Edited by
Elena B. Zavyalova · Elena G. Popkova

Industry 4.0

Exploring the Consequences of Climate Change

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Editors
Elena B. Zavyalova
Economic Policy Department
MGIMO University
Moscow, Russia

Elena G. Popkova
MGIMO University
Moscow, Russia

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Preface

Climate change is one of the main threats to human survival, which is especially urgent today. Throughout the thousands of years of human history, the state of the environment has defied either its monitoring or its management. In the twentieth century, against the backdrop of powerful and widespread industrialization and urbanization, climate change began to accelerate. However, until recently, climate change remained a phantom threat, recognized only in the academic environment but not in the general population, business, and government world.

Through media coverage of environmental issues, a progressive and responsible global society has emerged that has opened its eyes to climate change, ready for multilateral dialogue and solving environmental problems. The COVID-19 pandemic has been a long-awaited signal for the global community to heed environmental issues and rally for solving them. The interests of saving lives came first and overshadowed the interests of the Consumer Society.

The Fourth Industrial Revolution and the transition to Industry 4.0 deserve a controversial interpretation from the standpoint of the impact on climate change. The negative impact is associated with an increase in production capacity and the acceleration of digital economic growth, increasing the negative anthropogenic influence on the environment. Automation and technocratization lead to a critical increase in energy consumption. The information society is not ready to give up the usual benefits for the sake of saving nature, at least at the current stage of its development.

The positive impact is that high technologies today allow large-scale monitoring of climate change at the level of individual territories and the global economy using “smart” systems and frameworks. Industry 4.0 technologies are also helping to reduce the dependence of economic activities on the state of the environment, a prime example of which are autonomous and “smart” vertical farms.

This contradiction has yet to be resolved by humanity in the coming years. Industry 4.0 will still show itself—either by causing a global environmental crisis or by overcoming it with the help of technological support for responsible production and consumption. What choices humanity will make, science cannot predict but it can predict the likely consequences of each of the available alternatives for the development of Industry 4.0 and offer promising solutions for using the capabilities of Industry 4.0 to combat climate change.

This book, presented in two volumes, is devoted to these questions. The first volume reflects the impact of Industry 4.0 on climate change. The second volume presents a scientific vision of the prospects for combating climate change in the economy of the future based on Industry 4.0. The book has a broad scope of the readership, including not only academic scientists studying the issues of Industry 4.0 and climate change but also business entities making decisions on using the opportunities of Industry 4.0, taking into account the problems of climate change, as well as public administration bodies at the level of territories, countries, and the global economy, regulating the transition to Industry 4.0 and the fight against climate change.

Elena B. Zavyalova
Economic Policy Department
MGIMO University
Moscow, Russia

Elena G. Popkova
MGIMO University
Moscow, Russia

Climate Change: The New Reality of Our Time in the Context of the Transition to Industry 4.0

Over the past decades, the acuteness of the problem of global climate change has been growing, but the opinion that this problem is not serious or refers to the distant future continues to remain popular. Developed countries were the first to realize that climate change is indeed happening, but they interpreted it as a threat to their national security. Initially, instead of solving the problem of climate change, the global economy was dominated by the practice of transferring environmental risks from one country to another.

Within the framework of this practice, the formation of large industrial economies of developing countries (a vivid example: China) took place, which became production bases for transnational corporations with headquarters in developed countries. Developing countries initially focused on the benefits they gain in the form of massive job creation and accelerated economic growth, access to advanced technology, and increased global competitiveness. Subsequently, they realized the gravity of the burden of the environmental costs of industrial economic growth and began to take measures (e.g., to tighten environmental production standards) to protect the environment.

By now, all countries in the world—both developed and developing—have recognized that climate change is a universal problem for humankind, and if the environment deteriorates in one part of the world, echoes of this phenomenon will manifest in other parts. With the international recognition of comprehensive coverage of climate change, the Global Sustainable Development Goals were adopted in 2015, which marked the beginning of a true solution to this problem by reducing the environmental costs of the global economy as a whole.

At the same time, over the past five years, national programs for the digitalization of the economy and the transition to Industry 4.0 have been launched and actively implemented. Usually understood as parallel initiatives, the fight against climate change and the transition to Industry 4.0 are closely related. The transition to the Fourth Industrial order is a new wave of industrialization of the world economy, which, according to the experience of the first wave (which occurred in the twentieth century), can and most likely presupposes an increase in the environmental costs of economic systems.

Thus, climate change is the new reality of our time in the transition to Industry 4.0. The digitalization programs of the economies of the world countries should be linked to national strategies for sustainable development to avoid an environmental catastrophe. This first volume of the book "Climate Change in Industry 4.0" focuses on systemic coverage of the impact of Industry 4.0 on climate change.

Its first section reflects the impact of climate change on the economy in the context of the transition to Industry 4.0. The second section is devoted to the manifestations of climate change at the territorial level in the context of Industry 4.0. The third section reveals the regulatory framework for managing climate change issues in the context of Industry 4.0. The fourth section provides an overview and analysis of ongoing Industry 4.0 initiatives to combat climate change. The fifth and final section of this first volume of the book explores the financial implications of climate change combating based on Industry 4.0.

Contents

Notes on Contributors

Abdulmuslim M. Abdulmuslimov, Ph.D. in Agricultural Sciences, Researcher of the Federal Agrarian Scientific Center of the Republic of Dagestan. Research interests are sheep breeding, goat breeding, agriculture, and veterinary medicine. More than 50 scientific papers have been published in Russia.

Olga A. Ageeva Doctor of Economics, Professor at the Department of Accounting, Audit, and Taxation of the State University of Management.

Research interests: International financial reporting standards and their integration into the Russian accounting system; Accounting theory: development of methodological approaches and general accounting principles; Research search and substantiation of accounting methods that improve the quality of financial statements; Consolidated accounting (financial) reporting, accounting and reporting in corporations in the global economy; Research search and substantiation of an effective taxation system; Management accounting at Russian enterprises, its integration into international management accounting information systems.

Roza D. Akshalova Master of International Law, Master of Jurisprudence, Senior Lecturer at the Department of International Law of the L.N. Gumilyov Eurasian National University, Member of the World Commission on Environmental Law of the International Union for Conservation of Nature (IUCN WCEL). The author of over 50 scientific papers.

Alexander N. Alekseev Doctor of Economics, Professor at the Department of Organizational and Managerial Innovations, Plekhanov Russian University of Economics (Moscow, Russia). Sphere of scientific interests: digital economy, creative economy, and innovative personnel management. He has more than 250 publications in Russian and foreign peer-reviewed journals and books.

Liudmila V. Alieva, Ph.D. in History, Associate Professor at the Department of Russian History, Pskov State University, the Director of the Institute of Humanities and Linguistic Communications of Pskov State University (Pskov, Russia). Her research interests include social history, problems of social community, ecology of history, and education. Liudmila V. Alieva is the organizer of National and International Scientific and Practical Conferences. She has published over 80 papers in Russian and foreign peer-reviewed scientific journals and books.

Inna V. Andronova Professor, Doctor of Economics, Scientific Secretary of the Dissertation Council, Head of the Department of International Economic Relations of the Peoples' Friendship University of Russia (RUDN University).

She entered the Peoples' Friendship University of Russia in 1993. She graduated from RUDN University in 2000 with honors and a Certificate as a translator from the Spanish language.

In 2004 she defended her Ph.D. thesis "The impact of official multilateral financing on the socio-economic development of Asia, Latin America, and Russia". Then, In 2015 she defended her Doctoral thesis "Foreign economic security of the Russian Federation: new threats and their neutralization in the context of accelerated Eurasian integration". Research interests: economic and foreign economic security; economic interests of Russia in the regions of the world.

Lidia V. Antonova, Ph.D. in History, Associate Professor at the Department of General History and Regional Studies, Pskov State University (Russia). Her research interests include problems of British history from the imperial period to the present, issues of the socio-economic and political development of the countries of modern Europe. Lidia V. Antonova is a participant in All-Russian and International Scientific and Practical Conferences. She has published about 20 papers in Russian peer-reviewed scientific journals and collections.

Mariana H. Barcho Doctor of Economics, Professor at the Kuban State Agrarian University named after I.T. Trubilin (Krasnodar, Russia). Research interests: agricultural economy, innovative development of the agro-industrial complex, economic security, and digital economy. She has over 90 publications in Russian and foreign peer-reviewed journals and books.

R. Sh. Bazarbaeva Doctor of Economics, Professor. She has been working in higher education for 35 years. After graduating from the Kazakh State University, she began working as a teacher of political economy, and then became the Head of the Department of Economic Theory and Management, Vice-Rector for Science, and External Relations at the Academy of Management under the President of the Kyrgyz Republic. She is a Professor at the Department of the National Economy and Regional Development of the Kyrgyz-Russian Slavic University.

Research interests: economic theory and methodology of economic science, institutional economy, state regulation of the economy, and regional economic integration. More than 75 scientific and educational-methodical works have been published, including the monograph "Institutional changes in the transformational economies of the CIS countries: contradictions and ways of resolution", textbook "Fundamentals of Economics and Public Administration", and training modules for advanced training of state and municipal employees "Fundamentals and Mechanisms of Good Governance". She carried out projects as a developer of educational and methodological materials, an expert, and a trainer with the assistance of international organizations.

Nikolai I. Berzon Doctor of Economics, Professor at the National Research University "Higher School of Economics" (Moscow, Russia). Has over 50 publications in Russian and foreign peer-reviewed journals and books.

Hans-Martin Boehmer has worked in international finance and development for over twenty years holding different positions in the private sector, government, and international organizations. He is currently Visiting Professor of the Practice at Duke University's Sanford School of Public Policy and has been consulting for Multilateral Finance Institutions, including the Global Environment Facility, the World Bank Group, the Inter-American Development Bank, the International Investment Bank, and the Eurasian Fund for Stabilization and Development. He also teaches at the International Law Institute and Georgetown University's McCourt School of Public Policy, as well as Columbia University's School of International and Public Affairs.

Sergey M. Bogomolov Doctor of Economics, Professor, Professor of the Department of Finance and Banking of the Yuri Gagarin State Technical University of Saratov (Saratov, Russia). He was awarded the honorary badges of the Ministry of Education and Science of the Russian Federation "Honorary Worker of Higher Professional Education of the Russian Federation" and the Ministry of Finance of the Russian Federation "Excellent Worker in Financial Work". His research interests include banking, banking market pricing, banking auditing, securities market, and lending. Under his supervision, three Doctoral and eight Ph.D. dissertations were completed and defended. He has published over 70 scientific papers.

Aleksei V. Bogoviz Doctor of Economics, Independent Researcher. One of the leading Russian economists, an expert in the field of agricultural economics, food security, sustainable economic development, advanced digital technologies, Industry 4.0, comprehensive studies on energy economics, and energy security. He has more than 200 publications in foreign peer-reviewed journals and books.

Natalia A. Brovko Doctor of Economics, Professor of the Department of Economic Theory, Dean of the Department of Economics of Kyrgyz-Russian Slavic University. She is the first graduate of the Kyrgyz-Russian Slavic University who defended her Doctoral thesis on the topic: "Development of Economic Integration Processes at the Present Stage". Natalia A. Brovko takes an active part in the life of the Faculty and Department, is actively engaged in research activities, writes monographs, textbooks, and is the head of research works of graduates, undergraduates, and postgraduate students. She was awarded the Honorary Diploma of the Ministry of Education and Science of the Kyrgyz Republic. She actively participates in state contractual subjects of the Ministry of Education and Science of the Kyrgyz Republic.

Research interests: an economic theory of economic science, international economy, globalization, the digital and green economy, regional economic integration. More than 55 scientific and educational-methodical works have been published. Natalia A. Brovko is the organizer and participant of scientific conferences, round tables at the national and international level.

Murat A. Bulgarov Senior Lecturer at the Department of State and Municipal Administration of the Federal State Budgetary Educational Institution of Higher Education Kuban State Agrarian University named after I.T. Trubilin. Research interests include the theory of rural development, state, and municipal administration. He is the author of monographs and scientific articles.

Anastasia V. Buniakova, Ph.D. student, Moscow State Institute of International Relations (MGIMO University), Department of International Finance. Anastasia V. Buniakova graduated from the Moscow State Institute of International Relations (MGIMO University) with a Bachelor's Degree in International Economic Relations and a Master's Degree in Financial Analysis and Accounting. Anastasia's field of scientific interests lies within sustainable development, green finance, and responsible investment.

Vyacheslav V. Burlakov Doctor of Economics, Associate Professor, Leading Researcher at the Federal State Unitary Enterprise "All-Russian Scientific and Research Institute "Center" (VNII "Center") (Moscow, Russia). His scientific interests include the theory of economic growth, innovations, sustainable development, entrepreneurship, the digital economy, and Industry 4.0. He has published more than 90 works in Russian and foreign peer-reviewed scientific journals and books.

Nelia A. Deberdeeva Senior Lecturer at the Plekhanov Russian University of Economics (Moscow, Russia). Research interests: the psychology of professional development and personal growth, the economics of education, and professional self-determination. Has more than 30 publications in Russian and foreign peer-reviewed journals and books.

Olga S. Diakonova Associate Professor at the Departments of Accounting, Audit, and Taxation. She has published 4 books and more than 100 articles. Her interests are accounting and control in the context of digitalization.

Konstantin A. Dolonin Junior Researcher, Manager of the Samara branch of Sberbank. The area of interest relates to green investment and Industry 4.0.

Arthur A. Dmitriev an undergraduate student of the State Financial Control undergraduate program. His research interests are focused on the study of issues of economic theory at the macro and micro levels, management, as well as the practice of applying state financial control. Arthur A. Dmitriev takes an active part in All-Russian and International Scientific and Practical Conferences. He is the author of scientific articles recommended by the Higher Attestation Commission and indexed in the Russian Science Citation Index system (RSCI).

Olesya A. Dzyurdzya Senior Lecturer at the Department of Economics and Organization of Moscow Polytechnic University (Moscow, Russia). Her scientific interests include the theory of economic growth, innovations, sustainable development, venture capital, the digital economy, and Industry 4.0. She has published more than 30 works in Russian and foreign peer-reviewed scientific journals and books.

Yancha Tuasa Segundo Elías student. Participated in the scientific events of the Department and the cultural meetings and weeks of the University.

Natalia V. Efimova, Ph.D. in Economics, Lecture at the Department of Management, Marketing and Foreign Economic Activities of Moscow State Institute of International Relations (MGIMO University), Moscow, Russia. Her scientific interests include business administration and entrepreneurship, coal industry, international coal trade, sustainable development, environmental management, and Industry 4.0. Natalia V. Efimova is an author of collective monographs, scientific articles. She has published more than 45 works in Russian and foreign peer-reviewed scientific journals, and books.

Victor I. Efimov Doctor of Engineering, Professor at the Department of Public and Municipal Administration of National University of Science and Technology "MISIS" (Moscow, Russia). He has had wide experience as a researcher within several interregional and federal programs for environmentally friendly mining, development of scientific and teaching staff in Russian innovations, and specific research projects on geological and technical aspects of the coal mining industry. He is a member of the Dissertation Committee on Geo-ecology (in the mining industry), a member of the International Academy of Ecology and Life Protection Sciences and Academy of Mining Sciences, and a member of editorial boards of Russian journals "Izvestiya Tula State University. Earth Science" and "Economics of the 21st century", a member of Science and Engineering Research Council of Coal Industry of the Ministry of Energy. The main scientific interests are geo-ecology, in particular, modeling of gas emissions and forecasting of dangerous gas situations in coal mines, recycling of waste from coal mining; innovative mining technologies, and digitalization of the coal mining industry. Victor I. Efimov is an author of more than 200 scientific works, with most of them published in Russian and foreign peer-reviewed scientific journals and books, including 11 inventions, 5 patents, and 4 certificates on software.

Dmitri G. Egorov Doctor of Philosophy, Professor at the Pskov branch of the Academy of the Federal Penitentiary Service and Pskov State University (Pskov, Russia). Research interests—economic theory, philosophy of science (philosophical foundations of economics, earth sciences), philosophical anthropology (the origin of morality), and regional economics. Author of 130 scientific works, including 8 monographs.

Natalya V. Falina, Ph.D. in Economics, Associate Professor at the Kuban State Agrarian University (Krasnodar, Russia). Research interests: sustainable development, the economic security of business entities, and digital economy. She has more than 130 publications in Russian and foreign peer-reviewed journals and books.

Pavel V. Fedosov, Ph.D. Ph.D. student of the Department of Environmental Economics, Faculty of Economics since October 1, 2017.

Gilyan V. Fedotova Doctor of Economics, Associate Professor. She is a Chief Research Officer at the Volga Region Research Institute of Production and Processing of Meat and Dairy Products. Research interests—intelligent technologies in the agro-industrial complex, development of the concept of green management, intellectual capital, investment. More than 300 scientific papers have been published in Russia.

Olga V. Fedyanina Trade Advisor for the British Embassy in Moscow, Ph.D. candidate at the Moscow State Institute of International Relations, Department of International Finance, Moscow State Institute of International Relations (MGIMO University). Olga V. Fedyanina graduated from the Ryazan State University named after S.A.Yesenin (degree with honors). She has a Master's Degree in International Relations (Exeter University, UK) and a Master's Degree in Management (MGIMO-University). Olga Fedyanina is a participant and speaker at national and international conferences. She has published in various journals on the world economy. Main areas of research: international finance, financial institutions, financial capital, M&A.

Anna A. Gorbacheva Associate Professor, Ph.D. in Economics. Anna Gorbacheva joined the Department of Economics of MGIMO University in 2012 as an Associate Professor. The scope of her work covers conducting lectures, holding seminars and tutorials on Microeconomics and Macroeconomics, conducting science conferences, supervising students' term papers, setting entrance tests as well as participating in Certifying Committee, writing scientific and methodological materials on teaching courses, developing assignments for the school children contest in humanitarian and social sciences.

Research interests: globalization, globalization trends as challenges for national economic systems, global competitiveness of countries, and economy of civil society.

Anna A. Gorbacheva graduated from the North Caucasus Academy of Civil Service, where she received a Ph.D. in Economics for a thesis titled “Functioning of nation-state economic systems: globalization aspect”.

Anna A. Gorbacheva has 23 publications including “Principles of globalization and challenges of a nation-state economy” in Economics Bulletin, and a monograph Functioning of nation-state economic systems: globalization aspect.

Foreign languages—English

Vladimir V. Grigorenko student, Kuban State Agrarian University named after I.T. Trubilina (Krasnodar, Russia). Research interests: agricultural economy, innovative development of the agro-industrial complex, digital economy. Research topic: “Development of the Agro-Industrial Complex of the Region on the Innovative Basis”. He has 4 publications in Russian peer-reviewed journals.

Abdusalam A. Hozhokov, Ph.D. in Agricultural Sciences, Researcher at the Federal Agrarian Scientific Center of the Republic of Dagestan. Research interests are sheep breeding, goat breeding, agriculture, and veterinary medicine. More than 100 scientific papers have been published in Russia.

Tatyana Y. Ivanova Doctor of Economics, Professor, Head of the Department of Management, Head of the M.B.A. program at Ulyanovsk State University (Ulyanovsk, Russia). Research interests: synergetic management, management problems in a non-equilibrium economy. She is the organizer of All-Russian Conferences, editor, and author of collective monographs, a member of the editorial board of Russian and foreign journals. She has published 175 works, including articles, monographs, and textbooks. One of the textbooks has been translated into a foreign language.

Agnessa O. Inshakova Doctor of Law, Professor, the Head of the Department of Civil and International Private Law of Volgograd State University (the base Department of the Southern Scientific Center of the Russian Academy of Sciences), Honorary worker of education of the Russian Federation. The author of more than 400 scientific, educational, and methodological publications. Editor-in-chief of the journal reviewed by the Higher Attestation Commission of the Ministry of Science and Higher Education of the Russian Federation (HAC) Legal Concept = The legal paradigm. Member of the editorial boards of other 14 HAC journals. The Head of the Master’s program “Civil law, business law, international private law”;

The Head of the Scientific School “Law of economic entities in the conditions of technological and socio-economic transformations”;

The Head of the Scientific and Educational Center “Modernization of the legal system of modern Russia” of the Institute of Law, Volgograd State University;

The Head of the basic Department of the Southern Scientific Center of the Russian Academy of Sciences.

The Member of the Board of the Volgograd Regional branch of all-Russian Public Organization "Association of Lawyers of Russia", the expert of the Public Chamber of the Volgograd Region, the First Judge of the Arbitration Court of the Volgograd Arbitration Court Section, Judge of the Court of Arbitration for Resolution of Economic Disputes at Volgograd Chamber of Commerce and Industry.

Alexander P. Ilyin, Ph.D. candidate in Economics (MGIMO University, expected in June 2021). Graduate thesis: Enhancement of corporate strategy efficiency evaluation based on leveraged buy-outs involving international experience.

Master's Degree in Finance (MGIMO University, June 2018). Graduate thesis: "A company valuation: Russian and international experience" – Evidence from PJSC "Magnit" and "Wal-Mart Stores, Inc.".

Bachelor's Degree in Economics (MGIMO University, June 2016). Graduate thesis: "Financial analysis of a company" – Evidence from PJSC "Magnit".

Publications: "Journal of Economy and entrepreneurship", article "Modeling the leveraged buyout deal decision: possible approaches".

Larisa V. Iliyna Doctor of Economics, Professor, Professor of the Department of Finance and Banking of the Yuri Gagarin State Technical University of Saratov (Saratov, Russia). She was awarded the Honorary Badge of the Ministry of Education and Science of the Russian Federation "Honorary Worker of Higher Professional Education of the Russian Federation". Her research interests include methodology and mechanisms for the formation and use of bank insurance reserves, bank credit technologies, quality of banking products and services, financing of banking activities, analysis of banks' activities. She took international scientific and educational internships abroad. She is a member of the editorial board of the "Financial Markets and Banks" journal. Under her supervision, five Ph.D. dissertations have been completed and defended. She has published over 60 scientific papers.

Marina V. Plotnikova, Ph.D. in Economics, Associate Professor of the Department of Finance and Banking of the Yuri Gagarin State Technical University of Saratov (Saratov, Russia). Her research interests include banking, lending, and quality of credit services, balanced banking policy, and digitalization in the banking sector. She has published over 30 scientific papers.

Elena I. Inshakova Doctor of Economics, Professor at the Department of Economic Theory, World, and Regional Economy (the Basic Department of the Southern Scientific Center of the Russian Academy of Sciences) at Volgograd State University (Volgograd, Russia), and the Chief Researcher of the Institute of Social and Economic Development of Region at Volgograd State University. Her areas of research are the theory of economic and institutional mechanisms, the transformation of economic systems, globalization, and economic integration, economic and social impacts of Industry 4.0 technology application, economy digitalization, the world market for nanotechnology, and energy-related nanomaterials prospects. She is the author and co-author of about 200 scientific and educational works in Russian and foreign peer-reviewed academic publications.

Oleg V. Ivanov Professor, Doctor of Economics. Graduated from the Moscow State Institute of International Relations (MGIMO University).

Envoy Extraordinary and Plenipotentiary of the 1st class. Oleg V. Ivanov worked in various positions in the central office of the Ministry of Foreign Affairs and diplomatic missions abroad, including the Head of Japanese Department, Deputy Director of the Department of Economic Cooperation, Minister-Counselor for Economic Affairs of the Russian Embassy in Japan, Consul General of the Russian Federation un Osaka (Japan). Oleg V. Ivanov was a member of the expert group of the UN Security Council. He has experience of work in business (Senior Advisor of RUSNANO Corp.) Oleg V. Ivanov is the author of 8 monographs, books, and textbooks, including "Theory and world practices of public-private partnership" (2016).

Dr. Ivanov nowadays teaches the following courses:

Public-Private Partnership. Basics

Public-private (cross-sectoral) partnership

PPP mechanisms in the economic policy of Russia

International practices of PPP projects' implementation

Pason Abdul Jabar student. Participated in the scientific events of the Department and the cultural meetings and weeks of the University.

Oleg G. Karpovich Doctor of Law, Doctor of Political Science, Professor. Graduated with honors from the International Law Faculty of the Moscow State Institute of International Relations (MGIMO University). Author of over 370 scientific papers on various topics of political science, international relations, conflictology, international law, criminal law of Russia, and foreign states. Worked in the Administration of the President of the Russian Federation (Main State Legal Department). Member of the Dissertation Council at the Diplomatic Academy of the Ministry of Foreign Affairs of Russia and Lomonosov Moscow State University. Scientific Director of the Institute for Strategic Studies and Forecasts, Peoples' Friendship University of Russia. Member of the Expert Advisory Council at Rossotrudnichestvo, expert of the Russian Society of Political Scientists and the Russian Council on International Affairs. Full member of the Academy of Military Sciences of the Russian Federation and the Russian Academy of Natural Sciences. He is a member of the Editorial Board of the journal "Bulletin of the Diplomatic Academy of the Ministry of Foreign Affairs of Russia. Russia and the World", "International Public and Private Law", "Problems of the Post-Soviet Space". Awarded with state and departmental awards.

Elizaveta V. Kiseleva Master's student at the Moscow State Institute of International Relations (MGIMO University), Department of International Finance; graduate of MGIMO University in International Economic Relations. Speaker at national and international student conferences; has several publications in the field of economics and finance. Main areas of research: international finance, monetary policy, national financial system.

Tatiana G. Khrishkevich, Ph.D. in History, Associate Professor, the Head of the Department of General History and Regional Studies, Pskov State University (Russia), Senior Research Fellow at the Center for Comprehensive Study of Regional Security Problems, Pskov State University. Her research interests include the socio-political history of Germany in the 20th—early 21st centuries, security problems and peculiarities of the regional imbalance in Germany, as well as migration processes in the Baltic Sea Region. Tatiana G. Khrishkevich is the organizer of All-Russian and International Scientific and Practical Conferences. She has published about 100 papers in Russian and foreign peer-reviewed scientific journals and books.

Yana A. Kochkova is a Ph.D. student at the Ulyanovsk State University, and she specializes in Economics and National Economy Management. Her main research interests are modeling systems for evaluating e-business performance, social media marketing, sustainable development, and growth.

Natalia V. Komarovskaia Senior Lecturer, has been teaching at the Department of Economics of MGIMO University since 2006. She gives lectures, seminars, consultations and examinations on Micro- and Macroeconomics, Economic History and History of Economic Thought, and Theory of International Economics, makes tests, exams, and quizzes, and advises students on essays and term papers. She participates in planning and holding round tables and conferences at the Department of Economics. She takes part in the work of state examination boards and holding entrance examinations for master's programs of the School of International Economic Affairs.

Natalia Yu. Konina Doctor of Economics, Professor of Statistics at the Moscow State Institute of International Relations (MGIMO University), Department of Accounting, Statistics and Auditing. Doctoral Degree in Accounting, Statistics of Higher Attestation Commission of Ministry of Education, and Science of Russia in 2011.

Spheres of scientific research: methods of SNA, Structural Business statistics in the analysis of Globalization, Digitalization, energy industry, renewable energy sources, and online aggregators. More than 115 scientific and academic publications, 4 papers in Scopus and WoS bases.

Elected Member of International Statistical Institute. Member of IARIW etc.

Subjects taught: "Economic Statistics", "System of National Accounts", "Statistics" (in English)—Bachelor Double Diploma Program in Politics and International Relations, University of Reading (UK). International Standards for Economic Statistics (in English) —Master Double Diploma Program in International Management, ICN Business School (France). Statistics for social science—Bachelor Double Diploma Program of HSE and Kyung Hee University (Korea).

Yulia A. Konovalova, Ph.D. in Economics, the Head Lecturer, and the Associate Professor of the International Economic Relations Department of the Economics Faculty of RUDN University (Russia). Scientific secretary of the scientific journal "RUDN Journal of Economics" (RUDN University, Moscow, Russia). Scientific interests cover such issues as the global economy, international economic relations, USA, EU, and India.

Coordinator of the International Conference "Current issues of the global economy" (RUDN University, Moscow, Russia). Published about 30 works in Russian and foreign peer-reviewed scientific journals and books.

