incentives for participation in various volunteer activities for garbage collection, cleaning forests, parks, reservoirs, and much more.

The next step, together with the introduction of mechanisms for assessing and monitoring the ecological footprint, green technologies, sustainable procurement, green information and training, green jobs, and green products, is the possible transfer of companies and organizations to green accounting. Based on the results of green accounting, it is possible to accrue green money or points that can be spent on green purchases (technologies, equipment, materials, components, etc.) or directed to the funds of green investments.

Our research showed an up-to-date cross-section of general economic and environmental problems and tried to answer the questions: who is to blame for environmental pollution and, specifically, what needs to be done to improve the environment significantly.

The analysis showed that companies that are not included in the corporate social responsibility system cause huge harm to the economy. Their activities cause maximum damage to the environment. Their negative impact on the environment lies not only in direct technical, chemical, and carbon pollution of the environment but also in the fact that they continue to multiply destructive practices (do not use air filtration, dump untreated wastewater, dump waste into landfills, etc.) and use outdated or barbaric technologies (disposable plastic bags, dishes, and many others), practically leaving us, citizens, no choice–an ordinary consumer has to buy what companies produce and sell, breathe the air that they poison, eat the food that they impose on us, etc.

To the question of what to do, we formulated our opinion quite clearly and unambiguously.

First, when talking about ecology, it is necessary to stop predicting an inevitable catastrophe, as the media do, do not exaggerate and do not inspire citizens that everything is over with ecology, but start engaging in full-fledged propaganda and promotion of green practices and education of an environmentally responsible person.

Second, it is necessary to switch to systemic, smart, multidimensional measures to save nature and improve one's own habitat, actively involving such a development factor as "intelligence" in this.

Third, many years of experience have shown that it is impossible to achieve environmentally responsible behavior from companies and citizens, relying only on coercive and punitive measures; this requires clear, understandable, and simple economic incentives that would significantly increase the interest of businesses and citizens to invest resources and time in environmental measures and activities. We refer to measures such as green money as an economic lever to stimulate socially responsible behavior.

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Chapter 44
Environmental Behaviour: Aspects of Definition in the Modern System of "Man–Environment" Interaction

Olesya E. Ryazanova and Vera A. Gnevasheva

44.1 Introduction

Consumer behaviour has always been at the centre of scientific discussion. It is dictated by the needs, value orientations of a person, which are formed in the conditions of social and labour activity.

Various theoretical approaches to the study of the phenomenon of consumer behaviour boiled down to making a purchase decision. The theories of consumer behaviour presented in modern economic science, with a certain degree of convention, are considered limited, which are determined by behavioural constructs.

Consciousness is the decisive factor in consumer behaviour. In the context of our research, we will keep in mind the ecological consciousness of consumers, which affects the ecological behaviour of people in the system of interaction "man–environment".

The development of an industrial society gave social and labour activities an aggressive character and led to a rapid increase in human consumption (overconsumption), which not only exacerbated the ecological situation on the planet but also affected the way of people's life and their health. In modern conditions, it is necessary to rethink the key factors affecting consumer behaviour, considering it in the "man–environment" system since the theory of consumer behaviour does not sufficiently explain this type of behaviour, determined mainly by non-economic factors, such as: "ecological behaviour". In this study, it is proposed to substantiate an extended model of human relations with the environment, based on rational behaviour, but distributed by social, ethical, moral factors, to define behavioural

O. E. Ryazanova (✉) · V. A. Gnevasheva
MGIMO University, Moscow, Russia
e-mail: afinna2011@yandex.ru

V. A. Gnevasheva
e-mail: vera_cos@rambler.ru

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constructs in relation to personal obligations towards the environment, that is, a sense of “environmental responsibility” as a factor of “environmental behaviour”.

The reduction of natural resources, as a result of their extensive use, ecological congestion, environmental pollution, depletion of the ozone layer and an increase in the greenhouse effect, form a negative outlook for further economic activity and life for a person, sets the task of revising his behaviour concerning the environment to restore systems of interaction “man–environment” from the standpoint of further productive interaction and coexistence.

It is not surprising that some surveys show that the population is increasingly showing considerable concern for the environment, which suggests that the general attitude towards the environment is becoming more and more of an irrational consumer (Kempton et al., 1995). Unfortunately, the relationship between attitudes towards the environment and ecological behaviour is determined only in a few studies (Ryazanova & Gribova, 2016). But, at the same time, comparing human behaviour towards the environment on the one hand and positioned attitude, on the other, an asymmetry is evident (Maloney & Ward, 1973).

Although a significant part of the research literature on environmental psychology is devoted to the problem of human attitudes and behaviour concerning the environment, additional concepts were required, associated with an interdisciplinary approach and considering the system “man–environment” from the point of view of moral and ethical principles (Fuhrer, 1995).

44.2 Methodology

The system of relations “man–environment” is in direct relationship with the external environment. The environment itself is a public good, not excluded from consumption and not competitive, interaction with which can have both positive and negative external effects on both the habitat and humanity. The consumption of natural resources by one person affects other people. At the same time, the restriction in consumption is often carried out at one’s own expense but leads to an improvement in the situation of others (Biel & Garling, 1995).

This behaviour is increasingly seen as prosocial (Granzin & Olsen, 1991) or altruistic (Hallin, 1995).

This view defines environmental behaviour in terms of moral and ethical value systems (Howe et al., 1996).

Studies show that “ecological attitude” is most often demonstrated by people of rational choice, people who maximize utility, which contradicts altruistic assumptions since such assumptions do not imply improvement IN the situation of others at their own expense.

The ecological situation in a region, in a city or a state, is the result of joint interaction between man and the environment where the individuals, households, enterprises, the state themselves form both the demand and the supply of public goods. If demand is determined through the utility maximization mechanism, then supply is a potential result of a negative or positive impact that a given economic entity (individual, household, enterprise, state) carries out concerning the environmental situation, changing it for other participants in the system.

Thus, the proposal regarding the ecological situation (ecology) is the total chain effect of economic entities on the environment.

The ratio of the marginal social effect (MSB) and marginal social costs (MSC) allows us to draw a conclusion regarding the change in the ecological situation, as well as the possibilities of social and state regulation of the "man–environment" system, to maximize the utility for business entities when consuming the considered good.

44.3 Results

44.3.1 Attitude Towards the Environment in Terms of Rational Choice

Despite the large volume of literature on environmental psychology devoted to behavioural attitudes towards ecology and the formation of appropriate economic behaviour, understanding of appropriate attitudes towards the environment is unlikely to be consistent across studies, except for specially developed highly specialized concepts (Becker et al., 1981).

Three main traditional research directions can be noted:

- Relationship to the environment (Arbuthnot, 1977)
- Attitudes towards ecological behaviour (Hamid & Cheng, 1995)
- A new ecological paradigm (Dunlap & Van Liere, 1978).

In the new ecological paradigm, in particular, the path towards the rationality of the "man–environment" system was chosen.

Born in 1978 as a result of research by the authors Dunlap and Liere (1978) and Kempton (1995) the paradigm was a call for a change in the view of nature, abandoning an exclusive consumer attitude towards it.

Even though the paradigm emphasizes the exclusivity of man, it nevertheless affirms man as part of the global ecosystem, and human activity is also described as a complex system of interactions with the environment. In this regard, the long-term consequences of human activity concerning the natural environment can be unpredictable. Organized human activity should be considered the basis and connecting link of the elements of the existence of a complex socio-ecological-economic system.

Due to the basic economic principle of factor consumption—the principle of limitation, the problem of the finiteness of the natural environment as good is put forward and, in this regard, the need to revise economic activity in the direction of rational satisfaction of human needs on the one hand and ecosystem conservation on the other.

In addition to the traditional research directions concerning environmental behaviour, there are also some separate scientific tracks, such as the theory of intelligent action, designed to combine the traditional research directions based on the theory of consumer behaviour.

The theory of intelligent action is also defined as a unifying concept for different eco-approaches.

Some basic elements of the "man–environment" system are comprehended, and an attempt is made to search for their systemic interconnection. Amongst the basic factors of the system, environmental values and intentions to environmental behaviour are determined. As a result, a general theoretical model of relations is formed from the point of view of rational consumption.

As a special case of the development of the traditional model, the Kaiser model was developed (Kaiser & Shimoda, 2016), which differs from the original theory of rational action and does not appeal in a general sense to the rationality of choice; in this model, attitudes and norms are replaced by factors of knowledge and value, whilst the intention factor is transformed into a function of knowledge about the probability of behavioural actions, and the result of the function is a certain behavioural result of the functioning of the "man–environment" system.

At the same time, the models under consideration cannot predict with a sufficient degree of probability the causal relationships that influence the formation or transformation of ecological behaviour.

Another concept of morally conditional principles of behaviour, which determines human behaviour within the framework of morally recognized norms and social restrictions of deviation in society, is based on the philosophy of morality on the one hand and on social behavioural norms on the other (Keltner & Buswell, 1996).

Moral norms are a consequence of formed behavioural projections regarding the well-being of another person, the rights of another person and the principles of justice (Shean & Shei, 1995).

On the contrary, generally accepted social norms are based on social customs or traditions, peculiarities of interaction with authorities and the need for recognition by society.

In this regard, an important factor in the formation of environmental behaviour is the dominance of moral or social norms. In the first case, environmental behaviour is built following moral norms, in the second—following the opinion of society, which may differ significantly from the principles of moral behaviour.

Empirical studies support the opinion that various constructs of social thinking influence environmental decision-making (Stern et al., 1993), and a sense of personal responsibility, formed both within a small social group and society as a whole, cannot be ruled out.

44.3.2 Terminological Definition of Environmental Behaviour

The theory of rational choice in defining ecological behaviour is mainly focused on subjective norms; the area of its control lies in the zone of social conformity. The behavioural trajectories formed within the framework of the theory of rational choice do not appeal to moral norms.

Although the associative norms of social behaviour can be substantiated both in the traditions of society and within the framework of moral foundations, the theory of consumer behaviour does not sufficiently explain behaviour, including ecological, from the moral aspect.

Schwartz's norm activation theory is more focused on the moral sphere; unfortunately, the results of empirical studies within the framework of this theory are not always uniform.

Most of the modern models of ecological behaviour determination are aimed at including the moral aspect in the field of understanding behaviour, offering an expanded model of behaviour.

Intentions regarding environmental behaviour should be predictable, by including a morally related concept of personal duty (that is, a sense of personal responsibility).

Thus, environmental behaviour can be defined as a function of several variables: a sense of responsibility, environmental knowledge, the value of the environment. These variables form the intentions of environmental behaviour in the relationship, and their systemic totality forms environmental behaviour itself.

44.3.3 Approaches and Methods of Possible Assessments of the Directions of Formation of Ecological Behaviour

Intentions of ecological behaviour of the population can be conditioned in the system of benefits from the point of rational behaviour. For society, the maintenance of the ecosystem is laid down within the framework of a separate financial item.

From statistical data, it is possible to trace the degree of the financial burden and the degree of participation of different sectors of society in resolving the issues of preserving the environment.

According to the official statistics of the Russian Federation, there is a significant increase in the volume of spending on environmental protection during the period under review (from 2015 to 2019). More than half of it is provided by the commercial sector. Most of the expenditure is directed towards the water and air purification.

Commercial-oriented financing of environmental protection activities is predetermined by the fact that it is enterprises and organizations that can disrupt the functioning of the ecosystem with their activities in many respects and therefore are called upon in this regard to provide more opportunities for its preservation and prevention from destruction.

At the same time, both concerning the commercial sector and individual households, a hedonistic pricing function can be formed, where both internal and contextual factors of the "man–environment" system are considered to determine the value of the final good.

For example, an increased noise level near a residential area can significantly reduce the hedonistic value of housing in this area (He et al., 2014); as a result of such assessments, one can determine the Noise Sensitivity Depreciation Index (NSDI), determined as a measure of the percentage change in price due to a change in noise level (within the framework of this example).

Similar indicators can be determined to other negative externalities in the consumption of goods and services.

However, these estimates do not necessarily reflect any health costs associated with exposure to negative externalities (such as noise), rather the level of opportunity costs determined through the cost of accepting or rejecting the stimulus.

The idea of hedonic pricing is widely used as a standard method for measuring irritants—negative externalities to an ecosystem; however, the meta-analysis revealed wide and unexplained differences in NSDI values (Bristow et al., 2015).

Assessments of the readiness of the population to form a rational choice concerning environmental behaviour can also be given by analysing the structure of consumer behaviour concerning the means of compensating for negative externalities in the "man–environment" system.

For example, consider the change in consumer behaviour to the good "household water purification filters".

According to BusinessStat estimates, sales of household water purification filter in Russia increased by 20.9% over the period 2016–2020. The problem of drinking water purification is significant for the consumer; in addition, behavioural trends of individuals' appeals to a healthy lifestyle, the introduction of health-saving technologies into everyday life are observed. A significant role in such events is played by public consciousness, the influence of external information resources. However, the emerging trends of steadily increasing demand for minimal health preservation technologies have undergone significant transformations under the influence of external shocks, such as the COVID-19 pandemic, as well as changes in the general income level of the population and, accordingly, the structure of consumption of goods and services.

According to the estimates of the European Commission (Science for Environment Policy, 2018), it is possible to use some indirect methods to assess the willingness of the population to participate rationally in the "man–environment" system.

Willingness-to-accept (WTA) is an alternative method that determines the share of household income that a person would agree to accept to tolerate an increase in health risk from negative externalities of the "man–environment" system, for example environmental pollution.

In principle, the WTA score may be a more accurate assessment of the social value of confronting negative externalities since it assumes that the public should not pay to prevent industrial pollution externalities (Breffle et al., 2015), but in practice, the burden of compensation is the risk is largely imposed on the consumers of negative externalities themselves, through their "willingness to accept".

Since the WTA indicator is not tied to income, WTA estimates can give significant discrepancies in values (Kahneman & Taverksy, 1979). Such a difference cannot always be explained by the income effect. The ongoing research on the evaluation of the WTA indicator is aimed at developing recommendations for the adoption of measures to regulate the functioning of the "man–environment" system. However, the lack of direction and delay in the time of the implementation of such recommendations ultimately, in practice, leads to increased willingness to pay (Willingness to pay–WTP), especially in the case of information asymmetry and, as a consequence, underestimation of compensation for health risk to society.

44.3.4 Changes in Consumer Activity of the Population of the Russian Federation in the Context of the Likely Burden of Risk Compensation

Retail sale dynamics of goods in the Russian Federation annually for the period 2014–2019 in real terms fix a decrease in both the possibilities of food consumption and, to an even greater extent, of non-food consumption (FSGS, 2021).

According to the results of a study by the Deloitte Research Centre (Official Deloitte Data, 2020), the dynamics of consumer activity is formed against the background of a decrease in real incomes of the population. In accordance with the distribution of the main consumer items, respondents would like to reduce the share of food costs and mandatory payments, but expand consumption in terms of "leisure, recreation and tourism", as well as savings. In this regard, a general tendency towards the formation of consumption of goods other than essential goods is expected, which, amongst other things, can contribute to the growth of trends in environmental behaviour in terms of the consumption of health and life-saving goods and services.

Every fifth respondent (21%) in their consumer choice gives preference to goods marked "ECO" and is ready to purchase them, even if they are significantly more expensive than their analogues.

On average, citizens of the Russian Federation spend most of their disposable income on food (31%), on mandatory payments (25%) and savings (about 6%) on an average.

The modern structure of consumer behaviour in the context of disposable income is aimed at meeting basic needs. If the citizens are intent on consuming health-saving technologies, this can create prerequisites for the formation of environmental behaviour.

44.4 Conclusion

The “man–environment” system is the subject of many studies, but it is limited by some systemic and external factors hindering the sustainable forecasting of its development and the formation of behavioural trajectories within the framework of public interaction with the eco-environment. Ideally, a person should rely on the principles of social responsibility, holism, which in turn should be combined with public interests and personal benefit in the strategy towards creating a new model of the economy.

Some indicators are presented in research practice, which indirectly assess the attitude of individuals to the environment, mainly in terms of risk compensation.

The modern distribution of income of the population requires a greater transfer of responsibility to the state or public sector for risk compensation. The associated process should be an eco-oriented way of forming public opinion about the value of the environment, promoting environmental knowledge and building environmental goals to preserve the ecosystem within the value orientations of individuals.

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Chapter 45
Transformational-Overcointegrative Methodology as the Intellectual Core of Noosphere Approach to Governance and Achievement of the Goals of Sustainable Development

Alexander P. Gorbunov

45.1 Introduction

The concept of the noosphere, in its mutual connection with the concept of sustainable development, has considerable analytical and projective potential capable of forming an optimal and an optimistic vision of the future of humanity as it is.

However, the substantial problem is that both conceptions in their current variants have the same disadvantage—the weakness of their intellectual and practical instrumentality that outgoes from the weakness and outdatedness of dominant methodologic fundamentals. Thus, they cannot reflect in all completeness the systemity, dynamics, and dialectics of the development and transformation inside human society and in its interaction with nature.

Therefore, we see an acute need to widen and enlarge the potential of these concepts by applying a radically new methodology—named transformational-overcointegrative, overcogeneralizing methodology—to strengthen their fundamentality and instrumentality.

This non-usual (over-usual) methodology, worked out in the previous decade by the author, distinguishes by its overcocapturing and overcogeneralizing potential in reflecting and depicting all the complexity and even overcomplexity and all the determination and even overdetermination of the systemity, dynamics, and dialectics of development and transformation in nature and society.

We aim to strengthen the noosphere approach by giving it a stronger intellectual core capable of enlarging its instrumentality and, by this, its fundamentality. Besides, it can enlarge the systemity of management to achieve sustainable development goals.

The research tasks are pulled out of this aim and include the following:

A. P. Gorbunov (✉)
Pyatigorsk State University, Pyatigorsk, Russia
e-mail: gorbunov@pgu.ru

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- To analyze the noosphere approach and then, in mutual connection with it, the sustainable development approach from the point of view of transformational-overcointegrative methodology;
- To reveal in what particular respects these approaches may be strengthened with the help of the principles of this methodology;
- As a result, to show the strong and weak sides of both analyzed approaches and characterize necessary circumstances under what truly "noospheric" noosphere and truly sustainable development can be reached.

45.2 Methodology

The methodology applied in this research is very new, the newest, and it has apparent advantages because it is not only the methodology of analysis and research but also the methodology of projecting and proacting**.**

The author's methodology has two main points that are connected and combined mutually. On the one hand**,** it is transformational, i.e., it aims to understand and apply the laws and the relationships of organization and transformation (change) as they are. It is based on account of inner laws in the world construction and, consequently, on the existence of a determined order of changes and transformations in nature and human society.

On the other hand, this methodology is also overcointegrative or transcointegrative. That is, it aims to cointegrate over (trans) all barriers of usual methodologies (approaches), now differentiated and disunited, finding for them overpoints (transpoits) of their general, common crossage and unity. The time has come to counite—namely to overcounite—different approaches and concepts: noosphere approach, sustainable development concept, systemic approach (i.e., general systems theory), universal evolution concept, dialectic method, civilization development approach, formational (or dialectic-historical) approach, etc.

Only the methodology of this unusual (overcousual) type (in fact, overcotype) is able to embody true fundamentality and instrumentality, thus, true conclusiveness to the noosphere approach and, in combination and connection with it, to sustainable development concept. If this is not achieved, both approaches remain only a set of wishes and declarations, seeming non-reachable in the depths of their sense.

45.3 Results

One part (one complex realm) of the results is devoted to overcoming the limitations of the noosphere approach and strengthening its systemity and instrumentality.

Before all, we need to ask ourselves a very important question: "Is noosphere already exist now, or is it only forming and is thus only a vision of the future?" and answer it. This is really important because different authors have different views on this.

Our answer consists in that we need to differentiate the notion of the noosphere in the wide and narrow sense of the word.

In the wide sense, the noosphere appeared and formed out of the biosphere when human society emerged, and thus, a new type of system arose—namely, social (sociobiological, socionatural) type; we can say “sociosphere”. That is, intelligence and conscience are their distinguishing feature because only members of human society are empowered by cognition, conscience, and communication—which are all mutually merged as the sides, the joining parts of the same entire substance.

Thousands of years of human society’s (sociosphere’s) development have come away; using cognition, science, and conscience, people created techniques and technologies, i.e., “technosphere” (“second nature”—**K. Marx**) and now even advanced information and telecommunication technologies, i.e., “infosphere”.

However, is human intelligence already really intelligent in the full sense of the word? No, not at all. Human beings not only construct and create but also destroy the planet’s biosphere and geosphere, bringing damage to ecology and causing wars, enmities, rivalries, and hatred.

Thus, the problem is that the sphere of intelligence (conscience) needs to become intelligent (conscious) itself.

That is why we have a demand for the formation of the noosphere in the narrow sense as a sphere of “intelligence of intelligence” (or “reasonable reason”, “conscious conscience”), where the consciousness of the “higher-highest” and the “deeper-deepest” rank dominates and governs. Until the formation of this truly “noospheric” noosphere, i.e., the epoch and even the era of the positive creational and transformational activity—inside the human society and in the frame of interaction between the society and nature (particularly, biosphere)the human society and, thus, human beings still remain not completely intelligent, reasonable, and conscious.

What does all this mean in terms of transformational-overcointegrative methodology?

In all its realistic (even overcorealistic) sense, it means that we cannot turn off the formation of true noosphere from the real socio-economic, socio-structural, and socio-cultural base of human society taken in the continuum of its logical-historical development.

Thus, a truly “noospheric” noosphere does not equal only to a developed information society where humans and artificial intelligence are effectively combined. This does not and will not solve the very problem because artificial intelligence is capable of performing functions, but it does not understand what it is actually doing and, more importantly, for what purposes it is doing these particular things.

Therefore, artificial intelligence is not a real assistant for people in the most fundamental sphere—the sphere of production (creation) and exchange of meanings (essences), i.e., the sphere of conscience and culture.

From this, we can understand that the formation of the “intellectuality of intellect”, a truly “noospheric” noosphere demands not just an information society but, namely a communication society. This means a society of true communication, where its members understand each other and interact with mutual help and support because they are counited (in fact, overcounited) by the same, common, general for them interests, purposes, and values. We can say that they are overcounited, transcounited to the extent that they are united over, trans all their differences, all barriers—social, professional, national, religious, regional, etc.

However, it does not mean that their differences are just leveled out and that they lose their identities. They do not destroy their identities; on the contrary, they overcoharmonize them.

This "overcosocietal society", built on a positive constructive joint participatory creational and transformational activity and communication, is the systemic base of a true noosphere (see Fig. 45.1). The content of the activity and the content of communication correspond to each other. The noosphere is a space for creating and developing meanings and, even more importantly, significances. Intellect and intelligence should be now not only truly "intellectual", "intelligent", and "clever", but also moral and prudent.

A true "noospheric" noosphere is formed only when and where meanings and significances are united

This is a regular, more precisely, overcoregular stage in the development of human society and in its interaction with nature. This is the stage when society counites significances inside itself and between itself and the surrounding nature, and, by this, the entire internal and external communication of society (i.e., of the collective, general human being) becomes truly communicative.

Thus, intelligence (conscience) becomes truly intelligent (conscientious), society becomes truly societal, communication becomes truly communicative, and culture becomes truly cultural.

This is in itself a real and not invented (not mythical) dialectics, dynamics, and systemity in the development and transformation of society and its interaction with nature.

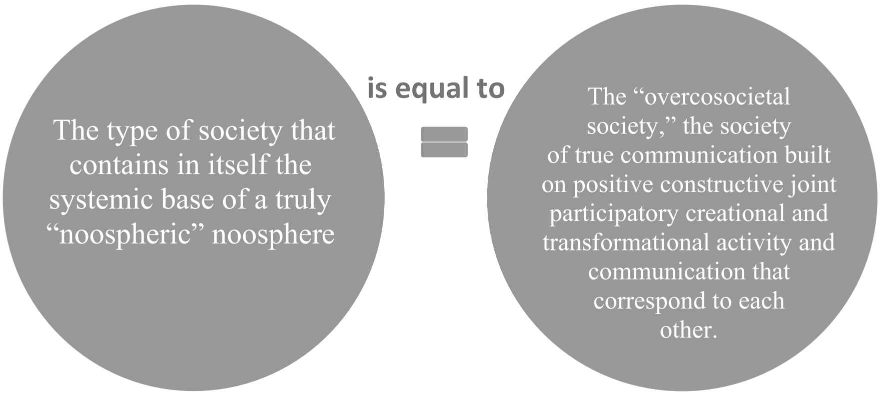

Fig. 45.1 Systemic base of a truly "noospheric" society. *Source* Developed by the author

However, these will remain just attractive declarations if not to reveal the true mechanisms and relationships (principles, algorithms) of transition to the logical-historical stage described and characterized in this research.

Especially considering the fact that contemporary society is still in the situation where communication is diffused, divided, split, and disunited by different lines and spheres:

- Professional;
- Socio-economic and socio-structural (i.e., by lines and spheres of counter-fighting economic and social positions and interests);
- Socio-cultural (i.e., race, nationality, religion, locality, etc.).

The entire system of knowledge, perceptions, and concepts is divided and fragmented.

Unity is now parted, divided, segmented, or, in the best case, interrelated, interdisciplined, and, thus, interprofessionally, intersocially, and interculturally connected and merged.

We have just "plurality" without the capability to build a real "community". Relativity is the queen in all thinking and activity.

However, human society needs to make a transfer to overcorrelated, overcodisciplined, overcoprofessional, overcosocial, overcocultural, and an overcointegrated type of unity, in fact, to counited (overcounited) unity (entity).

This way of transfer is, in reality, an actually true way of the development and transformation of the general systemity as it is. It demands the radical turnout, turnover (in essence, the most radical for all previous history of humanity after the appearance of human beings) in all systems of relations (correlations) in society and, before all others, in a system of socio-economic and socio-structural relations (correlations).

These most radical (overcoradical), most root-transforming turnout and turnover are now being prepared and calculated by the developing and widening in its ranks (intensively and extensively) of innovative mode of economy, changing all production structures (reproduction) and the core of production capacity (capability) itself. Innovators, regardless of the spheres, in which they act, form, and establish by themselves, a new non-usual (overcousual, overcospecial) productive-creational class that transcrosses all usual classes and layers of society.

We name and characterize this developing overcousual, overcospecial, and overcosocial class as the overcoclass, transcoclass of transformational leaders-innovators**.** The major objective direct ground (in fact, overcoground) and, thus, overcorresponding interests of this over(trans)coclass are no longer in getting and accumulating financial capital or any other type of usual capital but in creating and positive transforming as it is and, by that, in cultivating overcousual (extracoordinary) transformational (creative-innovative) capital—the capital (in fact, overcocapital) of transformational-creational knowledge and capacities.

Because of all this, the transformational-creational over(trans)coclass, extracoclass of leaders-innovators is predetermined to be the overcosocial, extracoordinary, and overcocreational (thus, truly noospheric) force capable of counting (namely, overcouniting) all efforts to achieve really sustainable development.

Thus, with this vision that considers basic socio-economic and socio-structural fundamentals, the promotion of a true noosphere and truly sustainable development becomes more theoretically fundamental and dependable but also practically (realistically) more instrumental and achievable.

The other part (the other complex realm) of the results consists of the methodological rethinking and, by this, strengthening (based on the results obtained in the first part) the grounds of the sustainable development approach and the systemity of achievement of its goals.

In this case, methodological rethinking begins with the revision of what sustainable development means as it is in its realistic, objective, and naturally possible sense.

Sustainability of development is equal to the sustainability of lively dynamics and dialectics of development, which cannot be torn off from real systemic evolution and transformation that is completely able to guarantee this sustainability as the process and the relationship that is soundly balanced in all respects.

Thus, it cannot be seen only and barely as an ordinary one-linear quantity-changing process. It can be comprehended and understood, if it is truly realistic**,** as a quality-changing process leading to a fundamentally new qualitative stage of development or, as we can say, to the social, socio-economic system of a different type (kind) and quality than the existing contemporary system.

Nowadays, the concept of sustainable development is opposed to unsustainable development, which is considered the type of development that currently dominates. It can be seen that through a series of complex and mutually connected measures, we can come to the model of sustainable development.

Nevertheless, in reality, is this possible just in the form of the ordinary evolutionary process without radically changing the fundamentals of the existing social system?

Development, as it is, cannot be understood and characterized truthfully if we see it just as a one-linear ordinary evolutional, in a narrow sense, quantitatively rising but not qualitative-changing process (Dmitrevskaya et al., 2002). In reality, it is the process of overcolinear, overcoevolutionary-overcocreational order (in fact, overcoorder), i.e., the process (overcoprocess) containing in itself transformations bringing precisely to qualitative, radical, and root-changing results.

If we wish to transfer to sustainability, stability, and continuity of the overcobalanced development itself (and we really wish it), then we need the radical (in fact, overcoradical) positively and constructively oriented transformation of key relations (correlations) of contemporary society.

Thus, in fact, we need to transfer from the contemporary type of "information" society or "post-industrial" (more precisely, science-industrial) society to the society of the higher and deeper type—"communication" society, "overcoindustrial, and overcoscience" society. Moreover, it is necessary to move from the currently dominant concept of "social state" to the concept of a "socially transformational" or "transformational-creational" state.