Yury I. Korobov Doctor of Economics,Professor and Chair of the Department of Finance and Banking at the Yury Gagarin Saratov State Technical University (Saratov, Russia). His scientific interests include the theory of money, credit, and banking, competition in financial markets, marketing of financial institutions, financial culture. Yury I. Korobov participated in international educational programs with universities of the USA, Great Britain, Germany, and France. He has published more than 130 scientific works and was the supervisor of more than 20 Ph.D. and D.Sc. dissertations.

Oleg F. Krivtsov Associate Professor at the Department of State and Municipal Administration of the Faculty of Public Administration and Law.

Research interests: taxes and taxation, finance, and state and municipal finance.

He has 32 scientific publications. Hirsch index—3.

Tatyana G. Krotova Lecturer at the Department of Economic Policy and Public-Private Partnerships, and the expert of the Center for Applied Research.

Sphere of academic interests: sustainable development, mathematical methods of analysis of achieving The Sustainable Development Goals.

Education:

- 2015–2018; Master's degree at the Moscow State Institute of International Relations (MGIMO University), an economist with knowledge of English.
- 2002–2008; Bauman Moscow State Technical University, Department of Radioelectronics and Laser Engineering, engineer of radio-electronic systems

Taught courses:

- Sustainable Development Management;

– Monitoring and evaluation theory;
– Basic course of statistical analysis and econometrics for writing research papers.

Publications:

– "Russian-Chinese Energy Cooperation".
– "Research on Employers' Attitude Towards Elderly Workers".
– "Methods for Achieving SDG 1, Poverty Eradication".
– "Can the Planet Be Cooled?"

Dmitry D. Krykanov graduated from the Moscow State Institute of International Relations (MGIMO University), has a Bachelor's Degree in Political Science (Comparative Politics) and a Master's Degree in Management (Public-Private Partnerships). Nowadays he is writing a Ph.D. thesis "On the Impact of International Infrastructure Projects on the Development of Regional Economic Cooperation". Dmitry D. Krykanov served as a Counselor at the Department of Digital Economy Development of the Ministry of Economic Development of the Russian Federation. Now he is occupied at the Digital Transformation Office of the Uralchem Group. Dmitry's scientific and applied interests lie in the fields of infrastructure development, corporate innovation and strategy, and service design.

Dmitry M. Kucheryavenko, Ph.D. in Economics, Associate Professor, Doctor of Business Administration. His research interests include the field of economics and management, the theory of economic growth, tax, and labor legislation.

Professional skills in the field of:

- changing the organizational and legal structure of the company (creating a group of companies with a centralized management system through a management company or building a classic holding company);
- building a centralized management system, financial and accounting reporting;
- optimizing existing internal business processes or developing new ones.

Dmitry M. Kucheryavenko is a participant of All-Russian and International Scientific and Practical Conferences, the author of collective monographs. He has published more than 40 papers in Russian and foreign peer-reviewed scientific journals.

He is a member of the Association of Independent Directors with the status of an Independent Director, and the National Association of Corporate Directors.

Yulia S. Kudryashova, Ph.D. in History, Senior Lecturer in Economics, Senior Research Fellow, Ph.D. in History. Yulia S. Kudryashova has been teaching at the Department of Economics of MGIMO University since 2010. She is conducting seminars, consultations, and examinations on the following Courses: Microeconomics, Macroeconomics, History of the World, and Russian Economy. She participates in preparation and conducting student Theoretical and Practical Conferences at MGIMO University, presides student papers.

Education—Graduate of the Institute of Asia and Africa Countries of the Moscow State University acquiring a profession the orientalist-Africanist with the qualification the interpreter from the Turkish language in 2001. In 2002–2005 was studying at the internal post-graduate course at MGIMO University specializing in the History of International Relations. Received her Ph.D. in History from MGIMO University for the thesis "The problems of Turkey-EU interaction after signing the Maastricht treaty" in 2007.

In 2006 gave author's course was based on lectures named "The EU's Enlargement to the East: Problems and Prospects" at the Institute of External Economic Links at MGIMO University. In 2006–2008 worked as a research fellow of the Center for Caucasian Studies at MGIMO University. In 2008–2009 worked as a Senior Teacher of Turkish language at the Department of Near and Middle Eastern Languages at MGIMO University. Since 2008 is a senior research fellow of the Center for Euro-Atlantic Security at MGIMO University. She is the author of the monograph "Turkey and the EU: History, Problems, and Perspectives of Interaction", 2010. Foreign Languages: English, French, Turkish.

Sergey E. Kuklev, Ph.D. in Economics, Head of the Strategic Development Department, Pskov State University. He is also an Assistant Professor at the Department of Management and Administrative Law. His scientific interests include sustainable development, management in the higher education system, and current educational technology trends.

Maria A. Kozlova Associate Professor at the Department of Economics. Maria Kozlova has been working at the Department of Economics since 2005. She is giving lectures, seminars, consultations, and examinations on micro-, and macroeconomics for Undergraduate and Postgraduate students.

Education

- Maria A. Kozlova graduated with honors from MGIMO University in 2000. She received a Ph.D. in Economics in 2004. She also received a Master's Degree in Cultural studies from the Institute of Cultural History in 2012.
- She regularly attends the courses of further training at MGIMO University, Higher School of Economics, and the Plekhanov Russian University of Economics.

Research Interests: economics, global public goods, national innovation system Publications. Maria A. Kozlova is an author of 25 publications about the national innovation system of Russia, the theoretic aspects of scientific development, the instrumental cultural policy and the relations between culture and economics, global public goods, and other subjects. In 2014–2015 she also edited the workbook for the students of Economics prepared by the Department of Economic Theory of MGIMO University. Foreign Languages: English, French, and Spanish

Inna V. Lipatova Ph.D. in Economics, Associate Professor at the Department of State Financial Control and Treasury. Her research interests are aimed at studying the theory and practice of state financial control, tax controlling, and audit issues. Inna V. Lipatova takes an active part in All-Russian and International Scientific and Practical Conferences. He is the author of collective textbooks and monographs. She has published over 320 papers in Russian and foreign peer-reviewed scientific journals and books.

Svetlana V. Lobova Doctor of Economics, Professor at the Altai State University (Barnaul, Russia). Her research interests are labor market and employment, entrepreneurship, education economics, digital economy, labor efficiency, integration, and cooperation. Svetlana V. Lobova is the author of more than 300 scientific papers, including those published in highly rated peer-reviewed journals.

Amar Mangal student. Participated in the scientific events of the Department and the cultural meetings and weeks of the University.

Alexey A. Miheev Doctor of Economics, an academician, public person, expert in the field of digital technologies and blockchain, and Assistant Professor at the Moscow State Institute of International Relations. Founder of "Miheev Consulting"; one of the most notable experts in the field of business efficiency improvement by Agile, SCRUM, and blockchain digital technologies. Speaker, moderator, and host of numerous large international conferences on the blockchain with a total number of participants of more than 100,000 people. Organizer, host, and moderator of investment meet-ups in which more than 25 million dollars were raised. Participant of the world's largest North-American Bitcoin and Blockchain Conference in Miami, which was attended by 5,000 participants. Author of more than 10 monographs, 70 research works, and publications on investment management, digital technologies, and blockchain. He publishes works on business development strategies, SCRUM and Agile adaptive management methods, and implementation of KPI, property administration, and city and region economics. Forbes' op-ed editor.

He has an M.B.A. degree in the field of property administration from the Russian Presidential Academy of National Economy and Public Administration under the President of the Russian Federation and a Doctor of Economics degree from the Saint Petersburg University of Economics. He was an exchange scholar at Bloomsburg University (USA), where he researched "Foreign Direct Investment in the USA" which resulted in a Ph.D. thesis. He is a Head of the Non-Profit Partnership Center for the Development of Innovative Business and Entrepreneurship. He is the executive secretary of the Expert Council for management of the knowledge-based economy under the Education and Science Committee of the State Duma of the Federal Assembly of the Russian Federation. Chairperson of the Non-Profit Partnership Center for the Development of Innovative Business and Entrepreneurship Board. He has an international independent director certificate from the Institute of Directors (UK).

Valerija S. Mincicova graduated from Financial University under the Government of the Russian Federation in 2009. Shortly after graduation in 2012, she got the scientific degree of Doctor of Philosophy, Ph.D. in Economics, and Associate Professor. Valerija S. Mincicova studies the questions of blue economy, state and corporate energy security, and foreign investments. Staying an active Professor she teaches a dozen disciplines such as World Economy, Energy Markets, National Economies, Risk Management, and others for Bachelors, Masters, and post-graduates. She has over 60 scientific publications in different fields of the world economy and also executes administrative work of Deputy Dean, Chair specialist, and others (at different periods) in the University. At leisure time she enjoys alpine skiing, yoga, and playing harp and piano in a band.

Ahmet R. Mirzaev student of the Moscow Timiryazev Agricultural Academy. Research interests are sheep breeding, goat breeding, agriculture, and veterinary medicine. 10 scientific papers have been published in Russia.

Araz O. Mursaliev, Ph.D. student of the Department of International Law, Leading Researcher at the Center for Strategic Studies in Energy and Digital Economy at the International Institute of Energy Policy and Diplomacy, Moscow State Institute of International Relations (MGIMO University), Moscow, Russia.

The scientific area of interest is related to the problems of ecology and law in the Caspian Sea. Author of more than 10 publications leading Russian and foreign scientific journals.

Diana M. Nadyseva, Ph.D. student at the Department of Economic Theory. Her scientific interests include the digital economics, Industry 4.0, institutional economics, macroeconomic growth, Data science, and econometric and programming methods in data analysing, social politics and quality of life, methods of modern teaching at universities with using the new technologies. Diana M. Nadyseva has an experience of working with German social organizations aimed at improving the quality of life within the framework of the European Social Fund program. She has published more than 20 works in Russian and foreign peer-reviewed scientific journals and books.

Nikolai I. Berzon – Doctor of Economics, Professor, Tenured Professor of the "Higher School of Economics". Professor Berzon is a Director of The Federal Methodological Center for Financial Literacy in General and Secondary Vocational Education, National Research University "Higher School of Economics", Moscow, Russia. He has published over 100 articles in professional journals and sixteen books as author, co-author, editor, and co-editor. His primary research expertise embraces financial and monetary policy.

Lyubov N. Orlova Doctor of Economics, Professor at the Financial University under the Government of the Russian Federation. Research interests intellectual capital, human resources, intelligence management, and financial investments. More than 120 scientific papers have been published in Russia.

Vladimir S. Osipov Doctor of Economics, Professor of Asset Management Department at MGIMO University (Russia), and also Guest Professor of School of Economics and Management at Beijing Jiaotong University (China). He is a Member of the American Law and Economics Association, Editorial Boards Member of several scientific Journals. He has published over 200 articles in professional journals and sixteen books as author, co-author, editor, and co-editor. His primary research expertise embraces institutional policy and public administration. He is Vice-Head of Dissertation Council of the Lomonosov Moscow State University.

Kseniia A. Patrunina graduated from the Moscow State Institute of International Relations (MGIMO University), has a Bachelor's Degree in Political Science (Political Decision Making) and a Master's Degree in Management (CSR Strategies). Nowadays she is writing a Ph.D. thesis "On the Impact of the Development of Information and Communication Technologies of Global Economic Inequality". Kseniia A. Patrunina works as a Dean's Assistant and Curator of EdTech Projects at the Faculty of International Economic Relations of the Moscow State Institute of International Relations (MGIMO University). The spheres of scientific interests include world economy, economic inequality, digital transformation, and higher education transformation.

Elena G. Popkova Doctor of Economics, the Founder and President of the Institute of Scientific Communications (Russia) and Leading Researcher of the Center for Applied Research of the Chair "Economic Policy and Public-Private Partnership" of the Moscow State Institute of International Relations (MGIMO University), Moscow, Russia. Her scientific interests include the theory of economic growth, sustainable development, and globalization, humanization of economic growth, emerging markets, social entrepreneurship, the digital economy, and Industry 4.0. Elena G. Popkova organizes All-Russian and International Scientific and Practical Conferences and is the editor and author of collective monographs, and she is a guest editor of international scientific journals. She has published more than 300 works in Russian and foreign peer-reviewed scientific journals, and books.

Elena L. Pozharskaya, Ph.D. in Economics, Associate Professor at the Department of Psychology of Plekhanov Russian University of Economics (Moscow, Russia). Research interests: management psychology, economic psychology, business psychology, organizational consulting, training, and coaching. Elena L. Pozharskaya is a co-organizer of Russian and International Scientific and Practical Conferences, she is the executive editor and author of collective monographs. She has more than 80 publications in Russian and foreign peer-reviewed journals and books.

Elena Y. Pertseva, Ph.D. in Economics, the GRI Certified Sustainability Professional, Deputy Head of the Corporate Governance and Sustainability at FBK Grant Thornton. Her scientific interests include sustainable development, corporate sustainability, non-financial reporting, and green project management. She is co-author of the monograph "Project approach to the implementation of the concept of sustainable development in the company", and numerous articles on corporate sustainability issues.

James Prest Doctor of Law, a Senior Lecturer in Law, specializing in Environmental Law with interests in Administrative Law and Litigation, and is a Member of the IUCN Commission on Environmental Law. He is a Member of the Executive of the Australian National University's Energy Change Institute a cross-campus inter-disciplinary network devoted to energy issues. His primary expertise is in national-level sustainable energy law and policy for deep decarbonization. Apart from his research interest in international climate law, his main research focus is on a comparative review of national and sub-national law and regulation for energy and transport sectors. His research has a strong focus on comparative environmental law, with an emphasis on renewable energy and climate change law, examining the legal and policy barriers to increased investment in renewable electricity generation. His work applies a comparative law approach to critically analyze key policy choices and legislative models in the field of domestic energy and climate law, drawing upon Australian, EU, Indonesian, and Japanese experience in the last decade.

Sayar Ahmad Reshad, Ph.D. student (Degree of Master of Economics). Scientific interests cover such issues as the global economy, international economic relations, India, and the energy sector.

Valery A. Romanov, Ph.D. in Philosophy, Associate Professor. Research interests: political philosophy, geopolitics, philosophy of law, political communications, and socio-philosophical aspects of political knowledge. Author of over 50 works in Russian and foreign publications.

Marina N. Rudenko Doctor of Economics, Professor, the Head of the Department of Entrepreneurship and Economic Security, the Head of the scientific direction "Innovative entrepreneurship and economic security as the basis of competitive advantages to the development of the country" of

Perm State National Research University (Perm, Russia). Her scientific interests include the theory of sustainable development, globalization, emerging markets, the economic security of social entrepreneurship, the digital economy, and Industry 4.0. Marina N. Rudenko organizes Russian and International Scientific and Practical Conferences. She is the editor and author of collective monographs, and guest editor of international scientific journals. She is the author of more than 10 monographs, 220 works in Russian and foreign peer-reviewed scientific journals, and books.

Timur V. Ruzmetov Assistant of the Corporate Governance and Sustainable Development Department at FBK Grant Thornton, which provides services in the field of sustainable development, including in the field of non-financial reporting, prepared according to international standards, independent assurance in the field of sustainable development. It is also part of the expert group of the Russian Public Organization Green Patrol, which carries out public monitoring and comparative assessment of the regions of the Russian Federation in the field of environmental safety and environmental protection. Graduated from the Russian State Geological Prospecting University named after Sergo Ordzhonikidze with a degree in Ecology and Environmental Management in Moscow, as well as the ELA Foreign Languages Academy in Edinburgh, Scotland.

Natalia A. Rykhtikova, Ph.D. in Economics, Associate Professor, Krasnogorsk branch of Russian Presidential Academy of National Economy and Public Administration (Krasnogorsk, Russia). Research interests: sustainable economic development of organizations based on a risk-based approach; formation of risk management systems for organizations. She has over 75 publications in Russian and foreign peer-reviewed journals and books.

Marina V. Safronchuk Ph.D. in Economics, Associate Professor at the Department of Applied Economics, Associate Professor at the Department of Economic Policy and Public-Private Partnership.

Educational activities

1. lecturing
2. holding of seminars
3. coursework and diplomas management
4. opponency
5. participation in examination boards
6. development of educational materials for the teaching courses.

The author of many monographs and scientific publications on various aspects of economics.

Professor Safronchuk teaches the following courses:

1. Applied Economics
2. Economic Theory (Microeconomics and Macroeconomics)

3. Government Regulation
4. Theory of Industrial Markets
5. Public Choice Theory
6. Priceing
7. Government Regulation and Economic Policy

Elena V. Sapir Doctor of Economics, Professor, Head of the Department of Global Economy and Statistics, P.G. Demidov Yaroslavl State University, Yaroslavl, Russia. She is a Member of the World Economics Association (Bristol, UK), Association of European Studies (Moscow, Russia), Editorial Board Member in the Russian Foreign Economic Journal. She has published over 150 articles in professional journals and more than twenty books as author, co-author, editor, and co-editor. Her primary research expertise embraces geoeconomy and globalistics. She is a Member of the Dissertation Council in the Financial University under the Government of the Russian Federation.

Lyudmila S. Samodelko Ph.D. in Economics, Senior Lecturer at the State University of Management, Moscow, Russia. Research interests include the theory of welfare, sustainable development, financial mechanisms for regulating environmental processes, environmental taxation. She has more than 12 papers in Russian peer-reviewed journals and books.

Galina N. Semenova Ph.D. in Economics, Department of Accounting and Taxation, Plekhanov Russian University of Economics and the Department of Economics and Entrepreneurship of the Moscow Regional State University (Moscow, Russia). Her research interests include theory and practice of taxation, audit, accounting, development of small and medium-sized businesses in Russia, digital economy, and Industry 4.0, innovation processes in the economy, and investments. Galina N. Semenova is an Advisor to the State Civil Service of the Russian Federation of the 2nd class, a tax expert of the Federal Civil Service of Russia in Moscow, is the author of collective textbooks and monographs. She has published over 150 papers in Russian and foreign peer-reviewed scientific journals, and books.

Ellina A. Shamanina Lecturer at the Department of Economic Policy and Public-Private Partnership, Moscow State Institute of International Relations (MGIMO University). She is an Assistant Lecturer at the Department of Economic Policy and Public-Private Partnership at MGIMO University and a Ph.D. candidate (specialization: World Economy) at the Department of Economic Policy and Public-Private Partnership of the MGIMO University. In 2017, she participated in a scientific project on making recommendations for Public-Private Partnership legal framework development in the Russian Federation, taking into account the analysis of the best foreign practices in the field of Public-Private Partnership regulation. Her research interests are mainly focused on Public-Private Partnerships (Public-Private Partnership), international practices of Public-Private Partnership, social policy, socially responsible business, social investments, social infrastructure development, cooperation between government and business.

Vladimir Y. Skobarev in audit and consulting business since 1992. One of the founders and a partner of NP Consult, which has a large number of projects with major Russian companies on accounting and reporting consulting, financial audit, tax audit, examination of tariffs, internal control, and audit. Since 2006, he has been developing the area of sustainability services. Since then he has implemented dozens of projects on preparation and confirmation of non-financial reporting, stakeholder engagement, improvement of non-financial reporting systems for the leading Russian companies, certified training on international standards of non-financial reporting under GRI recommendations. He is the only specialist in Russia with concurrently recognized qualifications (including international) in financial audit, internal audit, and sustainability audit. He has experience working at management and control bodies of some Russian companies with state participation as a Chairman and Member of Boards of Directors, and revision commissions. He has published on audit, internal control and audit, and sustainability topics. He participates in the development of internationally recognized sustainability standards. Since 2017—Partner at FBK, Director of the Corporate Governance and Sustainability Department.

Anna A. Skomoroshchenko, Ph.D. in Economics, Associate Professor at the Federal State Budgetary Educational Institution of Higher Education "Kuban State Agrarian University named after I.T. Trubilina" (Krasnodar, Russia). Research interests: food security, investment policy, entrepreneurship, and digital economy. She has 96 publications in Russian and foreign peer-reviewed journals, and books.

Evgeniy V. Skubriy Doctor of Economics, Professor of the Civil Protection Academy of the Russian Emergencies Ministry. Research interests: innovation, pricing, project management, and digitalization. About 40 scientific papers have been published in Russia.

Alexander M. Solntsev the Deputy Head of the Department of International Law, Law Institute, RUDN University. Alexander M. Solntsev received a Bachelor's and Master‘s degree from the People's Friendship University of Russia (RUDN University, Moscow). From 2005 to 2008 he was a postgraduate student at the Department of International Law of the RUDN and in 2008 defended his thesis on the theme: "The role of international judicial institutions in the settlement of the international environmental disputes". From 2005 to date, he teaches various international legal disciplines in the full-time and evening departments of the Law Faculty of RUDN, including "Human rights and environment" and "International environmental law".

Under his authorship and co-authorship over 600 papers (monographs, textbooks, manuals, research papers, reviews, etc) have been published in Russia and abroad. He initiated the unique project of publishing in Russian the International Environmental agreements, with comments. To date 4 out of 12 issues published ("Key UN documents"; "Protection of the environment in armed conflict", "Environmental Human Rights", "Protection of atmosphere").

Current position

- Member of International Union for Conservation of Nature (IUCN), World Commission on Environmental Law (WCEL)
- Member of European Society of International Law (ESIL)
- Member of the European Environmental Law Forum (EELF)
- Member of the working group No. 13 "Combating Climate Change" on the preparation of the voluntary national report on the Sustainable Development Goals (SDGs) 2019
- Member of the working group No. 15 "Conservation of terrestrial ecosystems" on the preparation of the voluntary national report on the Sustainable Development Goals (SDGs) 2019

Daria S. Sokolan a Ph.D. candidate, graduated from the Kharkiv National University named after V.N. Karazin (Ukraine, Kharkiv) in the specialization "International Economics". Continued studies at the RUDN University magistracy (Russia, Moscow) in the specialization "International Trade". In 2020, received a Certificate for completing the online courses "Alternative Investments" at Harvard Business School. During her studies, she was interested in various topics: global financial centers, integration associations in Asia, the oil market, investments. Today she is doing her Ph.D. thesis on the "Investment Activity of China in the EU Countries".

Evgeniya A. Starikova, Ph.D. in Economics, Lecturer at the Department of Economic Policy and Public-Private Partnership.

September 2015—present—Ph.D. in World Economy, the Doctoral course in Economic Policy, the Department of Economic Policy, and Public-Private Partnership at the Moscow State Institute of International Relations (MGIMO University).

2013–2015—Moscow State Institute of International Relations (MGIMO University), School of International Relations Master's degree with honors in International Relations (Master's program "International Politics and Transnational Business").

2009–2013—Moscow State Institute of International Relations (MGIMO University), School of International Relations Bachelor's degree with honors in Regional Studies (Oriental Studies Department)

Qualification upgrading courses: March 2018—qualification-upgrading program "Investment Project Management based on the Public-Private Partnership principles" held by the Public-Private Partnership Development Institute in cooperation with the Department of Economic Policy and Public-Private Partnership (MGIMO University) and the Public-Private Partnership Development Center

*Foreign languages:*English, Mongolian, and French.

Main fields of research and career interests:sustainable development, International Development Assistance (IDA), blended finance, multi-stakeholder (cross-sectoral) partnerships, cooperation between government and business, Public-Private Partnership (PPP), corporate social responsibility (CSR), and economic cooperation in the Asia-Pacific Region.

Conferences:

November 2016, November 2017—Participant, International Workshops "System Change for Sustainability" organized by the British Charity "Forum for the Future", British Embassy in Russia and Moscow School of Management SKOLKOVO. Awarded Certificates of Gratitude for active involvement and valuable expert contributions on the promotion of sustainable development and green economy in Russia.

December 2016—Participant, the 10th RISA (Russian International Studies Association) Convention: prepared a report on Sustainable Development Goals and Their Influence on the Corporate Social Responsibility (CSR).

Irina A. Strelets, Ph.D. in Economics, Doctor, Professor.

School of Government and International Affairs—Faculty Member

Department of Applied Economics—Professor

Teaching experience: Economic Theory (Microeconomic, Macroeconomics), Applied Macroeconomics, Industrial Organization, Network Economics, and the Theory of Commerce.

Research and Teaching Interests: network economics, industrial organization.

Regularly participates in International Conferences and has many publications including books, textbooks, and articles.

Vasily N. Tkachev, Ph.D. in Economics, Associate Professor of Finance at the Moscow State Institute of International Relations (MGIMO-University). He is a scientific advisor of the MGIMO University M.B.A. Programme "Finance". He serves as the Central Bank of Russia external expert at the Council of Eurasian Economic Union Financial Integration. Moreover, he is the Scientific Advisor of the MGIMO Finance Club. In 2017-20 he was Senior Visiting Fellow at Henley Business School (UK). He has over 20 years of teaching experience in the field of finance. He is either the author or co-author of over 30 articles and monographs on corporate and international finance; participant and speaker at national and international conferences. Main areas of research: money and credit, international finance, financial institutions, and markets.

Sergei G. Vagin Doctor of Economics, Professor. As a full-time Professor, he worked at the Samara State University of Economics, Higher School of Economics, The Federal Methodological Center for Financial Literacy in General and Secondary Vocational Education, and Russian Technological University "MIREA" (Moscow), Samara Interregional Methodological Center for Financial Literacy in General and Secondary Vocational Education. He is a member of professional associations: the National Register of the Russian Union of Industrialists and Entrepreneurs; he is also a Member of the Expert Council of the Russian Association of Experts and Specialists in Knowledge Management. Currently, he is a Professor at the MIREA—Russian Technological University. He has more than 100 publications dedicated to innovation in various fields.

Bogdan S. Vasyakin, Ph.D. in Economics, Associate Professor, the Head of the Department of Psychology. Research interests: economic psychology, management psychology, and development of human resources.

Egor A. Vasyunin an undergraduate student of the Bachelor's degree program "State financial control". His research interests are focused on the study of issues of economic theory at the macro and micro levels, and the practice of applying state financial control. Egor A. Vasyunin takes an active part in All-Russian and International Scientific and Practical Conferences. He is the author of scientific articles recommended by the Higher Attestation Commission and indexed in the Russian Science Citation Index system (RSCI).

Margarita V. Vertiy, Ph.D. in Economics, Associate Professor at the Kuban State Agrarian University named after I.T. Trubilin (Krasnodar, Russia). Research interests: main trends in the development of the agro-industrial complex of the Krasnodar Territory, the economic security of the country and the region, food security of the country and the region. Has more than 83 publications, including 14 in Russian and foreign peer-reviewed journals and books.

Veronika V. Yankovskaya, Ph.D. in Economics, Associate Professor at the Department of Psychology, Plekhanov Russian University of Economics (PRUE). Ph.D. in Economics, Associate Professor at Department of Industrial Management of the State University of Management (GUU). The editorial expert of the portal Seychass.ru news stories from the field of economics and management since 2017. She has the professional experience of a consultant: Specialist of the Strategic Analysis Department of Volga-Dnepr Airlines; Expert, Consulting Department, Union; Analyst, Department of Federal and Regional Programs, Compulink. Research interests: reforming the systems and structures of enterprise management; development and implementation of the strategy; problems of theory and practice of management, and management development model; humanization of labor of teaching staff (effectiveness and efficiency of teaching staff); information security.

She has more than 150 publications in Russian and foreign peer-reviewed journals and books.

Natalia A. Yarmolich, Ph.D. in Philosophy, Associate Professor at the Department of Philosophy and Theology of the Institute of Humanities and Linguistic Communications, Pskov State University. Research interests: geopolitics, geopolitical theories, political communications, methodology of socio-political science knowledge, and transformation of society in the modern era. Author of over 70 papers in Russian and foreign peer-reviewed scientific journals, and collections.

Yusupdzhan A. Yuldashbaev Academician of the Russian Academy of Sciences, the Dean of the Faculty of Animal Science and Biology, Russian State Agrarian University—Moscow Timiryazev Agricultural Academy. Research interests are sheep breeding, goat breeding, agriculture, and veterinary medicine. More than 700 scientific papers have been published in Russia.

Yury K. Zaytsev is a Senior Research Fellow at the Russian Academy of National Economy and Public Administration (RANEPA) and Ph.D. in International Economics from the Moscow State Institute of International Relations. He has authored and co-authored over 50 publications on various aspects of international development cooperation, international business, foreign direct investments, trade, and investment climate. Yury was involved as an expert in projects such as the DFID-funded "Sharing Responsibility for Development: Learning from Experience to Achieve Results"; the EC-funded "Transnational Cooperation among NCPs for International Cooperation"; "G20 compliance assessment" with the University of Toronto; and the World Bank-financed "Russia as a Donor Initiative".

His professional experience deals with consulting projects for the World Bank, Eurasian Development Bank, CISCO Entrepreneur Institute (USA), and IIASA (Austria).

Maksim V. Petrov, Ph.D. in Economics, Associate Professor at the Moscow State Institute of International Relations (MGIMO-University). Maksim V. Petrov has 20 years of teaching experience in the field of finance, corporate finance, and investments. He is either the author or co-author of over 25 scientific articles and monographs; participant and speaker at National and International Conferences. Along with this, Maksim V. Petrov has more than 25 years of practical experience in the financial sector. He has worked as a financial manager in the World Bank's Environmental management project, in the EBRD projects, as well as in leading Russian commercial banks.

Elena B. Zavyalova, Ph.D. in Economics, Associate Professor at the Department of Economic Policy and PPP, the Head of the Department School of Government and International Affairs, Faculty Member.

Academic career

- MGIMO, Lecturer at the English Language Department No.1;
- MGIMO, Lecturer at the World Economy Department;
- MGIMO, a Senior Lecturer at the World Economy Department;
- MGIMO Associate Professor at the World Economy Department;
- MGIMO, Deputy Director of the Institute of Foreign Economic Relations;
- MGIMO, Deputy Dean of the Faculty of International Economic Relations;
- MGIMO, Head of the Department of Economic policy and Public-private partnerships.

Rewards
The Council of the Federation of the Federal Assembly of the Russian Federation, Certificate of Honor Reward "200 Anniversary of the Ministry of the Foreign Affairs" MGIMO Alumni Award "The lecturer of the Year", 2007.

Professional interests
The Russian economy, the economy of the former Soviet Union, national economic security, economic policy, public-private partnerships, sustainable development, and international development assistance.
Scientific activities

- participated in the program of the World Bank — "Russia as a donor" (2009–2012).
- co-author of three Ministry of Economic Development of the Russian Federation researches (2012, 2013, 2014)
- gave a course of lectures in Shandong University (China), 2011
- lectures in Beijing Normal University (China), 2014
- author of over 60 publications.

Dr. Zavyalova teaches the following courses:

- The Russian Economy
- The Economy of the Post Soviet States
- National Economic Security
- Economic Policy
- Economic Policy. Practical course
- Corporate Social Responsibility

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Part I

The Impact of Climate Change on the Economy in the Context of Transition to Industry 4.0

CHAPTER 1

Influence of Climate Changes on Business Activity and Its Adaptation

Tatyana Y. Ivanova, Yana A. Kochkova, and Sergey E. Kuklev

Introduction

Climate change is the key external factor that is about to play a great role in the enterprise activity and elaboration of its policy. According to "Science ABC" climate change implies the long-term changes in the weather patterns in a region or in the world (Jain, 2018). Nowadays, there is a debate on whether climate changes and in what way it changes. Provisionally the specialists dealing with this problem can be subdivided into four groups:

- staunch adherents of global warming, they are certain that economic activity makes the greatest contribution into it;
- specialists who admit global warming but they consider the statement of its mainly anthropogenic origin to be hard to prove;
- specialists who doubt the validity of the ascertainment of global warming as a phenomenon;
- specialists who believe that in the decades to come and further on we are to witness not global warming but global fall of temperature (Vladimorov & Churakov, 2014).

T. Y. Ivanova · Y. A. Kochkova
Ulyanovsk State University, Ulyanovsk, Russia

S. E. Kuklev (✉)
Pskov State University, Pskov, Russia

E. B. Zavyalova and E. G. Popkova, *Industry 4.0*,
https://doi.org/10.1007/978-3-030-75405-1_1

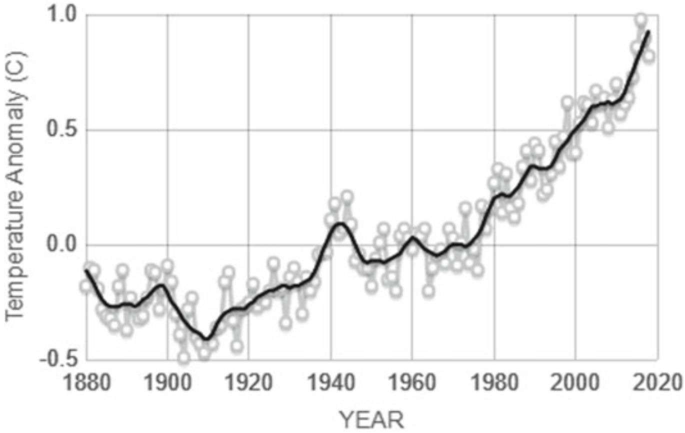

Fig. 1.1 Global change in temperature (*Source* NASA's Goddard Institute for Space [2018])

If to follow the previously mentioned points of view, we can come to the conclusion that there is no common view on the problem. Nevertheless, numerous researches show that changes do happen. According to NASA research in the field of climate change, a considerable increase in global temperature on our planet has been revealed (Fig. 1.1).

According to NOAA data, the first part of the year 2019 was on average one of the hottest years since 1880 when the first data were registered (NOAA National Centers for Environmental Information, Climate at a Glance: Global Time Series, 2019, https://www.ncdc.noaa.gov/cag/global/time-series/globe/land_ocean/1/2/1880-2019). In 2019 the average temperature of the land surface and ocean was by 0.88 °C higher than the average indicator of the twentieth century. The April of 2019 was approximately by 0.93 °C higher that the average indicator of the twentieth century and it makes it the second hottest April on record.

We can come to the conclusion that despite some skeptical views in the field of climate change, there are still certain proofs of such changes. Now we can witness a great number of events that harm the enterprise activity and cause extensive financial and physical damage. We can point out that climate change increases risks for business and because of these increased risks for many companies' insurance costs will also grow.

Background and Methodology

The technological, economic and policy dimensions of climate change are essential to understanding and formulating corporate strategic responses. However, while the impact of new global and regional carbon management regimes on businesses has been studied for some time (e.g., Kolk & Levy, 2001; Acquier et al., 2017), the physical impacts of climate on business change have received relatively little attention in management research (Bondarenko et al., 2018; Griffiths et al., 2009).

Results

But does climate change really influence financial aspects of an enterprise? Recent analysis conducted by Moody's Analytics focuses on economic implications of climate change (Lafakis et al., 2019). According to analyzers, climate change has many-sided effects on world economy, and it creates winners and losers and various stimuli to act. Developing countries and countries with a warmer climate are more vulnerable. The main expenses for developed countries of Northern Hemisphere will include increasing frequency of disasters and serious climate-related disasters. For these countries a decrease in productivity will not be so great and it will be compensated by stronger tourist flows and/or lower fuel prices.

According to another research, there also climate changes (McCarthy 2019). The research deals with four different scenarios leading to temperature increase by 1, 1.9, 2.4, and 4.1 °C up to the year 2100. For instance, it is expected that global economic damage in 2100 will amount to 54 billion dollars in case of 1.5 °C scenario, thus 2 °C scenario will lead to the damage of 69 billion dollars. If the temperature increases by 4 °C, then according to estimates India will experience the greatest blow at GDP in 2048 (of all biggest economies of the world) with the reduction by 2.45%. Canada, Great Britain, Germany, France, and the United States will witness a very modest growth of GDP if the worst scenario takes place.

According to KPMG research "Expect the Unexpected: Building Business Value in a Changing World" there are 10 "megaforces" that will influence dramatically corporative growth on a global scale in the next two decades and the forces are being studied. Such issues as climate change, energy and fuel volatility, water availability cost and resource availability, population growth causing new sprawling urban centers (KPMG, 2012). These interconnected tendencies will create risks and opportunities for business.

Another recent report "Carbon Disclosure Project" which presents the analysis of FTSE 100 companies has shown that almost 80% consider climate change as a substantial risk for their business. However, less than half of the surveyed companies have enlisted adaptive measures into their common strategies (Podosenova, 2019).

A recent report of the United Nations Framework Convention on Climate Change (UNFCCC) gives the following data: A group of the biggest companies of the world (their total capital amounts to 17 billion US dollars) estimated the cost of risks of climate change for their business approximately at 1 billion US dollars. On the other hand, entrepreneurs see in this situation some potential for development and reduction of risks more than twofold.

Thus, climate change is not only just an ecological problem; climate is closely connected with the human activity. We can affirm that it starts to influence business all over the world and will influence it even more in future. For the time being, climate change brings changes to business environment (Folk, 2018).

Firstly, due to extreme weather conditions caused by climate change there is a change in resources availability and their cost. These extreme weather conditions may break distribution chains and it makes the task of receiving resources and materials for modern enterprises even more complicated. Serious climate changes, for example, draughts, may cause shortage of agricultural plants that are used for production of food, clothes, and other products. An increase in energy costs and transportation can also increase transportation costs. Normative restrictions on goods connected with climate change can also increase costs. Shortage or depletion of resources may induce companies use alternative materials and recycle more and more waste. In 2018 in the framework of the project "Carbon Disclosure Project" more than 7000 companies were offered to estimate their financial risks connected with the climate change. It was found out that if they don't take any preventive measures, 215 out of 500 biggest world companies may lose about one billion dollars because of climate change. For instance, Alphabet (parent company of Google) is likely to deal with increased costs on cooling down their data processing centers. Company "PG&E" took responsibility for fire damage and was forced to declare bankruptcy after its electric power transmission lines caused the deadliest fire in California in 2018 (Cho, 2019).

Secondly, we believe that climate change is capable of changing the structure of demand in the markets. For example, as global temperature rises, demand for tourist services and demand for winter goods is sure to decrease. More and more consumers also prefer eco-friendly goods.

Thirdly, as global temperature rises and weather conditions change, labor conditions in some economic sectors may become stiffer. Physical work, especially in the open air, will grow more difficult and health and safety hazards in these spheres will increase. Consequently, costs in these sectors will also grow.

We reckon that change of rules which business is to follow will play (and already plays) the most important role. These are rules that aim at extenuating and preventing environmental pollution. Companies that produce a lot of waste have to invest much money in modernization of their projects, so that waste can be diminished or suppressed. Energy companies are sure to work at implementing eco-friendly technologies in energy production.

Moreover, nowadays we can witness an increase in social pressure. As the society is getting more and more aware of climate changes, it is more unwilling to accept business which does not strive to decrease its impact on the environment. Consumers want to find products that are produced on a sustainable basis, or at least, which do not harm the environment as the other compatible products. Companies are expected to be socially responsible and to take measures to make their activity more ecologically friendly or to donate money on environmental protection agencies.

Climate change has ecological, social, political, and economic consequences. Extreme and unpredictable weather conditions, floods, droughts, melting of Arctic snow, and increase of sea level are some of the main problems connected with climate change and they have direct consequences for world trade. Companies in developing countries are especially vulnerable. ICIMOD focuses the attention on the fact that climate change will produce a dominoes effect on agricultural and industrial operations. Agriculture is one of the sectors that suffered greatly from climate changes, but the influence of climate change may be different in different countries. Northern regions in which nowadays we see low temperatures and short vegetation periods may gain because of growing productivity of some cultures. In tropical regions which are subject to extreme temperatures one can witness reduction of yields (Gouel & Laborde, 2019). However, the role of indirect market adaptation to climate change has not been studied yet. For example, market adaptation will proceed from the fact that landowners will change their distribution of land not only due to new potential profitability but due to price changes in the new climate that take into consideration the adaptation of demand, supply, and trade.

One can say that climate change brings new risks for enterprises. Investigating the interconnection between climate change and competitiveness of industry the majority of researchers highlight the factors of business risk resulting from climate change (Hoffman & Woody, 2008). The results of the research impel practical business people observe the situation and make preparations for changes in competitiveness caused by political risks, such as rules of greenhouse gas emissions, economic risks, such as an increase in prices and changes in market demand, as well as physical risks such as disasters. Since customers' satisfaction is the source of corporative competitiveness, building up deep relationships with the stakeholders, such as the government, local communities, and investors, plays a key role in the accumulation of social capital by a company, which in its turn leads to economic growth. Firstly, firms are often expected to take an active part in the process of policymaking in the sphere of climate change on national and local levels that will help them create beneficial and regulative environment for their business. Secondly, financial investors show a growing concern for the problems of climate change because they understand that risks connected with climate change may undermine their corporative value and investment assets.

In September 2019 Russia announced its commitment to implement the Paris Agreement of 2015 to tackle climate changes. Climate change has caused rising temperatures especially in high Northern latitudes. For example, agriculture and forest management in high latitudes of Northern hemisphere, which implies earlier planting of agricultural crop in spring, a growing frequency of forest fires, changes in the forest structure due to plant pests, health hazards caused by heat, changes in contagious diseases and allergen pollen and changes in human activity in the Arctic (for instance, it is bound to influence hunting and tours to the Arctic). From 1900 to 2005, the amount of rainfall has increased in Northern Europe, Northern and Central Asia. These changes may cause sudden floods, more frequent flooding of riverside territories and soil erosion, species extinction, and reduction of snow deposits.

Climate change is a much more serious problem than just an environmental concern. This process will influence deeply the essence of business in the near future. Business will face problems if the influence of climate changes is not analyzed and if some steps are not taken to find the appropriate solutions. It is high time the leaders of companies reconsidered their business models. The recognition of climate change as an inevitable factor and the recognition of the necessity of adaptation require that business people take bold decisions. The most crucial idea is to understand that adaptation increases costs, but lack of adaptation will cost even more. What does the mechanism of adaptation imply? In our opinion, there can be several approaches to the problem. The first approach is to develop the economy of shared use. The term "collaborative economy" is quite a new notion. According to some authors, the economy of shared use nowadays has a potential to achieve sustainable development. The supposed potential of sustainability lies in the capacity of companies producing goods and services to decrease net consumption that leads to reduction of resource exploitation (Ala-Mantila et al., 2016). It is stated that shared use will lead to reduction of using water and energy and reduction of waste. Finally, it is said that collaborative economy will result in reduction in emissions, positioning shared use as an alternative practice of consumption to tackle the problem of climate change (Curtis & Lehner, 2019).

According to a new research the growth of shared use via Uber, Craigslist, Airbnb, and other platforms can help decrease the impact on climate of dense urban areas. Cities produce a growing share in global emissions of greenhouse gases that cause climate change (Yeo, 2017). In time the collaborative economy of resources may transform our transportation system and guarantee a deep cut of carbon emissions in connection with effective climate policy.

Motor vehicle emissions are one of the greatest problems that hit our planet and cause climate change. With less water and fuel consumption, the collaborative economy will help people reduce the amount of used resources. For example, a bed that is given by one person to another via Freecycle means that fewer trees will be cut and used to make new beds. Besides when a consumer buys used toys and household articles via Web sites such as "Letgo", they can reduce the amount of plastic used to make such goods.

The second approach to adaptation is to use economic instruments to decrease the impact on the environment. Economic instruments of stimulating reduction of emission of greenhouse gases and adaptation has become a crucial problem both for rich and poor countries, for big and small business. We believe that one of the usual mechanisms that have stood the test of time is standardization. One of the most authoritative international institutions in this sphere—International Organization for Standardization (ISO) has elaborated and adopted a new climate standard and the correspondence to this standard will mean the highest level of activity to adapt to climate change. Nowadays the certificate of ISO is the most widespread international authorization document in the world. In fact, correspondence to ISO is a proof that the quality management system at the enterprise and in the organization corresponds to international standards. Certification in this system covers a great range of enterprise activity spheres, the logistic chain and distribution of finished commodity.

Besides there are some standards that are underway and they include the evaluation of vulnerability, these standards are supposed to support organizations and communities adapting to climate changes and making their first steps on the way to climate sustainability. The main package of ISO on climate change includes:

- ISO 14064 and 14065—greenhouse gases;
- ISO 14080—GHG management and related activities—framework and principles for methodologies on climate actions;
- ISO 14091—adaptation to climate change—guidelines on vulnerability, impacts and risk assessment;
- ISO 14092—GHG management and related activities: requirement and guidelines of adaptation planning for organizations including local governments and communities.

The developers of the standards state that the principles, demands, and guidelines are to help organizations assess climate change and elaborate some plans for an effective adaptation to it and also to expose risks and manage them.

Understanding of climate impact is essential not only to those whose activity is connected with climate. The organization decisions are made taking into account risks and opportunities, that is why implementation of standards is necessary throughout all the stages of cost formation, for example, in the sphere of purchases, investments, and insurance.

Conclusion/Recommendations

We can come to the conclusion that nowadays business has to transform under the influence of such a serious external factor as climate change. In order to remain competitive in the market, any modern organization must take this fact into consideration in order to elaborate new economic policy. Many companies have started to adapt and all companies who want to achieve success in future will have to do the same. We consider the first step to be taken by any business is to carry out analysis to define in what way a company impacts the environment and what possible risks are in connection with climate change.

Two approaches to adaptation have been defined: They are implementation of standardization and development of shared use economy. The principles, demands, and guidelines in standardization are to help organizations assess climate change and elaborate some plans for an effective adaptation to it and also to expose risks and manage them. The collaborative economy will result in reduction in emissions, positioning shared use as an alternative practice of consumption to tackle the problem of climate change. The supposed potential of sustainability lies in the capacity of companies producing goods and services to decrease net consumption that leads to reduction of resource exploitation. Thus, in order to achieve success in future companies will have to adapt. In addition to risks, enterprises are to define opportunities for improving their ecological indicators. Companies must carry out a research if they can find alternative materials and evaluate the possibility of using renewable resources of energy, such as solar energy and wind energy. Enterprises can use this information to create a system of environment management that will be used for improving efficiency of their activity.

Nowadays business has to transform under the influence of such a significant external factor as climate change. In order to remain competitive in the business arena a modern enterprise has to take this factor into consideration and elaborate a new economic policy. Many companies have started to adapt and all the companies planning to achieve success in future will have to follow the same pattern. We reckon that the first step to be taken by business is to conduct an analysis to determine the way the company influences the environment and possible risks that the business faces in connection with the climate changes. Enterprises are also to determine the opportunities for improving their environmental specifications. Companies are to conduct a research if they are able to find any alternative materials and evaluate the possibilities for using renewable energy sources, such as solar energy and wind energy. Two approaches to adaptation have been determined; they are inculcation of standardization and development of collaborative economy. Enterprises can use this data to create a system of environment management which they may apply to increase their efficiency. Thus, companies will have to adapt to achieve success in future.

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CHAPTER 2

Climate Change as a Global Threat to the World Economy

Olesya A. Dzyurdzya, Vyacheslav V. Burlakov, Gilyan V. Fedotova, Evgeniy V. Skubriy, and Lyubov N. Orlova

Introduction

The world community considers climate changes as one of the main global threats that can not only reduce the quality of life on Earth, but also considerably change the planet's appearance. The climate changes can activate many adverse processes in the environment and cause crises in many countries. These changes pose a much more serious threat than it seems at first glance. They are not obvious and come gradually; their influence cannot be evaluated in everyday life.

O. A. Dzyurdzya
Moscow Polytechnic University, Moscow, Russia

V. V. Burlakov
All-Russia Scientific and Research Institute «Center» (VNII «Center»), Moscow, Russia

G. V. Fedotova (✉)
Volga Region Research Institute of Production and Processing of Meat and Dairy Products, Volgograd, Russia

Plekhanov Russian Economic University, Moscow, Russia

E. V. Skubriy
Academy of Civil Protection EMERCOM of Russia, Moscow, Russia

L. N. Orlova
Financial University Under the Government of the Russian Federation, Moscow, Russia

E. B. Zavyalova and E. G. Popkova, *Industry 4.0*,
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Meteorologists of the World Meteorological Organization (WMO) noted that in 2019, the mean temperature on Earth was higher by 1.1 °C than in 1850. In fact, 2019 was one of the warmest years in the history of mankind (Fig. 2.1).

The chart in Fig. 2.1 shows a steady increase in annual mean temperature due to an increase in CO_2 concentration in the Earth's atmosphere, which entails changes in natural phenomena—the protective ozone layer depletion in the planet's atmosphere, an increase in solar radiation, an air flows gain in the atmosphere and their changed directions, sea level rise, transformation of habitual ecosystems, and extinction of species of flora and fauna (Makarov, 2012; Rusakova, 2015; Zhigalov, 2015). The WMO gives discouraging forecasts regarding the concentration of carbon dioxide in the atmosphere. Ice core measurement data are presented in Fig. 2.2 and indicate a substantial increase in CO_2 concentration over the past decades (Dzhandzhugazova et al., 2018). According to the data for the last 2 years, the indicator reached a record value of 407.8 ppm. And this value will continue to grow in the future, creating a greenhouse effect.

The main share of gas (up to 30%) and heat (up to 90%) produced is absorbed by the World Ocean that is gradually acidified and heated (Ermolaev, 2011; Melnik et al., 2013). Thus, high environmental costs due to chemical reactions between the absorbed gas and sea water lead to a gradual rise of the sea level that rose by 90 mm for the period of 1993–2019 (Fig. 2.3).

Further sea level rise will cause flooding of some coastal land areas, which will disrupt the life-sustaining activity of more than 800 million inhabitants of the planet. Therefore, this problem to be solved deserves due regard.

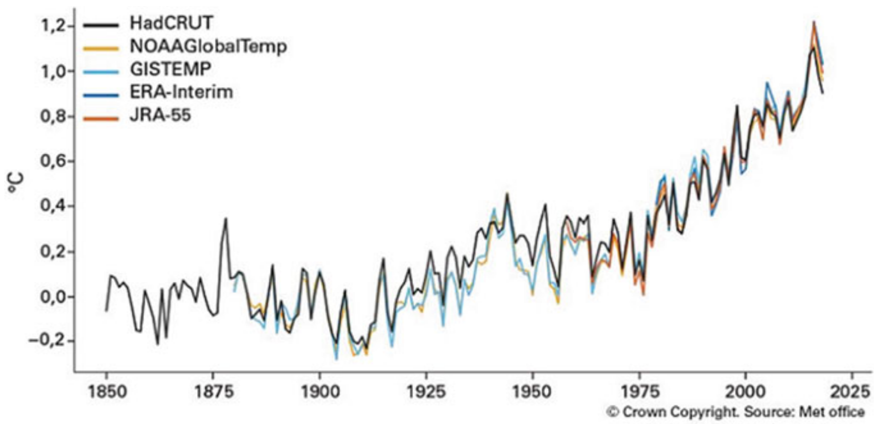

Fig. 2.1 Global mean temperature difference on Earth over the period of 1850–2025 (*Source* Compiled by the authors based on [Report on the climate in the territory of the Russian Federation for 2019; The Global Climatein, 2015])

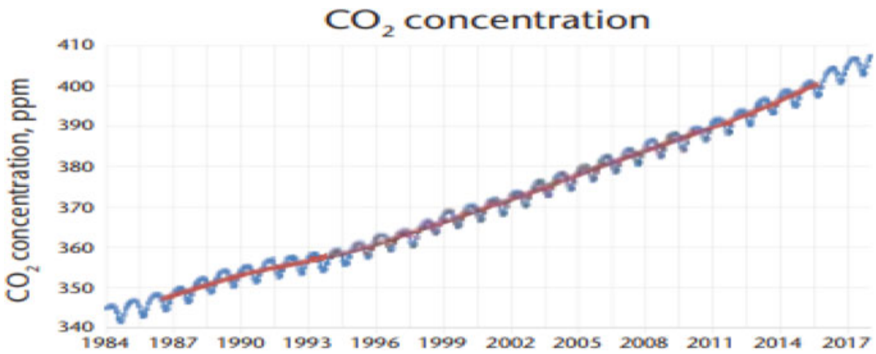

Fig. 2.2 Time series of globally averaged CO_2 concentration, ppm. *Note* Blue lines are the monthly mean global averaged concentration; and red lines are the five-year running averaged monthly mean concentration (*Source* Compiled by the authors based on [Big data of the modern world economy: digital platform for intelligent analytics, 2020])

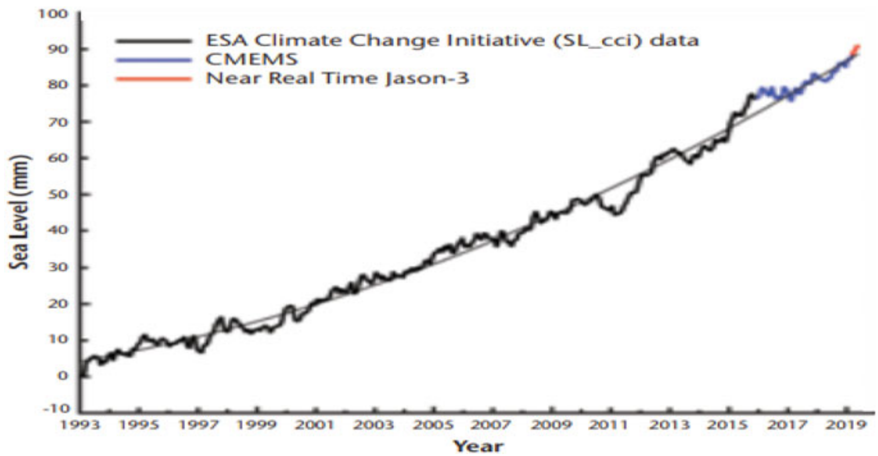

Fig. 2.3 Time series of altimetry-based global mean sea level for the period of January 1993–May 2019. *Note* The thin black line is the quadratic function showing the mean sea-level rise acceleration (*Source* Compiled by the authors based on [Report on the climate in the territory of the Russian Federation for 2019])

Materials and Method

The climate change and global problems of mankind today are discovered in many scientific works. Rising planet-scale threats are forcing the developed powers of the world to cooperate and seek solutions to overcome this situation. The international climate Conventions and Agreements approved and ratified by many countries over the past decades require revision and updating.

The world community draws the leaders' attention to global climate changes on Earth (Makarov, 2012; Melnik et al., 2013; Sekerin et al., 2018a; Zhou & Wang, 2018).

The current climate policies implemented by the developed countries and applied instruments of environmental regulation and control were studied by economists (Dudin et al., 2016; Ermolaev, 2011; Fetterer et al., 2017; Kaveshnikov, 2015; Kokorin, 2016; Plotnikov et al., 2015; Prokofyev, 2011; Rusakova, 2015; Zhigalov & Pakhomova, 2015).

The climate change problems primarily affect the human life quality in a society and pose a threat to the economic well-being of countries. The decline in the life quality results in deterioration of the environmental situation, recurring natural and man-made disasters, and interrupted supplies of large cities with quality products. These problems were highlighted by researchers who focused on the anthropogenic impact on the nature due to the accelerated industrialization and digitalization (Alkhimenko et al., 2014; Dudin et al., 2018; Dzhandzhugazova et al., 2018; Golubev et al., 2018; Sekerin et al., 2018b).

Many researchers in different countries are involved in this problem, which proves current interest and concern of the scientific community. The ongoing increase in climate threats is an irreversible process that can only be partially controlled and restrained by the efforts of all world powers.

Results

The global community has long been interested in the climate problem, which is proved by a number of international regulatory documents adopted and signed by most countries of the world. From 2020, the Paris Agreement adopted at the 2015 UN World Conference, involving 195 countries, comes into effect (Dudin et al., 2016; Fetterer et al., 2017). The main targets of this document are presented in Fig. 2.4.

The global community's concern over global climate issues made it possible to sign this agreement that was one of the greatest global events. According to the document signed, the countries that entered the agreement must bring their national climate doctrines into compliance with it by 2020 and carry out preliminary work to reduce the environmental burden. We briefly overviewed some of the most interesting plans.