Truly sustainable dynamics of development can be provided by the transfer to the fundamentally new system of reproduction of the main, dominant type (overcotype, supercotype, extracotype) of capital—which should be not financial capital and not just informational capital but the capital (in fact, overcocapital, supercocapital, extracocapital) of transformational-creational knowledge and capacities.

It is true overcocapital because it is the one and the only type of capital that can produce, create meanings and significances, and embody them into the life of society and nature. If we want to govern society and nature in a true direction, without damages and catastrophes, we need to own and hold the laws, relationships of organization, and transformation.

Therefore, we also need to transform our way of thinking and make our intellect "intelligent", even more than that—wise. Our intelligence can be wise only if it is empowered with an awareness of the relationships and rules of transformation as it is, as well as with the outstanding capability to positively and constructively transform. Thus, we really need a great outturn, overturn in all systems of relations and correlations in society.

This reveals demand for the new type of connection and combination in the methodology of thinking, cognition, and understanding; respectively, it will be the new, more perfect core for the connection and combination of sustainable development goals. Without it, nothing will be achieved that is really decent in its value.

If to speak about the new type (new core) in the methodology of thinking, we reveal that it is a real quintessence of consciousness and wiseness of the global collective mind, that is, the noosphere itself. It is not so that merely enough to just technologically, informationally connect, combine, and coincide all human intellects on the planet into one global collective general intelligence and empower it with informational and telecommunicational means—and thus, allegedly, we get a true noosphere ("noospheric noosphere") (Ilyin et al., 2014).

The thing is that if separate human intellects own only outdated, inadequate type of thinking, then nothing great will come of their informational-technological connection and combination, no matter how supermodern and superperfect it is.

Thus, if we want to get the collective global systemic and integrative entity with the new kind of quality, we should connect, combine, and coincide separate human intellects not just technologically but also methodologically, even overcomethodologically. It means that we should empower them with overcouniting, overcointegrating, overcocommunicating, overcosocializing, and overcogeneralizing methodology that they will take as their common (communal) overcospacing core.

If it is supposed that all human community, as well as each member of it, should act on the way of sustainable development as integrated unity, entity, then it takes to the necessity of the formation of all-general (generally-general), overcogeneraized interest (overcointerest) that connects, combines, and coincides all and everybody not just formally, intersurfacedly, just intermediately, but overcoformally, overcosurfacedly, and overcomediatedly.

Without such an overcouniting, overcoentire methodological core, we cannot have the true systematicity and integrity of sustainable development goals.

Thus, if to speak about the systemity of the sustainable development goals, we reveal that it has the very same shortages and disadvantages.

They are as follows:

- The current sustainable development goals do not have a holistic all-couniting core; they are only connected externally, superficially connected;
- As a result, the very set of goals is insufficient, not fully completed;
- The real (realistic) ways of achieving the set of sustainable development goals are not completely comprehended and understood by those who put them forward.

These shortages of the existing sustainable development approaches reveal that the level of the dominant type of thinking itself is now rather far from the true noosphere rank. Today's dominant type (way) of thinking, cognition, comprehension, and understanding remains on the level, in the best case, of cosystemity and intercosystemity and does not see, behold, and understand even the level of all-intercosystemity and, even more so, the levels of overintercosystemity and over-overintercosystemity that is acutely needed for the further promotion forward in theory and in practical governance.

That is why today's limited way of thinking needs radical transformation. This transformation is possible and should be carried out with the help of a transformational-overcointegrative methodology capable of empowering us with the newest, the most fundamental, and instrumental way of thinking (of mental visioning).

The existing sustainable development approach assumes that the set of goals it puts forward is possible to achieve without fundamental reconstruction, turnover in the contemporary type of society based on the accumulation and absorption of financial capital, and just formalistic intellectual capital. Thus, it tries, in reality, to achieve these goals by perfecting just the side, the surface but not the depth, the core, and the root.

Consequently, it itself begins to negate its own previously humanistic intentions. This negation is reflected, for example, in the widespread idea of the necessary reduction of the number of human beings on the planet—which absolutely contradicts the principles of humanism.

We need to be aware that the existing approach is generated by the contemporary type of globalization of the contemporary world order—that is why it prefers to be silent about the necessity of transformation of the world order into a more fair direction. For instance, it sets the goals for eliminating the inequality within countries but does not speak about the necessity of liquidation of the global inequality, that is, of shortening the gap between definite countries and groups of countries.

As we see, the current approach to sustainable development is not brave enough to consider that the main, all-defining factor is the very definite type of socio-economic and socio-structural organization of the human society. The problem is contained not in the abstract, vague wrong behavior of contemporary humanity in its interaction with nature, primarily with the biosphere, but in the wrong type of socio-economic and socio-cultural organization of contemporary humanity. If to change this type in the right direction, we will change everything because the base, the foundation of all, would be changed.

The only way is:
To transform, overturn the contemporary type of the human society into the newest type (in fact, overcotype, extracotype), where the transformative-creative overcocapital, reproduced and regrown by the transformational-creational over(trans)coclass of leaders-innovators empowered by the advanced methodology of thinking, projecting, and proacting

Fig. 45.2 Systemic social (in fact, overcosial) transformation needed to achieve truly sustainable development. *Source* Developed by the author

Let us be brave enough to accept that it is not just abstract human misbehavior that destroys nature and damages ecology but that it is actually done due to the very specific greedy, selfish interests of the very definite social groups of human society that dominate in it and thus determine all its activity and behavior.

Let us be so wise and brave as to understand that if we are to speak of common human interests, then it is primarily necessary that these interests be truly formatted. Moreover, it is necessary to understand that we cannot do it any way besides forming the social base for the truly common and united human interests—that is, all human beings must be put into the same common, generalized social (in fact, overcosial) position (overcoposition) which overcomes, surpasses all and each of their separate, disunited, differentiated, and disintegrated positions.

Only through this socially foundated transformation can we put them, consequently, into the same common mental position (overcoposition), giving them the same common, overcogeneralized vision.

There is no other way to come to overcounited, overcointegrated, overcosocialized, and overcogeneralizing interests of humanity as to change, transform, and overturn the contemporary human society in the direction, the vector of the formation of a positively transformational, positively creational way of socio-economic reproduction. Therefore, to transfer to the type (in fact, overcotype) of a society dominated by the transformative-creative overcocapital, which is reproduced and regrown by the members of the transformational-creational over(trans)coclass of leaders-innovators empowered by the advanced methodology of thinking (of cognition, comprehension, and understanding), projecting, and proacting (Fig. 45.2).

45.4 Conclusion

Rethinking, revision of the noosphere approach, and, in this connection, of the sustainable development approach from the position (in fact, overcoposition) of transformational-overcointegrative methodology has helped reveal advantages and disadvantages, strong and weak sides of both those approaches in their existing kind.

If we speak about the noosphere approach, its strong side is, first, the main idea of the universal evolution in nature and then in the appeared society and its interaction with nature, which brings them on our planet consequently to the stage (level) when completed intelligence, consciousness begins to rule and govern. Second, the other main, similarly important idea is that original consciousness, which appeared together with the appearance of human beings (human society), remains incomplete in itself until the mentioned stage (level) is achieved. Thus, we currently have just a developing and qualitatively growing but not yet fully developed and grown noosphere.

The weak side of the noosphere approach lies in the absence of showing regular instrumental mechanisms of achievement of the stage (level) when and where the noosphere becomes completely "noospheric", or consciousness becomes completely conscientious. In this case, we have the deal with the general evolutional and general civilizational approach combined with just surfacedly applied general systemic approach, but all this is turned off from the mechanisms and rules of systemic transformation and, thus, from the social-formational approach.

If to speak about the sustainable development approach (using the results of analysis concerning the noosphere approach), its strong side is the concentration on the survival of the human civilization, on the saving of the ecology, primarily of the biosphere, from the destruction and damage, and on the all-balanced governance of all processes and relations.

The weak side of this approach, in its existing form, is, again, the absence of an adequate methodology, which could be the real core uniting all goals of sustainable development in one essentially systemic entity. This approach has small real ground in the socio-economic, socio-structural, and socio-cultural base of contemporary human society, which is highly stratificated and disunited, disintegrated. That is why all its good intentions remain, in many respects, just "empty projecteering" because it hopes to achieve wide-scale goals without the corresponding transformation of the social "scale" itself, i.e., without positively, prospectively oriented transformation of the socio-economic, socio-structural, and socio-cultural grounds of the contemporary society and its world order.

Thus, this approach does not comprehend or pretends not to comprehend the fact that the epochal goals it proclaims come into the root contradiction with the contemporary way of socio-economic reproduction, the existing type of socio-economic organization, and, respectively, the type of the world order.

The weak sides of both approaches can only be overcome by making the most advanced transformational-overcointegrative methodology their own intellectual core, capable of enlarging their fundamental and instrumental potential. This methodology relies on the all-encompassing rules of systemity, dynamics, and dialectics of development and transformation as they are.

Besides showing realistic, genuine ways to reach the stage of "noospheric" noosphere (conscientious consciousness) and sustainable development—as, in reality, the development with permanent overcobalanced and overcointergated dynamics of reproduction in all spheres of human activity and in humanity's interaction with nature—this very methodology in itself is the great intellectual (in fact, already overcointellectual) instrument capable of empowering us with this very conscientious consciousness, this very wiseness of consciousness, which is contained in the essence of the truly noosphere itself as it is.

By gaining insight and understanding of the ways and mechanisms of real social transformation in the right direction with the help of this methodology, we become stronger, both theoretically and practically.

Thus, we stop producing empty declarations and begin understanding that truly noosphere and truly sustainable development should be only and exclusively the determined results of the change in the deepest qualitative parameters of the way of the socio-economic reproduction, the type of socio-economic and all corresponding organization of human society, including the type of the globalization (of the world order)—into the direction for the emerging of the economy of innovations, for the socially creational type of society and for the transformational-creational order over(trans)coclass.

Only with such a transformation we will get in reality (and not as a myth) the true global noosphere as it is and global truly sustainable development as it is, precisely in the form of the harmonious coevolution, cotransformation of the mutually combined and mutually determined counited system "society-nature" which is being directed and governed by the supersubject (overcosubject) of all organization and transformation—exactly overcointegrated, overcogeneralized (not just merely mechanically or just organically but precisely overcointerorganically, overcointersocially) globally collective supercointellect (overcointellect), noosphereintellect, wise and highly moral, virtue in its quality (in fact, supercoquality, overcoquality).

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Part VI
International Experience and Regulatory Specifics of Combating Climate Change in Different Countries

Chapter 46
Environmental Taxation: Experience of Foreign Countries

Elena V. Pilevina, Yulia A. Lukina, and Sofya N. Chernaya

46.1 Introduction

Today, the issues of ecology and nature management are extremely acute; for decades, the world community has been discussing the introduction of measures to support the environment. There is a wide range of environmental problems that require urgent action: pollution of the environment and the world's oceans, destruction of flora and fauna of the planet, as well as climate change. Food security, climate change, and biodiversity conservation are high on the international agenda for sustainable development (Cadillo-Benalcazar et al., 2020).

Currently, there are two categories of environmental disasters: those that can be prevented and those that are inevitable. Scientists are implementing new technologies to calculate damage and predict possible cataclysms, but in some countries, such as the Russian Federation, it is impossible to estimate the extent of pollution.

There are many methods for assessing the environmental situation to prevent eco-disasters, one of which, and certainly, the most effective is environmental taxation. Despite all the advantages, environmental taxation has not gained much popularity in Russia. Budget revenues under this item account for only 0.02% of the total volume of tax assessments, while for European countries the same indicator averages 2.5%.

Environmental taxation mechanisms are based on the "polluter pays" principle, which assumes that all costs of preventing and eliminating environmental damage are borne by the polluter company. At first glance, this principle seems fair, but in

E. V. Pilevina (✉) · Y. A. Lukina · S. N. Chernaya
MGIMO University, Moscow, Russia
e-mail: e.pilevina@inno.mgimo.ru

Y. A. Lukina
e-mail: starovaya.yu.a@my.mgimo.ru

S. N. Chernaya
e-mail: chernaya.s.n@my.mgimo.ru

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practice, it is not always a preventive measure in the context of environmental pollution. Often all the costs of these charges are borne not by the polluting companies, but by the consumer. So, harmful industries reduce their costs of "green" taxation by increasing the cost of final products. Another way to shift the costs of environmental taxation is to reduce the social benefits of employees because the legislation of some European countries provides for the implementation of such measures (Postula & Radecka-Moroz, 2020). Thus, it is the consumers and employees of the polluting companies that suffer, not the socially irresponsible enterprise itself. At the level of a basic economic analysis of activities, it can be concluded that it is much more profitable for a company to pay an environmental tax than to reduce the volume of environmentally hazardous production.

Another factor hindering the strengthening of the efficiency of environmental taxation is the lobbying of the interests of domestic companies by states. In other words, governments are reluctant to impose a tax rate that is too high, because this will negatively affect the level of prices of manufactured products, which in turn will lead to a decrease in the competitiveness of these companies. It is important to note that the greatest harm to the environment is caused by companies in the extraction sector, that is, environmental problems are especially significant for countries with a resource-based economy, the main source of income for which is the aforementioned companies.

In addition, environmental problems cannot be solved only by efforts made at the state level (Galli et al, 2020), and it is extremely important in this process to increase the environmental literacy of the population and develop a culture of environmental management. Only the adoption of the ideas of environmental awareness can fully solve the problems of climate change and environmental pollution.

46.2 Methodology

Taking into account the disappointing forecasts of scientists regarding the approach of a global climate catastrophe, more-and-more countries are beginning to actively use measures to support the environment. One of the most effective measures is considered to be environmental taxation, which allowed European countries not only to ensure the flow of funds to the budget for the development of "green" projects but also to promote the formation of environmental thinking. In this regard, an analysis of the key mechanisms of environmental taxation in European countries seems to be especially relevant in the context of an emerging climate threat.

The purpose of this study is to identify the degree of efficiency of environmental taxation mechanisms in the countries of the European Union and the subsequent development of methodological approaches to the formation of a tax mechanism for environmental regulation in the Russian Federation. In accordance with this goal, the following tasks can be identified: first, to study the existing mechanisms of environmental taxation in the European Union; second, to assess the effectiveness of existing mechanisms through comparative analysis; thirdly, to draw conclusions regarding the advisability of introducing “green” taxation in the Russian Federation, and to determine the possible risks and the scale of environmental benefits.

The methodological basis was the scientific research of foreign economists in the field of ecology and nature management, as well as taxation, civil, and budgetary legislation. The source of statistical data for assessing the effectiveness of “green” taxation was the open database of the OECD and Eurostat. Scientific generalization, methods of statistical, cause-and-effect, and comparative analysis were used as research methods. When conducting the analysis, the study of the effectiveness of environmental taxation was carried out based on EU data with the identification of the main trends and patterns of its development in European countries.

46.3 Results

As defined by the OECD, environmental taxation includes all taxes and fees levied for damage to nature as a result of pollution or the depletion of natural resources.

The environmental tax has appeared relatively recently and is still not levied in all states. The need for green taxes arose more than 30 years ago when it became apparent that environmental degradation was caused by inadequately balanced patterns of consumption and production of goods. Industrial disasters such as Chernobyl, Seveso, Bhopal, or AZF, oil spills such as Amoco Cadiz, Prestige, or Exxon Valdez, “global pollution”, signify ozone depletion and climate change, and are signs of anthropogenic impact on the environment.

Despite the tightening of environmental control by the OECD and the global trend toward relocalization of production, the volume of environmental pollution in these countries remains high (Daigneault et al., 2020).

In the countries of the European Union, revenues from the environmental tax in 2019 amounted to more than 330 billion Euros or 2.4% of the GDP of the European Union countries. At the same time, taxes on energy use amounted to 257.5 billion Euros or 1.8% of GDP, transport tax was 4 times less than income or 62.4 billion Euros, tax on environmental pollution amounted to 0.1% of GDP or 10, 6 billion Euros. On the one hand, this indicates a relatively low amount of harmful emissions into the atmosphere compared to the situation in countries with developing economies. On the other hand, it also points to government lobbying for domestic companies. For example, in the UK, environmental tax payments are made by reducing social benefits to employees. Thus, it is not the polluting company that suffers, but its personnel (Pichler et al., 2021). However, the tax burden can also be imposed on the end consumer, who pays twice as much for sustainable production (Table 46.1).

Figure 46.1 shows the dynamics of tax revenues to the budget from environmental taxation for 27 European countries. The absolute value of the indicator demonstrates constant growth, however, a similar trend is not observed for relative values, including the share in GDP and the share in total tax revenues, thus, the public policy (Fig. 46.1).

Table 46.1 Structure of environmental taxation in the EU, 2018–2019

	2019				2018		
	Million euro	% of total environmental taxes	% of GDP	% of TSC	% of (specific type of) environmental tax revenue (by tax payer)		
					Corporations	Households	Non-residents
Total environmental taxes	330,577	100.0	2.4	5.9	46.7	49.9	3.2
Energy taxes	257,534	77.9	1.8	4.6	50.4	45.4	3.9
Transport taxes	62,433	18.9	0.5	1.1	32.4	67.0	0.4
Taxes on pollution/resources	10,610	3.2	0.1	0.2	42.2	55.4	1.0

Source Compiled by the authors based on European statistical system (2020)

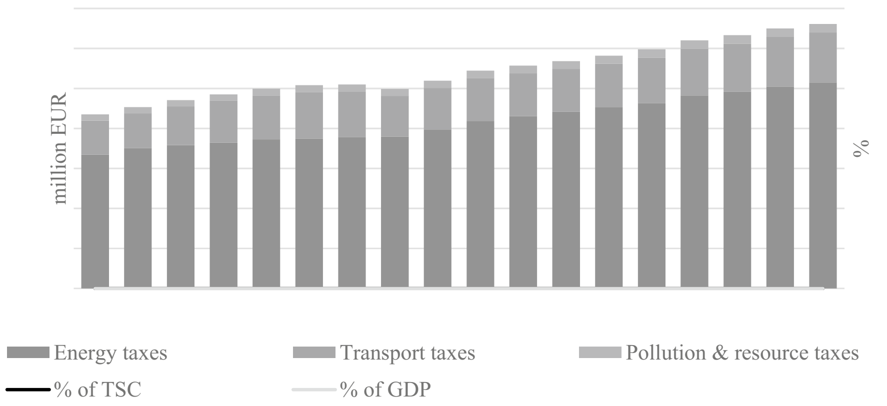

Fig. 46.1 Environmental tax revenue by type environmental taxes as a share of TSC and GDP, EU-27, 2002–2019 (million EUR, %). *Source* Compiled by the authors based on European statistical system (2020)

The structure of revenues from environmental taxation is sustainable. The energy tax accounted for an average of over 75%, the transport tax—about 20%, and the tax on environmental pollution averaged 3%.

The geographical structure in the context of environmental taxation is very uneven. Among European countries, there are obvious leaders in terms of the share of environmental taxes in the total amount of taxes, like Bulgaria, Greece, Latvia, and Estonia. There are also countries where the share of environmental revenues in the total amount of taxes is not so great, for example, Germany and Luxembourg. However, this trend is largely due to the development of environmental thinking in these states, as well as the strict requirements of the law regarding environmental pollution. For example, in Germany, a fine from 25 to 800 Euros can be levied for improper disposal of waste (Fig. 46.2).

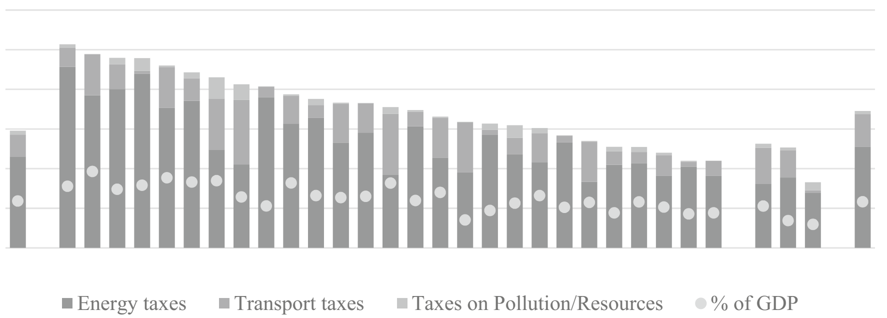

Fig. 46.2 Environmental tax revenue by category as % of TSC and GDP, 2019 (%). *Source* Compiled by the authors based on European statistical system (2020)

In all EU countries, the most profitable environmental tax is the tax on energy consumption. However, most of the taxpayers belong to households; in almost all countries, 40% of the budget revenues from energy taxes come from this sector of the economy. It is also important to pay attention to Luxembourg, where most of the taxpayers are non-residents of the country, this trend is due to the attractiveness of the business environment and a large influx of foreign investment into the country.

It is not by chance that the transport tax in the EU is classified as environmental. In 1993, the Euro-1 environmental standard was already published, which determined the maximum permissible value of harmful emissions into the atmosphere when the car engine is running. Currently, the Euro-6 standard is in force, where the requirements for the environmental friendliness of the vehicle have become much more stringent (Hajek et al., 2021). Also on the territory of the EU, there are fees for entering the "green" zones, for example, in France, there are 32 zones that differ in the degree of pollution, while each zone has its entry tariff. In many regions, travel on environmentally hazardous vehicles is prohibited. Transport tax revenue in the European Union has remained unchanged for 10 years now and fluctuates between 1–5%, since, as previously noted, an inflow of 62.4 billion Euros was recorded in 2019. At the same time, it can be noted that despite the insignificant changes, the situation is changing for the better, since the size of fines and taxes is growing from year to year and not the number of deductions to the budget (Johansson & Henriksson, 2020). This allows us to speak about the improvement of the ecological situation in the region. Earlier studies have shown that increasing the cost of emission allowances can help reduce emissions (Hajek et al., 2021). So, an increase in the cost of a quota of 1 Euro will entail a decrease in greenhouse gas emissions by 7.9 kg of CO_2 per person of the population.

The Russian Federation also has a transport tax that ranges from 2.5 to 5% depending on the engine size, but its nature is significantly different from its European counterpart. In Russia, when determining the tax base, a single criterion is taken into account, namely the volume of the car's engine, while in European countries; the transport tax is levied primarily on the number of harmful emissions released into the atmosphere. Thus, the transport tax in Russia cannot be counted among the "green" taxes, but rather belongs to the category of taxes on luxury.

As a result of the study, it is possible to draw certain conclusions about the key advantages and disadvantages of environmental taxation. The strengths of EU environmental taxation include the following: First, green taxation encourages companies to behave in a more environmentally friendly way as they strive to balance the marginal cost of reducing emissions and the cost of paying the corresponding tax. The level of the tax rate has a direct impact on the willingness of companies to switch to green production. Secondly, due to additional budget revenues from "green" taxes, the state can compensate for the damage caused to nature, organize events dedicated to the environmental agenda, and finance environmental projects. Thirdly, the experience of European countries confirms that the use of "green" taxes promotes the active introduction of innovations, the search for new sources of energy and in general, increases the well-being of the nation, for example, it has been proven that there is a synergy between renewable energy sources and rural development (Clausen & Rudolph, 2020).

Despite all the aforementioned advantages, the introduction of this type of taxation carries some disadvantages. Currently, the introduction of environmental taxation can be difficult for the state, since the determination of the marginal social costs, which are the basis for taxation, is not always possible. Under ideal circumstances, the tax should compensate for the entire set of damage caused to nature. However, when determining the tax rate, the state is guided by obligations established by international agreements. In addition, environmental taxation is heavily criticized by corporations as it increases production costs. It is no coincidence that many states subsidize manufacturing companies to ensure their competitiveness in the global market, otherwise companies register their activities in states that provide more trustworthy conditions in the context of supporting the environment and natural resource use. This leads to an outflow of capital from the country. The introduction of additional taxes or an increase in existing ones can have a significant impact on the company's business processes and force the management to significantly change their activities. For example, in earlier studies, there was a direct relationship between an increase in the greenhouse gas tax rate and the introduction of new transportation models within the company which are by no means always safer for the environment (Gaigné et al., 2020). "Green" taxes also negatively affect consumers for some reasons: the rise in the cost of final products, the rise in the cost of utilities in the context of the impossibility to switch to environmentally friendly energy sources. To mitigate these consequences, states are introducing measures to support the purchasing power of the population, for example, through social payments to the population.

Every year, the European Commission fights against all of the above negative consequences within the framework of the Stability and Growth Pact, which aims to coordinate the economic policies of the EU member states. The European Commission published recommendations on environmental taxation, intending to combat tax dumping by taxing imports from countries that have not introduced a single tariff on greenhouse gas emissions. All proceeds from this tax are used to finance the European Commission's Environmental Pollution Fund. In addition, governments practice the introduction of "incentive" taxes to increase the involvement of companies in solving environmental problems. The company can also be awarded a cash bonus for the transition to "green" production.

The experience of environmental taxation in the European Union, despite some shortcomings, can be regarded as an example of an effective tax policy. According to the authors, the experience of EU environmental taxation can become the basis for the development of an effective environmental strategy in Russia. It should be noted that the government bodies of Russia are gradually increasing spending on solving environmental issues. Especially, large-scale growth of expenses has been observed in the last two years, while it is achieved mainly due to an increase in other expenses. In 2020, the "other expenses" category amounted to over RUB 332 billion and exceeded all other items of expenditure. Since 2009, wastewater treatment has been a significant expense item; in 2020, water treatment costs took second place and amounted to 285 billion rubles Russia has spent over 138 billion rubles on solving the problems of climate change. In 2020, in general, there is a positive trend and growth of this item of expenditure, so the current volume of expenditures is twice as high as in 2009.

Solving environmental problems is an extremely important component of a socially-oriented state, but an increase in environmental costs should be accompanied by a more efficient distribution (Lötjönen et al., 2021). So, according to Greenpeace, the state plans to send a total of about 300 million rubles for waste incineration projects. Within the framework of this project, it is planned to build and modernize about 150 enterprises—waste incineration plants, which will cause even greater harm to the environment. Due to such a distribution of costs, the harm to the environment will not be leveled, therefore, it is extremely important not only to increase costs but also to spend the attracted funds more efficiently.

Determining the optimal environmental tax rate depends on many external political and economic factors. Thus, different environmental parties have different positioning on environmental issues and take into account the mood of the voters and the length of the party leadership when developing an environmental strategy (Hochman & Zilberman, 2021).

46.4 Conclusions/Recommendations

Environmental taxation is one of the most important instruments of government bodies to combat environmentally harmful industries and inefficient use of natural resources. Green taxes can be very effective if they are designed correctly; taxpayers, including environmentally hazardous enterprises, have been identified, and an optimal tax rate has been established. The proceeds from green taxes are used for financial consolidation or for lowering other tax rates. The principles of transparency and completeness of the information can become a decisive factor in the process of recognizing environmental taxation by the public as an integral element of the state's environmental strategy.

Based on the research conducted, certain conclusions can be drawn regarding the effectiveness of the environmental taxation system in the European Union and the potential for the introduction of "green" taxes in Russia. First, there are three main components of environmental taxation in the EU countries: energy tax, transport tax, and environmental pollution tax. The volume of budget revenues from various types of taxes differs significantly in the terms of attracted funds. The largest share belongs to the energy tax. Each EU country has its tax rate, which is determined based on the characteristics of a particular state.

Secondly, the mechanisms of environmental taxation can be considered effective, despite some shortcomings that can be identified within the framework of this system. The volume of revenues from environmental taxation is growing from year to year, which is direct proof of the effectiveness of the system. The funds received are the sources of many green projects and environmental initiatives, as well as catalysts for investing in renewable energy sources and optimizing production. For the countries of the European Union, the most serious problem at the stage of introducing the environmental tax was the danger of reducing the competitiveness of local companies. However, this disadvantage can be mitigated at the expense of other financial instruments of the fiscal policy of states, including grants and subsidies. It should be noted that to achieve the greatest efficiency of the tax system in the field of environmental protection, the introduction of taxes alone will not be sufficient, and "green" taxes should work along with other financial instruments.

Thirdly, for the Russian Federation, the issue of ecology is also quite acute. Although it is not yet so actively involved in the international environmental agenda, government agencies are gradually increasing spending on solving environmental problems; although sometimes, the effectiveness of projects is questioned. According to the authors, the introduction of a "green" tax in Russia would be advisable. When developing legislation in the field of environmental taxation, it would seem rational to take into account the vast international experience, in particular, the experience of the European Union. The environmental tax would increase the total amount of budget revenues, while these revenues could become a source of financing for various "green" projects, that is, the scale of the environmental benefit from the tax can be quite significant. The introduction of new taxes should not contradict the principle of economic rationale, i.e., the introduction of an environmental tax must be economically justified by the state, while the rate for other taxes may be adjusted.

Of course, the introduction of a new type of tax is associated with economic and political risks, but the experience of European countries shows that all risks can be neutralized through the use of auxiliary tools, including incentive taxes. It is also necessary to ensure the transparency of the environmental taxation system for the Russian citizens to accept this system and to maintain the authority of the state in their eyes.