EU countries concluded an agreement to reduce harmful carbon emissions to 0%. This document was signed by 8 countries (France, Belgium, Denmark, Luxembourg, the Netherlands, Portugal, Spain, and Sweden) that pledged to achieve the target level of emissions by 2050. The main tool for implementing this plan is to be the EU budget, where 25% of the spending should be aimed at climate change control. However, not all European countries supported this project.

In addition to the countries' leaderships, other international organizations undertook a commitment to provide resource support in combating climate

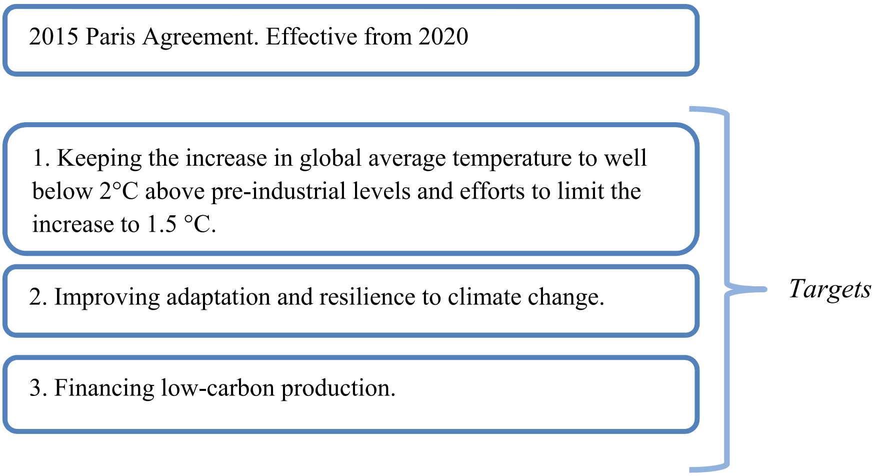

Fig. 2.4 General targets for the implementation of the Paris Climate Agreement (*Source* Compiled by the authors based on [Kokorin, 2016; Rusakova, 2015])

change on the planet and drew up their own environmental preservation projects.

The World Bank Group developed a Climate Change Action Plan to provide specialized support, taking into account diverse needs of developing countries. The World Bank Group developed a Climate Action Plan for Africa to meet specific needs of the continent. Considering a tremendous need of private sector for financing to tackle climate change, International Finance Corporation (IFC)—a World Bank Group's organization that works exclusively with the private sector in developing countries—also published its Climate Action Plan. We consider main activities of the Plan in various regions of the world (Dzhandzhugazova et al., 2018).

Sub-Saharan Africa is in sore need of adaptation, food security, sustainability, and access to energy. Most national climate plans in Africa give priority to adaptation. The WBG Climate Action Plan for Africa aims to attract $16 billion in investments for adaptation by 2020, increase the sustainability of the continent's environment and people, improve access to energy through renewable energy sources, ensure sustainability with the support of hydrometeorological services, and improve planning of climate sustainable investment. The IFC plans to invest in large-scale renewable energy sources, building environmentally friendly constructions and autonomous power generation, and helping the agricultural sector adapt to climate change.

The East Asia and Pacific region produces a third of the world's carbon emissions. The capacity of the generated energy is expected to double by 2030, and the energy production from coal sources will considerably increase, if current regional energy plans are not corrected. Many countries and islands in the region are highly vulnerable to the climate change effects.

Forests and landscapes are also a key element of climate issues and one of the main policies on climate change. The World Bank Group is coordinating its operations with INDCs, focusing on the development of renewable energy sources. The IFC plans to widen its participation in climate change control by supporting projects in renewable energy, urban infrastructure, and climate-friendly agricultural practices.

The region of Europe and Central Asia involves countries with high energy intensity and large forest resources that are especially vulnerable. In general, the INDCs focus on mitigating the climate change. Thus, the current regional climate change measures are aimed at addressing the issues of high energy consumption, environmentally friendly growth, sustainability of forestry and cities, and supporting the INDCs countries. The private sector has certain opportunities in the areas of renewable energy, sustainable urban development, and energy financing.

The Latin America and Caribbean region is vulnerable to natural disasters and is experiencing a shift in energy balance, which enhances the risks of emissions by increasing dependence on fossil fuels. But the region is also demonstrating climate policy innovations such as green growth, carbon tax in Mexico, and sustainable forest management in Brazil. The World Bank Group is focused on mitigating the climate change and managing disaster risks, with particular emphasis on private sector capabilities in urban infrastructure and agribusiness (Alkhimenko et al., 2014; Golubev et al., 2018).

The Middle East and North Africa region accounts for seven percent of global emissions and half of the world's energy subsidies. Extreme vulnerability to climate change results in water scarcity, poor agriculture, sea level rise, and extreme heat. The World Bank Group is stepping up its efforts to help countries mitigate climate change in fields of energy, finance, markets, and transport.

The South Asian region is vulnerable to sea level rise, floods, landslides, and poor agriculture; in rural areas, people have limited access to clean and modern energy services. The INDCs consider strong demand for financing both climate mitigation, adaptation efforts, and private sector capacity in urban infrastructure, and developing wind and solar energy and potential for sustainable agriculture.

In order to help developing countries successfully tackle climate change, the World Bank Group's Action Plan reaffirms President Jim Young Kim's promise to increase funding actions to combat climate change up to $29 billion per year in 2020.

The Russian Federation has certain results in implementing the recommendations of the Paris Agreement. From 2020, The National Action Plan for the First Phase of Adaptation to Climate Change for the Period up to 2022 was officially put into effect by Decree of the Government of the Russian Federation dated December 25, 2019, no. 3183-p. According to the commitment undertaken, Russia is to reduce GHG emissions to 70–75% of 1990 levels by

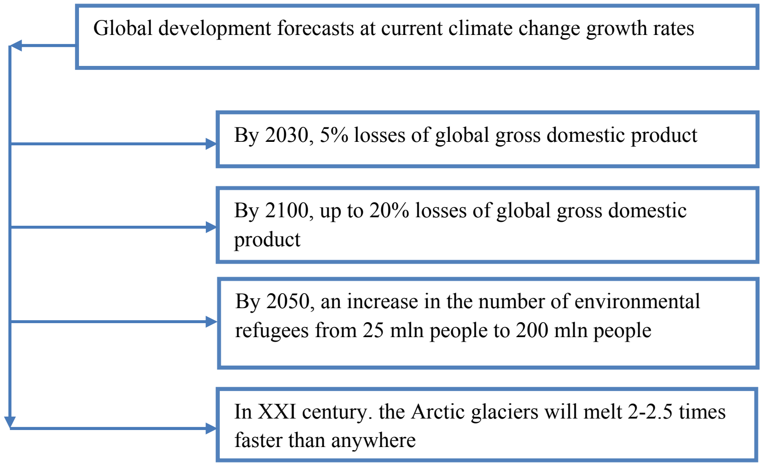

Fig. 2.5 Global development forecasts at current climate change growth rates (*Source* Compiled by the authors based on [Kaveshnikov, 2015; Prokofiev, 2011])

2030. By the end of 2020, there will be developed a standard safety passport that analyzes main climate risks.

According to UN estimates, it is in developed countries, where negative effect on the environment is the greatest, so they should bear the main burden in the fight against climate change. China, the United States, some EU countries, India, Russia, and Japan emit almost 70% of harmful gas into the atmosphere. It is these states that must lead the movement to combat climate threats. But not all of them want to bear this environmental responsibility (Dudin et al., 2018; Plotnikov et al., 2015; Sekerin et al., 2018a). In 2017, Donald Trump announced the US withdrawal from the Paris Agreement due to the impossibility to reduce harmful emissions and thereby the country's economic growth rate. This decision will have certain consequences not only for the American continent, but for the entire planet (Sekerin et al., 2018b; Zhou, 2018).

The specialists' forecasts are presented in Fig. 2.5 that shows prospects for the development of the world community by 2030 while maintaining the current level of environmental pressure on the environment.

Conclusion

Thus, we note the growing global climate threat that entails serious consequences for the development of all continents and regions of our planet and global economic system. They result in changing habitual ecosystems, extinction of some species of flora and fauna, reduction of coastal land areas, natural hydrometeorological and natural disasters, a decrease in freshwater reserves in glaciers of the Arctic region and Antarctica, an increase in the incidence rate of the world's population, growing food supply tension and global climate migration, etc.

The consequences of the climate change cannot be completely avoided, but can be slowed down to enable people's adaptation to it. So, international agreements were prepared and are being implemented by many countries to combat negative climatic manifestations and reduce the industrial burden on the environment. Mankind must be aware of the severity of the problem and its global implications for future generations.

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CHAPTER 3

Sustainable Development Goal 7 and Sustainable Development Goal 13: Possible Ways of Interactions

Alexander M. Solntsev and Roza D. Akshalova

Introduction

15 September 2015 the 2030 Agenda for sustainable development (2030 Agenda) was adopted by UN General Assembly resolution (The 2030 Agenda, 2015). It consists of 17 sustainable development goals and 169 targets. Among them, we would like to highlight Sustainable Development Goal 7 «Affordable and clean energy» and Sustainable Development Goal 13 "Climate action". The object of our article is to analyze the direct and indirect ways of interactions of these Sustainable Development Goal 7 and Sustainable Development Goal 13 and how to effectively achieve them together.

The 2030 Agenda stated that the sustainable development goals and its targets are "complex and indivisible and balance the three dimensions of sustainable development" (preamble, pg. 1; Declaration, art 5, art.10 etc., the 2030 Agenda, 2015) (the 2030 Agenda, 2015). Most of the sustainable development goals are interconnected, and the achievement of the objectives of one sustainable development goal can lead to the fulfillment or creation of favorable conditions for the achievement of other sustainable development goals. It is repeatedly stated in the text of 2030 Agenda: "The interlinkages and integrated nature of the Sustainable Development Goals are of crucial importance

A. M. Solntsev (✉)
The RUDN University, Moscow, Russia
e-mail: solntsev-am@rudn.ru

R. D. Akshalova
L.N. Gumilyov Eurasian National University, Nur-Sultan, Kazakhstan

E. B. Zavyalova and E. G. Popkova, *Industry 4.0*,
https://doi.org/10.1007/978-3-030-75405-1_3

in ensuring that the purpose of the new Agenda is realized" (preamble, pg. 2, the 2030 Agenda, 2015).

This relationship is especially evident through the realization of Sustainable Development Goal 7. As the United Nations Secretary General noted at the High Level Symposium on Global Energy Linkages in 2017, "energy is the golden thread that links all the Sustainable Development Goals".[1] Renewable energy sources make a significant impact in implementation of the sustainable development goals and involve all pillars (economic, social, and environmental) of sustainable development.

Renewable energy sources contribute to ensure that all people, regardless of social status, have equal rights to access to basic services and clean energy in particular (Akshalova et al., 2019), especially to electricity (Sustainable Development Goal 1), double the agricultural productivity and ensure sustainable food production systems (Sustainable Development Goal 2), equipping hospitals with electricity and spare power generators, even in remote parts of the earth, access to modern energy can significantly support the functioning of health clinics in rural areas (Sustainable Development Goal 3), equipping preschool, secondary, secondary special and higher educational institutions with electricity for the improvement the availability of educational services and increasing the likelihood that children will attend and finish school (Sustainable Development Goal 4), renewable energy sources contributes gender equality, have a positive impact on women's health by supplying clean cooking solutions, empowering women and girls by reducing time and labor burdens (United Nations-Women Sustainable Energy for All, 2013) (Sustainable Development Goal 5), "new energy sources improve access to safe water and sanitation in developing countries" (Karekezi et al., 2012) (Sustainable Development Goal 6), support the decent job creation, entrepreneurship, creativity and innovation by development renewable energy as new sphere of economy and productivity (IRENA Renewable energy and jobs, 2019) (Sustainable Development Goal 8), "modernization of the infrastructure in order to make it more resource-use efficiency and greater adoption of clean and environmentally sound technologies" (the 2030 Agenda, 2015), increase the competiveness of industries of developing states by reducing industrial energy intensity (United Nations Industrial Development Organization, 2009) (Sustainable Development Goal 9), reduces inequalities (Sustainable Development Goal 10), using clean transport, clean bio-diesel, creation sustainable cities (Sustainable Development Goal 11), sustainable consumption and rational using of renewable natural resources for generation energy (Sustainable Development Goal 12), renewable energy sources play considerable role in reducing greenhouse-gas emissions and thus mitigating the effects

[1] United Nations Secretary-General's remarks at High Level Symposium on Global Energy Interconnection: Advancing the Sustainable Development Goals in 2017. https://www.un.org/sg/en/content/sg/statement/2017-11-01/secretary-generals-remarks-high-level-symposium-global-energy. Accessed 12 August 2020.

of climate change (International Energy Agency, 2015) and decreasing the air pollution (Sustainable Development Goal 13), rational using of oceans and seas in the production of renewable energy (International Renewable Energy Agency, 2015) (Sustainable Development Goal 14), sustainably manage forests (Sustainable Development Goal 15), promotion "the transfer, development and dissemination of environmentally sound technologies to developing countries, including technologies of renewable energy sources" (the 2030 Agenda, 2015) (Sustainable Development Goal 17).

The mitigation scenarios envisioned by the Intergovernmental Panel on Climate Change deal with the promotion of the renewable energy sector to be key to climate change mitigation (Intergovernmental Panel on Climate Change, 2011). Moreover, lifecycle assessments for electricity generation indicate that greenhouse-gas emissions from renewable energy technologies are significantly lower than those associated with fossil fuel options (Farber & Peeters, 2016).

Methodology

The study includes a system of general scientific (dialectical, historical, inductive, deductive, analytical, synthetic) methods and private scientific methods (formal legal, comparative legal, interpretative, statistical, procedural, and dynamic).

Results

Thus, the effectiveness of Sustainable Development Goal 13 depends on the implementation of the Sustainable Development Goal 7. The target 13.2 on integration climate change measures into national policies and plans may be reached through the nationally determined contributions, which should be prepared in the framework of the Paris Agreement on Climate Change 2015 (The Paris Agreement, 2015). Renewable energy components feature prominently in the first round of nationally determined contributions arising from the Paris agreement. The nationally determined contributions are at the heart of the Paris agreement. Communications of new nationally determined contributions every five years are required to represent a progression in terms of mitigation ambition beyond the previous nationally determined contributions (Schleussner et al., 2016).

On 28 September 2015, Kazakhstan presented its initial nationally determined contribution pursuing "a 15% cut in GHG emissions down to the emissions level of 1990 by 2030, and a 25% cut with the international community support".[2]

[2] Intended Nationally Determined Contribution—Submission of the Republic of Kazakhstan. https://www4.unfccc.int/sites/ndcstaging/PublishedDocuments/Kazakhstan%20First/INDC%20Kz_eng.pdf. Accessed 19 August 2020.

The Russian Federation also presented its initial nationally determined contribution in 2015. It was agreed that the reduction of GHG emissions should be taken into account when taking into account the absorbing capacity of forests.[3] The legal framework regulates emissions to combat climate change until 2020 and envisages limiting greenhouse gas emissions to 75% of the 1990 level (Decree of the President of the Russian Federation of September 30, 2013; Resolution of the Government of the Russian Federation of April 2, 2014 No. 504 –r; Energy Strategy of the Russian Federation; Climate Doctrine of the Russian Federation).

International Renewable Energy Agency has undertaken an analysis of current nationally determined contributions (Abashidze et al., 2020). Of the 152 nationally determined contributions that were formally submitted to date (end-November 2018), some 111, or nearly three quarters, cite specific renewable energy targets, while another 34 acknowledge renewables as an important way to reduce GHG emissions and adapt to climate change impacts (International Renewable Energy Agency, 2018). International Renewable Energy Agency's analysis suggests that "while renewable energy targets and policies are indeed critical components of nationally determined contributions, there is substantial scope for countries to increase their renewable energy ambitions. This is true not only for the purposes of mitigation, but also to build resilience in the face of growing climate change impacts" (International Renewable Energy Agency, 2017).

Moreover, International Renewable Energy Agency drew attention to the fact that the majority of nationally determined contributions include renewable energy targets only for electricity generation. However, 14 countries also include targets for the production of liquid biofuels, 11 states call for advancement of biogas, and 8 states include the deployment of solar water heaters (International Renewable Energy Agency, 2017). All states participants of the UN Framework Convention on Climate Change have the opportunity to further strengthen their targets for renewables in next round of nationally determined contributions in 2020. To date, second nationally determined contributions have been submitted by Andorra, Marshall Islands, Republic of Moldova, Suriname.[4]

The range of policies and tools being adopted at national and local government levels include a provincial carbon tax (Britain Columbia, Canada), national renewable energy policy (Denmark), a seven-party agreement to reach a fossil independent transport sector by 2030 and become climate neutral by 2045 (Sweden), electrified short shipping, setting standards for building, national carbon tax to cut emissions (Chile), a pilot CO2 trading program

[3] Intended Nationally Determined Contribution—Submission of the Russian Federation. https://www4.unfccc.int/sites/submissions/indc/Submission%20Pages/submissions.aspx. Accessed 19 August 2020.

[4] All NDCs. NDC Registry. https://www4.unfccc.int/sites/NDCStaging/Pages/All.aspx. Accessed 19 August 2020.

(China), and the emissions reduction requirement for United States under the Clean Power Plan (though rescinded by President Trump) (Batruch, 2017).

The United Nations Secretary-General António Guterres has proposed six climate-positive actions for governments to shape the recovery, some of which relate to Sustainable Development Goal 7 implementation: green transition, green economy, green jobs and sustainable growth, invest in sustainable solutions (United Nations Secretary-General's Message, 2020). Green transition from fossil fuels, decarbonization of the economy, and development of a green economy were accompanied by the development and expansion of renewable energy sources (Sustainable Development Goal 7.2).

The green jobs were created by the closure of coal-fired power plants and the development of the renewable energy industry. The global renewable energy sector employed 11 million people in 2018 (in comparison with 10.3 million people in 2017). Rising output pushed biofuel jobs up 6% to 2.1 million. Employment in wind power supports 1.2 million jobs (International Renewable Energy Agency Renewable energy and jobs, 2019).

A clearer interaction and relationship between Sustainable Development Goal 7 and Sustainable Development Goal 13 was traced through the activities of the Green Climate Fund, which influenced the implementation of Sustainable Development Goals 13.4, 7.1, 7.2, 7.3, 7.c. Full functioning of the Green Climate Fund and its assistance to developing countries to mitigate or combat climate change contribute to the financing of renewable energy projects, especially solar, geothermal and hydropower, and "energy efficiency in the developing countries, least developed countries, small island developing states, and landlocked developing countries" (the 2030 Agenda, 2015). Renewable energy projects account for a large part of the measures for mitigation, which are financed by the Fund Since 2016, the Green Climate Fund approved the projects for 23 states and 3 projects for region or several countries (FP036 The Pacific Islands Renewable Energy Investment Program,[5] FP020 Sustainable Energy Facility for the Eastern Caribbean,[6] FP027 Universal Green Energy Access Programme[7]). For instance, the Green Climate Fund and EBRD provided funding project Kazakhstan Renewable Framework in October 2017 for a period of five years for supporting the construction of 8–11 renewable energy projects in Kazakhstan with a total capacity of 330 MW. This

[5] Project FP036 The Pacific Islands Renewable Energy Investment Program, Green Climate Fund Project. https://www.greenclimate.fund/project/fp036. Accessed 26 September 2020.

[6] Project FP020 Sustainable Energy Facility for the Eastern Caribbean, Green Climate Fund Project. https://www.greenclimate.fund/project/fp020. Accessed 26 September 2020.

[7] Project FP027 Universal Green Energy Access Programme, Green Climate Fund Project. https://www.greenclimate.fund/project/fp027. Accessed 26 September 2020.

project thus avoiding the emission 12.9 million of the anticipated tones of CO_2 equivalent.[8]

Therefore, the Global Climate Fund financing of projects for the construction of renewable energy facilities, especially hydropower and solar energy (Sustainable Development Goal 7.1 and 7.2), the transition to sustainable energy (Sustainable Development Goal 7.1), energy efficiency (Sustainable Development Goal 7.3), investment in renewable energy programs (Sustainable Development Goal 7.a) in selected regions and countries (Sustainable Development Goal 7.b) will contribute to the fulfillment of Sustainable Development Goal 7 and all its targets. It's necessary to be noted, that improving energy efficiency is crucial to reducing greenhouse gas emissions as the global climate goal.

In 2017, international government investments to developing countries in order to spread renewable energy rose to $21.4 billion. This is 13% more than in 2016 and double the level of 2010. Investment in hydropower projects represented 46% of 2017 flows, followed by investments in solar (19%), wind (7%), and geothermal energy (6%). While the progress is encouraging, only 12% of these financial flows reached the least developed countries, which are the farthest behind in reaching Goal 7 targets. Focused attention is needed to ensure that financing reaches countries most in need (The United Nations, 2020).

Moreover, if renewable energy programs receive the investment it will promote investment in renewable energy technologies. Henceforth, this investment will lead to expand international cooperation to facilitate access to clean and sustainable energy research and technology, including renewable energy technologies (Sustainable Development Goal 7.a, the 2030 Agenda, 2015).

We should notice that issues on the promotion and facilitation of environmentally sound technologies regulates by Article 4.5 of UNFCCC 1992.

In 2007, the Bali Action Plan was adopted, which decided to "enhance action on technology development and transfer to support action on mitigation and adaptation" (Report of the Conference of the Parties, 2007).

Climate change mitigation technologies include different groups of technologies divided by area of application. One of them is group of energy supply, that consist of "the most prominent being wind, geothermal, concentrated solar energy, biomass/biogas and hydrogen systems".[9] Technologies requiring significant additional Research & Development, government subsidies or other support, demonstration include "second-generation biofuels, hydrogen fuel

[8] Project FP047 GCF-EBRD Kazakhstan Renewable Framework. https://www.greenclimate.fund/projects/fp047. Accessed 26 September 2020.

[9] Climate Change: Technology Development and Technology Transfer. Background Paper prepared by the United Nations Department of Economic and Social Affairs for the Beijing High-level Conference on Climate Change: Technology Development and Technology Transfer Beijing, China 7–8 November 2008. https://sustainabledevelopment.un.org/content/documents/1465back_paper.pdf. Accessed 26 September 2020.

cells for cars, grid-connected solar photovoltaics, and carbon dioxide capture and storage".[10] According to World Intellectual Property Organization Global Challenges Report, key areas for climate change mitigation technology are biofuels, solar thermal energy, solar photovoltaic energy, wind energy (Helm et al., 2014).

Thereby, the facilitation of access to renewable energy technology, energy efficiency, and cleaner fossil-fuel technology will lead not only to implementation of Sustainable Development Goal 7 and Sustainable Development Goal 13, as well as the international conventions on climate change (Akshalova & Abaeva, 2020). The 2030 Agenda on Sustainable Development launched a Technology Facilitation Mechanism (para 70) (the 2030 Agenda, 2015).

Also we should show the progress of the implementation of these sustainable development goals. In United Nations Sustainable Development Goals Report 2020, "the share of renewable energy in total final energy consumption reached 17.3% in 2017, up from 17.0% in 2015 and 16.3% in 2010. This growth was driven primarily by increased consumption of modern renewables, which rose from 8.6% in 2010 to 10.5% in 2017" (The United Nations, 2020).

In 2017, global primary energy intensity was "5.0 megajoules per dollar – a 1.7% annual improvement from 2016, however, the progress slow down significantly, showing the lowest annual improvement since 2010. Preliminary estimates for 2018 and 2019 are 1.3% and 2.0%, respectively. This suggests that the improvement rate would reach approximately 2.1% between 2010 and 2019, thus falling below the annual 2.6% target rate" (The United Nations, 2020).

The practical implementation of the SDGs raises questions that can delay and complicate the process of achieving them. "The COVID-19 pandemic is highlighting the urgent need for affordable and reliable energy – for hospital and health facilities to treat patients, for communities to pump clean water and access vital information and for out-of-school children to learn remotely. At the same time, the crisis is certain to stymie efforts towards Goal 7. Disruptions in supply chains could wreak havoc on energy services, and declined incomes could limit people's ability to pay for them. Besides, deterring oil prices are likely to discourage growth in renewables" (The United Nations, 2020).

For instance, nearly all countries have adopted various national programs and concepts to support, develop, and spread the use of renewables (Akshalova et al., 2019). According to REN-21, 166 countries have national targets for renewable energy in power (Global Status Report, 2020). Government subsidies for renewable energy sources have become one of the subjects of

[10] Climate Change: Technology Development and Technology Transfer. Background Paper prepared by the United Nations Department of Economic and Social Affairs for the Beijing High-level Conference on Climate Change: Technology Development and Technology Transfer Beijing, China 7–8 November 2008. https://sustainabledevelopment.un.org/content/documents/1465back_paper.pdf. Accessed 26 September 2020.

trade disputes of the World Trade Organization Dispute Settlement Body. This impedes the development of clean energy technologies in the context of fulfilling other World Trade Organization obligations and thus extends the dependence on fossil fuels and, consequently, the increase in GHG emissions. The practice of settlement the renewable energy sources disputes in the World Trade Organization Dispute Settlement Body for states will have negative consequences for the development of renewable energy sources globally, which may lead to a slowdown in achievement of Sustainable Development Goal 7 and Sustainable Development Goal 13 and implementation of the goal of 2015 Paris agreement on climate change to keep the global average temperature much lower than 2 °C above pre-industrial levels (Akshalova et al., 2020).

Conclusion/Recommendations

On the basis of the above, we conclude that ways of interaction of Sustainable Development Goal 7 and Sustainable Development Goal 13 are very different and interdependent from each other. The achievement of the Sustainable Development Goal 7 needs the same actions of state, and results of these activity will lead to successful implementation of Sustainable Development Goal 13, 2030 Agenda and Paris Agreement on Climate Change 2015. A strong contractual and institutional framework has been created for this interaction, which operates not only within the framework of the above mechanisms, but also takes place in the activity of the Energy Charter Treaty, IRENA, IEA, World Bank, World Intellectual Property Organization. We believe that this framework will serve as an excellent coherent framework for achieving the 2030 Agenda.

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CHAPTER 4

Climate Change as the Basis for Creating a New Economic Theory

Dmitri G. Egorov, Valery A. Romanov, and Natalia A. Yarmolich

Introduction

The article dwells on possible transformations in the paradigm of the development of modern world civilization which will be caused by changes in the Earth's biosphere (in the context of climate change). Global changes in the Earth's biosphere (climate change being one of the aspects of obvious biosphere changes) in one way or another will bring about significant changes in the economy.

In the framework of this enormous (both in importance and scale) task, we will consider the aspect of those changes in economic theory which, in our opinion, are essential for developing a new economic policy. This thesis will be given a thorough consideration in the next section.

Background and Methodology

Socio-humanitarian knowledge is not in all aspects an analogue of the natural sciences knowledge. George Soros, a successful financier (and, along with that, a social philosopher), pointed out one of the important aspects of this difference, the reflexivity of socio-humanitarian knowledge, in his famous books.

D. G. Egorov (✉)
Academy of the FPS of Russia (Pskov Branch), Pskov State University, Pskov, Russia

V. A. Romanov · N. A. Yarmolich
Pskov State University, Pskov, Russia

E. B. Zavyalova and E. G. Popkova, *Industry 4.0*,
https://doi.org/10.1007/978-3-030-75405-1_4

If a statement (in the natural sciences) is consistent with facts, it is true, if not, it is false. But in the case of systems consisting of thinking participants, everything is much more complicated. On the one hand, individuals are trying to create a picture corresponding to reality. On the other hand, they are trying to influence, fake reality according to their desires. When both of these approaches are implemented simultaneously, a situation arises for which Soros suggested the term "reflexive" (Soros, 2003).

The need to distinguish two above-mentioned approaches in economics is declared: that is, the division of theories into positive (those describing what there is) and normative (describing models of what economy/society should be). In practice, however, it is hardly possible to avoid reflexivity while working out an economic theory: a high-level economic theory implicitly contains normative elements (in the form of fundamental principles, basic models, etc.). P. Samuelson, a Noble Prize winner (and the author of presumably the most well-known economics textbook), noted, " I don't care who writes the laws of the country if I can write her textbooks on economics" (Samuelson, 1990, p. 4).

The main institutions of the modern world economy have been established in Western countries; the neoclassical economic theory is their theoretical basis (by virtue of its total dominance also called "economic mainstream").

How are mainstream ideologies and the paradigm of extensive socio-economic development connected? What changes in contemporary economic theory are particularly required to transform the paradigm of modern civilization economic development (to prevent a global ecological catastrophe, quite realistic, in case the paradigm of extensive socio-economic development continues to overwhelm)? The answers to these questions are what we intend to find in this study.

Another aspect worthy of discussion in the methodological section of the work: the contribution of the anthropogenic component to the global warming (apparently taking place in recent decades).

The idea of the possibility of heating the earth's atmosphere with greenhouse gases (primarily carbon dioxide) was proposed by the Swedish scientist S. Arrhenius (1896). Over the past 100 years, mankind has increased the annual use of fossil fuels, the combustion of which produces carbon dioxide (CO_2); carbon dioxide concentration increase in the Earth's atmosphere has been detected last decades.

The assumption that these facts are interrelated (the burning of oil, gas, and coal entails an increase in CO_2 in the atmosphere, which, in turn, causes an increase in the average temperature on the Earth), that is, the climate on the Earth changes as a result of anthropogenic activity (emissions of greenhouse gases, primarily CO_2), was the basis of the Kyoto Protocol adopted in Japan in December 1997 (Kyoto Protocol to the UN framework Convention on climate change, 1998), which obliges the countries adopted it (the vast majority of such countries in the world; the treaty has not been ratified by the United States and Canada has withdrawn from it) to reduce or stabilize greenhouse gases emissions.

There are many publications that popularize the hypothesis of anthropogenic climate change (e.g., [Gor, 2006]); in 2018, a Nobel Prize in Economics was awarded to William Nordhaus for his research on the impact of climate change on long-term economic growth (Nordhaus, 2017).

There is also criticism of the anthropogenic climate change hypothesis (as well as the Kyoto and Paris protocols adopted on its basis). So, S. Bomer-Christiansen (2000) explicated unscientific (geopolitical) circumstances that caused market support for the concept under discussion.

If we turn scientific criticism proper, its arguments are as follows:

a. an increase in the concentration of CO_2 may not be the cause, but the consequence of climate change (Sorokhtin, 2011);
b. the nature of the global climate system is very complex, its changes cannot be explained by one factor; rising atmospheric temperatures in recent decades are highly likely to be part of a large-scale natural cycle (Demirchan et al., 2010; Kondratyev, 2000; Sorokhtin et al., 2007).

In 2004 the Russian Academy of Sciences conducted a scientific examination of the Kyoto Protocol. In the final document it was, in particular, said, "1. The Kyoto Protocol has no scientific justification < … > 4. The ratification of the Protocol in the presence of a stable relationship between CO_2 emissions and carbon-based economic growth means a significant legal restriction on the growth rate of Russian GDP" (Pavlenko, 2017, p. 34). Over the past years, the position of the RAS has not changed fundamentally (Osipov, 2016).

Our position here (in the context of the problem posed in the introduction) is as follows: Global warming does not threaten humanity on its own (no one is afraid of mass deaths from heat stroke), but has a negative impact on global biogeochemical cycles (Gorshkov, 1995). An extensive economic growth has this negative impact: both through an extensive use of biosphere resources required for it, and the high level of waste pollution of the biosphere.

The problem of detecting which channel of the negative impact of the economy on the biosphere should be considered the main one—CO_2 emissions, or some other, is not a matter of principle for the task of this research (explication of the connection between the ideologists of the modern economic mainstream and the paradigm of extensive socio-economic development).

Therefore, in the framework of this article, we can accept the official position of the Intergovernmental Panel on Climate Change (IPCC, 2013) as a working hypothesis.

Results

Aspects of the socio-economic paradigm that have a negative impact on the biosphere (and climate, as one of its key characteristics).

Hypertrophied consumption (primarily in the countries of the "golden billion" or "first world"), including conspicuous consumption (the acquisition of goods not for their intended purpose, but to demonstrate one's own status).

For example, the United States has consumed more than a third of the world's resources (giving virtual financial obligations in return). The beginning of the "era of abundance" was announced in 1946 in Fortune magazine by a retail marketing specialist V. Lebow (Luk'janenko, 2009).

Even Pope Francis in the encyclical Laudato si' stated that it was time for rich countries to think about containing economic growth and even "taking steps in the opposite direction before it was too late" (Francis, 2015). At the same time, he condemns the exaggerated attention to population growth, pointing out the main (Luk'janenko, 2009).

The hypertrophic development of the global financial system (primarily Great Britain and the United States). Anglo-Saxon financial institutions have dominated the global financial market for more than two hundred years (Soros, 2003).

So, by 2007, world financial assets exceeded the world GDP by tens (!) times (Buzgalin & Kolganov, 2009). From a superstructure over the real economy, the virtual finance economy has turned into a dominant system that systematically exploits the real sector of the economy.

This, in fact, ensures, to a large extent, the overconsumption of the "first world" (resulting in an environmental catastrophe on the planet as a whole): For example, the US foreign debt as of August 2019 amounted to $22.5 trillion, that is, $68.770 per capita. Obviously, its repayment is hardly expected, if any.

There is a concentration of obligations (dollars) at one pole (world periphery, countries of the South) and debts (for received but not paid values—"First World", countries of the global North).

The socio-economic polarization of the North-South world (largely responsible for the increasing pressure on the biosphere) was supported 100 years ago by the military dominance of Western countries. But now the situation has changed significantly.

Although the threat of the use of force still exists (it is worth recalling Libya in 2011), the main factor is the promotion of such economic ideas that initially suggest the creation of institutions in the interests of architects of the modern world economics. Ultimately, it is a single process where power and ideological pressure are closely coordinated.

At the same time, we do not at all mean some universal conspiracy of Western economists; the idea is that the dominance of the economic paradigm created in the years when nature was conceived a free everlasting resource objectively leads to the reproduction of the corresponding socio-economic model of extensive development.

So what, in the economic mainstream, underlies (and supports) those pathological features of the global economy that lead all mankind to the climatic (biosphere) apocalypse? In our opinion, this is the ultimate subjectivity, which in the neoclassical economic theory has taken the form of abandoning the category of "value".

Value is the amount that something is worth (a certain general property that allows us to compare the values of qualitatively different things). This theoretical construct explicates the essential property of economic reality—that people really somehow compare values of different nature.

From Adam Smith to Karl Marx, the concept of value was a key one in the economic theory. An alternative is the neoclassical approach, the domination of which has become a generally accepted point of view: All meaningful economic issues can be resolved without resorting to value. However, the rejection of value results in rejection of an objective measure (Egorov, 2017).

We previously showed:

i. as an ideal concept, value cannot be directly observed and measured, but it has an empirical interpretation (Egorov, 2017);
ii. a universal algorithm for measuring value can only be thought theoretically, but in practice its implementation is hardly possible (Egorov, 2013).

But the complexity of the concept "value" implementation does not imply that it is unscientific, just as the impossibility of a universal criterion of truth does not at all invalidate science as a whole, the meaning of which is precisely in the search for truth (Popper, 1966).

A detailed justification that a significant part of the criticism of the idea of value is not so much a science as an ideology, see also (Egorov, 2016).

The fact that the modern world economy is organized as a huge casino is directly related to the dominance of neoclassical theory in the minds of people, namely the ideas about the absence of objective value for any product, including money (Egorov, 2016). After all, if we deny the existence of value, the question arises—what is money a sign of? Within the mainstream framework, only the following answer could be given to it: "money is what fulfills the function of money". As a result, in modern economy, money has long been a measure without a standard.

The lack of a monetary standard and floating exchange rates give the organizers and architects of the modern "post-industrial" world economy nearly unlimited opportunities for exploiting the real sector by the virtual financial sector, which in reality turns into the extraction and transfer of huge masses of resources from the "third world" to the "first", followed by waste there of in hypertrophied and conspicuous consumption.

There is another aspect:

Identification of any economic growth with the public good: In the framework of the economic mainstream, the question of the qualitative characteristics of growth (macroeconomic indicators are extremely aggregated) is practically not raised. J. Keynes (probably the most influential economist in the last 100 years) wrote in the 30s of the last century that in order to combat unemployment, it would be wise to drop bottles of banknotes in the mines and then "get them" again (Keynes, 2007). This brings forth the "justification" of conspicuous consumption: It "gives work", and thereby "feeds the poor". But why should these "poor" feed themselves, satisfying the perverted whims of the rich (destroying the biosphere by overconsumption)? Wouldn't it be wiser to direct these labor resources to restore the Earth's biosphere?

Back in 1997, experts from the World Business Council for Sustainable Development pointed out that one of the main problems on the path to sustainable development was the lack of proper technology for measuring the value of the environment. Moreover, it is economic science that gives the measures that distort the idea of the environment (Kuznetsov et al., 2000).

Conclusions

The problem of modern economic theory is its disintegration. The creation of an integrated economic theory involves the formation of such a primary system of principles (axioms), in which the basic theoretical schemes would present specific cases (under certain additional conditions). The return of the "value" category to the economic theory will allow us to combine both mainstream and neo-Ricardian (neo-Marxist) trends of economic thought on a single theoretical foundation: In addition to the general principle of the existence of values, in the first case the principle of subjectivity (the absence of an objective measure for values) is adopted, and in the second—the principle of the existence of a measure of worth, that is value (Egorov, 2017).

The discussion about the problem of value (i.e., the degree of adequacy of the economic mainstream) is potentially of great practical significance: It is, in essence, the discussion of the legitimacy of the entire modern world financial and economic order. The return of great many economists, managers, and politicians to the idea of the objectivity of value (and, accordingly, to the need for the money standard—gold, energy, or some other, but necessarily objective) will deprive the modern system of floating exchange rates of legitimacy. In our opinion, this may be viewed as one of the necessary prerequisites for overcoming the modern socio-ecological crisis of world civilization, the climatic aspect being part of it.

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CHAPTER 5

75 Years of Nuclear Testing: Economic Assessment of Environmental Damage

Alexey A. Miheev

Introduction

July 16, 2020, marks the 75th anniversary of the world's first nuclear tests. During the time that has elapsed since then, the world has realized the destructive power of nuclear weapons and came to the conclusion that it is necessary to ban natural tests, which was necessitated, among other things, by the understanding that nuclear tests could pose a threat to the environment and the health of the population living near the test sites.

Today, US experts and the media are debating whether countries should resume nuclear testing or confirm their commitment to nuclear disarmament by ratifying the nuclear test ban treaty and under what conditions. It seems that the world has forgotten about the cost of nuclear tests, which presents itself as damage to the environment and the health of veterans who participated in tests and of local residents.

Methodology

Methodologically, the research is based on Russian and foreign authors' theoretical approaches in the field of the world economy and world politics. In Russia, the work of scientists of Moscow State University of Foreign Affairs, National Research University Higher School of Economics, Institute of World Economy and International Relations of the Russian Academy of Sciences, Moscow State University, and others have contributed to the

A. A. Miheev (✉)
MGIMO University, Moscow, Russia

E. B. Zavyalova and E. G. Popkova, *Industry 4.0*,
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study of the problem of nuclear tests. Although the topic of the nuclear factor in international relations has been well researched, and medical and environmental studies have shown that radioactive materials left over from explosions and weapons tests pose a threat to the environment and health of the population living near test sites, insufficient attention has been paid to the direct economic consequences of nuclear tests. The research contains statistical reports and analytical materials from international organizations, such as the international economic forum, the Brookings Institution, the Stockholm International Peace Research Institute, the Comprehensive Nuclear-Test-Ban Treaty Organization (CTBTO), and others. We used general scientific methods: comparative analysis and complex and systematic approaches.

Results

Today, nine countries—China, India, Israel, France, North Korea, Russia, the UK, and the United States—possess nearly 15,000 nuclear weapons.[1] This is enough to destroy our planet hundreds of times. Throughout the twentieth century, most countries that developed nuclear weapons tested them. According to the Stockholm International Peace Research Institute, more than 2,000 nuclear tests were conducted worldwide during 1945–2020 (consider how much money was spent on this). During the 75 years of the atomic era, the number of nuclear tests conducted by different countries began to be measured in tens and hundreds. The majority (85%) was conducted by the United States (1,054 tests) and the USSR (715 tests) in 1945–1992, 14.5% (300 tests) was conducted by Great Britain, France, and China, and less than 1% by India (6 tests), Pakistan (7 tests), and North Korea (1 test) (Bergkvist & Ferm, 2000). Probably, a joint nuclear test was conducted by South Africa and Israel (Belous, 2010).

Below is a graph showing the number of nuclear tests in different environments by the time they were conducted (Fig. 5.1).

Atomic Audit: The Costs and Consequences of U.S. Nuclear Weapons since 1940 provide a pie chart of the U.S. spending on nuclear weapons. Costs include, among other things, nuclear waste management and environmental remediation ($365 per bomb) and compensation for bomb victims ($2.1 billion) (Schwartz, 1998) (Figs. 5.2 and 5.3).

No other country in the world has spent on these goals as much as the United States. The United States spent about $400 million on dismantling old bombs, managing nuclear waste, and cleaning up the environment (Schwartz, 1998).

[1] Five other countries have warheads (Belgium, Germany, Italy, the Netherlands, and Turkey), and 23 other countries are members of nuclear alliances (Albania, Australia, Bulgaria, Canada, Croatia, Czech Republic, Denmark, Estonia, Greece, Hungary, Iceland, Japan, Latvia, Lithuania, Luxembourg, Norway, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, and South Korea).

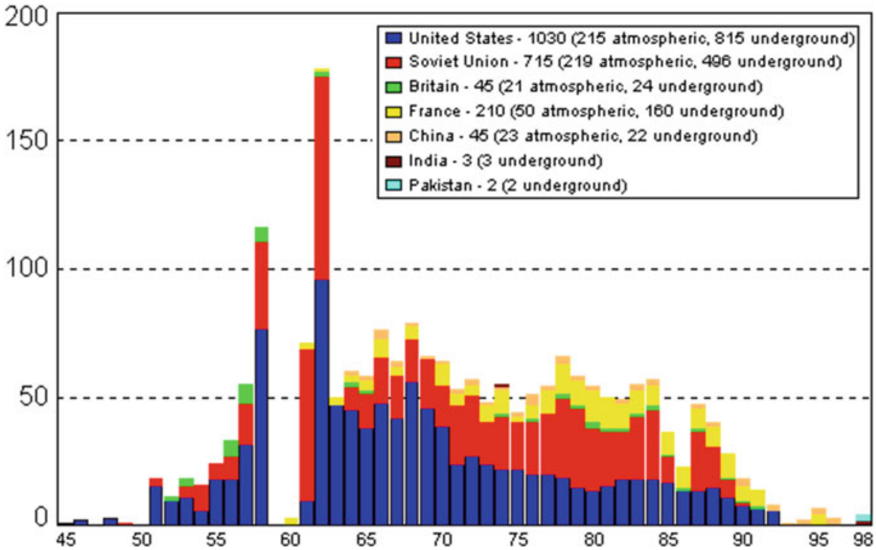

Fig. 5.1 Global nuclear testing—1945 to 1998. 2,050 Tests (528 Atmospheric, 1522 Underground) (*Source* Brookings, U.S. Department of Energy: Natural Resources Defense Council, Nuclear weapons Databook project)

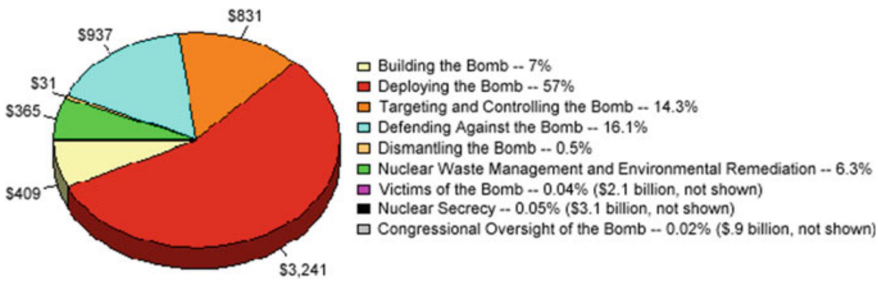

Fig. 5.2 U.S. spending on nuclear weapons (*Source* Atomic Audit: The Costs and Consequences of U.S. Nuclear Weapons since 1940 [Brookings Institution Press, 1998])

Let us take a closer look at the most striking pages of the history of nuclear tests in different countries from the point of view of the damage caused to the environment and health of the population.

We shall start with the United States. In 1954, some of the atolls (Rongelap, Utrik, and others East and Southeast of Bikini) were affected by radioactive fallout. Fallouts caused pollution over an area of more than 11,000 square km and resulted in spreading traces of radioactive material to Australia, India, Japan, the United States, and parts of Europe (CTBTO). Radiation contamination reached the Japanese fishing boat Lucky Dragon

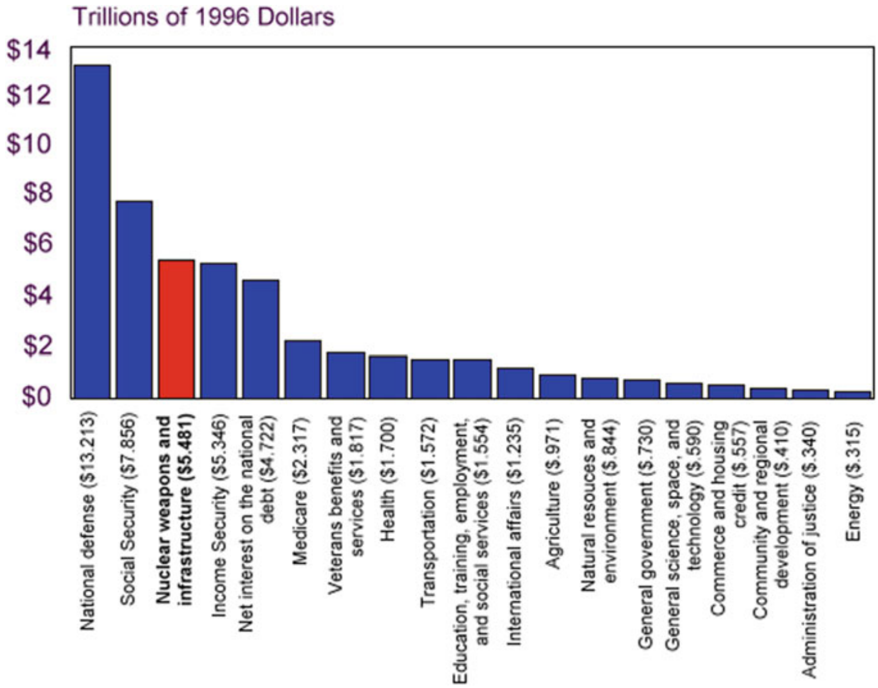

Fig. 5.3 U.S. Government Historical Obligations by Function, 1940–1996* (*Sources* Atomic Audit: The Costs and Consequences of U.S. Nuclear Weapons Since 1940 [Brookings, 1998], p. 5; Office of Management and Budget, Budget of the United States Government, Fiscal Year 1998 [GPO, 1997], pp. 42–49)

Number 5, located about 145 km from the explosion point. Many of the Lucky Dragon crew members went sick, and one of them died. Rongelap Atoll, which was about 170 km downwind, was also covered in radioactive particles. Several of Rongelap's 64 residents experienced immediate radiation sickness, including vomiting, skin damage, and hair loss. In Bravo for the Marshallese: Regaining Control in a Post-Nuclear, Post-Colonial World (Bravo for the Marshallese, 2012), anthropologist Holly Barker describes an epidemic of congenital disabilities, cancer, mental retardation, and suicide, in addition to thyroid disorders, among the locals.

Meanwhile, the time between radiation and cancer development can be from 10 to 40 years. Radiation exposure is still preserved on the islands today. Coconuts in Bikini are still radioactive. In addition to premature death, severe congenital disabilities, cancer, and other complications caused by radiation exposure, nuclear tests in the United States have changed entire communities' lives that led to repeated relocations.

In 1986, the US Congress admitted responsibility for causing physical and financial damage to the people who lived on the atolls most affected by nuclear tests—Bikini, Enewetak, Rongelap, and Utrik. A $150 million trust fund for nuclear claims was established. $30 million were also allocated to assist in implementing the healthcare system with the aim of damage control and $3 million to pay for medical screening and radiological monitoring. As of August 15, 2000, at least 42% of the 712 applicants died without compensation.

In addition, underground tests in the United States turned out to be dangerous. Tests conducted in 1962 left behind radioactive contamination in parts of Iowa, Nebraska, South Dakota, and Illinois, exposing millions of people to radioactive fallout. The health consequences of nuclear tests were an increase in leukemia and other forms of cancer in military personnel. This was the subject of lawsuits in the United States. As of July 2010, more than 22,716 claims for $ 1.5 billion had been approved for victims of radiation caused by nuclear tests and their families in the States of Nevada, Utah, and Arizona. Workers who participated in ground tests, uranium mining, and ore transportation also received compensation. As of 2014, the US government approved 28,000 880 claims totaling $1.9 billion as compensation to military personnel on test sites and the population exposed to radioactivity (Curious Droid).

The tests of the USSR also caused damage. The nuclear weapons tests conducted at the Totsky test site in the Arinbuk area of the southern Urals on September 14, 1954, continued to have a severe impact on human health and the environment decades later. People living in the blast region were exposed to ionizing radiation 42 years later, with plutonium-239 levels in the soil being five times higher than normal level. High levels of cesium-137 contamination were also reported. The population of the region suffers from a shorter lifetime and 1.8 times more frequent mortality than in other similar areas, high infant mortality, and a high level of physical disability in children.

Between 1949 and 1989, 456 nuclear and thermonuclear devices were detonated at the Semipalatinsk test site in intense secrecy. The explosions were carried out on the surface and in the atmosphere. Five of the surface tests failed and resulted in the dispersion of plutonium into the environment. Along with this, the first test happened on August 29, 1949, unexpectedly polluted villages northeast of the explosion site. The last test took place on February 12, 1989, and resulted in the leakage of a large amount of radioactive noble gases, xenon, and krypton (Gusev et al., 1998). The radionuclides produced as a result of these tests led to atmospheric and environmental contamination. Officially, during the testing program, only residents of the city of Kurchatov lived in the immediate vicinity of the test site. However, it later turned out that hundreds of people who lived within 80 km of the testing area were not taken into account (Elegant, 2002). A number of genetic defects and diseases in the region, from cancer to impotence, congenital disabilities, and other deformities, have been attributed to nuclear tests. Along with the epidemic of children born with severe neurological diseases and severe bone deformities, there were also many leukemia cases and other blood diseases (Lerager, 1992). The director of the Semipalatinsk cancer hospital estimates that at least

60,000 people in the region died from radiation-caused cancer. However, the region is "officially" considered to have the lowest cancer incidence in Kazakhstan (Lerager, 1992). Doctors also warn that the level of genetic disorders in the third generation after exposure may be even higher (CTBTO). N.V. Alishev and others show in their article that "dysimmunity and deterioration of health among special risk units and the population of the regions of Kazakhstan and the Altai territory located near the test site are of a long-term nature, manifested themselves decades after nuclear tests" (Alishev et al., 2012). Following the official closure of the site on August 29, 1991, various studies were conducted to determine the medical, social, and environmental consequences of nuclear tests in response to the government of Kazakhstan's concern about the radiological situation in Semipalatinsk and Western Kazakhstan. According to a study by the International Atomic Energy Agency (IAEA), the region has mostly little or no residual radioactivity directly related to nuclear tests in Kazakhstan, and it is recommended to restrict access to the test area.

In December 1997, a joint mission of the United Nations and the government of Kazakhstan visited Semipalatinsk to study the economic, environmental, and social consequences of Soviet nuclear tests. The population felt deceived by the government. The local economy suffered from the region's negative image that scared off major domestic and international investors. During the years of tests, agricultural land was polluted, and the groundwater cycle was disrupted. The effects of so-called small doses of radiation on health were recorded. Risks of environmental contamination with plutonium were also noted.

In 2012, Russian, American, and Kazakh scientists completed covert 17-year cleaning operations at a cost of $150 million in Semipalatinsk to make the site safe (Curious Droid).

Underground tests destroyed environmental links, which in turn accelerated the process of desertification of the region, which continues up to the present day. Extensive land and water resources were exposed to radiation pollution, and economic activity in the area around the test site was significantly reduced.

As a result of the Chagan project, the cloud from the explosion covered the territory of 11 localities, where about 2 thousand people lived. All of them received a dose of thyroid radiation; people affected most of all had its indicators 28 times higher than the critical level.

Tests on Novaya Zemlya represent the largest source of artificial radioactive contamination in the Arctic. From 1958 to 1962, a large number of atmospheric tests on the islands led to radioactive contamination not only of the Russian territory but also of Alaska and Northern Canada. Norway, located just 900 km from the islands, also received significant radioactive exposure.

Several tests went wrong or caused unexpected damage. On October 30, 1961, the Tsar Bomb, the largest and most powerful nuclear weapon (about 50 MT) ever detonated, was detonated. The Tsar Bomb caused significant damage to the environment: The surface of the earth, along with the rocks, was completely leveled off.

Later, researchers discovered that a large amount of radioactive material related to nuclear weapon tests was dumped in the Barents and Kara seas (CTBTO). A satellite study conducted by researchers from the Norwegian Institute of international relations has revealed the possible destruction of the ever-frozen layer on Novaya Zemlya.

The Committee on Special Risk Veterans has 6,000 members who participated in the production of nuclear weapons or control of nuclear tests at the Semipalatinsk and Novaya Zemlya test sites and other less known sites. Ninety percent of the Committee's members are disabled people, and many thousands of veterans have already died. To this date, they have received medical treatment for illnesses caused by nuclear tests but have not received financial compensation.

Residents of Cherdynsky, Krasnovishersky, Chernushinsky, and Osinsky districts of the Perm region began to notice an increase in cancer diseases. Later, in the 1990s, ecologists found traces of plutonium-239 at the site of the explosions, a half-life period of which is 240 thousand years.

As for the UK tests, about 22,000 of its military personnel and 16,000 Australian civilians and military personnel who participated in the tests (CTBTO) were exposed to radioactive fallout during the test period.

The impact of nuclear testing on health and the environment in Australia remains underinvestigated. During testing, many of the indigenous population of Maralinga Tjarutja continued to move throughout the region and could suffer. Up to 600 small-scale tests were also conducted in Maralinga, after which Maralinga was contaminated with approximately 8,000 kg of uranium, 24 kg of plutonium, and 100 kg of beryllium. Plutonium, one of the most toxic radionuclides with a half-life of 24,000 years, remains scattered over a vast territory.

The consequences were not only radiological: Restrictions on indigenous population access to their traditional lands also caused psychosocial and cultural problems. The British government did not pay enough attention to the indigenous population's vulnerability to the radiological consequences of the tests. Some factors as contamination of clothing and food with radioactive materials were underestimated.

British nuclear tests were conducted with a high level of secrecy. On October 15, 1953, a major nuclear test was conducted in the South Australian desert at Emu Field, resulting in a radioactive cloud known as "Black Fog" that covered an area of 250 km^2. The tests did not take into account the aborigines living downwind of the test site.

Nine explosions over Christmas and Malden islands in the South Pacific took place between November 1957 and September 1958. As a result, the effects of radiation (temporary blindness, skin rash, and others) were experienced by veterans who were too close to the explosion's epicenter. The military personnel was free to move around the island, drink local contaminated water, eat local fruit, swim in lagoons, and breathe in dust. Ingested radioactive particles can remain in the body and continue to harm for many years.

An operation on burying radioactive material (in pits with concrete) was carried out in Maralinga in 1967. In 1999, the British Nuclear Veterans Association interviewed 2,500 veterans, many of whom were in Maralinga. The interview found that 30 percent of men died, mostly in their fifties; the incidence of skeletal abnormalities in veterans' grandchildren was more than five times higher than in the UK; more than 100 children of veterans reported having reproductive difficulties. In addition to the British military personnel, thousands of Australians were exposed to radiation caused by the tests (CTBTO).