In conclusion, the authors would like to give some recommendations that will help to establish the optimal rate of the "green" tax. First of all, the competent authorities should take into account that the environmental tax should be aimed at a company that is harmful to the environment, or on harmful activities, in other words, it is necessary to clearly define the taxpayer and the object of taxation. The number of tax revenues should fully compensate for the damage to the environment and should be reflected in the level of the tax rate. At the same time, it is necessary to take into account the fact that the environmental strategy is of a long-term nature and regular monitoring need to be carried out by the state. The purpose of environmental taxation should be considered not to temporarily cover environmental damage, but to prevent it. Due to revenues from environmental taxation, it is possible to reduce the tax burden on economic agents for other types of taxes. When introducing environmental taxation, it is critically important to apply government support measures such as subsidies, tax incentives, and loans to "green" economic entities to achieve greater efficiency. This will stimulate economic actors to switch to "green" consumption through compensation payments. An open dialog with citizens of Russia on environmental taxation and spending in this area will help maintain the authority of the state and will allow the introduction of green taxes to be regarded as a necessary measure in the eyes of the public. If we take into account all the above recommendations, then environmental taxation can become an effective tool in the fight against climate change and other problems, as has been proven in the experience of foreign countries.

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Chapter 47
Quantitative Assessment of the Implementation of Sustainable Development Projects in the USA, the United Kingdom and China in the Context of Natural and Climatic Disasters

Olga A. Derendyaeva and Vladimir S. Osipov

47.1 Introduction

Achieving the Sustainable Development Goals (SDG) is a UN priority until 2030 (Transforming our world: the, 2030 Agenda…, 2021). However, inadequate capacity to quantify countries' performance and results pose a serious threat to the achievement of SDG. The closed nature of several states, the complex nature of the phenomena being measured—all leads to a distortion of the assessment of the results. Conducting a quantitative analysis of the implementation of sustainable development projects in different countries in the context of natural and climatic disasters is an urgent task. The purpose of this study is to assess quantitative indicators in the implementation of disaster resilience projects in the leading countries: the United States and the United Kingdom China. The object of the research is sustainable development projects in the context of natural disasters, and the subject of the research is the quantitative indicators of these projects.

O. A. Derendyaeva (✉)
All-Russian Research Institute for Civil Defense and Emergencies EMERCOM of Russia, Moscow, Russia
e-mail: derendyaeva94@mail.ru

V. S. Osipov
MGIMO University, Moscow, Russia
e-mail: vs.ossipov@my.mgimo.ru

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47.2 Methods and Materials

In order to quantify the implementation of sustainable development projects in the context of natural disasters in the leading countries, indicators of economic damage, the number of victims of natural disasters, government and expenditures on the implementation of resilience programs selected. In the context of natural disasters and climate change, human and economic loss and investment are critical criteria for assessing the performance and progress of sustainable development projects.

There are many ways to measure sustainable development indicators, although none of them is universal. States use various mathematical models to determine resilience indicators, such as the Regional Resiliency Assessment Program in the United States (The Regional Resiliency Assessment Program, 2021). The international indicator Sustainable Development Goals Index (SDGI) has been used relatively recently to assess the success of various countries in achieving sustainability goals (Transforming our world: the, 2030 Agenda…, 2021). This tool is still under development. Another attempt to assess the achievements of countries is the Monitoring Platform under the Sendai Framework Monitor, where states fill in up-to-date information on some key indicators (Measuring Implementation of the Sendai Framework, 2021).

Statistical data from official foreign sources were used: USA Federal Emergency Management Agency (FEMA), the UK Climate Change Committee (CCC), USA Environmental Protection Agency (EPA), China Ministry of Environmental Protection (MEP), USA Agency for International Development (USAID), the UK Department for International Development (DFID), the UK Department of Energy and Climate Change (DECC), the UK Department of Environment, Food and Rural Affairs (Defra), China International Development Cooperation Agency (CIDCA), etc.

47.3 Results

The following are summary tables of mortality and economic damage indicators in the UK, the USA and China from 2005 to 2016 (Tables 47.1 and 47.2). It is necessary to pay attention to the fact that in the UK mortality includes deaths during periods of heat and cold waves, which increases the statistical indicators. Without taking into account these data, the average is 0.09 cases per 100,000 people.

After Hurricane Katrina, the decision was made to make the response to natural disasters part of the policy for implementing sustainable communities. This approach is called “the whole community”, which seeks to involve the private sector, community groups and individuals in disaster preparedness. The whole community approach was based on the complexity of sustainable development ideas and focused on using assets that were not previously used: educating and training civil society, raising awareness of resilience to natural disasters and improving national coordination. It

Table 47.1 Indicators of mortality from natural and climatic disasters in USA, the UK and China, 2005–2016 (number/per person)

Year	USA	The UK	China
2005	2000	200	1630
2006	528	2323	3155
2007	523	150	2325
2008	558	102	88928
2009	559	200	1528
2010	477	250	6541
2011	1020	100	1014
2012	517	3000	1530
2013	453	600	2284
2014	335	90	1818
2015	578	88	967
2016	450	300	1706

Source Compiled by the authors based on (Evaluating UK natural hazards…, 2021), (Guidance: Risk assessment…, 2021), (Measuring Implementation of the Sendai Framework, 2021), (Number of fatalities due to natural disasters in the United States, 2021), (Sword-Daniels et al., 2018), (2010–2019 China's natural disaster victims), (Ning Jizhe, director of the National Bureau of Statistics & answered reporters' questions, 2021)

Table 47.2 Damage from natural and climatic phenomena in the USA, Great Britain and China 2005–2016 (billion US dollars)

Year	USA	The UK	China
2005	150	1.7	31.1
2006	11.5	4.2	37.9
2007	12.2	7.5	35.4
2008	11.5	6.1	144.0
2009	11.4	4.4	37.8
2010	9.8	8.3	80.0
2011	23.2	2.6	46.4
2012	38.6	4.8	62.8
2013	13.2	2.8	87.1
2014	6.5	2.6	50.6
2015	15.2	3.1	40.6
2016	18.4	2.9	75.5

Source Compiled by the authors based on (Evaluating UK natural hazards…, 2021), (Guidance: Risk assessment…, 2021), (Measuring Implementation of the Sendai Framework, 2021), (Number of fatalities due to natural disasters in the United States, 2021), (Sword-Daniels et al., 2018), (2010–2019 China's natural disaster victims), (Ning Jizhe, director of the National Bureau of Statistics & answered reporters' questions, 2021) includes the government-private sector partnership, which proved to be very useful during the last worldwide disaster of COVID-19 (Zavyalova, et al., 2021).

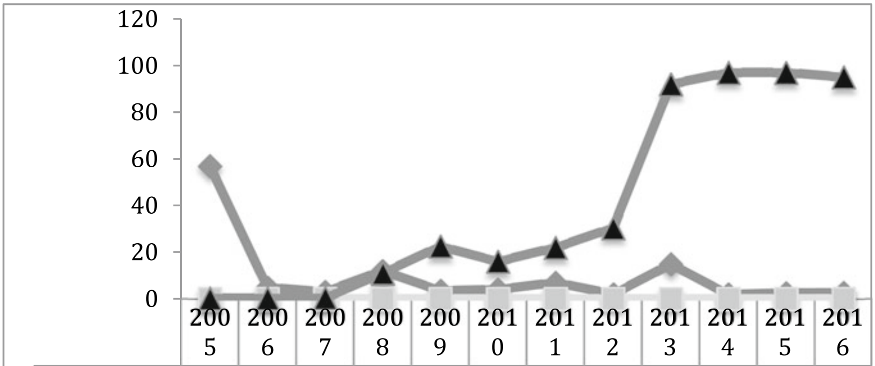
The UK is less prone to natural disasters. However, following the floods in the fall of 2000 and the 2001 FMD epidemic, the UK government felt that existing emergency management policies and structures were inadequate to deal with natural or climatic disasters. In July 2001, the Civil Contingencies Secretariat (CCS) was formed under the leadership of the Cabinet of Ministers. Soon after the September 11 attacks, the scope of the CCS was expanded to include mitigating the consequences of a large-scale terrorist attack (Lentzos & Rose, 2009). Until 2001, the UK Home Office carried out emergency preparedness planning through its Emergency Planning Division. It is important to note that heat waves are the cause of the greatest deaths from natural disasters in the UK, while floods and storms cause the greatest property damage. The wave of intense heat in Europe in 2006 was a period of extremely hot weather, which occurred at the end of June 2006 in some European countries (Rebetez et al., 2009). Britain has become one of the hardest-hit countries.

China is susceptible to all types of natural and climatic disasters, which is clearly shown by the equally high annual rates of mortality and material damage. However, this information has only recently become available. Until 2005, the country did not publish any reporting on human and material losses due to natural disasters. All information was a state secret (The Ministry of Civil Affairs of the State Administration of Secrets…, 2021). Nevertheless, even according to the information already available, it is obvious that the country is in a difficult situation, where geological and natural climatic conditions are superimposed on a specific economic and social situation. In China, disaster planning is gaining importance as an effective human intervention to ensure sustainable community development in the face of natural disasters. It draws on numerous scientific studies from various disciplines and contributes to the national and international science of sustainable development.

Another important indicator for assessment is the funds that countries allocate for projects to reduce the risk of natural and climatic disasters and climate change (Figs. 47.1 and 47.2). China's budget remains consistently high in all indicators. It especially grew in the period from 2008 to 2013, when, after a series of devastating disasters, China begins to reform the entire institutional framework for emergency response, guided by international experience and the assistance of the United Nations Development Program (UNDP), an organization jointly with which the development of sustainable community programs in China takes place.

Climate change issues began to be highlighted in China a little earlier, in 2005, when the decision of the State Council took a course to strengthen environmental protection. All these events led to the reorganization of the existing state bodies in China. The Ministry of Ecology and Environment was established in 2008 on the site of the former MEP. The ministry is the national department of environmental protection charged with protecting China's air, water and land from pollution (Relevant documents of the State Council, 2021).

Hurricane Katrina caused the spending anomaly illustrated in 2005. The study shows that excluding federal spending for Hurricane Katrina from data analysis does not affect the overall upward trend in federal spending on disasters. However, there



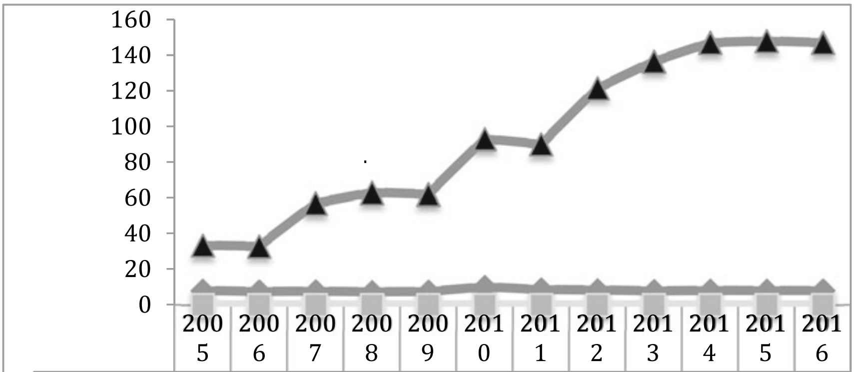
	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
USA	57	4.9	3	12	3.5	4	7	2	14.9	1.9	2.5	2.6
The UK	0.01	0.01	0.02	0.01	0.01	0.01	0.02	0.02	0.01	0.01	0.02	0.03
China	0.3	0.3	0.4	11	22.5	16	22	30.4	92	97	97	95

Fig. 47.1 Comparative table of the budgets of USA (FEMA), the UK (CCS) and China. Environmental & Historic Preservation Guidance for FEMA Grant ApplicationsFacility Search—Enforcement & Compliance Data. Available via U.S. Environmental Protection AgencyInternational Climate FinancePopular science natural disastersRelevant documents of the State Council, 2021 *Source* Calculated and built by the authors based on (Evaluating UK natural hazards…, 2021), (Guidance: Risk assessment…, 2021), (Measuring Implementation of the Sendai Framework, 2021), (Number of fatalities due to natural disasters in the United States, 2021), (Sword-Daniels et al., 2018), (2010–2019 China's natural disaster victims), (Ning Jizhe, director of the National Bureau of Statistics & answered reporters' questions, 2021)

is a lack of a clear amount of reform from the USA government. In China, the sharp increase in the budget can be explained by systematic institutional reforms and increased international cooperation, in the USA this trend is not observed.

In the UK, throughout the decade, the budget remains within certain limits, however, it should be recalled that the country's "Carbon Budget" project was launched in 2008, which involves costs significantly exceeding the EA budget, up to 1–2% of the country's GDP by the time of final implementation. The carbon budget imposes a limit on the total amount of greenhouse gases that the UK can emit over 5 years (UK Carbon Budgets). The UK became the first country to establish legally binding carbon budgets.

The USA is a leader in international funding for resilience programs and the provision of humanitarian assistance. These expenditures average 0.14% of the country's GDP and are mainly channeled through USAID and EPA (Reports & Data, 2021). At the same time, these costs sometimes exceed the indicators for the implementation of sustainability programs within the country. USAID is a leading international humanitarian organization and, at the same time, deals with international development issues in the USA government. On average, USAID allocates more than $20 billion annually and more than half of all foreign aid. The organization cooperates with 125 countries. Almost 40% of funds go to countries and regions of Africa, South



	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
USA	8.1	7.6	7.7	7.4	7.6	10.2	8.7	8.4	7.9	8.2	8.1	8.1
the UK	0.02	0.02	0.02	0.02	0.03	0.02	0.02	0.02	0.02	0.02	0.02	0.02
China	33.5	33	57	63	62	93	90	122	137	147	148	147

Fig. 47.2 Comparison table of USA (EPA), the UK (EA) and China (MEP) budgets. Environmental & Historic Preservation Guidance for FEMA Grant ApplicationsFacility Search—Enforcement & Compliance Data. Available via U.S. Environmental Protection AgencyInternational Climate FinancePopular science natural disastersRelevant documents of the State Council, 2021 *Source* Calculated and built by the authors based on (Evaluating UK natural hazards…, 2021), (Guidance: Risk assessment…, 2021), (Measuring Implementation of the Sendai Framework, 2021), (Number of fatalities due to natural disasters in the United States, 2021), (Sword-Daniels et al., 2018), (2010–2019 China's natural disaster victims), (Ning Jizhe, director of the National Bureau of Statistics & answered reporters' questions, 2021)

of Sahara and more than 19%—to Afghanistan and Pakistan (Reports & Data, 2021). Moreover, it is important to mention the investments in the new technologies, which drive the digital economy and transition to Industry 4.0. All these innovations are supposed to be very useful for digital transformation in socio-economic development and in reducing environmental hazards risk (Popkova & Zavyalova, 2021).

The UK invests 0.7% of its GDP in overseas aid and is one of the most generous donors. The share of finance allocated to resilience and climate change programs is, on average, 0.05% of the country's GDP. The vast majority of this funding is channeled through the International Climate Fund (ICF). It's a $5.6 billion fund backed by three government departments: DFID, DECC and Defra. The former makes the largest contribution to this fund (about $0.6 billion). The latter deals with forestry issues related to climate change. ICF originally received $4.06 billion in government funding when it was established by the government in 2010 (International Climate Finance, 2021). This pool of money was reserved for 2011–2014 and was derived from the GDP allocated for overseas development assistance.

In China, investments in sustainable projects abroad are somewhat more modest than in the USA and the UK. However, they tend to increase in accordance with the development of national sustainability programs and the decision to implement green projects through the Belt and Road Initiative (Popular science natural disasters). The region of the Belt and Road Initiative is becoming more and more important for many countries' private sector in terms of developing sustainable development projects. These projects are becoming the primary factors of its long-term competitiveness (Zavyalova et al., 2018). Before that, these activities were carried out by CIDCA, which independently or in partnership with UNDP, USAID and others implemented infrastructure projects that provided humanitarian assistance to the countries of Southeast Asia. With significant growth rates of the country's GDP in 2011–2013, the share of this financing even slightly decreased. Below is a graph of expenditures of the USA (USAID), the UK (ICF) and China (CIDCA) on international projects related to natural and climatic disasters and climate change in relation to GDP (International Climate Finance, 2021), (UNDP in China, 2021), (Ning Jizhe, director of the National Bureau of Statistics & answered reporters' questions…, 2021).

47.4 Conclusion

As can be seen from data for more than ten years, USA communities are severely affected by various natural and climatic disasters. The economic damage only increases every year. Increased urbanization and material exposure to extreme events are major drivers of increased losses. This trend is observed not only in the USA. It is especially clearly visible in the example of China, where the record growth of urbanization and the unavailability of institutional structures lead to a sharp increase in material damage and mortality rate.

The most active financial policy in the field of implementation of sustainability projects at the international level is carried out by the USA, allocating the largest amount of funds and being a donor of 1/3 of all international investments in sustainability programs. However, not everything is so obvious with national projects, since the impressive budgets of the relevant departments do not give proportional results in terms of the number of victims and material damage. This is most likely due to various problems, structural issues and specific approaches to understanding disaster resilience. The UK does not have as large a budget as USA or China at the national level, due to the country's relatively low exposure to natural disasters. However, the scale and innovative nature of investments in the green economy and climate change are impressive.

China has the largest national budget for climate change protection and green projects, however, the results are not clear in terms of casualties and property damage, which exceed those of the USA and the UK. This is because the country is in the process of establishing a sustainability policy, which coincided with the creation of institutions for dealing with emergencies, as well as environmental problems. All this gives hope that shortly there will be changes in China.

Like other statistical reports compiled based on data from the RRAP projects, SDGI and Sendai Framework Monitor (Evaluating UK natural hazards: the national risk assessment), (Facility Search—Enforcement & Compliance Data), (Guidance: Risk assessment: how the risk of emergencies in the UK), this study shows insufficient progress in the field of building resilience in the context of natural disasters. In the future, this study, together with data from RRAP projects, SDGI and Sendai Framework Monitor, can be used in a comprehensive analysis of the implementation of SDG plans for the development of sustainability projects by countries. Since this paper focused on the economic component of resilience programs in the field of natural disasters, the further development of this study can be the economic justification of projects in the field of resilience development in Russia or the field of international cooperation.

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Chapter 48
Whether Globally Leading Warming to Strengthen the Geo-Economic Position of China?

Natalia Yu. Konina and Elena V. Sapir

48.1 Introduction

The modern world economy is a single geo-economic space subject to several forces and factors impacted by climate change. Global warming and the associated climate change have an increasing impact on the global economy, creating a new geo-economic reality against the technological and digital revolution backdrop. Reducing emissions of carbon dioxide (CO_2) and other greenhouse gases will limit climate change. It may take 30 years for the global temperature to stabilize (Konina, 2021).

Climate change is one of the biggest geo-economic problems. As a conflict multiplier, climate change increases socio-political instability, creates migration pressures, exacerbates global injustice, and threatens human rights and peaceful life, especially in fragile states.

Climatologists say that the world will be able to prevent the average world temperature from rising above 1.5 °C is relative to pre-industrial levels subject future volume of carbon dioxide emissions should not exceed 580 gigatons. Currently, the level of global emissions is about 37 gigatons per year, which means we will exhaust this budget by 2035. Over the past 50 years, the world has already warmed by 1.1 °C (in many regions, temperatures have increased much more).

In recent decades, the traditional rivalry of states has shifted more and more towards the economic sphere; state power is more serving the achievement of economic goals. Since the 90 s of the twentieth century, several scientists from the USA, Europe, China and India researched different aspects of geo-economics. Many

N. Y. Konina (✉)
MGIMO University, Moscow, Russia
e-mail: nkonina777@gmail.com

E. V. Sapir
P G Demidov Yaroslavl State University, Yaroslavl, Russia

E. G. Popkova and B. S. Sergi (eds.), *Current Problems of the Global Environmental Economy Under the Conditions of Climate Change and the Perspectives of Sustainable Development*, Advances in Global Change Research 73, https://doi.org/10.1007/978-3-031-19979-0_48

books and articles on different geo-economic aspects in recent years were published by Amineh and Crijns-Graus (2017), Flint (2006), Lin et al. (2021), Moisio (2019), Sparke (2013), etc.

Modern studies in geo-economics started in Russia in the 1990s. However, deep research took place at the beginning of the twenty-first century. Russian scientists who have made significant contributions to geo-economics concept development include Anokhin and Lachininskii (2015), Bogaturov (2021), Konina (2018), Mikhaylov et al. (2020) and others.

Current geo-economics discourse presented by the works of Beeson and Li (2016), Chandler (2018), Doel et al., (2014), Konina and Sapir (2021), Stephenson (Voinov et al., 2021), Wegge and Keil (2018) the connection between geo-economics strategies of nation-states, energy activities structured in national, regional, and global context and "Green Economy" industrial, technological and climate phenomenon impact.

48.2 Methodology

The integrated approach to the analysis of the socio-economic systems was the basis of the methodology used in the article to study the geo-economic aspects of global warming and changes in the global positions of countries. The authors utilized an interdisciplinary approach as a fundamental principle, considering the complex nature of geo-economics and its manifestation in the world economy (Konina, 2018). The basic research methodology unites statistical analysis, trends research, comparison and systematization.

Conceptually, as a ruling notion, the authors rely on the geo-economic concept developed recently in Russian and foreign world-economy studies. The authors investigated renewable energy sources (RESs) developments and impacts in the context of different countries' geo-economic positions. Thus, the authors studied the state and strategies of leading countries concerning global warming (Sapir & Karachev, 2020).

The most important theoretical and practical issue of global climate change from the point of view of geo-economics is international competition and cooperation and the position of countries in the new world economy within the framework of the new emerging division of labour, taking into account various aspects of the aggravating environmental and climatic problems.

48.3 Research Goals and Objectives

The following features characterize the modern geo-economic landscape from the point of view of climatic issues. Researchers wonder if not all major geo-economic players are now only clarifying their position regarding the future relationship to the climate.

The purpose of this study is empirical and analytical testing of the hypothesis of (1) the growing influence of China in the global climate change agenda and (2) the fostering of the overall rivalry between the United States and China with a new intense competition between the two great powers for the leadership in a new climate policy.

48.4 Results Obtained

Reducing emissions must be a consistent, cumulative process. Human activities have warmed the atmosphere, ocean and land, causing widespread and rapid changes in the atmosphere, ocean, cryosphere and biosphere.

According to the latest available data, China and the United States emit more than 40% of the world's carbon dioxide (CO_2). China, the US, India, the 27 EU countries and the UK account for two-thirds of emissions. China's CO_2 emissions are now about double that of the US, the next most significant emitter (Gemmer et al., 2011). According to current estimates, China's emissions will continue to grow each year at a rate of 1 to 1.7% through 2025.

Therefore, any successful global effort to reduce greenhouse gas emissions must include significant contributions from both countries. Each country has taken this path with a commitment to reducing CO_2 emissions, and both have announced plans, policies and programmes to meet those commitments. However, the nature of the carbon problem differs from country to country, so whilst the plans, programmes and policies they pursue have some similarities, the focus is different. The mood of society and the behaviour of the mass of people play a huge role, reducing emissions.

China has already demonstrated a willingness and ability to lead in the fight against climate change. Over the past five years, China has deployed more solar and wind power systems than any other country in the world. China accounts for 50% of global electric vehicle sales and 99% of global electric bus production (Maizland, 2021).

48.4.1 China's Climate Policy: Controversial Phenomena

China's climate and environmental policies are generating conflicting sentiments and assessments. Until 2006, China did not attach much importance to climate and environmental policy; the situation began to change after the 2008 Beijing Olympics. As climate change and environmental degradation have become a top priority for the Chinese government, it is increasingly involved in global climate negotiations, eventually becoming the leader of the struggle to change the eating environment. In

2016, China announced its participation in the Paris Agreement, and since then, it has tightened its commitments.

According to the Global Energy Monitor and the Centre for Energy and Clean Air Research, China built three times more new coal capacity in 2020 than the rest of the world combined. China's ongoing investment in coal, a significant component of the country's energy supply structure, has exacerbated doubts about the feasibility of the announced decarbonization plans.

Dynamic urbanization in China has also contributed to improving the carbon footprint. Urbanization increases the need for energy to power new manufacturing and industrial centres. Energy-intensive products such as cement and steel are the primary materials for the construction of these centres. Another factor—the increase in the number of cars on the road: 2020 year consumers in China owned about 290 million cars, compared with about 27 million in 2004.

The vector of actions in China's environmental and climate policy field is set and directed in the right direction by the country's political leading elite. China will take all steps towards climate neutrality by the middle of the twenty-first century.

The PRC is the world's largest producer of solar power plants and wind turbines. Electric transport is rapidly developing in the country; pilot projects on hydrogen and fuel cell technology are being implemented, and innovative equipment is already being used to transport electricity.

PRC Chairman Xi Jinping at the General Assembly of the United Nations in September 2020 announced a new China's goals for CO_2 emissions peak by 2030 and achieving carbon neutrality by 2060.

China's 14th Five-Year Plan (FYP), adopted at the National People's Congress in March 2021, sets climate policy directions. The five-year plans are the main binding document for the development of China at all levels of government. China is also seeking to strengthen international climate work, as noted in the 14th Five-Year Plan, and calls for "constructive engagement and leadership in international cooperation on climate change." China aims to become a high-income country by the end of the 14th Five-Year Plan in 2025 and double its economy and GDP per capita by 2035. Decoupling GDP growth from emissions growth has become an essential component of the decarbonization strategy for China.

China's 14th Five-Year Plan provides details of China's decarbonization plans, including a 2025 target to reduce carbon dioxide emissions per unit of GDP by 18% and a reduction in energy intensity per unit of GDP by 13.5%. The 14th Five-Year Plan makes several references to coal development, emphasizing its "cleanliness and efficiency of use." Coal further use is consistent with the broader structure of the plan focused on developing the manufacturing sector based on innovation to provide self-sufficiency in the context of China's complicated external environment and, in particular, the strategic rivalry between the United States and China. In other words, the PRC's 14th Five-Year Plan does not include a target to reduce coal consumption, nor a clear target to peak emissions by 2025. Interestingly, the plan also does not mention the goal of reaching 1,200 GW of installed solar and wind power capacity by 2030, as President Xi Jinping announced in December 2020.

Chairman of the PRC Xi Jinping announced that from 2026 to 2030 China would gradually reduce its coal consumption. He noted that it would not be easy for the PRC to achieve its carbon neutrality, but the country is ready to make significant efforts. The Chairman of the People's Republic of China stressed that the country would control heat and power engineering projects and coal consumption growth during the "14th Five-Year Plan" (2021–2025).

By 2030, the country intends to reach the peak of its carbon dioxide emissions. The country will gradually reduce its coal consumption between 2026 and 2030. China will also adopt the Kigali Amendment to the Montreal Protocol, which should help tighten controls on non-carbon dioxide greenhouse gases.

The Ministry of PRC on Ecology and Environment will adopt more detailed measures on energy, renewable energy, coal and electricity in late 2021–early 2022. Chinese and international researchers on climate modelling declare that China's emissions have to peak no later than 2025 so that China could achieve carbon neutrality by 2050.

48.4.2 China-EU-USA: New Partnership or Competition on Climate Change

As climate change becomes more critical to economic interests, Europe and China will compete and collaborate amid an all-encompassing systemic rivalry. The EU cannot protect Europeans from the worst impacts of climate change—extreme weather events, migration crises and supply chain shocks—without China taking extreme action to tackle the problem. The same is true in China, where vast tracts of densely populated regions are highly vulnerable to the effects of climate change (Gemmer et al., 2011).

Globally, China accounts for 28% of greenhouse gas emissions and half of the coal-fired power plants under construction. What Beijing sees as a priority in its COVID-19 recovery plans, and the forthcoming five-year plan will determine global emissions for decades to come.

China's geo-economic position on climate change intensifies; China is an example and hopes for change for the better for many developing countries, where the prospects are gloomy, and which require rapid response to funding needs and goods. The PRC uses the fight against climate change as a soft power tool to promote and defend its geo-economic interests, in particular, within the framework of its One Belt, One Road project.

China has only recently begun to help formulate global responses to climate change actively. For decades, China has resisted accepting UN commitments. Chinese diplomats argued that China should not sacrifice its economic development for the sake of protecting the environment and that developed countries like the United States should bear more of the burden because they can grow their economies without restriction.

Statement by the Chairman of PRC Xi Jinping had tremendous geo-economic consequences since the intensified debate about the climate in the crucial pre-election time in the United States. Chinese climate new policy has a significant impact on politicians of other Asian countries, particularly South Korea and Japan, who hastened to follow the initiative of China. China is open to cooperation with other countries on climate issues. Environment ministers from Japan and South Korea, whose governments have expressed concerns about the smog and acid rain that cross their borders from China, meet with their Chinese counterparts every year. The European Union has agreed to support China's implementation of an emissions trading scheme. India, the world's third-largest issuer, has signed climate agreements with China, but escalating tensions in 2020–21 have raised doubts about future cooperation.

Despite deep-seated political and economic tensions, China and the United States have worked together on climate change, and experts see opportunities for future cooperation. Under the President Obama administration, countries have expanded collaboration between Chinese and American companies, scientists and experts on clean energy and carbon capture technologies. In 2014, they jointly announced a commitment to reduce emissions. Much of this collaboration ended under President Donald Trump, who took a confrontational stance towards Beijing and questioned climate change findings.

President Joe Biden, committed to cutting US emissions and restoring America's leadership in the fight against climate change, said engaging with China is essential. In April 2021, during a visit to Shanghai by President Biden's Climate Envoy John Kerry, the two countries agreed to make more ambitious commitments under the Paris Agreement. A few days later, the Chairman of PRC Xi Jinping participated in a virtual climate summit organized by the United States. At the same time, the Biden administration has highlighted competition with Beijing, including developing clean energy in the United States in response to China's dominance in this area. Both countries recognize that international cooperation is critical to tackling the climate crisis and the importance of leveraging multilateral institutions such as the United Nations and the World Bank to address climate-related challenges.

However, both see the climate crisis and the global response to it as serious competition for influence and primacy over the technologies and resources that will fuel the global economy in the decades to come. The US and PRC have already outlined a geo-economic confrontation line, focusing on the global energy transition from fossil fuels that generate carbon emissions as a critical arena for competition.

Meantime China also wants to get ahead of the geo-economic competition, using the global warming agenda in its way. The Chinese claims that compared to traditional fossil energy sources, new energy sources do not have clear competitive advantages in terms of technology and economics, whilst the global energy management system is being reconfigured at an accelerated pace.

The EU aims to stay climate leader whilst strengthening the EU's geopolitical position and positioning China as its leading partner for the future. At the same time, China seeks to support the weakening of the United States' climate position on the global stage and destabilize old alliances such as the transatlantic agreement.

Geo-economic competition between the US and China spans and now includes also problems of climate change. That does not mean that there is no room for cooperation—if only Beijing and Washington could agree on the basic rules of interaction, but at the moment, this does not look so promising.

US government hopes to separate climate issues from deep-seated differences between the United States and China, including human rights. China says this is not possible. After all, whilst Washington is imposing sanctions on Chinese-made solar panel materials due to forced labour concerns, the renewable energy partnership with the US could be seen as a sign of weakness.

For the United States, climate cooperation represents an opportunity to restore American global leadership, especially after four years of zero-sum politics and militant isolationism under the President Trump administration. President Joe Biden administration resumed efforts to combat the climate crisis. As stated in President Biden January 2021 executive order, the United States should "exercise their leadership" to form global climate ambition and strategically use their "voice and vote" in global financial bodies to promote measures declared in the Paris climate agreement. China is also looking to strengthen international climate work. The US, the EU and the PRC have set ambitious climate targets to become climate leaders. The US aims to achieve zero net emissions by 2050; China aims to achieve this by 2060. However, whilst necessary, shared goals are far from sufficient to forge a collaborative partnership, especially as fierce rivalries escalate.

48.5 Conclusion

In the new emerging architecture of the world economy, global warming and sustainable development are playing an increasingly important role. The prospects for geo-economic confrontation are increasingly determined by the themes of global warming, decarbonization and the development of renewable energy sources.

The stated goal of China is to achieve carbon neutrality by 2060, which involves substantial economic changes, it needs international cooperation, financial support and technological innovation. To achieve climate goals, China has begun and will continue concentrating focus on the accelerated commitments up to 2030 in the integration of the energy transition in the broader context of economic reform. Using an optimal combination of planning and market mechanisms, precise articulation of national development goals and the fight against corruption allows the PRC to strengthen its geo-economic positions in the situation of global climate challenges.

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Chapter 49
The Landscape of Social Entrepreneurship: A Case Study of India

Parul Tyagi

49.1 Introduction

Social entrepreneurship is defined as an 'entrepreneurial activity with an embedded social purpose' (Austin et al., 2006) and is a comparatively new buzzword in the business world today. Fundamentally, it is an initiative by innovative and empathetic individuals to work on a business model which goes beyond profit-making and focuses on low-cost products and services to resolve social problems. This do-good deed is mainly philanthropic at heart but economically viable as well. The goal is to create a social benefit that is not just for personal advantage. Social entrepreneurship is the process of bringing about social change and social entrepreneurs, are those change agents who use their business to create social value. Besides earning a profit, the equally important characteristic of such enterprises is that their businesses respond to social issues or social needs that they see in the environment around them.

Social enterprises may fulfil the three dimensions—entrepreneurial, social and inclusive ownership-governance—in different ways… Unlike traditional non-profit organizations, which typically rely primarily on donations and grants, social enterprises engage in market exchanges… unlike conventional enterprises, social enterprises rely on a mix of resources: voluntary work, donations and grants in addition to earned incomes, which are either generated by the sale of goods and services to private clients or by the provision of general interest services on public contractual bases… and unlike most traditional enterprises, social enterprises must ensure that the interests of all concerned stakeholders are duly represented in decision-making processes (Borzaga et al, 2020).

The process of social innovation includes six stages: To begin with, the need for social innovations prompts the idea of setting a social enterprise, which leads to the

P. Tyagi (✉)
People's Friendship University of Russia (RUDN University), Moscow, Russia
e-mail: parultmoscow11@gmail.com

E. G. Popkova and B. S. Sergi (eds.), *Current Problems of the Global Environmental Economy Under the Conditions of Climate Change and the Perspectives of Sustainable Development*, Advances in Global Change Research 73, https://doi.org/10.1007/978-3-031-19979-0_49

development of proposals that are tested in practice as prototypes. After successful testing, these ideas take formal shapes and are launched in a way to become a long run practice or sustainable only to grow and scale further and finally, they lead to systemic change in the society by creating positive social value (Murray et al., 2010).

It is the economic dimension that gives the enterprises a sustainable feature by ensuring a stable and continuous production of goods and services and market orientation. The social dimension ensures a social/general interest focus and the inclusive ownership dimension permits an inclusive and participatory governance model and profit distribution limits.

In a world mired by innumerable issues and government limitations, social entrepreneurship is emerging as the potential one-stop solution to economic and social problems. As in the words of the founder of Ashoka, Bill Dryton, 'Both, business and social sectors are in the midst of the most profound structural revolution. The rate of change and the degree and extent of interconnection between the two sectors have been accelerating exponentially for the last three centuries. The business started the revolution, but now both the sectors are fully engaged in this transition' (Singh, 2019).

Porter and Kramer (2011) saw social entrepreneurship as a transitional phenomenon in the process of making conventional for-profit enterprises refocus themselves on creating social value.

In the Indian context, a social enterprise is an enterprise that tries to attain sustainability and scalability in its social mission (which is its primary mission) through a blend of social value creation, market orientation and entrepreneurial qualities, to achieve a balanced impact, irrespective of the legal identity of the social enterprise (Sengupta & Sahay, 2018). Social enterprises are categorized into two for-profit enterprises (FPEs) which include companies registered under the Companies Act, sole proprietorships, partnership firms, HUFs and limited liability partnerships; and non-profit organizations (NPOs), which include Sect. 8 companies, trusts and societies (SEBI, 2020).

49.2 Methodology

This study attempts to present a comprehensive view of the growing impact of social entrepreneurs on Indian society and the Economy. The study utilizes empirical research by using empirical evidence to study the social entrepreneurship ecosystem of India. By way of direct and indirect observation, literature research and report analysis, an attempt had been made to gain knowledge and clarity on the pretty scattered, dissociated topic, but one believed to be the harbinger of future growth and emancipation of the Indian economy—the social Enterprise (SE) sector and present it to the readers in a comprehensible manner. A vast amount of material available from different sources including reports was deeply studied to clarify the picture of how these SEs are operating in different areas, how well they are being supported by government, public investors and incubators and what challenges they are facing.

49.3 Results

India is a country set in its uniqueness not only by the odd five-thousand-year-old continuity of civilization and its metamorphosis over the centuries but also by the ensemble of contrasts and com-possibility in every aspect of its existence. The country has seen the zenith of prosperity and the abyss of impoverishment. The current effort of the country to rise out of the ashes has attracted a lot of international attention, since it clocked one of the fastest GDP growth. In addition to the humungous task of managing its ever-growing population, uplifting its grassroots level population is a herculean task that the government is trying to achieve—increasingly with the active assistance of its social entrepreneurs.

Social work as a part of giving back to society is deeply ingrained in the ethical system of India. However, in modern India, social entrepreneurship has evolved as a profession, which comes in handy for the government in just not alleviation the problems of modern society but also in generating employment. However, social entrepreneurs are fundamentally different in their approach to business and society from the entrepreneurs as their main focus is not profit but the solution of problems that they see around them and which move them to an extent that they are ready to do something about it. To this day, contributing to society to make it better, is a popular concept. So, combine a whole bunch of people who have an unstoppable attitude, an incredible combination of personal resources, a population in need and a propensity towards helping others … and what do you get? A hotbed for social enterprise (Clinton, 2010). A recent survey commissioned by the Indian government found that there is one non-governmental organization for every 400 people—which means there are about 3.3 million NGOs. Regardless of how great each NGO's impact is, the sheer number of them is symbolic of a culture that favours trying to help those in need (Clinton, 2010). Tracxn, one of the world's largest platforms for tracking start-ups and private companies spread across many countries claims that in 2016–2017 1.73 billion dollars of growth capital was invested in the top 10 social impact companies in India. Intellecap, the advisory arm of the Aavishkaar Group had prepared a list of roughly 400 social entrepreneurs actively engaged in India in 2020 in fields ranging from microfinance to agriculture which provide an insightful view of the various ways the social enterprises are impacting society in India.

Social entrepreneurship models in India can be bifurcated into three: social for-profit enterprise, non-profit and hybrid model. In addition, other ways of creating impact in India are through philanthropy and corporate social responsibility (Swissnex India, 2015).

India has been making great progress in terms of socio-economic development in the last decade. This is paralleled by an equal thrust towards creating a better and equitable society by eradicating the long ignored and seemingly impossible to solve social problems. Social work had always been the central cog of the cultural ethos, its turn towards entrepreneurship is, however, a recent phenomenon and has been encouraged even as a source of employment generation besides the philanthropic angel. Cooperative and community-owned business models like Amul and Fabindia have existed in India since the 1950s. However, the global social entrepreneur support organization, Ashoka, introduced the term 'social entrepreneur' only in 1981. Today, there is an estimate of 2 billion social enterprises in India (Intellecap Avishkaar, 2019). Covering areas ranging from health care, agriculture, water and sanitation, energy, skill development, waste management, education, gender equality, elderly care, addiction, food and poverty. These social enterprises are actively supported by the government, impact investors from the country and abroad. According to the Beyond Profit 2010 survey, in India, about 68% of SEs have existed for about five years or less. Moreover, about 90% of SEs earn annual revenue of $500,000 or less. On average, about one in three SEs experience losses in their current operations. However, looking at the big picture, SE revenues are growing quickly; nearly one-third of the enterprises surveyed by Beyond Profit grew by over 50% between 2009 and 2010, while only 6% of the surveyed enterprises saw negative growth (Asian Development Bank, 2012).

49.3.1 History of Social Entrepreneurship in India

India is a civilization that has existed for 4,500 years. The length of its existence reflects its unique quality to survive and thrive, mainly because of its cultural ethos of 'survival based on cooperation and interdependence. All classes of society hold and support each other. The rich help the poor and the poor support the rich. Philanthropy and social work are ingrained into the fabric of life as a means of salvation. The ancient concept of 'Vasudhaev Kutumbkam' (the whole world is a family) is a common belief of Indians. The concept of 'Sarva dharma sambhav' refers to a sense of harmony and coordination among the duties of all sections of society. Added to this is the concept of restraining and satisfaction in life as opposed to an indulgence. A person who shuns the material world like Buddha or Mahatma Gandhi is revered in society. Helping the downtrodden and needy and giving back to the society by the 'haves' as a part of their due is a virtue that is esteemed deeply in this part of the world.

Religions like Hinduism, Jainism and Buddhism are all based on the principle of 'daan'. Since ancient times, the building of vidyalayas (schools), dispensaries and hospitals (aushadhalayas), wells, rest places (dharmashalas), water points (piyau), even shelters for animals was not just the duty of the king but also of businessmen and other wealthy and privileged members of the society. The Muguls levied Zakat (tax) of 2.5% on the income of citizens which was used for social upliftment. Khairat (donation) was a part of humanity.

Modern times have seen the emergence of educated and capable individuals who continued this tradition of 'seva' and volunteered to help society in various ways they thought fit. Ishwar Chandra Vidyasagar championed the upliftment of the status of women in India. In the field of education, Rajarammohan Roy found Brahma samaj, a social-religious reform movement and founded the Anglo-Hindu School and the Vedanta College to prepare the youth for the demands of modern life. The Servants of India Society was founded by Gopal Krishna Gokhale to promote education, sanitation, health care and fight the social evils of untouchability and discrimination, alcoholism, poverty, oppression of women and domestic abuse. Harijan Sevak Sangh, a non-profit organization was founded by Mahatma Gandhi in 1932 to eradicate untouchability in India, working for Harijan or Dalit people and upliftment of scheduled castes of India.

The first step towards the professionalization of social activities took place with the founding of TISS, Asia's oldest institute for professional social work in 1936 as The Sir Dorabji Tata Graduate School of Social Work.

49.3.2 Ground Realities

India is a country of extremes. With the second-largest population and the fifth largest economy of the world, its per capita GDP stood at only 1,900$ in 2021. World Bank puts one-fifth of the estimated population of India still below the poverty line in 2018 where those spending over INR 32 (US$ 0.45) a day in rural areas and INR 47 (US$0.66) a day in towns and cities are considered Above Poverty Line (World Bank data, 2018). This huge number of citizens who lack basic facilities like health and education provide a lot of scope for innovative social businesses.

India has traditionally been a rural economy. As per the 2011 Census, almost 69% of the country's population and 72.4% of its workforce still reside in rural areas. The divide between the living standards in cities and villages is huge. Rural areas lack basic facilities like electricity, sanitation, education and employment. With this lack of proper education, skill development the infrastructure, the contribution of the agricultural sector to the economy is only 15.4% of the GDP.

With the world's largest youth population, 356 million between the age of 10 and 24, the challenges of skill development and unemployment become stark. Moreover the proportion of the economically active population (15–59 years) was 62.5% in 2011.

The literacy rate in the country was 73% (as of the year 2011) with variation in rural/urban and male/female literacy rates. Urban areas have 80% literacy, while rural areas have only 68% literacy. In a traditionally patriarchal society, males are more literate (81%) than females (64.5) (Census of India, 2011).

49.3.3 Government Policy on Social Engagement

The government has chalked out various schemes and plans that would impact social innovation; MSME development; private sector engagement and social enterprise operations. The Ministry of Skill Development and Entrepreneurship; the Ministry of Micro, Small and Medium Enterprises and the Ministry of Finance are the three ministries laying down various measures to encourage start-up and operation and funding of or investment in social enterprises in the country.

In 2010, the Prime Minister set up a National Innovation Council (NInC) intending to help India 'to innovate to produce affordable and qualitative solutions that address the needs of people at the bottom of the pyramid, eliminate disparity and focus on inclusive growth model'. Under the Twelfth Five Year Plan (2012–2017), the government accorded priority to Bottom-of-the-Pyramid (BoP) focused enterprises and social good ventures by declaring the period between 2010 and 2020 as the 'Decade of Innovation'. It committed to helping social enterprises in capacity-building by investing seed capital through a new fund called India Inclusive Innovation Fund (IIIF) in areas of health care, energy, urban infrastructure, water and transportation (Potdar, 2016).

A programme, Mahatma Gandhi National Fellowship was announced by IIM Bangalore in 2019 at the initiative of the Ministry of Skill Development and Entrepreneurship (MSDE), Government of India (GoI) and implemented in collaboration with State Skill Development Missions (SSDMs) to encourage the youth of India to help in skill development at the grass-root level and promote rural employment.

Another radical move by the central government was to engage the private sector as well in the social development of the country by introducing an amendment in the Companies Act, 2013. The Act made it mandatory for companies with a net worth of 500 crore rupees or more, or a turnover of INR 1,000 crore or more, or a net profit of INR 5 crore or more, to constitute a committee for corporate social responsibility (CSR) and to spend at least 2% of the average net profits made during the three immediately preceding financial years in pursuance of the company's CSR policy. This authorization has substantially augmented the finances available to non-governmental organizations (NGOs) in India for investing in various social causes including social entrepreneurship.

Further, the 'National Skill and Entrepreneurship Policy' announced on 15 July 2015 by the Ministry of Skills and Entrepreneurship includes a section on social enterprises that aims to foster social entrepreneurship and grassroots innovation.

According to a 2016 report based on a survey undertaken by the British Council, there may be as many as 2 million social enterprises operating in India 53% of these social enterprises were engaged in skills development activities, 30% in education, 28% in agriculture/fisheries/dairy, 26% in financial services and 26% in energy and clean technology (British Council, 2016).

49.3.4 Education

Of all the different problems plaguing India today, education is still the most fundamental. Despite India's inching towards to becoming the most populated in the world, it is moving closer to achieving the highest GDP growth. For these two contrasts to converge on a balance, it will be important to provide good quality education. The challenge is huge with a 27% illiteracy level. Presently, India has a population of 193 million between the age of 6 and 14 out of which less than 50% have access to education. Of those enrolling, more than 50% drop out at some stage (Smile foundation of India, 2002). For those going to school, as of 2015–2016, there are 97,273 single teacher schools (8.8% of total schools) of which 83.6% are primary schools (Kavishwar, 2018). In rural areas, nearly 60% of students up to the age of 10 do not possess basic reading skills or can solve simple mathematical problems (Ralhan, 2016). Poor infrastructure of schools, poor quality of teaching, lack of monitoring, lack of digitisation, non-availability of proper materials, poverty and low motivation of students towards education are some common problems related to this sector. COVID-19 has only made the situation worse as most schools shifted to an online mode, hence becoming inaccessible to a huge majority of underprivileged children.

Indian government passed The Right to Education Act in 2009 which made the right to free and compulsory education of children between 6 and 14 years, a fundamental right. However, this alone is not enough to eradicate the problem. Some social entrepreneurs and non-governmental organizations have taken upon them this daunting task of providing education to not just children, but also adults through various programmes and initiatives. 30% of the social enterprise in India operate in the education sector (British Council, 2016). Social entrepreneurship in education has taken a two-faced approach: access to education for the underprivileged and rural, improvement in the quality of education.

Enterprises like Rumi Education and Enterprising Schools provide good quality affordable education to the underprivileged. Hole-in-the-Wall works to improve elementary education and life skills of children in disadvantaged communities of rural India and urban slums. The Asha Foundation provides education to the underprivileged children of the slums. With a mission to eliminate educational inequity in India, 'Teach for India' recruits college graduates and working professionals to serve as full-time teachers in some of the nation's most under-resourced schools for two years. These youngsters are then encouraged to become entrepreneurs and use their experience to create impactful and innovative solutions to the social problems of the country.

The digital education interface has been gaining a lot of popularity in the education sector in the country. Digitalisation has the potential to solve both accessibility and quality issues in education. Many start-ups have appeared on the market selling modern methods and techniques of teaching and learning. Online teaching and tutoring enterprises, with new and innovative technology, are making the learning of millions a better experience. Shortcomings of outdated teaching methods, shortage of properly qualified teachers, highly disproportionate student–teacher ratio, inadequate teaching material and outreach are effectively overcome by digital education.

49.3.5 Skill Development and Employment

India has the biggest youth population in the world. It has been estimated that India's economy needs to create 10 million new jobs annually until 2030 to keep up with the growth of its working-age population—that's more than 27,000 jobs each day for the next 12 years (Trines, 2018). Social entrepreneurs in the skill development sector are trying to bring a positive impact on society by helping the youngsters gather proper skills and improve their possibilities of employability and get high paid jobs.

Enterprises like Khwaab Welfare trust are dedicated to skill women to make them financially independent by teaching them tailoring, knitting and home decoration.

At NavGurukul, Employability programmes like coding skills are being built into the higher education programmes for empowering aspiring students of financially and socially underprivileged groups of the society. Ayansh foundation was set up to educate and empower underprivileged youth and provide them livelihood options by training them from carpentry to mass communication and graphic designing. Fabindia, popular for its ethnic wear and home furnishings, is the pioneer of connecting artisans to the market and creating a meaningful source of income for them. Established in 1960, Fabindia operates 327 stores across India and 14 international stores as of 2020. Its hand-crafted products keep alive the craftsmanship of 40,000 artisans and craftsmen across India by providing rural employment. Some social impact groups like Rangsutra (an artisan collective that supplies apparel to Fabindia) and Tana Bana, (a self-sustaining organization co-owned by artisans, weavers, promoters, employees and investors) are providing a global platform to the local artisans and increasing their source of income at the same time provide them training and protection from exploitation.

49.3.6 Energy

Sustainable, affordable and clean energy is one of the sustainability goals that India has promised as part of the 2030 Agenda for Sustainable Development adopted by 193 Member States at the UN General Assembly Summit in September 2015. As a developing and energy-poor country, India has a daunting task to balance the cost and sustainability of energy power. Despite the government of India claims of 100% electrification of the village, blackouts are a common occurrence, even in cities. Many social entrepreneurs have risen to this challenge. Two enterprises worth mentioning are SELCO Foundation and HPS.

Set up in 1995, SELCO is a for-profit social enterprise serving as a rural energy service company based in Bangalore, India. SELCO has played an instrumental role in raising the living standards of poor households in rural India especially in the state of Karnataka through solar energy-based interventions and low smoke cookstoves. They claim to have impacted the lives of more than one million people in 50,000 households in six states of the country. Husk Power Systems (HPS) offers 100% renewable energy 'pay-as-you-go' service through biomass gasification—utilizing biomass waste, such as rice husks, maize and cobbs to deliver six to eight hours of AC power to rural customers. HPS now runs 60 mini-power plants that power approximately 25,000 households in more than 250 villages, impacting the lives of 150,000+ people in rural India. At the end of 2020, Husk Power had more than 5,000 small business customers and 300% growth.

49.3.7 Health Care

According to the report titled 'State of Healthcare in India—Indian cities through the lens of healthcare', India spent only 3.5% of its GDP on health care in 2018, as compared to developed countries like the US, the UK, Japan, Germany and Canada which spent nearly 10–18% of their GDP on health care. Moreover, there is only half a bed available per 1,000 people in India. India also has the lowest number of doctors (0.86) per 1,000 people (Health care radius, 2021).

With such a background and the world's second-largest population, it is obvious that the healthcare sector is one of India's largest sectors, both in terms of revenue and employment and still has immense scope for improvement and growth. Government alone is unable to handle the needs of health care and therefore, innumerable private and charitable institutions, as well as social entrepreneurs, have taken over the charge.

From Eko Health's drive to help the patient save substantially on their medicinal and surgical expenditures, to Ayzh which sells low-cost sterile birth kits costing just 2 dollars, the Indian healthcare ecosystem is full of SE initiatives.

With Aravind Eye Hospital's mission to eradicate blindness among the poor in India, especially in rural India living with a minimum daily wage and who cannot afford medical treatment, its business model is highly social, yet sustainable. It runs on its revenue. Aravind Eye Hospitals provides large-volume, high-quality and low-cost care—either free or at heavily subsidized rates. Yet the organization remains financially self-sustainable. Great importance is given to equity—ensuring that all patients are accorded the same high-quality care and service, regardless of their economic status.

Narayana Health is another India's leading low-cost, high-quality Indian healthcare service provider with a network of 21 hospitals, 7 heart centres and 19 primary care facilities. NH has a strong presence across 18 locations in India. The NH group caters to over 2.6 million patients every year and provides an advanced level of care in over 30 specialities. The group has more than 15,000 employees and associates including over 3,300 doctors across its healthcare facilities.

49.3.8 Water

A safe water supply is the backbone of a healthy economy. However, even after 75 years of sovereignty, India struggles with the problem of providing safe drinking water to its population. The problem faced is three-faced water depletion, contamination and distribution. A NITI Aayog report in 2018 stated bluntly that 600 million people, or nearly half of India's population, face extreme water stress. In India, women spend an estimated 150 workdays every year fetching and carrying water. Three-fourths of India's rural households do not have piped, potable water and rely on sources that pose a serious health risk. India has become the world's largest extractor of groundwater, accounting for 25% of the total. 70% of its sources are contaminated, and major rivers are dying because of pollution (Chengappa, 2021).

For the government of India's Ministry of Jal Shakti, safe drinking water and sanitation remain high on the agenda. It has launched various programmes like the National Rural Drinking Water Programme, the Jal Shakti Abhiyan, Jal Jeevan Abhiyaan and swajal project to achieve this goal. 'Areas of SE activity are mainly comprised of rainwater harvesting, small-scale water networks, community water treatment and point-of-use filtration' (Asian Development Bank, 2012).

However, this is not enough. Many social enterprises have come forward to contribute their might. Piramal Sarvajal, seeded by the Piramal Foundation in 2008, is a social enterprise, which provides innovative solutions to water problems by creating affordable access to safe drinking water. They have set up water ATMs which are automated water dispensing units. These solar-powered and cloud-connected ATMs provide 24/7 safe water to underserved communities. Currently, they are reaching out to about 632,000+ consumers daily, through 1,580+ touch-points across 20 states.

Sulabh has innovated a drinking water system that converts the surface water in arsenic affected areas of West Bengal and Bihar to drinking water of suitable quality. This water is provided at an affordable rate of 1 Rupee/litre at Sulabh water ATMs. Another enterprise Naireeta, works to solve farmers' water and crop problems through an innovative product that filters, injects and stores rainwater at multiple subsoil strata. It claims to have positively impacted more than 100,000 rural poor and women small-hold farmers to date. Morarka Foundation has been engaged in developing technologies for water conservation for the last over ten years. It has developed many new technologies for water harvesting, conservation and recycling.

D&D Ecotech Services, KRG India, NS& Associates, Osmosis India are all working towards rainwater harvesting, water conservation and providing sustainable and eco-friendly solutions to the prevalent problem of water supply in India.

49.3.9 Sanitation

The sanitation facilities in India are both inadequate and insufficient. 'The key operating models adopted by SEs to tackle this problem are household toilets, pay-to-use community toilets and "ecosan" toilets, where toilet waste is used to create biofuel. SEs in the sanitation sector are structured both as for-profit and not-for-profit entities; the for-profit enterprises primarily operate in sanitation technology space, while not-for-profits construct and manage the toilets' (Asian Development Bank, 2012).

Only 32.7% of its rural households had access to toilets before 2014 when the Swaccha Bharat Abhiyaan was launched by the Government of India, the world's biggest behaviour change programme to eliminate open defecation. The national statistics now claim that over 100 million household toilets were constructed till 2019 benefitting 500 million people across 630,000 villages.

Private social entrepreneurs played a substantial role in this. Sulabh International Social Service Organization has alone built 1.5 million toilets in 27 states across

India. Sulabh toilets can be spotted in urban slums, near railway stations and other public areas as well as in rural India.

Similarly, social enterprises like Garv Toilets with an outreach of over 2000, Saraplast PVT LTD—an enterprise offering portable sanitation and waste disposal and Tiger Toilets have found space in the sustainable sanitation sector. Many non-governmental initiatives like The India Sanitation Coalition and Samhita Social Ventures have also advanced towards resolving sanitation-related issues in the country.

In the sphere of women sanitation issues, low-cost sanitary pad machines built by Muruganantham Arunachalam, a social entrepreneur are distributed to self-help groups (SHGs) run by women and are making lives of poor women hygienic, empowered and comfortable. Currently, more than 1,300 machines made by his start-up company, Jayaashree Industries, are installed across 27 states in India and seven other countries.

49.4 Conclusion

The Indian social entrepreneurship ecosystem is showing very healthy signs of growth and prospects. The internal zeal of innovation in the young population of India as well as the dire need to survive and prosper in the rural and underprivileged areas combined with the desire to rise in the social ladder of the social echelons has fired this silent revolution which has already started creating a buzz. India as such has a very varied and vibrant civil society that has responded to the needs of the underprivileged and excluded for centuries. There are innumerable examples of start-ups with social impact and social enterprises who are engaged in bringing the people on the outskirts to the mainstream of society and development. The study could only cover a few prominent ones. However, when it comes to practice, it is evident that the field of social entrepreneurship needs a supportive political, economic, social and institutional environment to excel (Poon, 2011). To this end, the government of India has put in a lot in terms of encouragement to these self-employing, employment-generating and problem-solving ventures. The launch of the Digital India program by the government has already begun to transform India into a digitally empowered society and knowledge economy. This greatly helps the excluded and isolated sections of society integrate with the global community and access the world markets. The sector today has no dearth of Incubators and Impact Investors ready to support innovations for finding the solution to the country's developmental challenges.

To advance the social welfare sector, organize it and provide access to capital to the social enterprise, the government has been taking steps since 2019 for the establishment of a Social Stock Exchange in India. The Social Stock Exchange will be set up under the authority of the Securities and Exchange Board of India (SEBI). It will render better market access and visibility to both non-profit and for-profit enterprises with social intent and impact as their primary goals. Moreover, it will give them a chance to raise capital through philanthropy, corporate social responsibility, impact investing as well as government funding.

However, a lot needs to be achieved in terms of consolidation of the sector, accessibility and awareness. The increase in SE space must be in tandem with the support ecosystem for it to be sustainable. A database with all information about this area needs to be created, propagated and updated. Digitalization can go a long way in achieving this. If the sector has to roll on, it needs a comprehensive organization and systematization. This will make the access of growth capital to innovative solutions and start-ups much easier and quicker.

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Chapter 50
Comparative Analysis of Climate Programs in Germany and the USA

Maria A. Kozlova and Taisiya V. Dianova

50.1 Introduction

An overall coordinated approach is required at the global level to combat global warming effectively. In 1997, the Kyoto Protocol which was an additional document to the 1992 UN Framework Convention on Climate Change was adopted. The main task set in the Kyoto Protocol was to reduce greenhouse gas emissions into the Earth's atmosphere to prevent global warming. According to scientists, an increase in temperature on Earth higher than 2°C will lead to serious consequences, including a lack of water in some regions, sea-level rise and the extinction of some species of animals and plants. The protocol entered into force in 2005, and by 2009, it was signed and ratified by 192 countries (while the United States signed but did not ratify the protocol, and Canada ceased its participation in 2012). The next step was the signing of the Paris Agreement, which was adopted within the framework of the UN Framework Convention on Climate Change. It entered into force in 2016 and has been ratified by 195 countries.