The study conducted by the New Zealand Nuclear Test Veteran's Association also found various health links, including disorders in some children of veteran testers.

In 1971, the Commonwealth passed the Compensation Act to compensate the public service personnel if they can prove that their disability resulted from radiation exposure due to tests. The Royal Commission recommended extending this right to civilians in test sites, as well as to aborigines and others exposed to the "Black Fog". In addition, applicants should be entitled to compensation if the government cannot prove that the disability is not the result of radiation caused by the tests. The British government continued to deny both legal and moral responsibility for the consequences of its tests in Australia.

By October 1986, the Australian government had registered a total of 272 claims arising from the testing program, 116 of which were rejected.

In 1986, the Australian government announced a payment of 500,000 Australian dollars (330,000 US dollars) in compensation to the indigenous population for contaminated land during the British testing program. The Australian government spent 108 million Australian dollars (71 million US dollars) to decontaminate the Maralinga and EMU sites between 1996 and 2000. In 1991, the Australian government paid 13.5 million Australian dollars (8.5 million US dollars) to aborigines as compensation.

On January 21, 2009, a group of more than 1,000 former military personnel who served in the South Pacific in the 1950s filed a case against the British Ministry of Defense for illnesses including cancer, skin defects, and fertility problems that as they claim are the result of radiation exposure during nuclear bomb tests. In May 2010, the Australian government provided 24.2 million Australian dollars (approximately 21.4 million US dollars) over five years to compensate Australian personnel who participated in the British nuclear test program. On July 28, 2011, 1,110 veterans of Britain's nuclear bomb tests of the 1950s won a court case against the Ministry of Defense (CTBTO).

France also conducted nuclear tests that had an impact on the environment of the colonies. For example, Tureia Atoll, with a population of about 60 people, was only 100 km from Moruroa and thus remained in the danger zone. Over the next 30 years, 193 atmospheric and underground tests were conducted in the region. During the tests, several radioactive fallout cases were recorded, that is, rain formed by particles of a nuclear explosion.[2]

As a result of 45 French atmospheric tests, including 4 in Algeria, contamination with nuclear elements was recorded in the atmosphere, ground, and water bodies. Since 1975, all nuclear explosions have been carried out underground, causing both short- and long-term environmental damage. Radionuclides have been found in marine organisms. The marine environment at Moruroa was also used as a test site for burying nuclear materials. A mission from Australia, New Zealand, and Papua New Guinea to Moruroa in 1983 found that plutonium-239 concentrations in the air were about four times higher than in continental France. After the last nuclear test in 1996, the French government applied to the International Atomic Energy Agency (IAEA) to conduct a study to assess the radiological impact of the tests at Mururoa and Fangataufa atolls. There were no attempts in the report to estimate the doses received by residents of the region because of nuclear tests in the atmosphere during those tests.

The French nuclear test veterans' association, Aven, conducted a survey in 2008 of more than 1,000 veterans and found that 35% had one or more types of cancer (including blood and thyroid cancer) and one in five were infertile. The problem has not been officially acknowledged for four decades. No sooner than November 2008, France announced a bill to compensate those suffering illnesses related to nuclear testing among the 150,000 military personnel and civilians who had worked on the tests in Algeria and the Polynesian atolls. On January 9, 2009, France agreed to spend over 80 million US dollars to rehabilitate the atoll of Hao, which was a key military base during the 30 years of nuclear weapons testing in the South Pacific. On March 25, 2009, the French Ministry of Defense offered 10 million euros (13.5 million US dollars) as compensation to victims of its nuclear testing program (CTBTO).

The consequences of nuclear testing in China on human and animal health and the environment are mostly unexplored. 20 million people of various ethnic groups live in Xinjiang. In 2008, China began paying subsidies to personnel involved in nuclear testing. However, the compensation has not been extended to civilian residents of the Xinjiang area, downwind of the Lop Nur test site (CTBTO).

A few hundred thousand people may have died due to radiation from at least 40 nuclear explosions carried out between 1964 and 1996 at the Lop Nur site in Xinjiang (Merali, 2009). Explosions caused the most severe damage

[2] These cases are specified in the report distributed by the International Physicians for the Prevention of Nuclear War (IPPNW) and the Institute for Energy and Environmental Research named "Environmental Effects of French Nuclear Testing."

to local residents in Xinjiang in the 1960s and 1970s, when a mixture of radioactive material and sand formed as a result of rain. Takada estimated that 194,000 people would have died as a result of acute radiation exposure (Takada, 2009). About 1.2 million people could have got doses enough to cause leukemia, cancer, and fetal damage. There is evidence showing that the cancer rates were 30 to 35% higher in the province than the national average (Merali, 2009).

As for India and Pakistan, the openly declared nuclear weapons tests (operation Shakti) took place in two stages at the Pokhran test site in Rajasthan, where a nuclear explosion was conducted in 1974. On May 11, 1998, three nuclear devices were detonated: one (considered thermonuclear) with a power of 45 kT, another with a power of 15 kT, and a third with a power of less than 1 kT. On May 13, two more nuclear weapons with a power of less than 1 kT were tested. It was immediately followed by Pakistan's nuclear tests.

The consequences of nuclear testing in India and Pakistan on human and animal health and the environment are mostly unexplored. Regarding India and Pakistan, it can be concluded that there are no significant instances of environmental contamination due to the very low number of nuclear tests (Prăvălie, 2014).

North Korea has conducted six increasingly powerful nuclear tests since 2006. The DPRK has enough plutonium to produce 12 nuclear weapons. On December 10, 2015, Kim Jong-un announced that North Korea had a hydrogen bomb. On January 8, 2017, by order of Kim Jong-un, the first thermonuclear bomb was exploded underground near the Chinese border.

North Korea's total defense spending is around $10 billion a year, or somewhere between a fifth to a quarter of its gross domestic product (about $30 billion to $40 billion).

South Korea has estimated the North's nuclear program's cost at $1 billion to $3 billion, with the higher number combining nuclear and missile development. How much it will cost to denuclearize North Korea and compensate for environmental damage is a good question.

Today, 75 years after the advent of nuclear weapons, the earliest victims of nuclear weapons are getting old, and their numbers are declining. Among the most relevant studies of the total collective radiation dose for the world's population are the reports of the UN Scientific Committee on the Effects of Atomic Radiation (UNSCEAR), especially those compiled in 1982 and 1993. Today, about 1,500 veterans and their descendants want official recognition of the sacrifices made. They consider nuclear weapons to be outdated, redundant, and unnecessarily destructive.

Conclusions

1. Nuclear testing is the largest source of artificial radioactive contamination of the planet. They were conducted by states in all environments, namely in the atmosphere, underground, and under water.[3] This can also be related to "peaceful" nuclear explosions.
2. The main radiation impact on the environment and human health occurred at the initial stage of nuclear tests when atmospheric tests of nuclear weapons were conducted. Their consequence was the release of significant amounts of radioactive materials directly into the environment. They caused the most massive collective dose of the world's population from human-made radiation sources.
3. Approximately 90% of all nuclear tests were conducted by nuclear powers in the Northern hemisphere, in the United States, the USSR/Russia, and China, and only 10% (about 208 tests) in the Southern hemisphere, by France and the UK. Thus, the Northern hemisphere is more polluted than the Southern hemisphere.
4. Several tests went wrong or caused unexpected damage. As part of medical and environmental studies, it was shown that radioactive materials left after explosions and weapons tests pose a threat to the environment and a danger to the health of the population living near the test sites.
5. The danger of nuclear materials is also in the long period of their decay. Without proper disposal, many generations of people can be exposed to nuclear materials.

This article attempts to calculate the damage to the environment and health of the population.

Suppose US spending on nuclear waste management and environmental remediation is transparent (the United States has spent about $ 400 million dismantling old bombs, managing nuclear waste, and cleaning up the environment). In that case, there is little to say about the spending of other nuclear nations for these purposes. It is known that in 2012 Russian, American, and Kazakh scientists completed a covert 17-year cleaning operations at the cost of $ 150 million in Semipalatinsk to make the site safe.

Employees of nuclear testing sites and the population living near or downwind of the test sites were most exposed to radiation caused by the tests.

Compensation for victims of nuclear tests in the United States amounted to 2.1 billion dollars. Compensation for victims of nuclear tests and the cost of restoring contaminated areas in Australia amounted to about 400 million US

[3] Approximately 25% (530 tests worldwide) were conducted in the atmosphere (or in some cases under water) and 75% underground (1,517 tests). The United States and the USSR/Russia accounted for 82% of all tests conducted in the atmosphere in 1945–1963, and 86% of those carried out underground in the period 1951–1992.

dollars. France's spending on similar purposes amounted to about 100 million dollars. The data on Chinese government spending are not disclosed.

From the point of view of assessing the damage to public health, it should be noted that there is an influence of radioactive contamination on the increase in the number of genetic defects and diseases in the regions of nuclear tests, the increase in the risk of cancer and impotence among the population.

From a theoretical and practical point of view, it is essential to address the cost of nuclear tests, i.e., the damage to the health of veterans who participated in tests, to the local residents, and the environment.

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CHAPTER 6

Mechanisms of Global Warming Impact on the Sustainable Development Goals

Tatyana G. Krotova and Elena B. Zavyalova

Introduction

Climate change is more pressing than ever before. Since the beginning of industrialization, mankind has brought such large-scale changes to the climate of the home planet with its activities that, even if any industrial activity ceases now, the earth will return to its original state for a very long time.

Global scientific community and the governments of most countries of the world realize that solving environmental problems is the primary task (Guillaume et al., 2019). Fighting climate change has been identified as a separate target in the seventeen sustainable development goals (SDGs) of the 2030 Agenda. Sustainable Development Goal 13 is aimed directly at combating climate change (Nilsson et al., 2016), but the rest of the goals are closely linked to the achievement of SDG 13.

Methodology

In this work, the author uses statistical research methods, including correlation, regression, and scenario analyzes based on the data from reports on climate change, greenhouse gas emissions, ocean and cryosphere changes,

T. G. Krotova (✉) · E. B. Zavyalova
MGIMO University, Moscow, Russia

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

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and the achievement of the sustainable development goals published by authoritative international organizations.

Results

Making forecasts is one of the most effective research methods that allow us to imagine what consequences certain actions will have at the current moment in time. Scientists have several scenarios for the development of climate warming events by 2100 (see Table 6.1) (Le Quéré et al., 2018; Peters et al., 2012).

The hardest scenario assumes high levels of greenhouse gas emissions. This will happen with the absolute inaction of the world community. The softest scenario shows a future with low levels of greenhouse gas emissions and a large number of measures to prevent climate change, which will limit atmospheric warming.

At the moment, the situation is as follows: global carbon dioxide emissions in 2018 increased by more than 2% compared to 2017 (and in 2017, the growth was 1.6%) (Olivier & Peters, 2019). Summer 2020 was the warmest in the Arctic on record. The melting rate of permafrost is growing exponentially. The incredible rise in water levels in Venice in 2019 and the snowless winter in Russia are all evidence of global warming. Warming trends to date are in line with the most severe scenario (Le Quéré et al., 2018; Peters et al., 2012).

In 2015, the United Nations endorsed the sustainable development goals to build a better future for people and the planet. These 17 goals and the 169 targets set out in them are aimed to end poverty and hunger, protect

Table 6.1 "Hard" and "soft" scenarios of the consequences of global warming

	Scenario	*Near term: 2031–2050* *Interval*	*End-of-century: 2081–2100* *Interval*
World average temperature rise (°C)	Soft	0.5 to 14	0.3 to 1.7
	Hard	0.9 to 1.8	2.6 to 4.8
The rise in the global average temperature of the world's ocean (°C)	Soft	0.33 to 0.96	0.20 to 1.27
	Hard	0.60 to 1.29	1.64 to 3.51
Ocean surface pH	Soft	−0.072 to −0.072	−0.065 to −0.066
	Hard	−0.106 to −0.110	−0.313 to −0.317
Oxygen depletion at a depth of 100–600 m (%)	Soft	−0.3 to −1.5	0.0 to −1.2
	Hard	−1.0 to −1.8	−2.9 to −5.0

Source Compiled by the author based on https://www.ipcc.ch/srocc/ (accessed 30 September 2020) the planet, and reduce gender, social, and economic inequalities by 2030 (see Table 6.2 for a complete list of goals).

As the Sustainable Development Report shows, achieving SDGs 12, 13, 14, and 15 is a challenge even for the world's leading economies (see Table 6.3). That is, none of the countries included in Table 6.3 has time to achieve 100% in these goals by 2030. We believe that the achievement of these goals is

Table 6.2 Sustainable development goals

Nomber	Designation	Short description
SDG 1	No poverty	Eradicate poverty in all its manifestations around the world.
SDG 2	Zero hunger	End hunger, ensure food security, improve nutrition and promote agricultural development
SDG 3	Good health and wellbeing	Ensure healthy lifestyles and promote the well-being of people of all age groups.
SDG 4	Quality education	Provide inclusive and quality education for all people and encourage lifelong learning.
SDG 5	Gender equality	Achieve gender equality and empower all women and girls.
SDG 6	Clean water and sanitation	Ensure access to water and sanitation for all people on the planet.
SDG 7	Affordable and clean energy	Provide access to affordable, reliable, high-quality, modern energy sources for all people on the planet.
SDG 8	Decent work and economic growth	Promoting inclusive, sustainable economic growth, full employment and decent work for all of the world's population.
SDG 9	Industry, innovation and infrastructure	Build sustainable infrastructure, promote sustainable industrialization and stimulate innovation.
SDG 10	Reduced inequality	Reducing inequality within and between countries.
SDG 11	Sustainable cities and communities	Investing in urban infrastructure will help make cities inclusive, safe and sustainable.
SDG 12	Responsible consumption and production	Increase productivity while reducing production costs and harmful production externals. Recycling and reuse.
SDG 13	Climate action	Take urgent action to combat climate change and its impacts.
SDG 14	Life below Water	Protect and sustainably use the oceans, seas and their resources
SDG 15	Life on Land	Rational use and restoration of forests, combating desertification. Protection of the diversity of animal species.
SDG 16	Peace, Justice and Strong Institutions	Contributing to the creation of a peaceful, just and open society.
SDG 17	Partnerships for the Goals	Building a global partnership for sustainable development.

Source Compiled by the author based on https://www.un.org/sustainabledevelopment/sustainable-development-goals/ (accessed 30 September 2020)

Table 6.3 Gap in achieving SDGs 12, 13, 14, and 15 for the world's leading economies

Country	SDG 12	SDG 13	SDG 14	SDG 15
Argentina	20,9	7,9	60,1	47
Australia	59,1	66,1	43,7	52,2
Brazil	21,3	8,3	36,8	39,1
Canada	49,9	31,5	40,5	39,3
China	18	8	63,8	37,3
France	46,6	13,6	35,8	23,3
Germany	52,6	9,8	59,5	17,4
India	5,5	5,5	48,8	48,9
Indonesia	9	5,2	49,6	58,1
Italy	48,3	15,3	58,9	17,1
Japan	44,4	9,6	46,4	30,0
The Republic of Korea	36,5	12,3	45,2	42,8
Mexico	21,2	9,4	30,5	52,4
Russia	30,9	17,8	57,5	33,8
Saudi Arabia	43,3	40,3	44,3	52,9
The Republic of South Africa	31,2	13	43,5	40,9
Turkey	26,2	10,1	72,6	46,7
The United Kingdom	57,1	15,4	42,5	26,3
USA	63,5	33,9	39,1	23,1

>20%	10-20%	2-10%	0-2%

Source Compiled by the author based on the Sustainable Development Report. https://www.sustainabledevelopment.report/ (accessed 30 September 2020)

interrelated. In addition, as countries make progress in combating climate change (SDG 13), countries will be able to achieve the remaining goals faster. Conversely, without investing in the fight against climate change, it will be very difficult and costly to succeed in achieving a range of other goals.

Since the beginning of time, the world's oceans and cryosphere have been of great importance in regulating climatic processes on our planet. Anthropogenic emissions of greenhouse gases have already had an indelible effect on climatic processes on earth. There are also natural cycles of warming and cooling, but now the climate is changing at an unprecedented rate and this is due to human economic activity. We can assume that global warming affects the life of mankind, ecosystems of water and land, human well-being, and overall sustainable development.

The ocean absorbs carbon dioxide (1/3 of the CO_2 released from burning fossil fuels has been absorbed by the ocean since the start of the industrial revolution) and excess heat (90%), while glaciers reflect solar energy, thereby reducing the heating of the earth's surface. This has slowed and continues to smooth out the warming. However, the ocean temperature is steadily increasing, and glaciers and permafrost, which was recently called "eternal", melt, releasing carbon dioxide, which increases the greenhouse effect. The reflective effect decreases as the surface of glaciers shrinks, which contributes to an increase in the average temperature in the Arctic (Nerilie et al., 2019).

Currently, about 2 billion people live in the coastal zone, while about 800 million live at an altitude of less than 10 meters above sea level. The life and well-being of these people are directly dependent on the sea. It provides them with food, the economy, and culture of the population depend on it, and they suffer from destructive hurricanes, the increase in the number of which is directly related to climate warming.

An increase in the earth's surface temperature has a profound effect on ocean ecosystems, especially the coastal zone. With warming, the amount of oxygen in the water decreases, and the concentration of carbon dioxide, on the contrary, increases. This is detrimental to all inhabitants of the coastal zone, whose food chains have been formed long ago. The death of microorganisms leads to a decrease in the number of fish and shellfish in coastal waters, and they provide about 17% of the protein in the human diet. Changes in this indicator directly affect the achievement of SDG2. The lack of seafood will affect the change in the structure of world exports and imports. Changes in sea level, coastal strip, and currents will affect changes in freight transport routes (80% of international imports and exports). In addition, the ocean also poses a threat to the population and infrastructure of coastal areas due to the impact of destructive cyclones, sea-level rise, flooding, and the penetration of seawater into groundwater, making it undrinkable and interfering. All of the above factors hinder the achievement of SDGs 2, 3, 6, 9, 11, 14, and 15 (Nerilie et al., 2019).

At the moment, about 700 million people live in the permafrost zone and in the highlands. The life, economy, and cultural ties of these people (including the indigenous small peoples) depend on snow and glaciers. Insufficient hardness and amount of ice formed in winter, melting of glaciers disrupts the transport system of the peoples of the north (Hansen et al., 2016). The retreat of permafrost causes soil subsidence, destroying structures and communications (including pipelines), destroying the terrestrial ecosystem, forcing them to abandon their usual farming, and forcing people (including indigenous small nations) to migrate from their places of residence.

The melting of high-altitude glaciers leads to an increase in avalanches and mudflows, destroying infrastructure and leading to death. An excess of melt water, and in the long term their sharp reduction due to the melting of ice caps, will force us to abandon the usual farming in high mountain areas. In addition, the tourism industry of these places will be severely affected by the rapid melting of glaciers and insufficient formation of snow cover, which will negatively affect the economy of the highlands, in many places based on ski tourism. It will make it impossible to achieve the desired SDG 2, 3, 6, 7, 9, 11, and 15 indicators.

In addition to all of the above, water evaporated from the ocean surface and melt water coming from glaciers are the largest sources of freshwater (directly related to the achievement of SDG6).

Warming in the Arctic and Greenland is especially dangerous. Melting permafrost will release huge amounts of methane and carbon dioxide into the atmosphere, which will further increase the greenhouse effect.

Global warming is destroying ocean ecosystems. Warm waters lose oxygen and accumulate carbon dioxide; infections develop in them, which quickly spread, causing disease and mass mortality of marine life. Such infections are also a threat for large populations of coastal areas. They lead to a decrease in tourist flow, which is the main income in many coastal cities. So the German authorities introduced a ban on swimming in the Baltic Sea in the north of Germany due to the spread of infections associated with an increase in water temperatures. These diseases include cholera, focal infections, etc. A decrease in the amount of oxygen in the water entails the death of marine life, the formation of so-called "dead zones". So in the Baltic Sea, such a zone has grown from 5 to 60 thousand square kilometers (Barinova, 2018). This impacts on SDGs 3, 14, and 15.

In addition, warm waters not only spread over the surface of the ocean, but are also drawn into the depths. Carrying an amount of oxygen that is insufficient to support life in the deep layers of the ocean, they also destroy deep-sea ecosystems.

In parallel with the decrease in the amount of oxygen, the amount of carbon dioxide in the water increases, causing a change in the Ph level and acidification of seawater. This adversely affects crustaceans and molluscs that build their shells from mineral carbonates such as corals, molluscs, and plankton. Along with the factors associated with climate change, overfishing, mineral fertilizers wash out into the seas and plastic pollution occurs. If the warming of the surface is not reduced and the anthropogenic impact on the ocean is not stopped, changes in the ocean ecosystem by 2050 are predicted to cost the global economy $428 billion (Nerilie et al., 2019).

Other impacts include continued sea-level rise, causing salt water to penetrate inland, contaminating drinking water and irrigation sources for some coastal communities. Actions to address these threats will likely require new infrastructure to manage rainfall, melt water, and river flow to make water supplies more reliable. These actions will also benefit SDG 3 (good health and well-being) by reducing the risk of flooding and negative health effects from extreme rainfall and outbreaks of glacial melting.

The impacts of climate change on the ocean and cryosphere also have multiple implications for progress in food security, which is addressed in SDG 2. Changes in rainfall patterns caused by ocean warming will increase aridity in some areas and more (or more intense) precipitation in others. In mountainous areas, these changes pose various challenges to maintaining reliable crop and livestock production. Some opportunities for adaptation can be found in the development of crop varieties and livestock that are better adapted to future climatic conditions, but this answer is also questioned by the rapid pace of climate change. In the Arctic, very rapid warming temperatures, shrinking sea ice, declining snow cover, and degradation of permafrost restrict habitats and migration patterns of important food sources (SDG 2 Zero Hunger), including deer and several marine mammals (SDG 15 Life on Land; SDG 14 Life Below Water), reducing hunting opportunities for basic foodstuffs on which many northern indigenous communities depend.

The fate of small-island states is of particular concern. Their lives depend mainly on the ocean. For them, with a warming climate, impoverishment of ocean ecosystems, a lack of tourists, and, in the long term, absorption by the ocean, all the sustainable development goals become absolutely unattainable. Their very existence is threatened. Rising sea levels can consistently lead to the flooding of coastal cities and infrastructure, severe tropical storms, and the disappearance of the usual economy: tourism and fishing. The worst thing that can happen is the lack of financial capacity to relocate the population of the islands in case of flooding.

Vast glaciers of Antarctica and Greenland currently contain about 66 m of potential sea-level rise (Fretwell et al., 2013). And their melting occurs even faster than forecasts.

Now, we will find out the achievement of which goals affect the SDG 13 and to what extent.

To do this, we found a correlation between SDGs 13, 7 (affordable and clean energy), 9 (industry, innovation, and infrastructure), and 12 (responsible consumption and production) according to data for 60 countries, for which there is a complete set of indicators (Table 6.4).

The correlation analysis shows that there is a strong link between SDG 13 with SDG 9 and SDG 12, but the correlation between SDG 9 and 12 is also very strong. This means that the achievement of SDGs 7, 9, and 12 is closely interrelated, and by investing in green energy, building infrastructure on its basis, we may achieve all these goals.

For further analysis, we exclude SDGs 7 and 9 from the model to avoid multicollinearity and conduct a regression analysis of the impact of achieving SDG 12 on achieving SDG 13.

Table 6.4 Correlation analysis

	SDG 13	*SDG* 7	*SDG* 9	*SDG* 12
SDG 13	1			
SDG 7	−0.32	1		
SDG 9	−0.53	0.6	1.0	
SDG 12	0.65	−0.6	−0.9	1

Source Compiled by the author based on the calculation

To do this, we compose a regression model:

$$SDG13 = \beta 0 + \beta 1 SDG12 + \varepsilon \tag{6.1}$$

SDG13 is the value of achieving SDG 13; SDG 12 is value of achieving SDG 12; ε-error (Fig. 6.1 and Table 6.5).

Results of the regression analysis are shown in Table 6.6.

The regression analysis shows that the achievement of SDG 13 is 42% dependent on the achievement of SDG 12 (responsible consumption and production), which, as stated in the explanation to Goal 12, means: to increase productivity while reducing production costs and harmful externalities of production, and create closed production and consumption cycles.

Let's evaluate the quality of the model and write down its final formula.

The value of the coefficient of determination (R^2) is 0.42, which indicates the good quality of the resulting model.

To test the significance of the regression in general, we put forward the following hypotheses:

H0: $\beta 1 = 0$, i.e., the regression is generally not significant;
H1: $\beta 1^2 > 0$, i.e., the factor affects the dependent variable.

Let's check by Fisher's criterion:

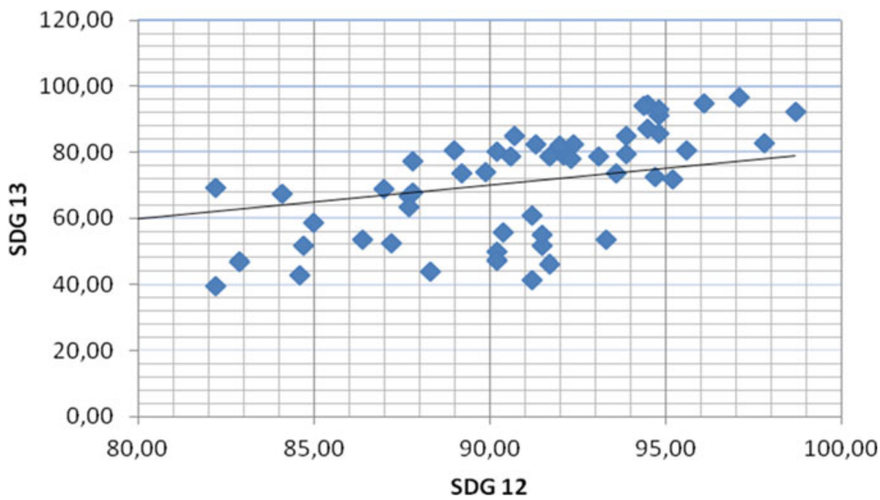

Fig. 6.1 Correlation of SDG 13 achievement on SDG 12 (*Source* Compiled by the author)

Table 6.5 Input data for evaluating the regression model

Country	SDG 13	SDG 12
Argentina	92.10	79.10
Australia	33.90	40.90
Bangladesh	97.10	96.50
Belgium	82.90	46.70
Brazil	91.70	78.70
Bulgaria	87.70	66.60
Chile	94.70	72.50
China	92.00	82.00
Colombia	90.70	84.80
Croatia	93.60	73.50
Cyprus	72.20	41.70
Denmark	90.20	49.80
Ecuador	93.90	84.80
Egypt	97.80	82.90
Estonia	85.00	58.70
Finland	71.00	48.70
France	86.40	53.40
Georgia	91.30	82.20
Germany	90.20	47.40
Greece	82.20	39.40
India	94.50	94.50
Indonesia	94.80	91.00
Iran, Islamic Republic	89.00	80.60
Ireland	91.70	46.30
Israel	91.20	41.50
Italy	84.70	51.70
Japan	90.40	55.60
Kingdom of Jordan	94.80	85.80
Kazakhstan	75.10	62.40
Kenya	94.80	93.10
Latvia	87.80	67.90
Lithuania	84.10	67.40
Malaysia	87.80	77.10
Mexico	90.60	78.80
Morocco	92.40	82.50
Netherlands	88.30	44.00
New Zealand	91.50	51.50
Nigeria	96.10	94.80
Norway	54.40	30.50
Pakistan	98.70	92.10
Panama	90.20	80.20
Peru	93.10	78.80
Philippines	94.40	94.20
Poland	89.20	73.70
Portugal	91.50	54.80
Romania	95.20	71.90
Russia	82.20	69.10
Singapore	50.50	35.00
Slovenia	91.20	60.80
South Africa	87.00	68.80
Republic of Korea (South Korea)	87.70	63.50
Spain	93.30	53.40
Sri Lanka	92.30	77.90
Sweden	87.20	52.20
Thailand	93.90	79.50
Turkey	89.90	73.80
Ukraine	95.60	80.40
United Kingdom	84.60	42.90
United States	66.10	36.50
Vietnam	94.50	87.10

Source Compiled by the author of the Sustainable Development Report. https://www.sustainabledevelopment.report (date of treatment: 19 September 2020)

Table 6.6 Regression analysis results

Regression statistics						
Multiple R	0.65					
R-square	0.42					
Normalized R-square	0.41					
Standard error	8.88					
Observations	60.00					
ANOVA						
	df	SS	MS	F	Significance F	
Regression	1.00	3315.33	3315.33	42.03	0.00	
The remainder	58.00	4574.69	78.87			
Total	59.00	7890.02				
Odds		Standard error	t-statistics	P−value	Bottom 95%	Top 95%
Y-intersection	59.60	4.43	13.46	0.00	50.74	68.46
Variable X1	0.41	0.06	6.48	0.00	0.28	0.54

Source Compiled by the author

The threshold value $Fcr = 4.006$, which is significantly less than the value $F = 42.03$ obtained for our model, and the validity of hypothesis H1 is proved; the regression is generally significant.
Checking by F-value gives a similar result, since F-value = 0.00, which is less than $\alpha = 0.05$.