A significant role in coordinating international efforts belongs to world leaders who have achieved the greatest success in the fight against global warming, primarily the EU. The United States also claims a key role in combating the problem of climate change, therefore, this article focuses on studying the contribution of Germany as one of the leading countries of the EU and the United States and on comparing the policies pursued by these countries.

M. A. Kozlova (✉) · T. V. Dianova
MGIMO University, Moscow, Russia
e-mail: michandy@mail.ru

T. V. Dianova
e-mail: diatai@yandex.ru

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Within the framework of the European Union program, the goal is to achieve climate neutrality in the EU countries, which, in a narrow sense, means the possibility of carrying out production activities without emitting carbon dioxide or offsetting this waste through carbon-negative projects. In a broad sense, this definition implies very low, climate-friendly emissions. The overall strategy for achieving a resource-efficient, and at the same time, competitive economy is outlined in The European Green Deal. The document provides for the implementation of more than fifty measures that will affect all sectors of the economy. The study of the program to combat climate change in Germany is of particular interest since the country sets itself quite ambitious goals and is a recognized leader in the field of "green" technologies. It is worth noting that Chancellor Angela Merkel constantly raises questions about climate protection in the international arena, securing the image of a "climate chancellor". In addition, Germany was one of the first countries to submit to the UN a long-term strategy to reduce greenhouse gas emissions. The United States of America has now also moved to actively combat climate change following the arrival of the new Biden administration. The United States re-entered the Paris Agreement and made additional commitments in the area of climate policy.

It should also be noted that Industry 4.0 technologies play an important role in climate policy. The introduction of digital technologies will significantly reduce emissions of exhaust gases and will contribute to the transition to renewable energy sources since it makes the transition to new technologies cost less. In general, changes in industrial production will occur at three levels which can be implemented either together or separately. First, assistive computer systems allow workers to increase their productivity. Secondly, these are cyber-physical systems, or systems of "smart or digital production" where machines are connected into a network and can work autonomously; due to this cooperation, it is possible to control the technological process using special consoles. Thirdly, the most difficult level is artificial intelligence. It can carry out various types of work, for example, processing and sorting orders and independently making decisions when interacting with other robots. This is the most expensive and revolutionary technology. A gradual transition to a new type of production will entail a reduction in the size of the labor force. Such negative changes in terms of lower living standards will lead to positive changes in the environmental sector since people will reduce their consumption, and together with the ability to remotely control the functioning of automated systems, the number of citizens using transport to commute to work will also decrease (Smit et al., 2021).

50.2 Methodology

The undertaken research focused on a comparative analysis of the climate policy pursued in the United States and Germany. Based on it, the features of each of the countries are highlighted, and possible problems in the implementation of the current policy as well as the prospects for its implementation are considered. The essential role of Industry 4.0 technologies is also noted, and the role of the latest technologies in accelerating and reducing the cost of the transition to less energy-intensive technologies is shown. The authors carried out a systematic analysis of the programs, which made it possible to structure the main areas of activity of the United States and Germany.

50.3 Results

The main features of the climate policy carried out in Germany and the United States are first considered, and then, the features of each of these countries are highlighted.

Let us begin with a description of the climate program in Germany. In 2016, the Federal Cabinet of Ministers approved the Climate Action Plan 2050. The implementation of this program should lead to the achievement of the goals under the Paris Agreement. To be most effective, the program will be revised every 5 years to be able to adapt it to the current technological, economic, political and social realities. In general, 2 main goals can be distinguished: to achieve neutrality of carbon and greenhouse gas emissions and also to keep global warming below 1.5–2°C (Federal Ministry, 2021).

The key aspect of the approved plan will be the transformation of the energy sector. The plan is to phase out electricity from fossil fuels and expand the use of renewable sources. This will reduce emissions in this sector by 61–62% by 2030 compared to 1990. It is obvious that the extractive industry will suffer when switching to alternative energy sources. To mitigate the negative effects in Germany, a special commission has been created, which is engaged in supporting regions and individual industries related to coal energy.

In the industrial sector, it is planned to reduce emissions by 49–51% by 2030. This should be facilitated by increasing the efficiency of energy use (introducing energy-saving technologies into production), reducing emissions from industrial processes, which were previously considered inevitable, as well as using the potential of lost heat.

For the construction sector, the goal is to reduce emissions by 66–67% compared to 2030. To this end, standards for the construction of new buildings have been developed, and a plan has been proposed to modernize existing buildings and phase out heating systems powered by fossil fuels. Additionally, it was decided to compensate the expenses of citizens in the amount of 40% of the cost of replacing diesel boilers with more modern and environmentally friendly ones. From 2026, the installation of old-style boilers powered by fuel will be prohibited.

In the transport sector, emission reductions of 40–42% need to be achieved by 2030. To achieve this goal, it is essential to make a transition to the use of electric vehicles, as well as hybrid cars. These changes will affect not only private but also public transport. To stimulate the purchase of more economical and environmentally friendly cars, the state will pay an additional €4,000 to each car owner, provided that the cost of the car does not exceed €40,000. Besides, the strategy provides for encouraging train passengers by upgrading the relevant infrastructure, as well as

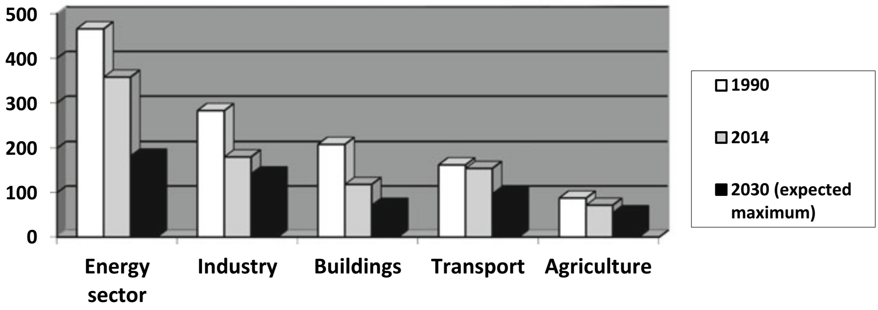

Fig. 50.1 Sectoral targets in the Climate Action Plan 2050 (the target goals are shown in millions of tons of CO_2 equivalents) *Source* Compiled by the authors based on (Federal Ministry, 2021)

reducing VAT on railway transportation from 19 to 7%, which will ultimately make train tickets cheaper. Plane tickets, on the other hand, will double the price due to the gradual increase in the cost of CO_2 emissions. Thus, the government seeks to motivate citizens to use the railways to travel within the country. In small towns, comfortable conditions will be created for cycling and walking.

In agriculture, it is planned to reduce emissions by 31–34% by reducing the excessive use of fertilizers. The German government will take climate concerns into account when subsidizing the agricultural sector. An important role is played by the conservation and development of forests that naturally mitigate the effects of climate change. Figure 50.1 illustrates the emission reduction targets for 2030 in various sectors of the economy.

For 2050, the German government has formed the following key goals (Federal Ministry, 2021):

- increase the share of electricity generated from renewable sources to at least 80%;
- reduce electricity consumption by 25%;
- reduce the consumption of primary energy by 50%;
- carry out the reconstruction of the housing complexes in order to achieve climate neutrality;
- reduce the final energy consumption in the transport sector by 40%.

If these goals are achieved, then it will be possible to reduce greenhouse gas emissions by 95% in aggregate. The calculation is carried out on the assumption that energy-saving technologies will be improved, which will make it possible to adjust the introduced measures. Along with this, it is expected that the behavior of people will change, and there will be a conscious reduction in consumption, as well as a transition to the use of more environmentally friendly vehicles, equipment, etc.

To implement the planned program in Germany, it was decided to take a measure that will have a comprehensive impact on the transport system, heat supply, air transportation, construction and many other sectors of the economy. This is an introduction of CO_2 emission certificates. Their cost will be 10 euros per ton in 2021, but by 2025, the price will increase to 35 euros, and by 2030, it may reach 180 euros. According to the government's calculations, this system will bring over 18 billion euros to the state budget. These funds will be used to implement the environmental program, as well as to partially offset the costs of households for the transition to a new way of life, in which emissions should be reduced in all sectors of the economy.

However, a gradual increase in emission fees will inevitably lead to higher prices for all types of non-renewable fuels for end-users, which will cause an additional burden on citizens and businesses (Supyan, 2019).

Now let us look at the current climate change policy measures in the United States. New US President Joseph Biden has taken some steps to return the United States to an active environmental policy. Immediately after his inauguration on January 20, 2021, he signed a decree for the United States to join the Paris Climate Agreement, and he also withdrew permission to lay the Keystone XL pipeline and introduced a temporary moratorium on the lease of oil and gas production in the Arctic National Wildlife Refuge. On January 27, 2021, the Internal Climate Policy Department was established under the Presidential Administration, whose powers include coordinating the development of the internal climate agenda, as well as monitoring its implementation.

On January 27, 2021, an Executive Order on Tackling the Climate Crisis at Home and Abroad was signed, which draws attention to the emphasis of the United States as a leader in climate change on an international scale (Executive Order on Tackling the Climate Crisis at Home & Abroad, 2021). This is where the decree begins, and only after covering international issues, it turns to domestic policy within the United States. In order to maintain the role of a global leader, the United States plan not only to actively participate in addressing issues related to climate change within the framework of the UN and the group of 20 but also to discuss this issue at the US-initiated Leaders' Summit on Climate and the Major Economies Forum on Energy and Climate.

In addition to the political steps, economic measures such as the introduction of new standards for carbon capacity in the energy sector and leading industries, standards for reducing car emissions as well as government subsidies and government support programs distributed following the companies' implementation of climate measures are also being taken.

The executive order provides for the following regulations:

- transition to a carbon pollution-free electricity sector by 2035;
- shifting to zero-emission vehicles at Federal, state and local levels.

A Plan for a Clean Energy Revolution and Environmental Justice was also adopted, which calls for achieving carbon neutrality no later than 2050.

The United States has pledged to cut greenhouse gas emissions by 26% by 2030 compared to 2005. However, S.A. Roginko notes that the Paris Agreement assumed a reduction in emissions relative to 1990, while the United States took 2005 as the starting point when the number of their emissions increased compared to 1990, which somewhat reduces the number of emissions if we consider comparable years (Roginko, 2021).

A significant amount of money is allocated for the implementation of measures related to energy policy. In 2021, a $65 billion infrastructure bill was passed to modernize the aging U.S. electricity grid, improve carbon capture technologies and move electricity generation to clean sources such as hydrogen. It also included $7.5 billion for electric vehicle charging stations and $5 billion for government procurement of electric and hybrid school buses. However, these measures may not be enough, since the main funds for combating climate change are provided for in a large-scale $3.5 trillion program, which includes tax incentives designed to facilitate the transition to clean energy in the energy, production and transport sectors; the introduction of carbon pollution charges; the introduction of technologies related to the production of clean energy; benefits for clean energy companies, as well as funds for financing and research in this area (Roberts, 2021). The approval of this bill is still pending in Congress.

There are numerous difficulties that the Biden administration may face in implementing the climate policy plan. One of the main problems is related to the fact that the decrees adopted under the previous President Trump will have to be canceled (Sakharov, 2018). Experts estimate that Donald Trump has worked to abolish or weaken more than 200 environmental protection measures during his tenure as President, with 170 amendments being adopted (Vasilenko, 2021). Measures were introduced to weaken the control over atmospheric air pollution and greenhouse gas emissions, and the requirements to control methane emissions from oil and gas production were removed. Even if some decrees or directives can be easily canceled (for example, the Kigali Amendment to the Montreal Protocol); in other cases, it will be necessary to send decrees to the Senate for ratification or seek approval by Congress, and the Republican Party may not support the President's initiatives. Another problem is associated with the need for large financial investments to combat climate change, while the successful implementation of programs requires not only public funding, but also private initiatives, and in the context of the crisis caused by the coronavirus pandemic, the financial capabilities of enterprises have diminished. It is also important to note that if the United States wants to take the role of a leader in the field of climate policy, it must set higher requirements for its economy since the EU sets more ambitious plans to reduce emissions.

Conducting a comparative analysis of the climate policies of the United States and Germany, it is necessary to highlight the features characteristic of each of these countries.

First, let us consider the main features of climate policy in the United States.

1. One of the defining features of US climate change policy is its dependence on the party that comes to power. For the Democratic Party, climate action tends to be high on the political agenda, while the Conservative Party is more restrained. In 1997, US President Bill Clinton signed the Kyoto Protocol, according to which countries were supposed to reduce harmful emissions to 1990 levels, but then, the next President Republican George W. Bush came to power, and the treaty was not ratified. In 2015, the representative of the Democratic Party Barack Obama decided to sign the Paris Agreement, which suggested that the United States

should reduce greenhouse gas emissions by 26–28% compared to 2005, but the next US President, Republican Donald Trump, in 2017 decided to withdraw from The Paris Agreement because he considered participation in it to be unprofitable for the United States from an economic point of view. Trump also announced the end of payments to the Green Climate Fund and announced that the United States will not join the number of countries in supporting the G20 Climate and Energy Action Plan for Growth. However, it should be noted that per Art. 28 of the Paris Agreement, the termination of the participation of a country that signed and ratified it is possible only four years after its entry into force, i.e., not earlier than November 4, 2020. The next US President Joe Biden decided to return the United States to the implementation of the Paris Agreement, and on February 19, 2021, the United States became a full party to the agreement again.

2. Another feature that is characteristic of the United States of America is that individual states have the opportunity to pursue their policies that do not correspond to the country's policy at the level of the entire state. After Trump withdrew from the Paris Agreement, a coalition of states, cities and companies has formed and decided to take their steps to curb greenhouse gas emissions. As California Attorney General Xavier Becerra noted, "for four years, we have fought tooth and nail against the Trump Administration's efforts to dismantle critical protections [for the environment] and reverse hard-fought progress" (Irfan, 2021). The acceding states include California and New York, and the companies include Arizona Public Services, the largest energy company in Arizona, which is committed to producing all its electricity from carbon-free sources, although the state does not require that.
3. The specifics of the United States also lie in the fact that no matter which party is in power, measures related to the implementation of energy policy find more support than measures directly related to climate change from the state; although, energy policy is also closely related to the problem of climate change (Bang, 2021).

On the supply side, the development of energy with a low amount of greenhouse gas emissions is facilitated by a change in technology due to the introduction of hydraulic fracturing for oil and gas production, which made the production cheaper in comparison with the coal industry (the number of producing U.S. coal mines fell, 2020) and the development of renewable energy sources (Table 50.1). On the demand side, this transition is facilitated by government subsidies and tax breaks for emissions-reducing businesses.

On the other hand, measures directly related to climate change face challenges in adopting laws, as they impose restrictions on the activities of enterprises and can potentially reduce the rate of economic growth.

The specific features of Germany are as follows:

1. Unlike the United States, Germany has a consistent policy in the field of combating climate change, so the course is more sustainable. The state assists enterprises that have suffered from the package of energy-saving measures, for example, those that used coal energy in their production. As noted above, the

Table 50.1 Increase in the amount of energy received from renewable sources

Year	1965	1980	1990	2000	2010	2015	2020
Total, terawatt-hours (TWh)	941	1,781	2,280	2,870	4,197	5,519	7,444
Hydropower, Twh	923	1,732	2,159	2,652	3,436	3,885	4,297
Wind, Twh	0	< 1	4	31	346	831	1,591
Solar, TWh	0	0	< 1	1	34	256	856
Other renewables, TWh	18	49	117	186	381	547	700

Source Compiled by the authors based on Statistical Review of World Energy, (2021)

state provides all-around support to citizens who are ready to help in achieving this goal, choosing favor of energy-saving technologies for heating, construction and transport.

2. One of the main problems is that Germany is following the policy adopted within the EU as a whole, therefore, the procedure for approvals and changes may take longer. Germany, unlike its neighbors and Eastern Europe, is determined to apply higher CO_2 emissions charges that countries with a lower level of economic development cannot afford (German Council of Economic Experts, 2019).
3. The Climate Action Plan has the greatest emphasis on the energy sector, where it is planned to reduce emissions by 62% by 2030 compared to 1990. The gradual introduction of alternative energy sources is stimulated by charging fees for CO_2 emissions, so all market agents take interest in their reduction.

50.4 Conclusion

To summarize, it should be noted that global coordination must play a key role in climate policy, therefore, all countries around the world must coordinate their programs for the successful performance of climate change policies.

The implementation of the climate program is also a deal of great importance for Russia. The European Union is the main trading partner of the Russian Federation, and energy export (oil, gas, coal) is a significant share of Russian international trade. If the European Union significantly reduces the consumption of traditional types of energy, this could significantly affect the value of trade between Russia and the EU.

At the same time, there are several difficulties on the way of implementing the planned climate program. In October 2021, European countries faced a serious energy crisis, when the cost of traditional energy sources skyrocketed. This was partly due to the desire of the EU countries, and Germany in particular, to switch to alternative energy sources at a time when they could not fully meet the needs of the economy (Cohen, 2021). In addition, in 2021, Germany missed 21% of the electricity received from wind energy, and the project for the liquidation and closure of nuclear power plants in Germany next year also pushed up prices for traditional energy sources (Energy Crisis in Europe, 2021).

Another danger, which has already been mentioned and applies both to the United States and Germany, is that huge financial resources are required for the implementation of climate programs, and they should be allocated not only by the state, but also by private companies, and in times of crisis caused by the coronavirus pandemic, many companies have shifted their priorities, and it will not be easy to raise the required amount.

Finally, we should note that the transition to alternative energy sources can also be associated with unplanned costs that do not fit into the framework of the "green economy". On the one hand, the expansion of photovoltaic energy production contributes to the protection of the environment, since there is no burning of fossil and biotic energy carriers, but on the other hand, these same technologies are associated with high environmental impact costs when mining the necessary raw materials (tin, silver, components for silicon solar cells). In addition, indium, tellurium, gallium and germanium required for photovoltaic panels can only be obtained as by-products of metal mining, and these are not the most environmentally friendly industries. The storage or destruction of old solar cells is also a difficult problem; therefore, in future, it is necessary to provide for the possibility not only to get rid of the current problems with emissions but also to avoid potential problems related to the new sources of environmental pollution associated with new technologies in future.

If countries manage to coordinate their efforts and take measures to solve existing and potential problems, then climate policy will be implemented most successfully both in the leading countries and in the world as a whole.

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Chapter 51
Analysis of Some EU Legal Initiatives Within the Green New Deal Framework

Yuriy A. Episkoposyan

51.1 Introduction

In a rapidly changing world, it is clear that climate change issues are receiving increasing attention all over the world (Council of the European Union, Council conclusions on climate diplomacy, 2020; UNEP, 2019). According to research by the Intergovernmental Panel on Climate Change (IPCC) climate change factors and causes are so numerous that effective regulation must cover all aspects of human activity due to the universal nature of climate change (IPCC, 2021).

The European Union leadership foresaw the need to establish a set of legal measures in order to reduce nature-related risks and social tension among its citizens and improve the external economic conditions (Hibbs, 2022).

The climate agenda is becoming one of the leading areas in the development of this integration association. The need for an appropriate model for the European Union is due to the following factors: first, its natural resource scarcity and global warming; second, social and political demand from the general public; and third, the fact that climate reforms are seen as one of the leading forces of economic restrictions and revitalization (United Nations, 2021).

The European Union has an extensive regulatory framework and practice concerning climate policy. Since the adoption of the Paris Agreement in 2015 (The Paris Agreement, 2021) which replaced the Kyoto Protocol (United Nations, 1997), the European Union has positioned itself as the most responsible leader in the field of climate policy. For example, even under the Kyoto Protocol, the European Union developed its own Emissions Trading System (EU ETS) which was conceived as a key instrument for greenhouse gas emissions regulation and reduction while combating climate change.

Y. A. Episkoposyan (✉)
MGIMO University, Moscow, Russia
e-mail: yur-mail@mail.ru

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A new "Green Deal for Europe" was adopted in 2019, which sets a major goal for the European Union to become the first continent to achieve climate neutrality by 2050 (European Commission, 2019). To achieve its goals the European Union is expected to develop some legal instruments and reforms. The Climate Agenda covers an extensive list of measures to reduce greenhouse gas emissions from anthropogenic impacts. Climate legislation is already complementary for sectoral legal systems, for example, environmental protection, energy and industry, trade and transport, construction, agriculture, etc.

In this regard, it should be made clear that it is of utmost importance to study the legal instruments of the European Union climate policy, since climate regulation is at the core of climate policy and predetermine its future. However, the implementation of such an ambitious initiative requires an appropriate approach. The working hypothesis is to find out how developed and successful the implementation of the mechanisms is.

This study aims to confirm the hypothesis that appropriate legal and economic instruments existing in the EU can implement the New Green Deal and the comprehensive energy transition. In order to achieve this goal the following tasks must be completed:

- to analyze climate legislation in the European Union, as well as, the content of the Green Deal for Europe;
- to identify the relevant economy areas and the key legal instruments for implementing the energy transition;
- to analyze some functioning legal mechanisms: the Carbon Border Adjustment Mechanism (C-BAM) and the EU Emissions Trading Scheme (ETS).

51.2 Materials and Method

The theoretical basis of the study will be based on the fundamental legal acts of the European Union, scientific studies of its functioning and law-making. It is important to note that the climate agenda is evolving in relation to the ongoing political processes and natural scientific and technological advances. So it is especially important to consider the most recent and relevant works concerning the development of the law-making system in the jurisdiction under study as well as climate science in general.

The methodological basis of the study consists of a number of general scientific and interdisciplinary methods, such as the method of systems analysis and structure-functional method, logical and dialectical methods, systematization and statistical methods; as well as a group of private scientific methods, such as comparative-legal and formal-legal. It is worth emphasizing the role of systemic and structure-functional methods, as they can help to identify and describe the functioning of the legal instrument and its place in the legislative system.

A large number of studies conducted by the European Union itself, international organizations and universities are devoted to legal regulation of the European Union climate policy. The most comprehensive and useful studies are conducted by the Intergovernmental Panel on Climate Change (IPCC), and the United Nations.

This study will require the analysis of the primary law of the European Union with regard to the legislative procedure and competencies; current directives and regulations (acts governing climate policy); and other documents reflecting the climate agenda. The work will take into account international documents such as the reports of the United Nations; the Kyoto Protocol; the Paris Agreement; IPCC synthesis reports on climate change, etc.

In the field of climate and environmental agenda, one can highlight works by Claeys et al. (2019), while studies of European energy-economic policy are described in publications by Horn et al. (), Makarov et al. (2017), van Cleef (2021), Wolff (2019).

51.3 Results

51.3.1 What is the EU Climate Policy and the Green Deal?

The EU Green Deal can change the usual business practices in all sectors of European economy. To achieve the desired green transformation requires a systematic and comprehensive approach. This means, for example, that it is impossible to raise the price of greenhouse gas quotas without developing RES or green infrastructure.

To begin the analysis of this issue, it is necessary to outline the initial positions. When we talk about the Green Deal, we mean energy transition. When we talk about the energy transition, we involve the climate change problem for which the starting point is 1990. It is the starting point for estimating the reduction of greenhouse gas emissions. In 1990, emissions in the EU-27 amounted to about 5 billion tons of CO_2 equivalent. The EU had previously set a goal to reduce emissions by 20% by 2020. It was achieved even without COVID-19 factor (Hibbs, 2022).

However, the ultimate goal of the plan is to be the first in the world to achieve full carbon neutrality by 2050. The EU also sets an intermediate goal to reduce greenhouse gas emissions by 40% by 2030 (Regulation (EU) 2021/1119 of the European Parliament and of the Council of June 30 2021). This is all in line with the Paris Agreement. Yet, there is still a difference between expected and desired reductions in greenhouse gas emissions, and the Green Deal is about this gap between expected and desired. "Fit for 55" is the new target with minus 55% in the new package (European Commission, 2020a, 2020b).

As for the status of this legislative package the European Commission has proposed it to the Council and the Parliament (Keating, 2022). It is not obvious how long the negotiations will last. The Council and Parliament must agree on the final package of measures which may be included in mandatory EU legislation. However, the plan runs until 2030 and must be implemented as soon as possible.

The Green Deal includes 15 pieces of legislation, i.e., 8 regulations, 6 directives and 1 decision (amendment to the directive). Among them, there are 4 completely new and fundamental acts.

Regulations:

- stricter greenhouse gas emission reduction goals for member states annually,
- stricter production standards for passenger cars and light commercial vehicles,
- stricter land use, forestry and agriculture regulations,
- updated legislation on alternative fuel infrastructure,
- carbon Border Adjustment Mechanism (taxation of border CO_2),
- social Climate Fund,
- proposal to increase the production and consumption of sustainable aviation fuels,
- proposal to use low-carbon marine fuels.

Directives:

- update of the taxation on energy products and electricity,
- stricter rules for the Emissions Trading Scheme and Market Stability Reserve,
- more allowances to be placed in Market Stability Reserve until 2030 (stricter ETS for heavy industry),
- amendments regarding offsetting for aircraft operators,
- aviation contribution to reduction target and implementing a global market-based measure,
- more ambitious targets for the promotion of renewable energy,
- update of the Energy Efficiency Directive (recast).

51.3.2 How Should the Energy Transition Be Proceed? Renewable Energy Goals

The energy transition is a set of processes aimed at improving energy efficiency while reducing greenhouse gas emissions and thus preventing anthropogenic climate change. Its implementation envisages a number of initiatives among which we can highlight the following:

- the development of renewable energy sources and alternative infrastructure,
- increasing energy efficiency, strengthening requirements in industry and agriculture,
- pricing and tax mechanisms.

Europe uses the concept of Gross Final Energy Consumption (Directive (EU) 2018/2001 of the European Parliament and of the Council of December 11 2018) to estimate the amount of energy consumed which includes energy used by end users, used by the energy sector itself, and lost in distribution. The share of RES in the EU is about 21% in 2021. The goal, according to the Green Deal, is to bring the figure to 40% by 2030. To achieve such an ambitious goal, it is necessary to agree on a consolidated position as soon as possible.

To achieve results on renewables, the EU is initiating the creation of a three-step approach to create a more sustainable energy sector:

- minimizing energy consumption,
- the use of sustainable energy production,
- efficient use of fossil fuels.

In addition, the EU pays special attention to the development of technology and green infrastructure, projects such as floating power plants, energy storage, geothermal and hydrogen energy (European Commission, 2020c). As for biomass, nuclear and gas energy (whether to consider them sustainable or not) is open to debate!

The energy efficiency strategy is about minimizing energy consumption (European Commission, 2020a, 2020b; Proposal for a DIRECTIVE OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL). According to the Green Deal, it is necessary to reduce consumption by 9% by 2030, which is equivalent to 77 million tons of oil equivalent. If this target were achieved, the EU energy consumption reduction will constitute 36% of the year 2007 level by 2030. As for the speed of reduction, the current legislation actually states that each year the reduction should be 1.5% from 2014 to 2020 and 0.8% later. The European Commission, on the other hand, proposes to return to the new value of minus 1.5% since 2023.

A serious problem for the EU in energy issue is energy poverty (European Commission, 2020d). About 7% of European households are struggling to pay their energy bills. Many people could be affected by the proposed energy transition. Therefore, the EU energy efficiency directive provides incentives to increase energy efficiency based on the principle of protecting poor households. Countries must establish national energy efficiency funds to fully fund and compensate energy efficiency improvements for such households.

51.3.3 Taxation and Pricing of CO_2 Emissions. How Does the Trading Scheme Work?

To regulate greenhouse gas emissions the EU divides its companies into 2 large groups: large emitters (multinational companies and aviation) which require equal rights to compete on all international markets (ETS-sectors are covered by the same legal and political instrument) and small regional (Effort Sharing Regulation sectors like transport or agriculture).

Originally, 40% reduction by 2030 was divided equally between the two groups, but since 2005 the reduction for the groups has been revised and constitutes minus 43% for large sectors from 2005, and 30% for small ones.

The total reduction is now minus 55%, not 40% as before. Therefore, the goal for the ETS sector is minus 61% and minus 40% for the ESR.

The tool to achieve the reduction for the ETS sector is called the European Union Emissions Trading System (EU ETS) (van Cleef, 2021).

The Scheme collects all greenhouse gas emission allowances according to reduction targets, companies emit greenhouse gases only if they have allowances, otherwise they can be fined or simply shut down. The volume of quotas decreases from year to year and the price of quotas increases. This Scheme is often described by analogy with a deflating balloon.

Intra-EU air travel is also covered by the Scheme. However, the Green Deal will provide a new instrument [Corsia (Council Decision (EU) 2018/2027 of 29 November 2018)] for cross-border flights. Corsia is a sectoral air travel initiative that aims to keep greenhouse gas emissions at 2020 levels, taking into account the growth of flights through operational improvements, technological advances and carbon offsets (tree planting…).

Effort Sharing Regulation Sectors (ESR) where emission reductions are set for countries privately. The legal toolkit for this sector is more complex. Targets for countries correspond to real possibilities, current situation and political aspects of negotiations.

51.3.4 What Is the Design of the Carbon Border Adjustment Mechanism (C-BAM)?

The Carbon Border Adjustment Mechanism (C-BAM) is a tool that sets the import charge based on carbon footprint of imported product (European Commission, 2020a, 2020b).

So, there is an ever-shrinking CO_2 allowance, because the goal is to reduce ETS allowances by 61% by 2030. This provokes an increase in the price of these permits.

Quotas are getting smaller, they are getting more expensive, but it is very important for large emitting companies to get these quotas. There are two ways to get them.

Firstly, they can participate in auctions held in the EU to buy permits at the current rate. Secondly, free allocation is available under the ETS. Free allocation is designed to overcome competitive disparity between European companies and foreign companies which will help keep production inside Europe without moving it to other countries. There are many contradictions and different opinions around free allocation. Nevertheless, the utopian ideal is that everyone in the world pays the same price, and there is no need to create a mechanism of free accommodation, as long as it is unattainable and companies will be forced to leave the EU (Claeys et al., 2019). So how does free accommodation work?

Let us say there are European and Chinese manufacturers of the same product. They produce this product at identical or equivalent production costs. Now, the European company is in the ETS and pays extra for CO_2 emissions (60 euros per ton).

Thus, it becomes uncompetitive. The company is forced to move production out of the EU which the EU wants to prevent. This is where free allocation applies especially to the sectors that are most risky. However, the volume of this free accommodation will also decrease over time. In the end, all companies will have to consider the emission fee factor in their planning trying to reduce their emissions.

That is why the European Commission proposes to develop a suitable mechanism C-BAM (Wolff, 2019). Once it is launched, companies will not have the need free allocation, they will pay the full price for CO_2. Now foreign producers must pay an equivalent price for imported goods while crossing the border.

According to the Green Deal, the system will take on the following form:

European emitters would buy emission allowances at auction. Foreign producers will buy C-BAM certificates to take their products into the EU. There will be an unlimited number of such certificates. The price of ETS and C-BAM will be the same.

For example, a Chinese steel producer buys a certain amount of C-BAM from the French emissions authority. After a year the exact amount of products delivered (respectively, the exact amount of greenhouse gas emissions taking into account the possible modernization of energy efficiency in the company) to the EU market becomes known. Then the approval process with French authority takes place. It may have to buy new certificates and either sell them back or can keep them for two years. The approval process has to confirm correctness of the payment of the entire volume according to the price.

There is a ten-year plan for the introduction of C-BAM. It is proportional to the free distribution. If a European company receives 80% of the free approvals and buys 20% at auction, the C-BAM for foreign is 20%.

C-BAM covers all goods and services that are included in by the ETS. If another jurisdiction sets its own fee per ton of CO_2, this amount will be deducted from the border tax.

Regarding the WTO, the European Commission argues that there is no conflict between C-BAM and WTO norms. However, this position is likely to be clarified. If a European company, being in the ETS, makes a production chain for a foreign company there is a risk of double taxation, so there will be a special adjustment mechanism for these cases (Horn, 2019, 2020; Makarov & Sokolova, 2017).

51.3.5 Changing Regulation of the Fuel Sector and Alternative Transportation Infrastructure

Currently, fuel taxes are levied per liter of fuel, the rates for which were determined in 2003. The rates are determined by the countries themselves but the minimum rate is set at the EU level. Nevertheless, because the price of fuel has risen considerably in recent decades this minimum rate is outdated and not in the interest of the EU.

Recently the volume of sustainable fuels which due to their properties provide less energy than their fossil counterparts has been growing in Europe. However, the taxation is equal and happens at the same minimum rate as for fossil fuels. Thus, sustainable fuels are at a disadvantage compared to fossil fuels. In addition, there are several incentives and exemptions for fossil fuels (exemptions reductions) in several sectors: agriculture, households are likely to remain in the future, industry, fisheries, and air transport. The European Commission proposes to retain these benefits, if they are not less than the minimum taxation set by the EU.

There are 5 types of unleaded and leaded fuels, such as gasoline, gasoil, kerosene, LPG, natural gas. The minimum tax rate for these fuels should increase by 2023 according to the European Commission. Under the new terms the tax will be charged not per liter but according to the energy content of the given fuel. In addition, the updated regulation introduces 10 new categories of fuel, both sustainable and not such. All of them will have their own tariff. Thus, suppliers of environmentally friendly fuels will not be subject to tariffs onerous for less sustainable fuels.

Speaking of transport infrastructure, it is important to say that the EU is a single economic area in which movement is free. Since the 1990s the EU has developed many connecting infrastructure projects, such as the Trans European Transport (TEN-T) Network (Directive (EU) 2021/1187, 2021). The goal of this project is to strategically connect and make the entire union accessible. However, this project was previously implemented without regard to policies of reducing greenhouse gas emissions and without regard to green land, sea and air transport. Now the situation is changing.

Speaking about the network of land roads, the EU distinguishes two concepts of road routes: core (central) and comprehensive (inter-regional). By 2026 road transport (core and comprehensive) must be equipped with refueling stations every 60 km with a maximum capacity of 300 kW of which 150 kW will be in one charge. By 2030 the total capacity should be 600 kW with a minimum of 2 charging stations of 150 kW each.

Charging stations for heavy vehicles for central roads should be placed every 60 km, every 100 km for inter-regional. By 2026 the total capacity should be 1400 kW (one 350 kW charging station) and by 2031 the total of 3500 (two 350 kW charging stations). The placement for hydrogen refueling stations is defined every 150 km with a volume of 2 tons per day and 700 bars. The required number of CNG stations should be on core and comprehensive roads, but after 2026 the obligation to place them will have been removed. The driving on LNG is likely become difficult in Europe. Similar regimes are envisaged for maritime and air transport.

In addition, there will be measures to protect consumer rights. The availability of payment methods, transparency of price structure, unified signs and markings, as well as “smart charging,” a cheaper way of charge.

51.4 Conclusion

The EU is a global player whose role in defining global processes is essential. The EU aspires to be a leader in climate change and carbon neutrality. It is the first to set ambitious goals and to develop a large number of legal and economic mechanisms, which have a complex influence on all business processes and the life of the society.

This article investigated the following. The European Union is indeed developing and implementing an ambitious initiative to "green" economy through decarbonization. For the EU the Green Deal is a major program affecting all areas of regulation from energy to the protection of socially vulnerable groups. For decades now the EU has been implementing and strengthening its climate program. It affects more and more sectors of economy and becomes increasingly stringent. New ambitious targets (minus 55% by 2030) only confirm this. The EU is adopting many regulations and directives aimed at maintaining the green course. However, there are many obstacles including political disagreements and economic losses.

Particular attention is paid to the energy sector and infrastructure especially to energy efficiency and transition to clean energy from renewables. Energy pricing and taxation are developed with special attention payed to poverty and social justice. Energy intensity of the product and its carbon footprint become a reality in industry and trade. This article has described the operation of the Emissions Trading Scheme (ETS) and the challenges that will reform and strengthen the action of climate legislation. The article also explored a new instrument that will support the transition of European economy to a more carbon–neutral economy, i.e., the Carbon Border Adjustment Mechanism (C-BAM).

From above mentioned, we can conclude that in fact, the European Union is taking many initiatives and steps to modernize its economy and public life. Its comprehensive climate policy touches on a wide range of relations. Several legal instruments help this integration entity to realize what it has envisioned in the New Green Deal. However, many questions remain unclear as to whether the EU will be able to finally implement its program, especially given the political instability and the energy crisis, as well as, how it will affect international trade and cooperation.

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Chapter 52
European Practice of Building a Carbon-Free Economy

Tatiana M. Isachenko and Irina A. Medvedkova

52.1 Introduction

The European Union and its member countries are at the forefront of the environmental agenda. One of the integration priorities of the EU is environmental protection. Over the last 20 years, European countries adopted more than 200 laws and regulations related to environmental protection. Measures implemented or planned within the EU are intended to contribute to the achievement of the objectives of the European Green Deal in the field of environmental protection and climate change. Nowadays, "green" and "digital" transition in the industry is characterized as parallel processes, which should be considered one of the challenges of industrial transformation toward sustainable development. They should be based on an integrated approach to solving problems in both directions, which ideally provides for common tools for transformation. If this is not seen as one single issue, the opportunity to achieve climate neutrality and industrial competitiveness will be missed in many countries. Being one of the main initiators of the fight against climate change and counteracting environmental degradation, the EU prioritizes fiscal instruments and motivation for environmental protection. Over the past few years, the EU legal framework has been considerably enriched with new or revised documents aimed, as they explain in Western Europe, at solving priority environmental problems. Along with measures aimed at the active introduction and use of resource-saving technologies, the EU focuses on legal regulation and financial incentives, which, according to the European Commission, is currently a more reliable tool.

T. M. Isachenko (✉)
MGIMO University, Moscow, Russia
e-mail: tatiana_isachenko@yahoo.com

I. A. Medvedkova
National Research University—Higher School of Economics, Moscow, Russia
e-mail: imedvedkova@hse.ru

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52.2 Methodology: Approaches to the Study of Environmental Problems and Climate Change

For decades, economists have lauded the virtues of market or economic approaches to environmental protection. Almost a hundred years ago, the English economist Pigou (1920) proposed corrective taxes, called the Pigouvian tax, to offset negative externalities and equal the marginal cost of damage. He considered environmental pollution as one of these negative externalities. Half a century later, economists proved that transferring the responsibility on the producer can be more effective in terms of environmental protection at a lower total cost than trying to impose high standards or subsidize pollution control programs. Summarizing the results of previous studies, Hann and Stavins (1991) argued that all subsequent theories were developed based on two fundamental ideas-corrective taxes and the transfer of responsibility for pollution to producers.

Simultaneously, already at the early stages of the research, it was recognized that separate measures that are possible in conditions of rapid economic growth could affect the economic prospects of other countries in different ways. The theory of green protectionism, in a certain sense, is based on current research in the field of sustainable development, which refutes the direct relationship between the growth of environmental pressure and economic growth. On the contrary, studies have shown that, under certain conditions, economic growth can further improve the quality of the environment. Such arguments are presented in works devoted to the non-linear dependence of environmental degradation on economic growth, considered in the framework of the "environmental Kuznets curve" theory described by Grossman and Krueger (Grossman & Krueger, 1995).

Over the past two decades, research in this area has increased significantly. Economists try to determine how theory and practice can be combined. Until recently, most research has focused on theory or related modeling products due to the lack of practical experience with incentive-based environmental protection mechanisms. The situation began to change somewhat in the 1980s with the increasing use of fees and permits to sell emissions allowances by governments to combat pollution. It should be noted that this method seemed to be the most effective in practice. This experience shows a big gap between the theory developed by economists and the application of tools in practice. Additionally, the scale of environmental problems has also changed. From environmental pollution issues, the discussion has expanded to the problems of global climate change, the significance and solutions of which require deeper and more updated economic and technological approaches.

Differences in technology, skills, and administrative resources can have important implications for developing the so-called environmental policy. In general, it can be argued that it is more appropriate to pursue a flexible policy in cases where the administrative authorities have the opportunity to implement it. Thus, for example, Los Angeles may be able to create a market to reduce smog emissions that would allow exchanging emission reductions between vehicles and stationary sources. On the contrary, Indonesia or Mexico should think about a policy that is easier to implement. One of the possibilities is to use an indirect instrument such as a tax on gasoline or, as a more general tool, a fuel tax. The primary approach should be based on the need to adapt the tools used by the state to the problem it is solving in the context of institutional and cultural characteristics. The recent experience of numerous studies on developing regulatory tools applicable to complex systems can be useful and relevant in environmental regulation issues. This can be especially important when finding compromises in conditions of limited management and control resources, for example, in developing countries (Wu et al., 2014).

A comparable level of research would be useful in identifying trade-offs in the development of environmental policy instruments in cases where management and control resources are severely limited, such as in developing countries.

The attempts of some politicians to hide behind environmental protection as the main and only goal of environmental regulation are, in fact, futile due to the need to coordinate multiple goals and make compromising decisions against the backdrop of international obligations and real restrictions. Based on the traditional thesis that the goal of state regulation is to create the most favorable conditions for the development of society, the task of state environmental policy can be interpreted as one of the ways to maximize overall welfare. The criterion for effective state policy is (potential) Pareto efficiency-maximizing net benefits (benefits minus costs) from protecting the environment. Alternatively, a cost–benefit criterion can be applied: the ability to achieve the desired level of environmental protection while minimizing the associated abatement costs, as will be further discussed in this research, the indirect costs arising from potential response measures in the case of using environmental measures as a means of protectionism. Simultaneously, efficiency and cost-effectiveness are by no means the only criteria against which environmental policy can or should be evaluated. During the development of a state policy that will allow improving the state of the environment and climate, it is necessary to consider the overall efficiency of production, the non-discriminatory nature of the policy, technological and information requirements, the possibility of enforcing environmental legislation, and, in a way, the literacy and perception of the population of the country and its producers of new standards and requirements (Panayotou, 1993).

In recent years, there has been a significant increase in interest in environmental issues not only by the government and environmental non-governmental organizations but also by the private sector and academia. The widespread introduction of the concept of environmental and social responsibility of business (ESG) has provoked an increase of attention to environmental policy at the macro and micro levels. Currently, priority is given not to goals that are objective and clear to everyone but to market tools to achieve them and approaches to stimulate companies and citizens. In the process of searching for tools, there is a threat of replacing the concepts of "goals" and "incentives." For example, effective or cost-effective environmental regulation is a policy goal. The choice of market-based instruments to achieve it should be based on the level of national economic development, the technological and legal foundations, and the basic principles of international cooperation. Another reason for being careful in selecting instruments is to meet legitimate goals other than efficiency or cost-effectiveness. These goals could reasonably include, for example, fairness and administrative simplicity. If market-based instruments are considered, the investigation should include not only fees, tradable permits, and quotas but also deposit-refund schemes, strategies to lessen government barriers to market activity, and means to eliminate or at least reduce distorting government subsidies. Many other (“non-market”) approaches should also be considered, such as different types of standards, enhanced monitoring and enforcement mechanisms, and reporting.

52.3 Results

52.3.1 Influence of Industry 4.0 on the Implementation of the Tasks of a Carbon-Free Economy

The contribution of advanced technologies to sustainable development can certainly be extremely significant if its full potential is realized. The variety of methods and approaches provided as a result of the use of management technologies, artificial intelligence, and new production capabilities allow achieving significant savings in natural and raw materials and reducing the costs of managing all processes. In particular, the use of the achievements of Industry 4.0 can become extremely significant in the following industries and the agro-industrial complex of many countries:

- Electric power industry: control of work efficiency, control of substations and transmission lines due to remote monitoring;
- Agriculture: temperature control, water and fertilizer supply;
- Transport: control of fuel consumption, switching to electricity;
- Logistics: reduction of freight transportation costs, optimization of waste disposal costs;
- Oil, gas, and mining industries: increase in production volumes at already depleted deposits and forecasts for electricity consumption.

Simultaneously, with the apparent advantages of a new technological approach to the use and management of consumption and processing of resources, certain contradictions cannot be ignored.

The impact of technology on the environment is not limited to raw materials and their origin. Primarily, post-industrial production and the use of technologies that increase the energy efficiency of production allow reducing emissions of pollutants. However, it requires large energy costs, which increases the consumption of the same energy and, consequently, raw materials, mainly hydrocarbons. It takes much energy for manufacturers to turn them into the sophisticated electronic technology products we use. Transporting these products around the world also comes with high carbon costs.

The use of the Internet and the introduction of new artificial intelligence (AI) technologies also lead to increased energy consumption. The massive servers and databanks that make these technologies work consume huge amounts of energy. Much of this energy does not come from renewable energy sources. For example, global electricity demand for data centers in 2018 was estimated at 198 TWh, or nearly 1% of global final electricity demand. This leads to increased efficiency and increased use of renewable energy sources. Nevertheless, society still has a long way to optimize costs and benefits. It is also worth remembering that every time we connect an electronic device to a non-renewable source, the use of this device has a carbon cost. This contributes to the emergence of greenhouse gases and the deepening of the climate crisis.

By abandoning the idea of single-use technological items and moving toward a circular economy, we can reduce the impact of technology on the environment. The closed economy is focused on restoration and regeneration. In a circular economy, in perfect conditions, all companies should be increasingly interested in reusing materials for a more sustainable approach to consumption.

Unfortunately, tech companies often hinder rather than help move toward a more responsible, domestic economic model. Leading manufacturers of computer equipment and smart devices and marketing teams slow down these processes and, in the pursuit of profit, “build” planned obsolescence into their products, which predetermines the replacement of these products after a certain period.

A smartphone with a functional service potential of 4–6 years becomes obsolete quickly. Every year, there is a new and more advanced model announced. Some companies reduce the performance of older devices or make it harder to access repairs, encouraging customers to make new purchases.

The constant update of hardware and software, along with very aggressive marketing, promotes hyper-consumerism. It becomes harder for consumers to keep their devices longer, which is actually the best way to reduce environmental harm. Many big tech companies also refuse to carry responsibility for the negative effects of the e-waste they generate.

Another serious controversial factor identified during the study of the impact of Industry 4.0 on the environment is the significant differentiation of technological development between individual countries. The world is divided into advanced countries and peripheral countries, which widens the gap and hinders sustainability goals because many companies find it more profitable to move production to countries with lower climate and environmental standards than to introduce new technologies.

Emissions tend to increase as countries reach average per capita income levels, but once income growth is high, this environmental degradation slopes steeply, i.e., reverse U-shape. The information of post-industrial production shows that it reduces the level of environmental pollution, technologies are being developed that increase the energy efficiency of production, which makes it possible, without reducing its volume, to reduce pollutant emissions (Pigou, 1920). In such an environment, more advanced and technologically advanced trading partners cannot resist the temptation to use their high standards to protect themselves from unwanted competition.

In this regard, the Paris Agreement on Climate Change and the Sustainable Development Goals (SDGs) have become increasingly important because they aim to achieve sustainable economic growth through concerted efforts to reverse environmental degradation and climate change. However, these initiatives give impetus to new environmental measures, launching another wave of contradictions between environmental measures and methods of environmental protectionism.

The development of the so-called new environmental measures is driven by the rapid development of green industrial policy, using traditional tools to stimulate the development of renewable energy and green industries. It is noteworthy that the measures affected by recent disputes in the WTO multilateral forum have more in common with industrial policy measures (steel, automotive, and semiconductor sector) than with environmental protection measures, as was the case with classic environmental disputes of the 1990s.

The classic speculation about the underpinnings of trade and environmental disputes has been reinforced in recent years by the political debate on climate change. Countries that develop measures to reduce greenhouse gas emissions and apply taxes on emissions seek to reduce their production costs and ensure a level playing field with competitors who are not completely ready to implement the same policies. Thus, adopted under the auspices of protecting the environment and limited natural resources and human, animal, and plant health, green barriers are often used by the governments of importing countries to restrict trade and protect from unwanted competitive imports.

In this situation, the WTO's efforts to regulate world trade in light of climate threats can become an important factor. These issues were repeatedly raised during the negotiations and currently experiencing a new round of activity. The role of the WTO can and should be to explore opportunities and approaches to encourage and facilitate trade in environmental goods and services to achieve environmental and climate goals, including through the development of supply chains and technical and regulatory instruments. To this end, the WTO seeks to identify and synthesize best practices and explore opportunities to ensure that trade and trade policies support and contribute to the achievement of a more resource-efficient circular economy; promote the sustainable supply and increase the ability to achieve high standards, which requires promoting and facilitating access to environmental goods and services, including encouraging the global adoption of new and emerging low-emission and other environmentally friendly technologies. Another important and promising area of the work of the WTO is to prevent the use of environmental norms and standards as a means of protectionism due to the difference in the existing technologies and the capabilities of particular countries and regions.

52.3.2 The EU as the Flagship of Environmental Regulation

Since 2005, as part of environmental regulation, the EU has had a carbon trading system. Each year, the European Commission sets a "cap" on the total amount of carbon emissions allowed for a particular industry and then allocates a finite number of carbon trading credits to companies operating in that industry. In 2019, the EU launched the so-called European Green Deal (EGC) program, which, as stated on the website of the European Commission, is aimed at overcoming the existential environmental threat to Europe and the world and is designed to turn the EU into a modern, resource-efficient, and competitive economy (European Commission, n.d.).

In July 2021, the European Commission (EC) announced a package of bills called "Fit for 55" designed to bring EU sectoral legislation in line with the European Climate Act adopted in June 2021, which aims to reduce greenhouse gas (GHG) emissions by 2030 by at least 55% compared to 1990 and achieve "climate neutrality" of the EU economy by 2050. Analysts call the adoption of the 14 legislative initiatives included in this package the start of accelerated systemic implementation of the EGC through the enforcement of interlocking rigid rules. As the analysis of these documents shows, their implementation will require a regulatory revision of the current EU legislation, which was designed to reduce GHG emissions by 40% by 2030.

52.3.2.1 Modernization of the European Emissions Trading System (EETS) for Greenhouse Gas (GHG) Emissions

Central to the "Fit for 55" package is a bill amending the European Credit Transfer and Accumulation System Directive (European Parliament and the Council of the European, 2003a, 2003b, 2003c). According to EC experts, greenhouse gas emissions from electricity production and energy-intensive industries have been reduced by 42.8% since 2005. The European Commission proposes to go further and reduce emissions in the sectors included in the European Credit Transfer and Accumulation System by 61% by 2030 compared to 2005 (as mentioned above, it has been about 43% so far). For this purpose, the EU-wide "ceiling" for GHG emissions will be reduced by 117 million "permits" (quotas) for emissions at a time. One "permit" (quota) corresponds to 1 metric ton of GHG emissions in CO_2 equivalent. Additionally, the rate of annual reduction in the total number of "permits" for GHG emissions is proposed to be increased from 2.2 to 4.2%. In total, 1.572 billion "permits" were circulating in the block market in 2021. The "ceiling" of "permits" decreased by 1.74% annually until 2020. Starting from 2021, in accordance with EU Directive 2018/410 (European Parliament and the Council of the European, 2018a, 2018b, 2018c, 2018d), the reduction rate is 2.2% per year.

With respect to air transport, the EC proposes to phase out free quotas by 2026, moving completely to selling them through auctions from 2027. Currently, the European Credit Transfer and Accumulation System covers flights within the EU and the European Economic Area (i.e., the EU, Iceland, Liechtenstein, and Norway). It is also proposed to implement the Carbon Offsetting and Reduction Scheme for International Aviation (CORSIA) developed under the auspices of the ICAO through the EETC.

As regards maritime transport, it is proposed for the first time to include GHG emissions of large ships with a total displacement of more than five thousand tons in the AETC. A transitional period would have to be extended to further discuss this issue within the International Maritime Organization (IMO).

Despite the mixed reaction of the European media, Brussels additionally advocates creating a separate system for trading greenhouse gas emission allowances in the housing and communal services sector and road transport. It is assumed that such a system could already start functioning from 2026, providing a reduction of 43% by 2030 compared to 2005.

As a leveling off the concerns of consumers who fear an additional financial burden from innovations in housing and communal services and road transport, it is proposed to create a Social Climate Fund in 2025. This fund will receive the equivalent of 25% of the income from the trade of "permits" under the EETS from the EU budget to help the most vulnerable households to switch to cleaner and more energy-efficient home heating systems and modes of transport. According to the EC estimates, the amount of funding that this fund will provide to member countries through the EU budget will be 72.2 billion euros. The same amount is proposed to be collected from member countries from their income from the sale of "permits" for emissions at auctions, which will make it possible to mobilize a total of 144.4 billion euros within the fund. In general, the EC proposes to direct all income from the work of the EETS and the new system (excluding transfers to the Social Climate Fund) to projects related to climate and energy, including projects in the field of transport and housing and communal services.

European officials also intend to strengthen the so-called "Market Stability Reserve" (PCP, Market Stability Reserve). This mechanism for reducing excess greenhouse gas emission allowances in the market and increasing its sustainability was enshrined in a special EU Directive in 2019 (European Parliament and the Council of the European, 2003a, 2003b, 2003c). It is currently proposed to make changes to the document to ensure the smooth operation of the PCP when approaching the limit values of market indicators. A similar reserve fund of "permits" is planned to be created within the framework of the new STK for housing and communal services and road transport.

With regard to the practice of distributing free quotas for GHG emissions in energy-intensive industries to protect them from the so-called "carbon flow"(the withdrawal of enterprises to countries with less stringent environmental standards), it is proposed to maintain such quotas until at least 2030, but begin to gradually reduce them from the middle of the current decade, making them more targeted. For less vulnerable sectors in terms of "flow," the ECTS modernization project provides for a gradual reduction in the number of free "permits" after 2026 from the maximum possible 30% to zero by 2030.

In parallel, until 2026, it is proposed to solve the problem of "carbon flow' using the so-called "Carbon Border Adjustment Mechanism" (CBAM). This mechanism has been elaborated by the European Commission since 2010. According to the stated goals, it is designed to remove the risks of "carbon flow"—the transfer of a source of pollution to countries with lower environmental standards, as well as to eliminate the associated "unfair" competitive advantages of EU trading partners. Draft EU Regulation on the implementation of the CBAM (European Parliament &

the Council of the European, 2018b) assumes that when certain goods are imported (the list currently includes cement, fertilizers, steel products, cast iron, aluminum, and electricity), the importer will be obliged to purchase the required number of "permits"("PCMP-certificates"), the value of which is determined by the average exchange prices for emissions of one ton of CO_2 equivalent within the framework of the EETS.

The 2018 EU Regulation on land use, land-use change, and forestry adopted in 2018 (European Parliament and the Council of the European, 2018a, 2018b, 2018c, 2018d), which committed member countries to fully offset GHG emissions in relevant sectors by absorbing CO_2, will also be reviewed. In principle, member countries were supposed to do this under the provisions of the Kyoto Protocol, but now this commitment is proposed to be legally enshrined for the first time in EU legislation for the period 2021–2030. The problem of reducing the absorption capacity of forests and other natural swallow holes of CO_2 is planned to be addressed through their restoration and expansion. According to the EC, from 2013 to 2018. The absorptive capacity of forests and other natural sinks in the EU has decreased by about 20%. Between 2026 and 2030, carbon dioxide absorption in the EU should increase from the current 268 million tons to 310 million tons per year of CO_2 equivalent. At the next stage, as conceived by Brussels, it will be possible to strive for "climate neutrality" in the sectors of land use, agriculture, and forestry by 2035.

Additionally, the 55% target package includes modernization projects for three so-called EU "energy" directives: in the field of renewable energy resources, energy efficiency, and taxation in the energy sector.

52.3.2.2 Measures in the Field of Renewable Energy Sources

Changes proposed to the EU Directive on RES are designed to make the new energy system more flexible and capable of fully integrating "green sources" into the energy grid (European Parliament and the Council of the European, 2018a, 2018b, 2018c, 2018d).

According to EU statistics, the energy sector accounts for about 75% of all GHG emissions in the EU. The new instruments will allow "decarbonizing" the economy in sectors that do not yet demonstrate high rates of green modernization but have serious potential in this regard. In particular, we are talking about construction, industry, transport, etc. According to the statistical agency "Eurostat," in 2004–2019, the share of renewable energy resources in final energy consumption in the EU increased from 9.6% to 19.7% (with the 2020 target of 20%). In the electricity sector, it is currently 34%. The EC also invites member countries to increase the current target for the share of renewable energy in their energy balance from 32 to 40% by 2030, significantly increasing the share of green energy consumption in the housing and communal sector, bringing it to 49% (European Parliament and the Council of the European, 2018a, 2018b, 2018c, 2018d).

The draft of the updated directive provides for a revision of the methodology for accounting for GHG emissions from transport fuels and their reduction by 13% by

2030, which is equivalent to a 28% reduction using the current calculation methodology based on energy intensity (the current target for transport fuels for 2030 is 14%). Additionally, a separate goal is set to bring the share of "advanced" types of biofuels to 22%.

To attract additional investment in the renewable energy sector, measures are envisaged to accelerate the electrification of all sectors of the economy. Additionally, goals are set for the development of "green hydrogen" energy, i.e., the energy produced with the help of renewable energy and synthetic fuels based on it. In particular, half of the hydrogen used in the industrial sector should be green by 2030. To promote this type of hydrogen, the goal is also to provide up to 2.6% of the share of renewable fuel of inorganic origin for heavy vehicles. Green hydrogen is planned to be eventually included in the future unified certification system for renewable fuels of the European Union.

Additionally, Brussels sees bioenergy as one of the important components of green energy. According to the EC, it accounts for 12% of the total energy balance and 60% of the energy consumed from renewable energy. Thus, the environmentally responsible use of bioenergy resources can significantly affect the level of GHG emissions and contribute to the "decarbonization" of the EU economy.

In the context of the EU Biodiversity Strategy 2030 adopted in May 2020, it is planned to introduce a ban on energy production due to biomass obtained from primary forests, peatlands, and wetlands. It is also proposed to ban state stimulation of the use of logs for sawdust or veneer, stumps, and roots for these purposes (European Commission, 2020). By 2026, all support for the use of biomass from wood as a fuel for electric power equipment should be completely discontinued. Biomass-fired power plants and CHP plants of 5 MW or more must comply with EU "sustainability" criteria and achieve greater reductions in GHG emissions than burning fossil fuels for the same purposes (Hann et al., 1991).