Let us check if the coefficient of coefficients β1 falls within the confidence interval:

$0.28 < \beta 1 < 0.54$, therefore, β1 does not differ significantly from 0.41;

The formula for the final equation for the relationship between SDG 13 achievement and SDG 12 achievement is as follows:

$$SDG13 = 59.6 + 0.41\ SDG12 + \varepsilon,$$

This means that with an increase in the value of SDG12 by 1, the level of achievement of SDG 13 increases on average by 0.41.

For example, for China, this means that in order to close the gap of 8 points to 100 points on the value of SDG 13, on average, the value of SDG 12 should increase by 19 points, which is more than 100 on the value of SDG 12. This means that other measures should be taken, beyond those aimed at achieving SDG 12.

Conducting a similar analysis for Russia, we find that overcoming the gap of 18 points for SDG 13, the value of SDG 12 should increase by as much as 43. The conclusion is similar to the example with China.

SDG 12 is calculated based on 6 indicators. These are indicators of greenhouse gas emissions into the atmosphere (listed by their type separately per capita), arising both in connection with production in the country and in connection with imports, and the importance of electronic waste and electronic equipment. Therefore, in order to improve the SDG 12 indicator, the governments of the countries concerned should pay attention to the creation of waste-free industrial complexes, enterprises for the processing of solid industrial waste, as well as water treatment plants and waste processing complexes.

Figure 6.2 shows the resulting picture of the impact of public investments in achieving the sustainable development goals and the "chain reaction" of achieving other SDGs as a result of such "injections".

In addition, one should pay attention to the value of the statistical indicator of total greenhouse gas emissions per 1000 USD of GDP by country, published in the report "Trends In Global CO_2 And Total Greenhouse Gas Emissions" (JGJ Olivier and JAHW Peters; 2020), which was not used in the calculations. SDGs 12 and 13.

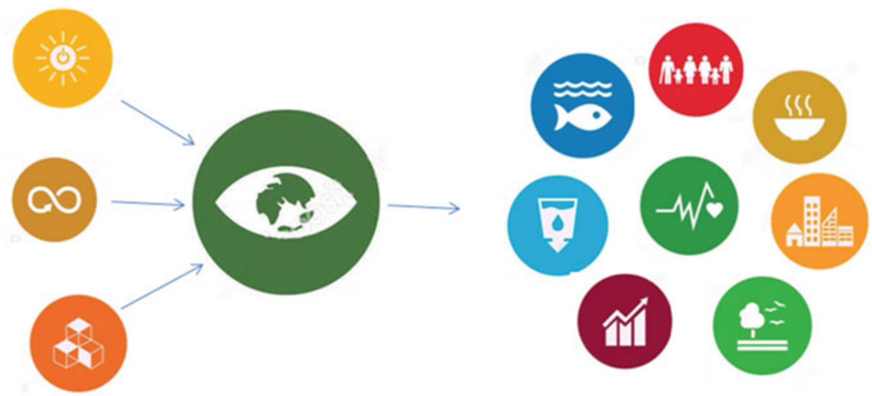

Fig. 6.2 Ways to achieve the SDG 13 and in the impact of achieving it on the implementation of other SDGs (*Source* Compiled by the author)

The values of these indicators and the trends that can be obtained on their basis correspond to the concept of sustainable development, namely the growth of GDP (welfare of the country) while reducing emissions of harmful substances (in this case, greenhouse gases).

Table 6.7 shows the current indicators of this parameter, its reduction over 10 years, the average annual rate of this reduction, as well as the projected values while maintaining the current average annual rate of reduction and the forecast value of the parameter for 2030, by which the sustainable development goals should be achieved.

According to the data of the Sustainable Development Report, we may conclude that China's trend toward achieving SDG 13 is approaching what is required to achieve the goal by 2030 (Guillaume et al., 2019). The average annual rate of reduction in greenhouse gas emissions for China is 4.5%. If this rate is maintained, by 2030, China's greenhouse gas emissions per 1000 USD of GDP will be 341 kg in CO_2 equivalent per 1000 USD or decrease compared to the current one by 42.4%.

For Russia, this indicator has practically not changed over 10 years. The growth rate of its reduction is 0.0%. Thus, to reduce the rate of greenhouse gas emissions by 1000 USD of GDP by 42.2% (similar to China), the government needs to take urgent measures. The desired value of this parameter in 2030 is 375.7 kg in CO_2 equivalent per 1000 US dollars, and the average annual rate of this reduction should be at least 4.9%.

A decrease in this indicator directly depends on the structure of the national energy sector and national plans for the transition of the economy to alternative energy sources. The idea of "zero emissions" is extremely attractive today and is already being implemented in the United States and the EU. But it is worth remembering that the production of wind generators and solar panels is also energy-intensive so that, as in Germany, it is not necessary to reactivate old coal-fired plants to generate enough energy (Golubkova, 2020).

Table 6.7 Greenhouse gas emissions in relation to the country's GDP and the estimated reduction in this parameter

Country	Total greenhouse gas emissions per USD of GDP , per country / group , 1990-2018 (unit : kg CO 2 eq per 1,000 USD of GDP (PPP , 2011 prices))										Growth over the period,%	Annual growth rate,%	Forecast for 2030	Reduction over the period, %
	2008	2009	2010	2011	2013	2014	2015	2016	2017	2018				
China	890	870	860	820	790	740	700	650	620	590	-33.7	-4.5	341.0	-42.2
United States	440	450	430	410	410	410	390	380	370	370	-15.9	-1.9	293.7	-20.6
European Union	290	290	280	270	270	250	250	240	240	230	-20.7	-2.5	168.8	-26.6
France	210	210	200	200	200	180	180	180	180	170	-19.0	-2.3	128.3	-24.6
Germany	290	290	280	280	280	260	260	260	250	240	-17.2	-2.1	186.5	-22.3
Italy	240	240	230	230	220	210	210	200	200	190	-20.8	-2.6	139.1	-26.8
Netherlands	280	290	270	270	270	260	260	260	240	230	-17.9	-2.2	176.9	-23.1
Poland	500	510	480	470	450	430	410	410	400	390	-22.0	-2.7	280.0	-28.2
Spain	250	250	250	250	240	230	230	220	230	220	-12.0	-1.4	185.5	-15.7
United Kingdom	280	280	260	270	250	230	220	210	200	190	-32.1	-4.2	113.3	-40.4
India	530	500	500	500	470	470	450	420	400	400	-24.5	-3.1	274.9	-31.3
Russian Federation	650	670	670	650	630	620	640	640	640	650	0.0	0.0	650.0	0.0
Japan	300	300	310	310	320	310	290	290	290	280	-6.7	-0.8	255.4	-8.8
Australia	780	740	840	800	690	690	680	640	660	640	-17.9	-2.2	491.6	-23.2
Canada	540	540	530	530	530	530	530	520	510	510	-5.6	-0.6	472.6	-7.3
Mexico	430	420	410	400	390	370	370	360	360	350	-18.6	-2.3	266.0	-24.0
South Korea	430	440	440	430	420	400	400	390	390	390	-9.3	-1.1	342.4	-12.2
Turkey	340	320	310	320	290	300	300	320	320	320	-5.9	-0.7	295.2	-7.8
Other G20 countries	460	450	430	440	430	440	430	430	430	420	-8.7	-1.0	372.0	-11.4
Argentina	520	470	450	460	450	480	470	480	470	480	-7.7	-0.9	431.4	-10.1
Brazil	390	400	390	390	390	400	410	420	420	420	7.7	0.8	463.6	10.4
Indonesia	390	380	370	360	350	350	340	330	320	320	-17.9	-2.2	245.8	-23.2
Saudi Arabia	440	450	430	440	430	440	440	440	440	430	-2.3	-0.3	417.0	-3.0
South Arica	940	930	870	880	870	880	850	850	830	830	-11.7	-1.4	703.1	-15.3
Egypt	380	360	370	380	360	350	340	340	330	320	-15.8	-1.9	254.5	-20.5
Iran	590	570	560	610	630	620	620	570	570	620	5.1	0.6	662.4	6.8
Kazakhstan	940	950	920	990	970	910	880	880	880	930	-1.1	-0.1	916.8	-1.4
Malaysia	470	470	450	430	440	430	410	390	370	370	-21.3	-2.6	269.0	-27.3
Nigeria	370	370	370	360	340	310	300	320	320	310	-16.2	-1.9	244.9	-21.0
Taiwan	350	340	330	320	310	300	290	300	300	290	-17.1	-2.1	225.7	-22.2
Thailand	430	430	420	410	410	400	380	360	360	340	-20.9	-2.6	248.6	-26.9
Ukraine	1090	1110	1110	1090	1060	1000	920	940	820	810	-25.7	-3.2	545.2	-32.7
United Arab Emirates	430	440	430	430	430	410	410	400	400	400	-7.0	-0.8	363.2	-9.2
Vietnam	730	730	690	650	630	630	650	650	610	620	-15.1	-1.8	498.7	-19.6
Zambia	750	810	760	790	760	730	730	700	670	690	-8.0	-0.9	617.4	-10.5

Source Compiled by the author on the basis of the data report, The JGJ Olivier and JAHW Peters. Trends in global CO_2 and total greenhouse gas emissions

Conclusions

The primary task of the world community today and for the next 10 years is to achieve sustainable development through the implementation of 17 sustainable development goals.

In our work, we demonstrate that success in combating climate change (SDG13) is key to achieving many other goals: preserving ecosystems of the earth and ocean (SDGs 14 and 15), and good health and well-being (SDG 3). Failure in this matter makes it impossible for a number of regions to achieve both the above goals and also SDGs 1, 2, 3, 6, 8, 9, and 11. These are mainly regions located on the coast, in highland zones and the permafrost zone, the entire economy, and whose life depends on the ocean and glaciers.

Achievement of SDG 13 is directly linked to the achievement of Goals 7 (affordable and clean energy), 9 (industry, innovation, and infrastructure), and 12 (responsible consumption and production). From the performed correlation analysis, we found that they are all closely related and their joint or consistent implementation has an impact on the success in combating climate change.

Progress toward SDG 12—Responsible Consumption and Production—has the greatest impact on SDG 13. From the description of this goal, it follows that it is necessary to increase productivity while reducing production costs and harmful externalities of production. At the same time, a closed economy with a system for processing industrial waste and household waste is assumed.

To achieve this goal, close interaction between the state and business is necessary, since providing the enterprise with closed water supply systems, air purification systems, absorption of harmful impurities and greenhouse gases, and land reclamation requires very serious financial investments from the enterprise. Tightening environmental legislation, in this context, should be accompanied by government subsidies and tax incentives.

But all of this is not enough to achieve 100% SDG 13 in the countries that are the main emitters of greenhouse gases (China, United States, Russia, India) (J.G.J. Olivier and J.A.H.W. Peters; 2020).

It is necessary to switch to "clean" and at the same time efficient energy sources.

In this regard, the authors draw attention to a very important statistical indicator that is not used in the UN methodology to find the value of SDGs 12, 13, 7, and 9, namely the amount of greenhouse gas emissions per country's GDP. A decrease in this indicator is fully consistent with the concept of sustainable development, i.e., increased productivity while constantly reducing environmental impact. Especially, depressing is the fact that for Russia this indicator has not changed at all over the past 10 years. For comparison, its decline for China is almost 43% over the same period.

The transition to green energy sources and the move away from a resource-based economy should be gradual. In order to avoid a shortage of energy, you should first switch coal plants to coals with low CO_2 emissions during combustion (anthracites) (Zavyalova et al., 2019) and gas, produce a sufficient number of wind turbines and solar panels, and then gradually switch cities and enterprises for alternative energy sources with zero CO_2 emissions.

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Part II

Climate Change Manifestations at the Territorial Level in Industry 4.0

CHAPTER 7

Formation of a Green Economy in Moscow: Opportunities and Prospects

Natalia V. Komarovskaia

Introduction

Modern cities, with their huge energy consumption, excessive emissions of pollutants, and tons of garbage, have become the so-called "environmental monsters". Cities account for the bulk of both energy consumption and carbon dioxide emissions (about 60–80% of the global total, according to experts from the United Nations Environment Program) (UNEP, 2011). A major metropolis like Moscow is no exception. Rather, no matter how sad it is to state this fact, at the moment Moscow is an example of such an "ecological monster". Conversely, it is these very cities which have the necessary human capital with the appropriate knowledge and qualifications to generate the necessary creative ideas and can innovate to solve pressing environmental problems.

The objectives of this study are: (a) to identify the main environmental problems urgent for Moscow at the moment and (b) to assess the possibilities and prospects for solving these problems using world experience.

Materials and Methods

The methodology of this study includes, firstly, a critical analysis of regulatory legal acts of the Russian Federation adopted with the aim of creating an

N. V. Komarovskaia (✉)
Moscow State Institute of International Relations (MGIMO University), Moscow, Russia
e-mail: n.komarovskaya@inno.mgimo.ru

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institutional framework for "greening" the economy, an analysis of statistical data regarding the place of Moscow in the ranking of sustainable development of cities, an assessment of the environmental indicators of Moscow, and the results of the policy of the Moscow authorities in relation to improving the state of the environmental situation.

Secondly, to identify the significance of the main environmental problems of Moscow and assess the perception of young people of the need to follow the strategy of "sustainable development" and the formation of a green economy in Moscow, a written survey was conducted among 114 respondents, students of 1st to 3rd year courses of MGIMO.

Results

Moscow in the Ranking for Sustainable City Development

The methodology for assessing sustainable urban development involves assessing economic, environmental, and social factors. The Sustainable Cities Index 2018 of the consulting company Arcadis contains an assessment and rating of one hundred cities in the world based on three areas: the social sphere, including the assessment of the quality of life (people), the economy (profit), and the environment (planet). The ecological situation in cities is assessed according to criteria such as environmental risks (exposure to natural disasters), green zones (the ratio of the area of green areas to the area of the city), energy (total energy use, use of renewable energy sources, energy consumption per dollar of GDP), air pollution, greenhouse gas emissions, waste management (landfill or recycling, percentage of wastewater treatment), and water and sanitation quality (percentage of households with access to drinking water and modern sanitation).

For each of the three areas, cities are assigned points and a total score for the sum of three is displayed. In the "overall standings", Moscow is in 58th place between Budapest (at 57th) and Dallas (at 59th), having dropped one place since 2016. Separately, in each sphere, Moscow takes the following places: in the social sphere—14th (between Rotterdam and Canberra); in economics—53rd (between Miami and Detroit); and in ecology—only 87th (between New Delhi and Istanbul) (Arcadis, 2018). It is obvious that the main task of Moscow on the way to sustainable development is to solve environmental problems, as a priority.

Green Energy and Ecological Construction

In developed countries, about 40% of greenhouse gas emissions are from buildings, of which less than 10% is from building materials, and more than 90% is from operations. Residential, public, and industrial buildings worldwide consume 40% of the energy used. Carbon dioxide (CO_2) emissions and energy consumption of buildings are higher than industry and transport combined.

Energy can be saved by modernizing buildings and equipping them with modern control systems, for example, automating the consumption of thermal energy in apartment buildings. According to studies, energy consumption during the operation of buildings can be reduced by 50–80% (Fucks, 2016, p. 262). Energy saving can be facilitated by the transition to non-traditional sources of energy supply: solar power plants, heat pumps, heat accumulators, and heat recovery units. When using renewable energy sources, it is possible to reduce the volume of harmful emissions to zero. The strategy for the development of world megacities includes increasing the energy efficiency of urban infrastructure as a result of equipment modernization and on the basis of the development of "smart" (smart) power transmission networks (smart grid), as well as the introduction of renewable energy sources (RES).

A special feature of Moscow is its northernmost location among megalopolises with a population of more than 10 million people. According to Mosgorstat, the resident population of Moscow as of January 1, 2020, was 12.68 million. This imposes a number of restrictions to reduce energy consumption. On the other hand, global warming, which has become one of the main drivers of "greening" megalopolises in recent years, may have favorable consequences for Moscow by shortening the heating season.

At the moment, according to Russian standards, the specific consumption of heat energy for heating new multi-story buildings ranges from 95 to 195 kWh/(m_2*year). Construction experience shows that there are technical possibilities to provide 95-122 and even 77 kWh/(m_2*year). At the same time, the actual consumption of heat energy, especially by old houses, is several times higher than these indicators. Thus, Moscow has a huge potential for energy savings in building operations. As a result of the modernization of apartment buildings, the energy consumption of their heating systems can be reduced to 150 kWh/(m_2 * year). However, it should be noted that the rate of heat consumption even by energy-efficient buildings in Russia is twice as high as in Germany (Korendyaseva, 2018).

In 2009, the Federal Law on Energy Saving and Efficiency Improvement was adopted. The regulatory framework created since then is in line with world practice, as proved by Russia's 17th place in the World Bank's ranking of state regulation in the field of energy efficiency. Despite this, it is not without its drawbacks. Unfortunately, the State Program of the Russian Federation "Provision of affordable and comfortable housing and communal services for citizens of the Russian Federation", approved by Decree of the Government of the Russian Federation of 15.04.2014 No. 323, and "Strategy for the development of housing and communal services in the Russian Federation for the period until 2020" do not contain targets for improving energy efficiency, which makes it difficult to improve energy savings in residential buildings.

According to the Federal Law "On Energy Saving and Improving Efficiency", construction companies are required to install heat meters in new buildings so that residents can pay for heating not based on the area of the premises, but upon the use of utilities. Foreign experience shows that the use of such devices and apartment metering reduces energy costs by 20%. However, in 2019, the Ministry of Construction came out in favor of the abolition of mandatory meters due to the fact that a decrease in temperature in one of the apartments leads to an increase in heat consumption among neighbors.

The Moscow subprogram “Energy Saving and Energy Efficiency Improvement” has been implemented as part of the Moscow City State Program “Development of Utilities and Engineering Infrastructure and Energy Saving” (Moscow Government, 2011). As a result of the implementation of the subprogram in 2016, the indicators have exceeded the planned limit in total electric energy savings (by 125%), total gas savings (by 50%), and reduction of greenhouse gas emissions (by 50%). However, the indicators of total savings of heat energy and consumption of renewable energy did not reach the planned values (85% of the planned value and 25%, respectively).

Such a lag in the indicators of heat energy savings and renewable energy consumption is not accidental. In Moscow, the penetration of renewable energy is very slow due to the following reasons: (1) the use of solar energy is hampered by its geographical location with one of the lowest levels of insolation in the world; (2) the use of wind generators is difficult due to the low wind speed; (3) the high availability of raw materials, minerals, and non-renewable energy sources in Russia hinders the introduction of resource-efficient technologies. The lack of resource-efficient technologies leads to the fact that in Russia the efficiency of the use of primary resources, including energy and water, is more than twice inferior to the leading economies (State Council of the Russian Federation, 2016).

At the moment, a number of solar-powered devices have been installed in Moscow: parking meters, Wi-Fi stations in city bike rental stations, traffic lights at pedestrian crossings, and some street lights. However, in general, the use of renewable energy sources in Moscow remains at an extremely low level.

The experience of the Scandinavian countries, North Germany, Great Britain, and Canada shows that it is possible to achieve widespread use of green technologies even in weather conditions similar to Moscow. Green buildings are an example of a model for sustainable construction, which consume energy from their own production, supply excess electricity to the grid, and minimize water consumption. There is already a set of environmental building standards in the world (e.g., BREEAM and LEED) that can be used in Moscow. At the moment, only a few dozen buildings have been built in Moscow using green technologies. In addition to low energy prices and the associated low motivation of Russian investors for green construction, its development is also constrained by the fact that long-term operational use of buildings slows down the rate of innovation in the construction sector. Accordingly, additional regulatory and legal incentives are needed to increase the attractiveness of green building for investors.

Another area of green building in large cities is the reorganization, renovation, or integration of industrial facilities and the creation of business ecosystems on their basis. Currently, there are 208 industrial zones and 28 techno parks in Moscow, occupying a total of about 17% of the city's territory. Within the framework of the concept of sustainable development of a metropolis, dissimilar industrial facilities are to be combined into a system of differently functional but ecologically interdependent facilities.

Transport

Transport is one of the main environmental pollutants. In large cities, road transport is the main source of harmful emissions. According to analysts from the Moscow Department of Transport, the number of cars in the city currently reaches 4.7 million units and 7.7 million units in the Moscow region. The active growth in the number of cars began in the mid-1990s. In recent years, the number of cars has grown by 8–10%, i.e., by about 400 thousand units per year. For comparison, in 1960, the number of cars in Moscow was 150 thousand units and in 1970—500 thousand units. Among the exhaust gases of carburetor engines, the main share of harmful products is carbon monoxide, hydrocarbons, and nitrogen oxides and in diesel engines—nitrogen oxides and soot. The main reasons for the harmful effects of motor transport in Moscow, in addition to the rapid growth in the number of cars, are the lack of proper environmental certification and the insufficient number of installations for neutralizing such exhaust gases. The EU has validated the Euro 5 environmental certificate since 2010. But in Russia even the Euro 4 standard is valid only when importing cars from abroad. Due to the unwillingness of the Russian automotive industry to switch to the production of engines that minimize emissions of harmful substances, the date for the introduction of the Euro 4 certificate for Russian cars has been repeatedly postponed.

One of the most important components in the formation of "green" megalopolises is the development of the public transport system, where priority is given to the most environmentally safe types, such as trolleybuses, trams, and the metro. In recent years, the main directions of improving Moscow's transport infrastructure have been the creation of dedicated lanes for public transport, the introduction of a paid parking system, the creation of a Moscow car-sharing system, the arrangement of bike lanes and the organization of city bike and scooter rental, the development of rail modes of transport, the introduction of new ecological modes of transport (the launch of electric buses, creation of infrastructure for charging stations for electric vehicles), and improvement of public spaces. In 2016, the Intelligent Transport System (ITS) was created to efficiently manage traffic flows.

The development of rail transport contributes to the reduction of the automobile load. According to statistics, the volume of passenger traffic by rail transport in 2019 amounted to 11.3 million passengers per day, which is 20% more than in 2010. The increase in passenger traffic is facilitated by the development of the urban electric train traffic system, including the creation of railway lines for the Moscow Central Circle (MCC) and the reconstruction of railway lines within the framework of the Moscow Central Diameters project. In 2019, on average, 11 million trips per working day were made on rails. From 2010 to 2019, 6.7 million new passenger seats per day appeared on rails (increased by 37%) (Moscow Transport, 2020).

Another measure to improve the city's transport infrastructure is the allocation of lanes for mainline land transport. In total, from 2010 to 2019, 351 km of dedicated lanes were created, through which the daily passenger traffic in 2019 amounted to 4 million passengers. In 2018, five electric bus routes were launched for the first time, carrying over a million passengers. In 2019, the rolling stock of wheel transport was updated by 1,633 buses, trams, and electric buses (Moscow Transport, 2020).

New mobility models such as car sharing, bike and scooter rentals are also helping to reduce traffic. Since the creation of the Moscow car-sharing system in 2015, the number of cars has grown to 31,000 in 2019, and the total number of trips in 2019 amounted to 47 million. It is planned to increase car-sharing machines by 5000 annually. The bicycle rental network established in Moscow in 2013 made 5 million trips in total in 2019. A city electric scooter rental was launched in 2018; the total amount of trips on which in 2019 amounted to 0.5 million (Moscow Transport, 2020). The introduction of a paid parking system since 2012 has also significantly reduced the traffic load in the city center.

The My Street public space improvement program, which began in 2011, also contributes to a reduction in traffic. Since the beginning of the program, 350 streets, highways, and public spaces have been landscaped and reconstructed overall. A negative point is that the growth of traffic congestion and noise pollution during construction work in the adjacent territories causes discontent among urban residents. However, since 2010, the number of walking tours in Moscow has increased twice, which indicates an increase in the attractiveness of public spaces for pedestrians.

Control over the environmental characteristics of freight transport operations in the city during the day using the access system, on the one hand, reduces the amount of harmful emissions and the level of noise pollution in the daytime, but, on the other hand, it leads to an increase in traffic and lack of control over environmental quality at night.

According to a study by TomTom, the Netherlands, as a result of the listed measures to improve transport infrastructure from 2012 to 2018, the traffic load on Moscow roads decreased by 25%. In 2016, at the International Transport Forum in Germany, Moscow received the most prestigious ITF Awards in the passenger transport category for significantly improving the traffic situation in the city.

The growth in the attractiveness of Moscow transport for citizens is evidenced by the increase in the number of trips by city transport in 2019 by 12% compared to 2010. In absolute terms, the growth in the passenger traffic of economically active citizens from 2010 to 2019 amounted to 600 million trips per year (Moscow Transport, 2020).

The transport system of Moscow occupies a high place in the ratings among other megalopolises. According to the PWC City Space for People Index, Moscow ranked third in the development of the transport system in 2018. In the rating of McKinsey & Company "Transport systems of 24 cities of the world: components of success", the transport system of Moscow in 2018 was in 6th place. According to the Moscow State University Transport Complex Development Index (calculated for a group of comparable megacities as follows: Hong Kong, London, Mexico City, Moscow, New York, St. Petersburg, Singapore, Istanbul, Tokyo, and Shanghai), Moscow shared the 2nd and 3rd places with London on the development of transport infrastructure in 2017, giving way only to Tokyo. In terms of the impact of road transport on the environment and road safety, Moscow has risen from 8th place in 2010 to 2nd in 2017.

Since 2013, emissions of nitrogen oxide and carbon monoxide in Moscow have decreased by 20 and 30%, respectively, and emissions of particulate matter have also decreased on average by about 10%. However, despite the positive dynamics, the overall level of air pollution remains very high.

Green Spaces

As for the landscaping of Moscow in the truest sense of the word, the following characteristic features can be distinguished: Due to the northern geographic location of Moscow, there are a number of serious restrictions on the range of green spaces. However, despite the qualitative limitations, at the moment, the area of green areas is estimated at about 54.5% of the total city area, and the number of park areas is about 12% (Moscow Department of Nature Management and Environmental Protection, 2019). This figure is planned to increase by 7% by 2030 due to the improvement of the territories of industrial zones. It should be noted that a high rate of landscaping is achieved due to the presence of large green areas that have the status of specially protected natural areas. These massifs are unevenly located and are concentrated mainly in three administrative districts, namely in the East (17%), West (15%), and South (12%) (Losiny Ostrov National Park, Bitsevsky Forest, Filevsky Park, and Izmailovsky Park).