Separately, it is supposed to ensure the sustainable use of biomass through the so-called "cascade principle," in which priority is given to one or another way of using it, depending on the amount of added value for the economy and the longer life cycle of wood products, i.e., according to the scheme: a new productincreasing the service life of the product by repairing it-reuse-recycling the product to create new materials—energy production from wood-wood recycling.

Against the backdrop of all new energy "decarbonization" measures outlined within the framework of the EPC and in the context of the modernization of the RES Directive, in Western Europe, for the time being, they are trying to "ignore" half of the carbon-free electricity produced in the EU coming from nuclear power plants. The new target to reduce GHG emissions by 55% by 2030 seems to stimulate the use of nuclear energy. However, the tone in a number of EU member states (in particular, Germany, Austria, etc.) at the current stage hinders the demonstration of this source as one of the basic ones for the "green" transition (Koch & Keijzer, 2021).

52.3.2.3 Energy Efficiency Measures

Regarding the modernization of the EU Directive on energy efficiency (European Parliament and the Council of the European, 2018a, 2018b, 2018c, 2018d),Brussels proposes to raise the current common goal of the European Union by 2030 compared to 2007 from 32.5% to 39% in final consumption and 36% in primary consumption, as well as to make it mandatory at the EU level. To monitor the overall goal of energy efficiency of the integration bloc, the EC proposes using a new system for evaluating the individual contributions of member countries, considering the specifics of their energy balances.

Heating or cooling, industry and energy services are identified as key sectors of the economy with the greatest potential for energy savings in the draft of the corresponding updated directive. The public sector has been designated as a leader to accelerate its transformations during the transition period, which should "pull up" the rest of the sectors. Thus, in 2024–2030, member countries will be required to improve energy efficiency annually, i.e., save energy in final consumption by 1.5% (the current target is 0.8%) and by 1.7% in the public sector (European Parliament and the Council of the European, 2018a, 2018b, 2018c, 2018d).

By modernizing the EU Energy Efficiency Directive, a regulatory framework is created to implement the first principle of energy efficiency to apply the relevant principles in political and investment decision-making in the EU.

52.3.2.4 Measures in the Field of Taxation of Energy Carriers

In the context of adaptation to the "green course" of the EU Directive on Taxation in the energy sector (European Parliament and the Council of the European, 2003a, 2003b, 2003c), the European Union strives to make renewable energy and green fuels more attractive by changing the taxation procedure for energy carriers. The EC assumes that the "right" price signals in the energy market will help spur green innovations and attract investment in renewable energy.

Currently, the procedure for taxation of energy carriers is determined by their volume. In the future, it is planned to link it to energy intensity while considering associated GHG emissions and public health impacts. It is proposed to abolish some obsolete tax incentives and exemptions assigned to member countries in relation to the taxation of fossil fuels that are characterized by a high level of environmental pollution, but retain the right of national authorities to support the most vulnerable households to prevent the spread of "energy poverty." It is also envisaged to remove fossil fuels from the zero-tax rate for regional air and water transport.

In the draft of the modernized directive, proposed by the EC, energy carriers are divided into four categories depending on their impact on the environment-the dirtier they are, the higher the tax rates. In fact, the first two categories fall into unacceptable and potentially unacceptable fuels; the rest are "sustainable" (European Commission, 2021). These categories are as follows:

1. "Heavy" fossil fuels, primarily petroleum products, and non-sustainable biofuels. The minimum tax rate (which is the basis for calculating the tax rates of the other two categories) is 10.75 EUR/GJ for transport use and 0.9 EUR/GJ for heating.
2. Natural gas, liquefied carbon gases, and non-renewable inorganic fuels. The minimum tax rate (2/3 of the base rate) is 7.17 EUR/GJ for transport and 0.6 EUR/GJ for heating. It is assumed that this rate is applied during a ten-year transition period and subsequently increases to the base rate.
3. "Sustainable" but not "advanced" fuels and biofuels. Minimum tax rate (1/2 of the base rate)-5.38 EUR/GJ for transport and 0.45 EUR/GJ for heating
4. Electricity, "advanced sustainable" fuels, and biogas, such as "green" hydrogen. Over ten years, it is also planned to include the so-called "low-carbon" hydrogen in this category, i.e., the one whose production minimizes the carbon footprint by the carbon capture and storage procedure. The minimum tax rate is 0.15 euros/GJ regardless of the application sectors (European Parliament and the Council of the European, 2003a, 2003b, 2003c).

In terms of promoting the use of clean energy sources in maritime and air transport, it is envisaged to apply a zero-tax rate for sustainable alternative fuels for a ten-year period.

It is planned to update the minimum rates annually, considering the dynamics of prices for energy resources to maintain the level of their harmonization.

It is important to note that the mentioned changes within the framework of the "55% Target" package, among other things, are linked to the following legislative initiatives:

- ReFuelEU Aviation (jet fuel);
- Fuel EU Maritime (ship fuel);
- Tightening of CO_2 emission standards for new passenger cars and light commercial vehicles;
- The EU Directive on the deployment of alternative fuels infrastructure (electric vehicles).

According to EU analysts, the transport sector accounts for more than a quarter of GHG emissions in the EU (20.4% for automobiles, 3.8% for aviation, and 4% for marine modes of transport). Brussels expects to reduce emissions in the transport sector by 90% by 2050.

In general, the package of "revolutionary" measures "55% Target," proposed by the EC, even before its presentation, caused a mixed reaction in the EU member states and European business circles. The bills proposed by Brussels will have to be coordinated with the member countries and the European Parliament, where there is also no unity on many controversial issues included in the package of initiatives. There is little chance that the EU will be able to implement all proposals. It is also apparent that the process will not be fast. Time frames of one and a half to two years are given for legislators to agree on them. However, the amount of work is unprecedented. Thus, the start date for the forced implementation of the EPC based on interconnected cross-sectoral strict rules may be postponed.

52.4 Conclusion

The study led to the following conclusions.

1. The ideas of regulation and reduction of the negative impact on the environment are not fundamentally new research topics. Separate concepts were developed at the beginning of the twentieth century. Subsequently, environmental protection issues and proposed measures were considered in the context of the economic development of countries and regions.
2. Technological development, innovation, and Industry 4.0 have a controversial impact on climate. On the one hand, new approaches to the organization of production, marketing, and investment can significantly reduce costs, introduce resource-saving technologies, and, thus, reduce the negative impact on the environment and climate. On the other hand, the use of advanced technological means of organization and management is increasingly expensive and requires the use of many non-recyclable materials.
3. In the face of uncertainty and a unified approach to environmental issues at the multilateral level, the EU, as the flagship of the climate agenda, is extremely cautious in solving the problem. The main market regulation instruments in the current EU strategy are fiscal instruments. This, however, does not mean a refusal to use new technologies. In this area, the EU countries are ready to cooperate with other countries, but the priority task is to protect the EU internal market.
4. For the EU partner countries, measures to protect the environment and solve the climate problem can become an additional instrument of protectionism. In this regard, the green course of the EU requires careful study, the development of measures to adapt to new norms and requirements, and, if possible, the development of a coordinated approach.

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Chapter 53
The Role and Place of Russia in the World Grain Market

Vera A. Tikhomirova

53.1 Introduction

The problems in cross-border logistics of goods, which have worsened against the background of the global COVID-19 pandemic, hinder the implementation of the mechanisms of the international division of labor and form a request for a significant number of states around the world to ensure the maximum possible development of domestic production cycles. An effective solution to this problem requires the organization of unhindered access for industry to raw materials, including through imports (Falkendal et al., 2021).

One of the most important resources for maintaining the stability of any state formation is the timely provision of access for the population to the basic categories of food necessary to maintain an active and healthy life.

Grain is a backbone resource for any food system because food products and raw materials needed for other sectors of the agro-industrial complex are produced as a result of grain processing. Accordingly, the level of self-sufficiency in grain and the presence of its carryover stocks are among the most important indicators of the current state of the national food system (Tikhomirova, 2019, pp. 62–99).

Rising living standards in the countries of North Africa and Southeast Asia stimulate the transformation of consumer habits of the population toward an increase in demand for animal proteins, which, in turn, requires a progressive expansion of access to fodder crops. Simultaneously, a significant reduction in the supply of corn on the world food market due to the political crisis in the Black Sea region, as well

V. A. Tikhomirova (✉)
Private Educational Institution of Higher Education "Moscow International Academy", Moscow, Russia
e-mail: vera-t@myrambler.ru

Federal State Budgetary Institution "Federal Center for Development of Agricultural Exports of the Russian Federation" (FSBI "Agroexport"), Moscow, Russia

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as adverse climatic factors, contributed to an increase in the use of feed wheat in the formulation of feed for livestock, poultry, and aquaculture.

The above factors have contributed to the current wheat price super-cycle and the consequent destabilization of the global food system (Falkendal et al., 2021). As one of the world's largest wheat exporters, the Russian Federation now needs to adjust its foreign economic strategy in the global wheat market to take full advantage of the existing opportunities and minimize possible threats.

Summarizing the above, in this research, using a comprehensive assessment of the current level of self-sufficiency of this category of food in Russia and studying customs statistics, the author reveals the role and place of Russian products in the world wheat market. The presence of a large amount of empirical data allows for forecasting the further development of this sector of the national economy and identifying the most promising directions for the development of the economic activity of Russian agro-industrial enterprises.

53.2 Materials and Method

The research carried out as part of the preparation of this scientific work is based on a comprehensive functional analysis of the current state of the global food trade. The use of the structural analysis method, as well as statistical and mathematical methods, allowed the author to give the most balanced assessment of the role of Russian wheat supplies in shaping supply on the world wheat market, as well as to describe its structure.

The theoretical basis of the research is the statistical data of the FAO, Federal State Statistics Service of the Russian Federation (Rosstat), the US Department of Agriculture, and the ITC Trade Map. Graphical interpretation of the data allows the most clearly visualizing the main conclusions of this scientific research. Simultaneously, comparing the obtained results with relevant studies of Russian and foreign scientists is intended to ensure a high degree of scientific reliability. The implementation of the methodology described above allows identifying the main trends in the development of the world grain market and the most promising areas for developing the Russian industry of cereals and products of their processing.

53.3 Results

From Antiquity to the present, grain crops have been the basis for providing humanity with food and occupy a significant place in people's diets worldwide. The system-forming role of this branch of crop production is unique due to the high degree of integration into other sectors of the agro-industrial complex and consists in supplying a wide range of sub-sectors of agriculture and the food industry with raw materials. In particular, cereals cover the needs of enterprises engaged in the production of

Table 53.1 Global balance of supply and demand for major cereals in 2019–2022 (million tons)

Type	Period	Production	Domestic consumption	Ending stocks	Import	Export
Wheat	2019/20	762.4	741.3	296.8	189.4	194.4
	2020/21	776.3	774.6	290.7	194.9	198.7
	2021/22	778.8	788.1	278.4	198.2	201.7
Corn	2019/20	1120.1	1131.6	306.4	169.8	175.7
	2020/21	1125.9	1143.6	292.2	180.4	183.7
	2021/22	1210.5	1182.2	305.5	184.2	189.7
Rice	2019/20	498.8	492.7	181.6	43.8	45.3
	2020/21	508.8	499.1	187.0	49.7	51.6
	2021/22	513.0	510.1	188.8	50.6	52.5

Source Compiled by the author based on source (Foreign Agricultural Service (FAS) of USDA, 2022)

cereals, alternative proteins, animal protein cultivated in a laboratory environment, as well as flour milling, feed, chemical, and other products. It should also be noted that state food reserves are formed from these products, which are necessary for maintaining uninterrupted access of the population to food for a long time in cases of anthropogenic and natural emergencies (Zhidkov & Voronina, 2019). Accordingly, in many ways, it is the organization and maintenance of a stable supply of grain crops that ensure the stability of the political and economic situation at the national and global levels (Table 53.1).

The analysis of FAS USDA statistics presented in Table 53.1 clearly illustrates that the most cultivated crops in the world in the 2020–2021 marketing year are corn, wheat, and rice, with global production of 1125.9 million tons, 776.3 million tons, and 508.8 million tons, respectively. It is important to note that the wheat supply to the foreign market significantly exceeds that of corn and rice.

On the one hand, this circumstance is associated with a high level of domestic consumption of these products, including as raw materials for the manufacture of feed for the needs of livestock, poultry, and aquaculture. On the other hand, it is associated with the transformation of consumer preferences in Asian countries toward increasing the consumption of products made based on wheat processing. In accordance with the agency's forecast, this trend will continue in the 2021–2022 marketing year (Foreign Agricultural Service (FAS) of USDA, 2022).

A similar situation is observed when studying the global cereal market through the prism of the cost of export deliveries of this food category. The growing demand for grain products due to the desire of an increasing number of subjects of international relations to increase self-sufficiency in high-value-added agricultural products stimulated the establishment of a super-cycle of prices in the segment, which reached truly record levels in 2021–2022.

Thus, an analysis of ITC Trade Map customs statistics data showed that over the past decade, global grain exports in value terms have grown by 29% and reached a record high of $119.3 billion in 2020. The structure of the world cereal market clearly demonstrates the ratio of the cost of supplies in this segment of international trade. At the end of the period, the largest export categories are wheat—$44.9 billion (38%), corn—$36.8 billion (31%), and rice—$25.6 billion (22%).

Thus, we can conclude that wheat accounts for the lion's share of global supply and demand in the global grain market. According to statistics from the UN Food and Agriculture Organization (FAO), the largest producers of this category of food are currently China, India, Russia, the USA, Canada, and France.

It should be noted that the role of Russian products in the formation of global wheat production is steadily growing. From 2000 to 2020, the value of this indicator increased by almost 2.5 times and reached 85.9 million tons (Table 53.2). Simultaneously, self-sufficiency in wheat in China showed lower growth rates and increased 1.3 times to 134.2 million tons, India—1.4 times to 107.6 million tons, and Canada—1.3 times to 35.2 million tons. There was a reduction in production in the USA and France by 18.1% and 19.3% to 49.7 million tons and 30.1 million tons, respectively (FAOSTAT, 2022).

Considering the performance indicators of the Russian wheat industry in dynamics, we can conclude that despite the permanent presence of periods with relatively low yields, national grain production is steadily growing (Zhidkov & Voronina, 2019; Zhilyakov et al., 2020). The Russian Federation has the largest land resources in the world, a significant part of which is located in the zone of risky farming or currently cannot be used in crop production. Global climate transformations, the first prerequisites of which are currently observed in various regions of the world, will contribute to the expansion of agricultural areas in the eastern part of the country, which will bring Russia to a qualitatively new level of self-sufficiency in crop products and agricultural raw materials (Pinke et al., 2022).

The above forecast is also confirmed by the results of current scientific studies of respected foreign research institutes. In particular, analysts of the French association The Demeter predict that the reduction of territories under permafrost in Siberia will increase Russia's grain potential by an average of 100–150 million tons per year by 2080, which will ultimately allow reaching the annual production of grain crops at the level of one billion tons. In the foreseeable future, within one calendar year, the Russian crop sector will be able to harvest several crops of wheat, barley, rye, corn, and soybeans (IRIS, 2021).

Further comparison of statistical data in Fig. 53.1 showed that the world's largest wheat producers are mainly focused on domestic consumption of this food category. Simultaneously, some exporting countries with a significantly lower level of production provide imports equal to or greater than the volume of the crop directed to meet domestic needs.

It should be noted that the considered phenomenon is primarily observed in countries with a developed livestock sector and is caused by the need to redistribute part of the crop for the needs of the feed industry. Thus, China and India, as the two most densely populated countries on the planet, are less interested in export activities in this

Table 53.2 Ratio of the gross wheat harvest in the Russian Federation and its exports in 2010–2021 (million tons, %)

Period	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
Gross harvest (million tons)	41.6	56.3	37.8	52.1	59.7	61.8	73.3	86.0	72.1	74.5	85.9	75.9
Export (million tons)	11.8	15.1	16.0	13.7	22.1	20.9	25.3	33.0	43.9	31.8	37.2	27.3
Share of exports in total production (%)	28.3	26.8	42.3	26.2	37.0	33.8	34.5	38.3	60.8	42.6	43.3	35.9

Source Compiled by the author based on source (Federal Service of State Statistics of the Russian Federation., n.d.; International Trade Center (ITC), 2021)

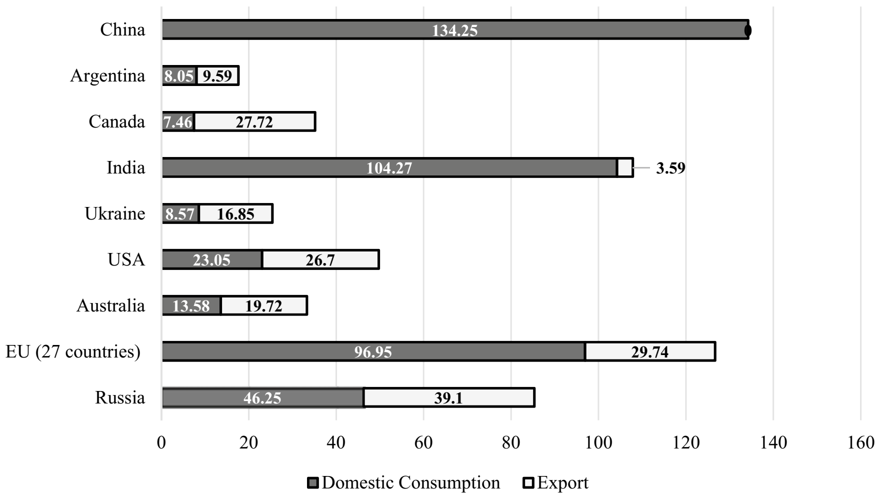

Fig. 53.1 Balance of domestic consumption and exports of the largest wheat exporting countries in the 2020–2021 marketing year (million tons). *Source* Compiled by the author based on (Foreign Agricultural Service (FAS) of USDA, 2022)

area and are pursuing the course for the maximum possible self-sufficiency in ingredients for the production of animal feed, thus maintaining a balance of self-sufficiency in crop and livestock products.

Simultaneously, wheat exports from Canada, the USA, Australia, Ukraine, and Argentina largely exceed the volumes directed to domestic consumption. This circumstance is primarily connected with the specialization of these countries in the production of mainly durum wheat, which is widely used in the flour-grinding industry. The market value of these products traditionally significantly exceeded analogs with a lower protein content, which largely predetermined the national marketing model used by the countries mentioned above (Mukaddasi et al., 2020).

On this indicator, Russia occupies an intermediate position, combining domestic processing and redistribution of most of the wheat produced in the country with dynamic export activity, which is highly correlated with the prevailing practice in the EU. Simultaneously, the dominance of the production of fodder wheat over durum wheat, previously considered by some industry experts as an obstacle on the way to world leadership in the segment, in light of the current agenda, gives Russian farmers new competitive advantages. The global shortage of supply of soybeans and corn, caused by climate change and market imbalances, has led to a massive replacement of these products with economically available analogs, including feed wheat, which stimulated the formation of the current super-cycle in prices for agricultural raw materials and contributed to the reduction of the price corridor between soft and hard wheat varieties (International Trade Center (ITC), 2021).

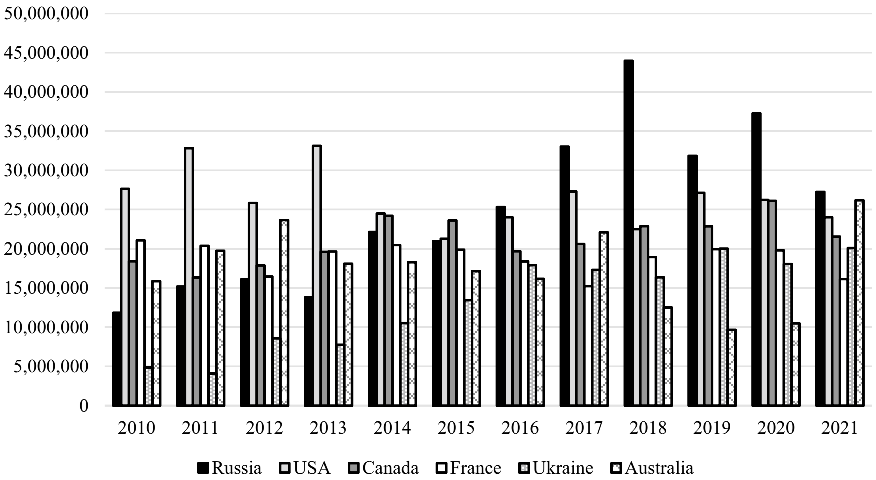

Fig. 53.2 Dynamics of wheat exports (HS Code 1001) by largest exporting countries in 2010–2021 (million tons). *Source* Compiled by the author based on (International Trade Center (ITC), 2021)

The trend to reduce the physical volumes of shipments of Russian wheat abroad (Fig. 53.2) is inspired, on the one hand, by an increase in the demand of the dynamically developing domestic livestock industry for economically affordable feed ingredients and, on the other hand, by maintaining a level of foreign exchange earnings comparable to the previous period due to an extraordinary increase in prices in the segment. This circumstance allows exporting smaller volumes of products while maintaining the total cost of deliveries at the level of previous periods or higher.

53.4 Conclusion

Caused by the consequences of the COVID-19 pandemic and political tensions, the global economic recession of our time is undermining the foundations of the global division of labor in the field of value added for agricultural products. Grain, in general, and wheat, in particular, strengthen their status as strategic commodities, the foreign economic turnover of which determines the political stability of the world order.

As one of the leading producers of wheat, as well as the world's largest exporter of this product, Russia has significant potential to strengthen the resilience of the national food security system to external challenges and threats. Simultaneously, the growth of proceeds from the implementation of export activities can become a catalyst for the formation of the financial basis necessary for the further development of the national wheat industry in terms of preparing and introducing new territories into the crop rotation, breeding a highly productive seed fund, scientific developments, and creating logistics and other necessary infrastructure.

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Chapter 54
Model to Predict Waste Generation Within the Context of Sustainable Development: The Example of the Regions in the Far East of the Russian Federation

Raisa N. Shpakova, Dmitriy I. Gorodetskiy, and Sabir K. Mustafin

54.1 Introduction

The accumulation of production and consumption waste remains one of the most problematic social and economic issues. The constantly growing amount of waste requires the expansion of landfills for its disposal. The composition of waste becomes increasingly complex. The cost of waste disposal and recultivation of the disturbed lands grows.

These issues are present in all regions of the Far Eastern Federal District of Russia. The past twenty years saw economic growth of the entire district that had growing waste generation as its direct result. Simultaneously, the structure of the gross regional product (GRP) in the regions of the Far Eastern Federal District changes, and such a change does not slow down the generation of production waste. In particular, the share of sectors capable of generating increased amounts of waste, primarily the mining industry sectors, grows gradually. The share of the mining sectors in the economy of the Far Eastern Federal District grew by 17% from 2005 to 2018 (Federal State Statistics Service of the Russian Federation, 2007, 2020, p. 506). Certain steps aimed at increasing the economic growth of the district are planned for the near future (Oleynik & Eremin, 2016, p. 28), which probably will not make the issue less pressing as well, in view of the sector-specific nature of such steps implemented mainly in the resource industry. Nowadays, the mining projects in the Jewish Autonomous Region,

R. N. Shpakova (✉) · D. I. Gorodetskiy
MGIMO University, Moscow, Russia
e-mail: aglaonema2012@gmail.com

S. K. Mustafin
Bashkir State University, Ufa, Russia

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the Kamchatka Territory, and other regions of the district have already reached the design capacity or are close to reaching it.

Addressing the issues related to the growth of the production and consumption waste generation and accumulation falls mainly within the competence of local governments of the Far Eastern Federal District. Subject to the Russian laws, they have certain powers with respect to waste handling:

- Taking of steps to prevent and respond to natural and human-made emergencies related to waste handling actions;
- Drafting, approval, and introduction of regional waste handling programs;
- Participation in the drafting and fulfillment of the federal waste handling programs;
- Drafting and approving the territorial waste handling schedule, including municipal solid waste, etc. (Federation, 1998).

We believe that the more efficient use of these powers is only possible with the assessment of the anticipated behavior of the production and consumption waste generation. We agree with the existing idea that "the most important condition of environmental management efficiency in the region is … a due regard for the long-term outlook of environmental and economic interactions" (Burmatova, 2017, p. 197) and believe that it applies to the case discussed herein.

As has already been mentioned, the standard directives for the short-term regional social and economic development planning do not pay enough attention to the production and consumption waste (Shpakova, 2019, p. 35). It is worth mentioning that, according to the existing legal requirements, the local governments are entitled to specify the estimates and set out steps to reduce the amount of municipal solid waste (MSW) intended for landfilling in their social and economic development programs [Article 6 of the Federal law "On production and consumption waste" (Federation, 1998)]. However, the laws do not contain a similar provision for production waste.

The correlation between economic development and waste generation over time and the estimation of the waste generation scope at a regional level have not received sufficient attention in research papers and publications. We would like to mention the following works:

- The works of Barlukov (2014) and Shkiperova (2014) on the relationship between economic performance and the environmental pollutant factors in certain regions of Russia;
- The works of A. A. Nikanorova and A. N. Pimenov on estimating the MSW scopes based on the behavior of the accumulation standards (Nikanorova & Pimenov, 2017);
- The works of Lo and Ilchenko (2013) and Berezyuk (2010) on the use of mathematical modeling in establishing the correlation between the economic indicators of the region and the level of pollution, etc.

The forecast of waste generation trends and changes in their composition from the point of view of international comparisons is presented in the works by Uzyakova et al. (2020). Shnaydermann (2016) analyzed the statistically significant connection between the changes in the Russian GDP and the generation of waste at the federal level. Considerable interest is aroused by the attempt to use the dynamic model of intersectoral balance with an ecological block for forecasting the formation, use, and disposal of waste, undertaken by Gilmundinov et al. (2020), but this technique is also developed for the federal level.

There are developments in forecasts of the generation and disposal of certain types of waste on a global scale, for example, plastic (Lebreton & Andrady, 2019), electronic (Awasthi et al., 2018), construction (Kim & Tae, 2014), etc. The gross domestic product (GDP) is the most important main factor influencing these processes. The close relationship between the GDP (per capita) and the generated waste volume is applied in the inter-country analysis of the dependence of the waste generation intensity on the country's income level (Kaza et al., 2018).

The regularities of the formation of solid household waste are studied extensively. In such cases, forecasting methods are developed in relation to cities or urban agglomerations. At that, the most obvious correlation between the generated waste volume and the gross product of the territory, in this case, with GRP, is also revealed (Samson et al., 2017; Vatsal & Srinivasarao, 2013).

The approaches used in the development of waste generation prediction methods vary widely: from complex, applying artificial neural network models (Vatsal & Srinivasarao, 2013) to fairly simple ones based, for example, on the availability of normative process standards for waste generation in a particular industry (Kim & Tae, 2014). The research provides a detailed review of these approaches (Goel et al., 2017).

It is worth noting that the relationship between the bottom-line indicators of economic development and the annual industrial and consumer waste generation volume at the regional level has not been sufficiently studied, especially in relation to regions with a large share of mining industries within the regional GRP structure.

Thus, the relevance hereof is determined by the need to ascertain the relation between the development of the economy and the generation of waste, and the following estimation of waste generation and use thereof when planning the environment protection at a regional level. For this purpose, the GRP parameters are a sufficient indicator of economic development. On the one hand, the GRP is a uniform standard parameter. Its behavior over time is estimated in the strategic documents of all Russian regions, and it has a planning horizon of up to 15 years with the required routine adjustments, which means that the accurate source data for the estimation of production and consumption waste generation are always available. On the other hand, this parameter is integral and concentrates in itself all present economic states, and, therefore, the state of the total consumption.

54.2 Materials and Methods

To determine how the GRP is connected to the scope of the waste, we used physical methods and a statistical approach. In this, the relation between the input and the output parameters is determined through statistical techniques. The parameters themselves are not random; they are selected in such a way as to make sure the anticipated connection between them has a clearly expressed physical value and meaning for the studied process. In this case, the statistical approach provides for a formalized expression and assessment of the quality of the connection between the parameters. In this paper, we used correlation regression analysis as a statistical method. The physical value of the connection between the input and the output parameters is the evident assumption that as the economy grows, the amount of the production and consumption waste generated by it should be growing as well.

The regression models were assessed using the determination factor of R^2 (Kinyakin & Milevskaya, 2014). The following scale of the determination factor serves for the description of the resulting connections:

- $R^2 \geq 0.7$ is a strong connection;
- $0.7 > R^2 \geq 0.3$ is a weak connection;
- $R^2 < 0.3$ means the connection is not observed or is very weak.

In our previous papers on the correlation between the production waste generation scope and the production scope expressed in the *GRP* (Shpakova, 2016, 2019), we obtained a set of results for the far eastern regions of Russia. The said results allowed for a rather optimistic outlook with respect to the possibility of using the method to assess the anticipated production waste generation at the given GRP in a more or less long term (Table 54.1).

The results were obtained based on the waste generation and GRP calculation data from 2002 to 2016. Since then, more data have been gathered over the following four

Table 54.1 Constraint equations for the GRP and waste generation by regions of the Far Eastern Federal District, overview and quality assessment

Region	Equation type	R^2 value
Amur region	$Y = 856.5\ln(x) - 8848$	0.27
Jewish autonomous region	$Y = 14.19\ln(x) + 34$	0.01
Kamchatka territory	$Y = 302.3\ln(x) - 2891$	0.49
Magadan region	$Y = 11342\ln(x) - 111186$	0.71
Primorye territory	$Y = 244770x^{-0,1181}$	0.08
Republic of Sakha (Yakutia)	$Y = 64051\ln(x) - 610552$	0.33
Sakhalin region	$Y = 5700\ln(x) - 47560$	0.30
Khabarovsk territory	$Y = 59330\ln(x) - 719040$	0.87
Chukotka autonomous district	$Y = 3634\ln(x) - 25569$	0.21
Far eastern federal district	$Y = 125800\ln(x) - 1430000$	0.76

Source Calculated by the authors (Burmatova, 2017) years, which allowed assessing the acceptability of the correlations to forecast the future figures by comparing the estimates and actual data for 2017–2020.

The results were as follows:

- A strong connection in two of the regions and the district in general;
- A weak connection in three of the regions;
- No significant connection between the GRP and the generated production and consumption waste was discovered in four of the regions that have a minor share of the mining industry in the economy.

We believe it is also worth mentioning that mining industry sectors that are known for having increased capacity to generate waste, as compared to other waste-generating sectors, play an important role in the overall production of the regions of the Russian Far East (Gulin, 2016; Moskalenko & Vorsina, 2014). Thus, as of 2016, 45–60% of the GRP of such regions as the Sakhalin Region, Republic of Sakha (Yakutia), and the Chukotka Autonomous District and 29% of the GRP of the Magadan Region consisted of the mining industry products. Simultaneously, the share of the mining industry in the GRP of the Jewish Autonomous Region, Primorye Territory, Kamchatka Territory, and the Khabarovsk Territory is almost zero (Federal State Statistics Service of the Russian Federation, 2020, p. 498).

As we see, despite the territorial closeness, the studied regions differ from each other substantially with respect to the GRP structure. Over the past three years, certain regions, like the Kamchatka Territory, Jewish Autonomous Region, etc., began implementing major mining industry projects. From the point of view of this research, the Far Eastern Federal District is sufficiently informative: It includes regions with various GRP structures and behavior patterns of such a structure over time. These features allow verifying the applicability of the suggested method in various economic conditions.

Since the final official statistics have not yet been fully available by the time of the making hereof, some data were taken from progress reports and memorandums of the regional governments and, therefore, are preliminary in nature.

54.3 Results

The new data for 2017–2020 have different correlations with the results obtained from the materials for 2002–2016. The following figures contain the points from the initial model in light colors, while the points representing the new independent data are dark. The line corresponding to the initial model is a full line, and the adjusted one is a broken line.

Thus, for example, in the case of the Amur Region, the new points are generally consistent with the previous model (Fig. 54.1). In only one case, the deviation of the calculated value from the actual value reaches 60%, with an average deviation of 37.7%. The best estimates would have been obtained if the initial model were based

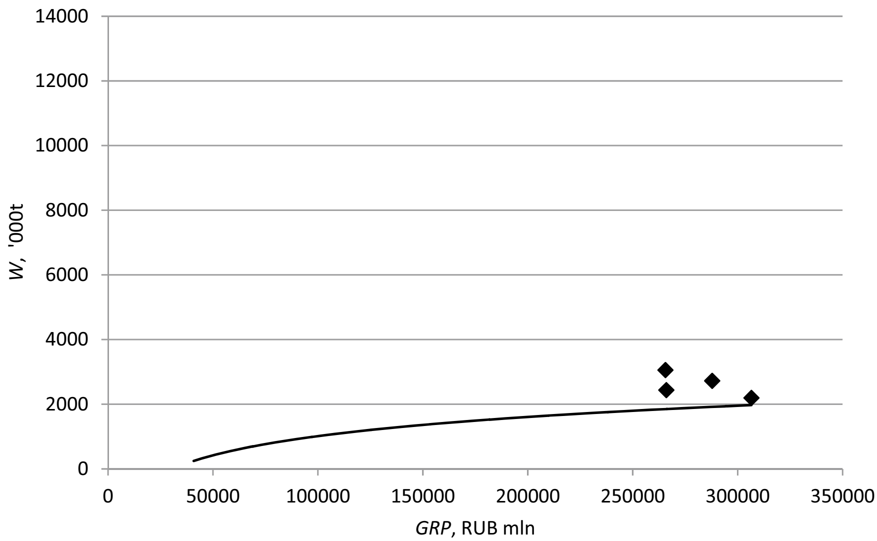

Fig. 54.1 Relation between the production and consumption waste generation and the GRP for the Amur Region. *Source* Calculated by the authors

on a linear approach. In this case, the average error of the estimates would not have exceeded 18%, with a maximum of 25.8%.

In the Jewish Autonomous Region, two cases out of four confirm the initial model (Fig. 54.2). Even though the average deviation of the estimated waste from the actual results is rather high (37%, on average), it is important to remember that the waste to GRP correlation model for this region was extremely weak: The determination factor equaled 0.01. In such a case, it is hard to expect a high-quality estimation. However, new points sufficiently confirmed the main trends shown by the initial model.

A significant divergence in two of the points (Fig. 54.1) is due to the rapid growth of production waste starting in 2019 due to a new mining facility reaching its design capacity. We have already suggested the need to adjust the relations between waste generation and the GRP in previous papers (Shpakova, 2019). In connection with this issue, it is also worth noting that this change is so radical because, as mentioned above, until recent years, the share of the mining industry in the economy of the Jewish Autonomous Region was very small.

The situation is the same in the Kamchatka Territory, Magadan Region, and the Republic of Sakha (Yakutia): The model fell short of expectations. The points corresponding to the recent 2–3 years deviated significantly from the estimates. The reasons for this are the same as for the deviation in the Jewish Autonomous Region results: New projects reached their design capacity, or the mining industry production scopes changed significantly due to other factors.

However, in the Primorye Territory, despite the significant deviation in the new points (the average is 51.1%), their placement confirms the gradual reduction in the

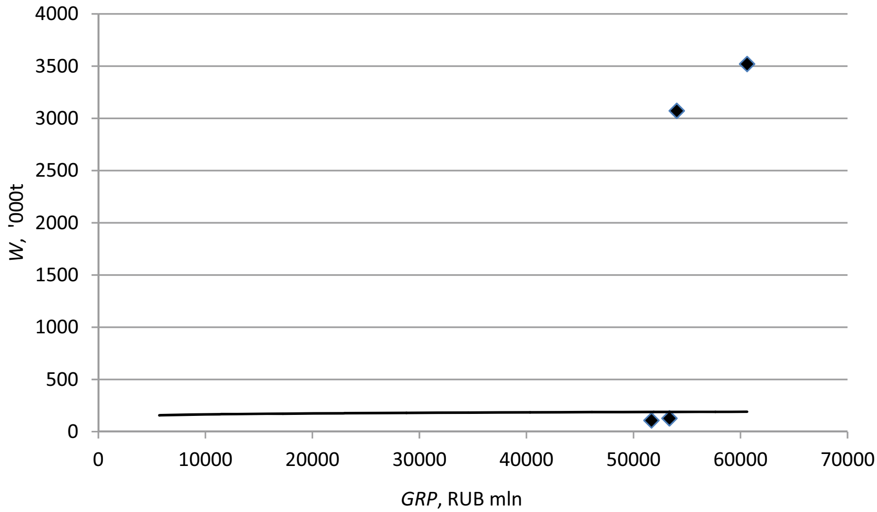

Fig. 54.2 Relation between the production and consumption waste generation and the GRP for the Jewish Autonomous Region. *Source* Calculated by the authors

generated waste against the GRP growth—a trend identified for the region (Fig. 54.3). The new data allow adjusting and specifying the model substantially (see the broken line).

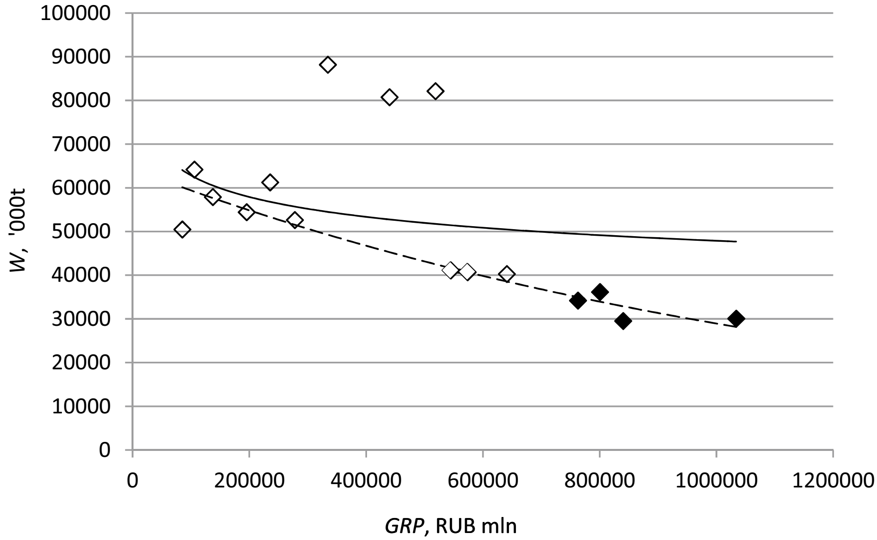

Fig. 54.3 Relation between the production and consumption waste generation and the GRP for the Primorye Territory. *Source* Calculated by the authors

Three cases of waste generation of over 80 million tons, clearly deviating from the main field, may be excluded from the data used for defining the correlation because they, evidently, reflected the implementation of a temporary (2009–2011) project with an unusual waste generation for normal economic development. Excluding these points, a simple exponential method describes the waste to GRP correlation model most accurately (1). Correlation assessment, $R^2 = 0.904$.

$$W = 64357.9 * \mathrm{EXP}(-7.988\mathrm{E} - 7 * GRP) \tag{54.1}$$

According to Fig. 54.3, the new points (marked in black) fall directly into the exponential model; if it were taken initially, the average error of the estimation would not have exceeded 6.6% (with a maximum of 11.4%).

A model drawn for the Khabarovsk Territory was also confirmed (Fig. 54.4). The average deviation of the estimates from the actual data was 5.9% (with a maximum of 12.4%).

The actual and estimated parameters of the waste to GRP relation model for the Chukotka Autonomous District correspond to each other less. However, in this case, similar to the Jewish Autonomous Region, the low quality of the initial model must be considered ($R^2 = 0.21$). The average deviation of the estimates from the actual data was 66.9%, with a maximum of 169%. The average deviation of new points equals 29.3%, with a maximum of 45.5%. Thus, the new actual data on the production and consumption waste generation in Chukotka in 2017–2020 confirmed the initial model.

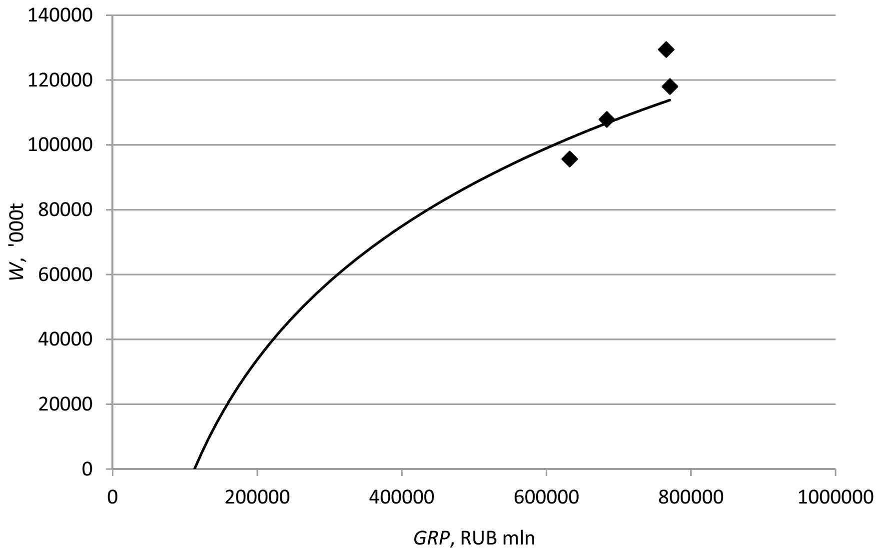

Fig. 54.4 Relation between the production and consumption waste generation and the gross regional product for the Khabarovsk Territory. *Source* Calculated by the authors

Table 54.2 Final assessment of the production and consumption waste generation correlation models for the regions of the far eastern federal district

Region	Assessment result	Reason for adjustment
Amur region	Confirmed	–
Jewish autonomous region	Confirmed	–
Kamchatka territory	Adjustment required	New mining facilities
Magadan region	Adjustment required	New mining facilities
Primorye territory	Confirmed	–
Republic of Sakha (Yakutia)	Adjustment required	New mining facilities
Sakhalin region	Adjustment required	New mining facilities
Khabarovsk territory	Confirmed	–
Chukotka autonomous district	Confirmed	–

Source Estimated by the authors based on the results of calculations

Table 54.2 contains the overall quality assessment of the verification of the production and consumption waste generation correlation models.

According to Table 54.2, the models were confirmed by independent data in more than half of the cases.

The four models require adjustments in view of a significant change in the economic conditions, namely the new mining enterprises being commissioned and reaching the design capacity. The scope of adjustment depends on the facility's performance, the density of mineral resources in the mine, and the extraction technology used. The method for determining the scope of adjustment depending on these factors is a topic for separate research.

We would like to add that we have not discovered any correlation between the quality of the models and the share of the mining production in the GRP, even though mining facilities seem to belong to the sectors with the maximum capacity for waste generation and the regions with a high share of such products in the GRP should have had a clearer relation between waste generation and the GRP.

54.4 Key Findings

1. A method for estimating the production and consumption waste generation depending on the anticipated GRP change may be designed for most regions, requiring significant adjustments only in cases when major mining projects begin to be implemented. It is probable that a method for determining the scope of such

an adjustment will be designed in the future depending on the performance of the facility commissioned, the density of the mineral resources in the mine, and the extraction technology used.

2. As a rule, 15 years of data on the GRP and the corresponding waste generation is enough to build an estimated correlation.
3. When building dependencies, cases related to implementing one-time projects in the region (lasting 1–3 years) should be excluded.
4. Typically, the best production and consumption waste generation correlation models are the ones based on a logarithmic approximation instead of power or exponential approximation.
5. The main trend in the production and consumption waste generation correlation over time in the regions of the Russian Far East, if no new mining projects are being commissioned, is the decrease of the normalized waste generation.

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Chapter 55
Achieving the Sustainable Development Goals Through the Prism of Participation in Regional Integration (Using the EAEU as an Example)

Aygerim M. Karagulova

55.1 Introduction

In 2015, the UN General Assembly approved the 2030 Agenda for Sustainable Development, to be implemented through the prism of three dimensions: economic, environmental, and social development. The UN Resolution is a policy document that envisions achieving 17 Sustainable Development Goals through the implementation of 169 targets. These SDGs are closely interconnected, integrated, and aimed at improving the population's well-being.

In the context of global economic instability, it becomes necessary for each country to use not only domestic resources but also to realize its integration potential through participation in regional associations. In the framework of the EAEU, the SDGs identified by the UN at the global level, in addition to their implementation at the level of individual countries, are also implemented at the regional level.

The paper aims to examine the impact of integration processes in the EAEU on the achievement of the UN SDGs by EAEU member countries.

55.2 Methodology

The contribution of the Eurasian Economic Commission to achieving the SDGs has four areas of activity: implementation of the UN SDGs, monitoring, evaluation, and development.

The main areas of the activity of the EAEU, as well as the goals and principles of its functioning, as defined in Article 3 and Article 4 of the EAEU Treaty, correspond

A. M. Karagulova (✉)
Eurasian Economic Commission, Moscow, Russia
e-mail: ai.karagulova@gmail.com

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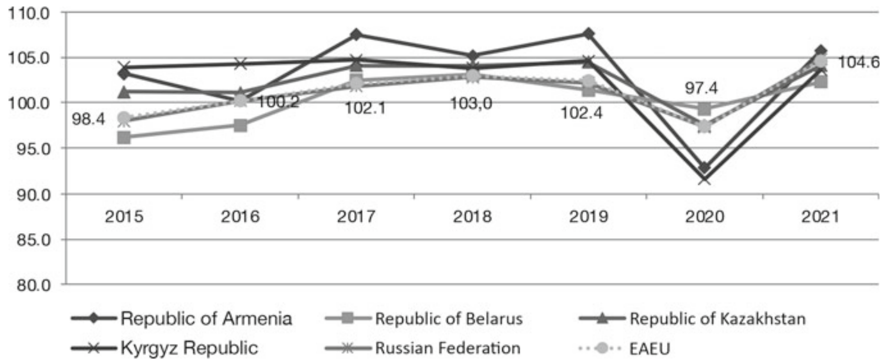

Fig. 55.1 GDP dynamics of EAEU member countries from 2015 to 2021, in % to the previous year. *Source* Compiled by the author based on the EEC statistics (Eurasian Economic Commission, 2022a)

to the SDGs approved by the UN at the global level and are designed to ensure their achievement at the regional and national levels.

According to the EEC statistics for 2015–2021 (Fig. 55.1), the growth rate of aggregate GDP of EAEU member countries showed a positive trend, except for the pandemic year of 2020, when the fall of GDP in the EAEU for 2020 relative to 2019 was 2.6%. However, there occurred a recovery to the pre-pandemic level already in 2021.

The SDGs have been implemented in the following main areas.

A coordinated agro-industrial policy is implemented to develop the agro-industrial complex in the EAEU. The primary purpose of this policy is to effectively realize the resource potential of the EAEU for optimizing the volume of production of competitive agricultural products and food, meeting the needs of the common agricultural market, and increasing exports of agricultural products and food (Republic of Belarus, Republic of Kazakhstan, and Russian Federation, 2014).

To implement a coordinated policy, in 2021, the EAEU adopted a roadmap for developing the agricultural industry in the EAEU, which is an information resource consisting of 70 major investment and innovation projects worth about $7 billion (Eurasian Economic Commission, 2022b). The implementation of these projects aims to increase the import-substituting and export potential of EAEU member countries, including crop, livestock, processing, and agricultural logistics.

The placement of such information, its update in the online mode, and the accessibility of this information will make it possible to coordinate the actions of EAEU member countries, promote the development of production cooperation chains within the EAEU, and optimally distribute the resources of member countries to support import-substituting projects.

Ensuring the food security of the EAEU through the development of economic integration in the agricultural sector will contribute to achieving SDG 1 “No poverty” and SDG 2 “Zero hunger.”

The implementation of SDG 3 “Good health and well-being” contributes to the formation of common markets for medicines and medical devices in the EAEU, as a significant category of goods, the guarantee of safety and effectiveness of which is aimed at improving the population’s health in EAEU member countries.

Strategic directions of the development of the EAEU up to 2025 provide for a separate area of economic cooperation of member countries in the field of health care (Council, 2020). Under this direction, it is planned to create and implement cooperative projects in the field of health, including scientific research and innovative developments in the treatment and diagnosis of infectious diseases, as well as projects in the field of scientific and practical capacity building.

The key strategic document defines that the EAEU seeks to improve common approaches to health protection and medical care, including the goal of creating effective tools of interaction between medical services to prevent the spread of socially dangerous diseases (tuberculosis and other infections).

These priorities and the desire of EAEU countries to share the integration effects underscore the ability of the EAEU to achieve SDG 3 “Good health and well-being.”

Even with the global challenge of the COVID-19 pandemic requiring a response and coordinated action from countries, participation in the regional alliance allowed its participants to quickly take additional measures at the supranational level aimed at normalizing the economic situation and preventing the spread of COVID-19.

A unified system of technical regulation and coordinated policy in the application of sanitary, veterinary, and phytosanitary quarantine measures in the EAEU contributes to the achievement of SDG 1, SDG 2, SDG 3, SDG 6, and SDG 15 because it is aimed at ensuring the safety of goods and food and protecting the life and health of the population.

Common energy markets are gradually being formed in the EAEU, which certainly contributes to the achievement of SDG 7 “Affordable and clean energy” by the countries.

In 2022, the international treaty on the common electric power market of the EAEU came into force, which defines the framework for the functioning of the common electric power market. The results of its implementation will be the freedom of movement of electric power in the EAEU.

The EAEU has adopted concepts and programs for forming common markets of oil, petroleum products, and gas, which involves adopting a set of regulations and implementing technological and organizational measures that will ensure the functioning of common markets ().

The common energy markets will not fully work until 2025. However, in the meantime, EAEU members need to agree on common rules of the game. The aggregate energy market of the EAEU has the necessary potential for sustainable development of the region and the EAEU countries, ensuring the population’s welfare, and strengthening the energy security of the EAEU.

The implementation of an effective transportation policy contributes to the sustainable development of the country in the context of SDG 9 and SDG 11. There is a coordinated transport policy in the EAEU (Republic of Belarus, Republic of Kazakhstan, and Russian Federation, 2014), which is implemented through the implementation of a set of measures for planning periods. The latest action plan for 2021–2023 is aimed at developing the Eurasian transport corridors and improving the system of permits for transportation and procedure for the passage of ships on inland waterways of the EAEC. Particular attention is paid to the gradual removal of restrictions on air traffic until 2025.

Through the implementation of road maps in the EAEU, the member countries strive for a common transport space and a common market of transport services.

The achievement of SDG 1, SDG 8, SDG 9, and SDG 10 will be facilitated by the creation of a common financial market in the EAEU, ensuring freedom of capital movement and unimpeded access to financial services.

The concept of forming a common EAEU financial market, adopted in 2019 in the EAEU, provides for the creation of a common exchange space, common payment space, ensuring mutual access of financial market participants of member countries, and the creation of a supranational regulator for the financial market of the EAEU.

Cooperation in the area of labor migration is important in facilitating the achievement of SDG 1, SDG 8, and SDG 10 in the region.

Thus, citizens of member countries can perform labor activities within the EAEU without regard to restrictions on the protection of national labor markets; they do not need work permits. When hiring citizens, EAEU countries recognize the educational documents of other member countries. In the labor market, under the policy of compulsory medical education, medical care is provided under the same conditions as for citizens of the country of employment.

It should be noted that the EAEU has recently launched a digital platform "Work without Borders," which unites the national job search databases of member countries. Through the digital platform, employers from EAEU countries can remotely find workers and job seekers—suitable employers (Work without Borders: Official Service of the Eurasian Economic Union, 2022).

The implementation of such measures creates favorable conditions for the free movement of labor and contributes to the formation of a unified labor market.

Additionally, within the EAEU, there is a coordinated macroeconomic policy, which provides for joint actions of member countries to achieve a balanced development of the economies of member countries (Republic of Belarus, Republic of Kazakhstan, and Russian Federation, 2014).

The main areas of coordinated macroeconomic policy in the EAEU include the following:

1. Ensuring sustainable development of the economies of the member countries using the integration potential of the union;
2. Creating conditions for enhancing the internal sustainability of the economies of member countries, including ensuring macroeconomic stability;
3. Elaboration of common guidelines for forecasting the socio-economic development of member countries.

Additionally, the heads of EAEU member countries approved the main macroeconomic policy guidelines for 2021–2022 (Council, 2021), in which countries are

Table 55.1 Ranking of EAEU member countries according to SDSN research in 2018 and 2021

EAEU member country	Place in the ranking	
	2018	2021
Republic of Armenia	58	66
Republic of Belarus	23	34
Republic of Kazakhstan	65	65
Kyrgyz Republic	51	48
Russian Federation	63	45

Source Compiled by the authors based on SDSN data (Global Responsibilities Implementing the Goals, 2018; SDG Index and Dashboards, 2022)

invited to implement measures to restore their economies after the spread of COVID-19 in 2020. The main recommendations contain measures to expand the opportunities of the EAEU internal market and develop scientific, technological, and production potential.

Regional economic integration in the areas mentioned above helps to achieve the SDGs identified by the UN at the global level and becomes an additional tool to support the quality and sustainable growth of each of the EAEU members.

According to a study by the United Nations Sustainable Development Solutions Network (SDSN), presented in 2022, the ranking of EAEU countries is as follows (Table 55.1) (SDG Index and Dashboards, 2022).

Thus, the Kyrgyz Republic and the Russian Federation improved their positions, the Republic of Kazakhstan retained its place, and the Republic of Armenia and the Republic of Belarus worsened their positions.

A detailed examination of the results of the SDSN surveys of the achievement of the UN SDGs by EAEU member countries in 2022 is presented in Table 55.2 (SDG Index and Dashboards, 2022).

Countries have shown the most accomplishment in achieving SDG 1 and SDG 10. Simultaneously, the achievement of SDG 7, SDG 8, SDG 13, SDG 15, and SDG 16 causes the most problems.

> "Strategic Directions for Developing the Eurasian Economic Integration until 2025" provide for the development of economic cooperation in the field of environmental protection and the introduction of green technologies (Council, 2020). The EAEU plans to create a concept for implementing the principles of the green economy. Moreover, it provides for cooperation between member countries in using renewable energy sources and environmental protection. At the end of 2021, the heads of EAEU countries made a statement on cooperation in the climate agenda, which is the first step toward the convergence of countries' positions and their close dialog in achieving SDG 13 "Climate action" and SDG 15 "Life on land."

EEC constantly monitors the implementation of the SDGs in the region. For monitoring purposes, a regional list of indicators of SDG achievement in the EAEU was adopted in early 2022, which contains 130 indicators, 63 of which relate to the global level and 67 to the regional level (The EAEU has agreed on a regional list of indicators for achieving the Sustainable Development Goals, 2022c).

Table 55.2 Ranking of EAEU member states in achieving all UN SDGs in 2021 according to SDSN research

No. of SDG	Republic of Armenia	Republic of Belarus	Republic of Kazakhstan	Kyrgyz Republic	Russian Federation
SDG 1	2	1	1	2	1
SDG 2	3	3	4	3	3
SDG 3	3	3	3	3	3
SDG 4	3	1	3	2	1
SDG 5	3	2	2	3	3
SDG 6	3	3	3	3	3
SDG 7	3	4	4	2	4
SDG 8	4	4	3	4	2
SDG 9	3	3	3	3	3
SDG 10	3	1	1	2	3
SDG 11	3	3	3	2	2
SDG 12	2	3	3	1	3
SDG 13	2	4	4	2	4
SDG 14	n/d	n/d	n/d	n/d	4
SDG 15	4	4	4	4	4
SDG 16	3	3	4	4	4
SDG 17	3	2	4	2	2

Note 1—the goal is achieved, 4—the least progress in achieving the goal
Source Compiled by the authors based on SDSN data (SDG Index and Dashboards, 2022)

55.3 Results

In the current geopolitical conditions, it is expected to revise the vector of the strategic development of the union. The EAEU needs to set more ambitious goals for deepening and expanding integration over the long term until 2030–2040, considering the SDGs identified at the global level. As an additional factor in ensuring sustainable development, integration processes should be coupled with the directions of the SDGs and, in this regard, be implemented in the following directions:

- Promote the Sustainable Development Agenda in the Eurasian region through events involving academia and other international regional associations with a focus on the SDGs in the region;
- Adopt a roadmap to achieve the SDGs for the five EAEU members;
- Synchronize the strategic direction of the development of integration processes in accordance with the 17 areas of Sustainable Development Goals, including the synchronization of the timeline to 2030;
- Attract investment and joint implementation of projects under the UN SDGs using the capabilities and infrastructure of the EAEC.

55.4 Conclusion

To summarize, there remain many problems in the EAEU in achieving certain SDGs, where the countries need to take action to improve their rating and, in particular, to use the integration potential from participation in the EAEU. Given the trends and tendencies followed by the whole world, including the introduction of green economy principles, EAEU member countries need to review and transform the directions of Eurasian integration and expand the scope of integration areas, considering the SDGs.

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Conclusion

Elena G. Popkova and Bruno S. Sergi

The Decade of Action is the current stage of development of the environmental economy, which is characterized by: 1) the extraordinary advances in science and technology that allow us to successfully combat climate change; 2) the critical scale of environmental disasters; 3) an unusually high level of social progress and universal support for the 17 UN SDGs; and 4) the exacerbation of various crises in the environmental economy.

The last point deserves special attention because it identifies opportunities for unlocking the potential for sustainable development of the environmental economy. The Decade of Action began with the COVID-19 pandemic and crisis (2020–2021), which many scientists interpret as a global environmental disaster. One of the widespread and convincing versions of the genesis of COVID-19 is a new zoonotic disease that has been transmitted to humans from animals due to the disruption of their natural habitat by global climate change.

In 2022, the world is on the verge of a food and energy crisis. These crises are related to the disruption of global value chains in the agro-industrial and fuel and energy complexes, respectively. Agriculture and energy are at the core of the environmental economy and the fight against climate change. This allows us to formulate the imperatives of sustainable development of the global environmental economy and to combat climate change in the Decade of Action as biodiversity conservation, prevention of the emergence and spread of zoonotic diseases; development of climate-resilient agriculture and food security; development of clean energy and ensuring energy security.

E. G. Popkova
MGIMO University, Moscow, Russia

B. S. Sergi
Harvard University, Cambridge, USA

University of Messina, Messina, Italy

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Clearly articulating the proposed imperatives is the first step in achieving them. However, this raises new research questions about the conditions under which these imperatives will be achieved and the mechanisms for achieving them most effectively. The second step is to identify these conditions and mechanisms. It is suggested that further research in the follow-up to this book be devoted to finding answers to the raised research questions for putting into practice the imperatives of sustainable development of the global environmental economy and combating climate change in the Decade of Action.