The development of urban areas in Moscow appeared in the 1930s in the general plan of reconstruction and development of the city. Given the climatic conditions, the decisive factor was frost resistance. Due to the need for rapid greening of large urban areas after the Second World War, in the 1950s and 1960s, the main principle for the selection of plants, in addition to frost resistance, was the speed of growth. Accordingly, about 50% of urban plantations were trees of various types of poplar, ash, and maple. At the moment, poplars during the flowering period are a big problem for people with allergies. Other types of woody plants common in the city are small-leaved and large-leaved linden—27%; drooping birch—8%; and only 3% of evergreen conifers, which could be in accordance with the climatic features. Later, in the 1970s and

1980s, although "greening" continued, the quality of green spaces was low due to insufficient funding for landscaping and the management of green spaces. The technology of growing planting material was destroyed, valuable species disappeared from nurseries, plant care no longer included feeding, washing and shaping the crown, etc. (Dmitrieva, 2018).

Another feature of the greening of Moscow is that the green areas of the city fall under different departments of federal organizations and authorities, namely the Department of Natural Resources and Environmental Protection, Department of Housing and Communal Services and Improvement, Department of Culture, and Department of Labor and Social Protection of the City of Moscow. The gardening of courtyards in the city is subordinate to the prefectures. Thus, it becomes difficult to develop a unified strategy for green spaces.

The adoption of the Million Trees, a major landscaping program, helped to overcome these administrative challenges. Since 2013, within the framework of this project, more than 2.5 million trees and bushes have been planted in the city (Official website of the Moscow Mayor mos.ru, 2019). At the moment, within the framework of compensatory landscaping measures, it is planned to plant: 41.5 thousand trees and 181 thousand shrubs in 2020, approximately 41 thousand trees and 340 thousand shrubs in 2021 and 2022 each. As part of the Million Trees campaign, planting is carried out in courtyard areas (in spring—according to the results of residents' voting on the Active Citizen portal; in autumn—at the request of residents through district councils), in the territories of social facilities (at the request of the relevant organizations) and to replace the losses due to emergency situations and drying, or as a result of abnormal weather events. In 2019, a family ecological project "Our Tree" was launched, which makes it possible to plant a personal tree for free in honor of the birth of a child.

Disposal and Recycling of Waste

The problem of waste disposal and recycling is an acute problem for any megalopolis. At present, cities around the world produce about 1.3 billion tons of municipal solid waste per year, and by 2025, the volume is projected to increase to 2.2 billion tons. Waste management costs will grow from $ 205.4 billion to $ 375.5 billion (Korendyaseva, 2018).

Environmental waste policy in developed countries is part of resource efficiency and environmental conservation policies. Waste is used as a source for the production of energy and heat in cities, and as a source of secondary resources, including ferrous, non-ferrous, rare, and scattered metals. Rational organization of waste processing makes it possible to use up to 90% of recycled products in the construction industry, for example, as concrete aggregate. The use of thermal methods of combustion of 1000 kg of municipal solid waste makes it possible to obtain thermal energy equivalent to the combustion of 250 kg of fuel oil (Korendyaseva, 2018).

In many megacities of the world, the problem of waste is solved through the use of modern waste incineration technologies that do not give harmful emissions into the atmosphere. For example, in Vienna, a waste incineration plant, designed by the famous Austrian architect Friedensreich Hundertwasser, utilizes municipal waste, generates thermal energy for heating 107 thousand buildings, and even beautifies the city. Overall, solid waste thermal utilization plants in Europe can reduce emissions by 30 million tons of CO_2 when replaced by waste coal and by 20 million tons of CO_2 when displaced by waste gas (cewep.com).

In Moscow, the existing incineration plants are not enough to dispose of the entire waste stream. It is necessary to build additional factories using modern technologies that reduce the amount of harmful emissions into the atmosphere.

Strategic planning of waste disposal in Moscow is carried out in accordance with the Decree of the Moscow Government dated 09.08.2016 No. 492-PP "On approval of the territorial waste management scheme, including solid municipal waste". In total, in Moscow's residential and non-residential areas, about 7.9 million tons (40.8 million m_3) of municipal waste is generated annually. 56.55% of hazard level IV and 27% hazard of level V end up in a landfill (Moscow Government, 2016). According to the adopted strategy, this share should be reduced to 40 and 20%, respectively, by 2025. In terms of this indicator, Moscow lags far behind European countries, whose experience shows that it is possible to reduce the share of landfill disposal to the very minimum, up to 2% of all garbage generated. Only 6.73% of hazard class IV waste is recycled in Moscow.

Moscow is just beginning to create a centralized system of separating collected waste with its subsequent processing into secondary raw materials. A favorable factor is that, according to sociological surveys, more than half of Russians are ready for separating waste, realizing its importance.

Another direction is to solve the problem of landfills. Moscow already has a positive experience in the elimination and reclamation of large landfills. For example, the City Park of Technical Sports was opened on the site of a large landfill in Pechatniki in the Kuryanovo industrial zone, in 2018.

An effective organization of the drainage system is also required. At the moment, a rainwater drainage system operates in Moscow to collect surface runoff from the city's territory. Since this system appeared at the end of the nineteenth century, it did not involve cleaning the water from various pollutants, and to this day, the rainwater drainage is directed to the Moscow River, bypassing the treatment facilities. Now the main harmful substances in the surface runoff are suspended solids, organic matter, oil products, biogenic elements, and mineral salts. Thus, in order to reduce the negative impact on the environment, it is necessary to create a unified plan for treatment facilities for the surface runoff of the Moscow River and adjacent rivers and canals (Martirosov, 2018).

Noise Pollution

Another type of environmental problem in modern megacities is noise pollution. According to public opinion polls, the main problem for Moscow residents is car noise. The main way to reduce noise pollution in Moscow is to reduce the traffic flow, which is facilitated by the development of the urban transport system discussed above (see Transport). The introduction of "green" modes of transport (such as electric buses, which are 30% less noise-emitting than buses) should also help reduce noise exposure.

Moscow legislation provides for monitoring noise levels and implementing measures to combat noise. Residential and public buildings near highways, located in the zone where the standard noise level is exceeded, are protected. A special Resolution of the Moscow Government dated 16.10.2007 No. 896-PP "On the Concept of Reducing Noise and Vibration Levels in Moscow" was adopted, according to which measures should be developed to control vehicles during their technical inspection and improve the quality of the road surface to reduce noise from the motor and contact of the wheels with the road (Moscow Government, 2007).

Various sound control measures to combat noise, such as noise screens, windows, walls, special layouts, and placement of buildings, can only be applied in areas of new development. In the areas of existing buildings, only soundproof screens and windows are used.

A Survey of MGIMO Students on the Possibilities of Creating a Green Economy in Moscow

To identify the significance of the main environmental problems of Moscow and assess the perception of young people on the need to follow the strategy of sustainable development and the formation of a green economy in Moscow, a written survey was conducted among 114 students of 1-3 courses of MGIMO. The following questions were asked (multiple choice or open-ended) and the following results were obtained:

1. Are you familiar with the concept of sustainable urban development (yes / no)?

60% of students answered this question in the affirmative, while 40% are unfamiliar with this concept. It can be concluded that in order to be able to use the potential of young people as a driving force for achieving sustainable development goals, it is necessary to promote education and information in the field of ecology and sustainable development among young people.

2. What, in your opinion, does the notion “green metropolis” mean (open question)?

The most common answers included: the presence of green spaces (a large number of forests, parks, boulevards where people can spend a lot of time), the integration of environmental technologies, taking measures to protect the environment, the use of alternative energy sources, the cyclic use of resources, waste control, separate waste collection, clean air, exhaust gas control, less use of gasoline vehicles and infrastructure for the use of electric vehicles, development of cycling and more pedestrian zones, and more use of trolleybuses and trams than buses and cars. There were also responses such as creating conditions for safe human development and the absence of threats to human health, using granite chips instead of reagents, cleaning water bodies, minimizing personal transport, and developing a comfortable public transport system.

Thus, students have a general understanding of the ways to create a green economy in metropolitan areas, despite the fact that not everyone is familiar with the concept of sustainable urban development.

3. In which cities, in your opinion, a green economy is successfully forming (open question)?

Most often, students named the capitals of the Scandinavian countries (Copenhagen, Stockholm, Oslo), as well as such European cities as Berlin, Geneva, Zurich, London, Helsinki, Vienna, and Amsterdam. Among American cities, Washington and New York were most often mentioned, among Canadian cities—Toronto; among Asian cities—Singapore and Tokyo; and among Australian cities, Sydney was also named.

Thus, students are aware of the successful experience of leading cities in the field of green economy formation. The fact that the Scandinavian cities were most often named allows us to emphasize once again that the effective integration of green technologies is possible in weather conditions similar to Moscow.

4. Which of these environmental problems, in your opinion, are most typical for Moscow: (a) air pollution; (b) pollution of water bodies; (c) household waste; (d) lack of green spaces; (e) noise pollution; (f) soil pollution; (g) climate change (multiple answers are possible)?

The most urgent problem identified for Moscow was air pollution (86%), followed by noise pollution (63%), household waste (62%), and water pollution (55%). Young people considered soil pollution, climate change, and a lack of green spaces as the least urgent problems (30, 24, and 17%, respectively).

5. What do you think, the main environmental pollutants in Moscow can be attributed to: (a) road transport (cars and trucks, buses); (b) rail transport (trams, metro); (c) river transport; (d) air transport; (e) operation of residential buildings; (f) operation of industrial facilities; (g) household waste (multiple answers are possible)?

The students rightly attributed automobile transport to be the most environmentally harmful transport (92%). Other types of transport were not considered causing significant damage to the environment (river transport was noted by 15% of respondents; air—14%; rail—6%). The second most important pollutant considered by young people was industrial facilities (75%), and the third—household waste (64%). Students do not consider the operation of residential buildings to be a significant cause of pollution (21%), which does not reflect reality, since, as already noted, this is one of the main environmental problems of megacities. It is necessary to inform young people that green construction and energy conservation are an important part of the formation of a green economy.

6. In your opinion, has the transport infrastructure in Moscow become more environmentally friendly over the past five years (yes / no)?

The majority of respondents (71%) answered positively, which confirms the success of measures taken to reform the transport system of Moscow.

7. Have you started walking more often in Moscow in the last five years (yes / no)?

The majority of students (80%) answered in the affirmative, which indicates that the reconstruction of public spaces in Moscow makes them more attractive for walking.

8. Do you sort the trash (yes / no)?

Only 36% of young people sort waste, which once again confirms that Moscow is lagging behind other megacities which have successfully implemented a waste recycling system.

9. Do you rent bicycles and electric scooters in Moscow (yes / no)?

40% of students use it, 60% don't. Despite the fact that users are in the minority, their relatively high percentage indicates that the system of bike paths, bicycle and electric scooter rentals that have appeared over the past few years is gradually gaining popularity among young people.

Thus, the survey has shown that despite the fact that not all students are familiar with the concept of sustainable urban development, they have an idea of the ways to form a green economy in cities and recognize the need to solve environmental problems in Moscow. The survey of students confirmed the success of reforming the transport system in Moscow, the increase in the attractiveness of public spaces, and the need for further measures to "green" Moscow, primarily to solve the problem of air pollution and recycling of household waste.

Conclusions/Recommendations

As a result of the study, the following conclusions were made:

1. Moscow is known for a high degree of environmental pollution, therefore, urgent need for comprehensive measures to improve the environmental situation in the city.
2. Despite the great potential in the field of energy saving and energy efficiency, Moscow is taking only the first steps toward green energy and green construction. The high supply of raw materials and minerals in the Russian economy and low prices for traditional energy hinder the introduction of renewable energy sources and lead to a shortage of energy-efficient technologies.
3. The improvement of the transport system carried out in Moscow in recent years has led to a significant decrease in road congestion and a reduction in the negative impact of transport on the environment. Further introduction of ecological modes of transport and the approval of modern environmental standards for cars are required.
4. Despite the harsh climatic conditions, Moscow has a fairly large number of green spaces. A negative feature of green areas is the unevenness of their location. Under the Million Trees program, the number of trees and shrubs has grown significantly over the past five years. It is necessary to continue to take measures to increase the density of green spaces and their more even distribution within the city.
5. At the moment, Moscow lags far behind other megacities in terms of waste processing. Moscow is faced with the task of creating a system for separate waste collection and rational waste processing.
6. The main source of noise pollution in Moscow is traffic noise. The main difficulties in the fight against noise in Moscow are the constant increase in the number of cars, as well as the impossibility of using radical noise protection measures in the areas of existing buildings. It is necessary to continue improving the transport system, including reduction in the flow of cars and introducing ecological modes of transport.
7. As shown by the survey of Moscow students, they are aware of the importance of solving environmental problems in Moscow and have a general idea of how to create a green economy. The survey of students

confirmed the effectiveness of reforms in Moscow transport, the increase in the attractiveness of public spaces, and the need for further measures to "green" Moscow, primarily, to solve the problem of air pollution and recycling of household waste. To use the potential and creativity of young people in the implementation of the concept of sustainable development in Moscow, further development of environmental education and awareness is necessary.

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CHAPTER 8

Impact of the Phenomenon of Taobao Villages on Local Sustainable Development

Elena B. Zavyalova, Dmitry D. Krykanov, and Kseniia A. Patrunina

Introduction

E-Commerce in Rural China

E-commerce has been developing rapidly in China since the emergence of the Chinese publicly available marketplaces. The volume of electronic commerce in the People's Republic of China (PRC) amounted to 1.85 trillion RMB in 2013 (7.9% of the national retail market), reaching 4.45 trillion in 2017 (12.4%), and the forecast for 2020 is 13.91 trillion (26.7%).[1] A sharp increase in 2020 was provided by a rapid growth in online trading amid coronavirus infection and the suspension of offline retail. It is noteworthy that the growth of e-commerce in China is provided not only by the accelerating industrialization of urban areas, but also by the transition of a number of rural areas to a new model of Internet trade in local goods, in fact, developing a local economic model and entering into foreign markets, which was previously available only for medium and large agricultural enterprises.

[1] Online shopping in China to double by 2020: Goldman report. https://www.alizila.com/online-shopping-in-china-to-double-by-2020-goldman-report/ (update by 22 September 2020).

E. B. Zavyalova (✉) · D. D. Krykanov · K. A. Patrunina
Moscow State Institute of International Relations, Moscow, Russian Federation
e-mail: e.zavyalova@inno.mgimo.ru

E. B. Zavyalova and E. G. Popkova, *Industry 4.0*,
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Following a study by the McKinsey Global Institute,[2] back in 2013 out of 649 million Internet users in the PRC 27% were rural residents. By 2015, the number of Internet users in the country had grown to 662 million, which is 50% of the Chinese population. Transaction value (customs value of an imported good computed on the basis of the price actually paid or payable for it at the time it was exported[3]) of e-commerce goods was 1% in 2000. By 2020, this figure reached 40%, which exceeds the indicators in developed countries.[4]

On the one hand, the rapid development of rural e-commerce is explained by a decrease in the growth rates of the national economy of China due to a decline in industrial production and, on the other hand, by the development of physical infrastructure aimed at supporting e-commerce in rural areas by the largest e-commerce corporations.

Having determined rural areas, which are usually characterized by high unemployment rates with a large amount of labor capital, as a new point of growth in production and trade, the largest national corporations involved in e-commerce—Alibaba, JD, Suning—began to develop the necessary infrastructure. For example, Alibaba's plan "Thousand Counties, Ten Thousand Villages"[5] includes an investment of 20 billion RMB to build 2.000 district operations centers and 200.000 commodity service centers in villages. JD corporation is investing 5 billion RMB in the construction of warehouse and logistics centers in 2200 districts, which has enabled to cover almost all villages in the PRC by 2017. In 2015, the National Post of China opened 110.000 post offices in villages, along with 275 operations centers and 100 warehouses and distribution centers. Suning corporation has opened 10.000 service centers, which embrace 14% of the country's rural population.

[2] McKinsey Global Institute. China's e-tail revolution: Online shopping as a catalyst for growth. https://www.mckinsey.com/~/media/McKinsey/Featured%20Insights/Asia%20Pacific/China%20e%20tailing/MGI_China_e%20tailing_Full_report_March_2013.ashx (update by 22 September 2020).

[3] Business Dictionary. http://www.businessdictionary.com/definition/transaction-value.html#:~:text=Customs%20value%20of%20an%20imported,the%20time%20it%20was%20exported.&text=General%3A%20Appraising%20or%20estimating%20the,or%20monetary%20value.%20... (update by 20 September 2020).

[4] AliResearch. In China's Taobao villages, e-commerce is one way to bring new jobs and business opportunities to rural areas. http://www.aliresearch.com/en/Opinions/Opinionsdetails?articleCode=21626 (update by 20 September 2020).

[5] Alibaba Group Social Responsibility Report. (2017/2018). http://csr.alibaba.com/Uploads/file/20181120/5bf385982121c.pdf (20 September 2020).

Materials and Methods

The research question is: does the Taobao village phenomenon have an impact on the processes of sustainable socio-economic development of territories?

The study analyzes the concept of Taobao village using the method of system analysis to determine the factors that play a role in the transformation of an ordinary rural settlement into Taobao village. Porter's diamond model is used to analyze the further development of Taobao villages. The model describes the factor influence on the object under study. In this context, both the prerequisites for the formation of Taobao villages and its further life cycle can be assessed. The conducted factor analysis will allow comparing the expected and existing effects with indicators of sustainable socio-economic development of territories.

Literature Review

At the moment, the subject of the Taobao village phenomenon has not been sufficiently developed in academia. Until now, theoretical approaches to explaining the occurrence of Taobao villages have not been developed, and most researches are based on own sociological research. At the same time, the topic is covered mainly by researches from the PRC. A survey conducted by Friedrich Ebert Stiftung can be mentioned as an exception.[6] An attempt to build an economic model based on Poisson regression, which predicts the possibility of transforming rural settlements into Taobao villages, can be also noted.[7] It is also worth pointing out an attempt to use Porter's "competitive diamond" to analyze the reasons for the success of the Taobao village development strategy.[8] The use of Porter's "competitive diamond" to assess the strategic development of Taobao village seems to be an effective analysis tool due to lack of empirical data, and therefore, this study attempts to develop this approach and form the key parameters of the integrated development of Taobao village. Moreover, there is a study in which the correlation of state development programs for rural areas with the emergence of Taobao village is considered.[9] Considering the fact that most of the significant researches are

[6] Fan, L., & Friedrich Ebert Stiftung. (2019). Taobao villages. The emergence of a new pattern of rural ecommerce in China and its social implications.

[7] Jiaqi, Qi, Zheng, X., Guo, H. (2018). The formation of Taobao villages in China. Chieco.

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[9] Wang, Q. X. (2018). Study on the development of rural e-commerce against the backdrop of rural revitalization. *Open Journal of Social Sciences, 6*, 1–7.

conducted in the form of field research, works describing the structure and algorithm of business processes in major Taobao villages are noteworthy.[10]

Results

What Is a Taobao Village?

A Taobao village is a locality (mostly a village) where more than 10% of households run an online shop, and rural e-commerce generates more than 10 million RMB per annum.[11]

In 2009, only three villages satisfied these criteria. However, in 2017, there already were 2218 villages that can be considered as Taobao villages. It is important to mention that a Taobao village is a regional, not yet a national phenomenon: 97.8% of Taobao villages are situated in developed provinces of the eastern coast of China.[12]

The term arose against the background of a rapid and sporadic development of e-commerce in rural areas and small towns in China. The development of e-commerce in rural areas has led to an unexpected increase in e-commerce activity on national retail and even wholesale marketplaces.

There is also a less popular term Taobao town which describes a town, municipal area, or a street that meet the criteria of a Taobao village at least in triple the amount.

Taobao[13] is a peer-to-peer (customer-to-customer) virtual trade platform that functions on the principle of aggregated Internet-stores where the site itself (Taobao) acts as a mediator between a buyer and a seller. The sales are carried out in retail and wholesale as well. The marketplace is created by Alibaba Group. Taobao functions abroad under different franchises—for instance, in Russia Taobao works through Aliexpress system.

Success of Taobao is explained by a well-matched structure of the platform. Alibaba concentrated on the following specifics by the launch of the platform in 2003:

- Peer-to-peer interaction;
- Retail options;
- Focus on micro-business;
- Concern about the needs of the Chinese consumer market.

[10] Liting, W., & Zhang, H. (2019). *IOP Conference Series: Materials Science and Engineering*, 688, 055089. Study on the Operating Mechanism of Taobao Village Ecosystem from the Perspective of Information Management.

[11] Alibaba Group Website. https://www.alizila.com/taobao-villages-driving-inclusive-growth-rural-china/ (19 September 2020).

[12] Wu, W., et al. (2020, January). ICT empowers the formation of rural e-commerce.

[13] Taobao Website. https://world.taobao.com (20 September 2020).

Table 8.1 Comparative analysis of Taobao, eBay, and Yandex.Market

Segment	*Taobao*	*eBay*	*Yandex.Market*
Consumer segment	Broad	Middle class	Broad
Product development	Alitalk	Skype	Yandex.Chat
Commission	Alipay	Paypal	Yandex.Kassa
	Flexible commission on transactions (including zero-rate commissions)	Fixed commission on transactions	Flexible commission on transactions (starting from 25%); previously—commission on referrals
Client interaction	Active involvement of a mediator in disputes	Minimal involvement of the platform staff in disputes	Minimal involvement of the platform staff in disputes
Monetization	Advertising (80%)	Commissions (90%)	Commissions (80%)

Source Comprised by authors on the basis of Yang, F. (2017). *Evolution of ecommerce players' strategy – The cases of Alibaba and JD.com* (p. 37). Master's thesis. Jilin University

The system is functionally similar to the American platform eBay and the Russian platform Yandex.Market[14] (Table 8.1).

Median income of Taobao village dwellers is close to the median income of urban population. At the time of 2017, per capita income in Taobao villages was around 35,000 RMB, while those who hold an e-store in a Taobao village demonstrate an income of 55,000 RMB. Common rural areas demonstrate per capita income of 13,432 RMB and 36,396 RMB for urban citizens.[15]

In 2020, Taobao villages are not only occupied in customer-to-customer sector (a model of Taobao platform), but in business-to-customer (Tmall marketplace) and business-to-business (JD marketplace). This leads to an option of scaling up of business models within a Taobao village.

Clustering of Taobao villages is evident by their geographic concentration. 36.5% of all Taobao villages in China are situated in Zhejiang Province.[16] Moreover, the largest Taobao villages are situated closer to the coastal area as maritime transport infrastructure gives an advantage of overseas export sales.

The development of Taobao villages is unique by the fact that it proceeds in a grassroots format, which is not typical for rural areas. Traditionally rural spatial development is stimulated by state economic development programs (in a Keynesian way), which create a stimulus to overcome a state of a prolonged economic and social depression. Despite several governmental and municipal

[14] Adapted from Yang, F. (2017). Evolution of ecommerce players' strategy – The cases of Alibaba and JD.com (p. 37). Master's thesis. Jilin University.

[15] Lee, D., & Mueller, J. (2017). Junpu "Taobao" Village – A validation of Porter's Diamond Model? *Journal of Asian Entrepreneurship and Sustainability, XIII,* 51–72.

[16] Ali Research. (2019). China Taobao village research report. Ali Research.

programs, it is e-commerce entrepreneurs who acted as drivers for emergence and sprawl of Taobao villages.

How Did TV Emerge?

Researchers from Alibaba connect the emergence of Taobao villages with the development of shadow entrepreneurship in villages functioning on marketplaces. This form of business was possible due to a soft regulatory policy, control and oversight activities. In 2017, more than 490000 e-stores were "electronic analogues" of shadow offline businesses. Moreover, marketplaces allowed the shadow entrepreneurs to widen the range of their services and scale them up by an affordable platform payment system and integrated logistics services. A marketplace also helps the entrepreneurs to get a loan to support their businesses. Moreover, municipalities and province administrations contribute to the development of Taobao villages as the transformation of villages to Taobao villages leads to a lower crime rate and higher living standards. There are special educational courses on e-commerce in four provinces.

Researchers from Alibaba point out four key drivers of the development of Taobao villages[17]:

1. A rapid popularization of e-commerce in China;
2. The development of express delivery services along with capital investments in telecommunications infrastructure;
3. A favorable regulatory climate;
4. The idea of the platform economy corresponds with the national business and cultural traditions, which ensure an easy transmission of traditional villages to the Taobao "system".

Governmental and municipal incentives are usually presented as concessional loans and infrastructure development (Fig. 8.1).

There are four typical business models of a Taobao village[18]:

1. An entrepreneur buys commodity, produces and sells the final products online. Such a business model emerges sporadically and leads to the product specialization of a village;
2. A village has reached its limit on scaling up and outsources some parts of its production chain. In this way, a producer buys a share of the company

[17] AliResearch. E-commerce for poverty alleviation in rural China: From grassroots development to public-private partnerships. http://www.aliresearch.com/en/Opinions/Opinionsdetails?articleCode=21763 (18 September 2020).

[18] AliResearch. E-commerce for poverty alleviation in rural China: From grassroots development to public-private partnerships. http://www.aliresearch.com/en/Opinions/Opinionsdetails?articleCode=21763 (18 September 2020).

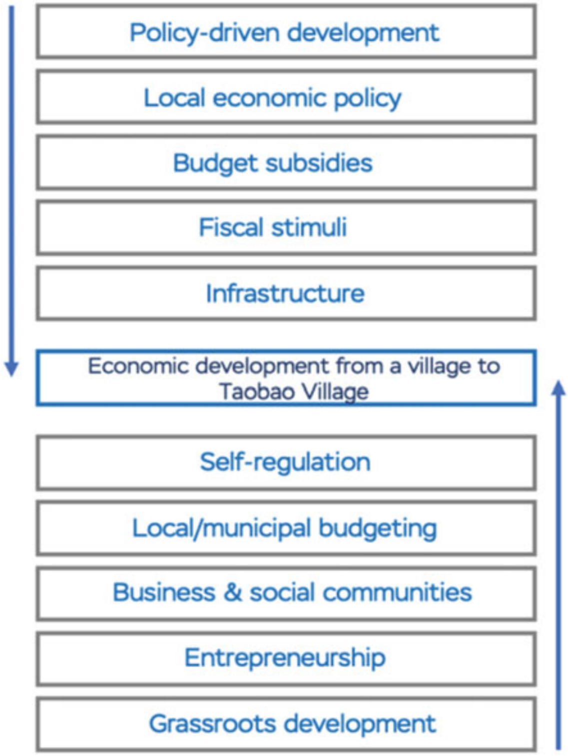

Fig. 8.1 Economic development from a village to Taobao Village (*Source* Comprised by authors)

in other village or arranges a long-term contract on production of a certain number of products and sells it in its e-store;

3. An online seller is active on several platforms with different brands, thus adapting to the needs of the auditoria;
4. Different productions in a single village unite their productive power to produce a new product and then sell it on a marketplace.

In most cases, every village forms a closed value chain and acts as an autonomous community on an e-market, covering all the processes in a value chain up to the graphic design of an e-store and packaging of the goods.

The Taobao village ecosystem can be represented as a set of interrelated and interdependent actors included in functional groups. Functional groups can be divided into core, producing, supporting, and related.[19]

[19] Wang, L., & Zhang, H. (2019). *IOP Conference Series: Materials Science and Engineering, 688*, 055089. Study on the operating mechanism of Taobao village ecosystem from the perspective of information management.

1. Core

   Core elements of a Taobao village provide interaction between Taobao village entrepreneurs and consumers. They are represented by the marketplace, entrepreneurs in Taobao villages, and consumers of goods.

2. Production and distribution

   Production and distribution groups can be divided into agricultural (in case of the extraction of raw materials), production (processing of raw materials, production of goods), and sales (activities of online stores).

3. Supporting actors

   These groups include financial organizations (primarily microfinance organizations), trade unions and business organizations, civic committees and other social and professional organizations, as well as municipal public authorities. The supporting group forms the institutional environment of Taobao villages, which also includes the entrepreneurial culture.

4. Related actors

   Related actors are external to Taobao villages, but they are built into ecosystems and ensure the functioning of entrepreneurial activities aimed at external markets. These include suppliers and distributors, logistics companies, IT service providers (in this case the set of services includes outsourcing services for online marketing, Internet advertising, search engine optimization and social media marketing, development and support of sites), as well as e-commerce specific professional photography and video filming service for goods. Thus, the accompanying actors support the business processes of Taobao villages (Fig. 8.2).

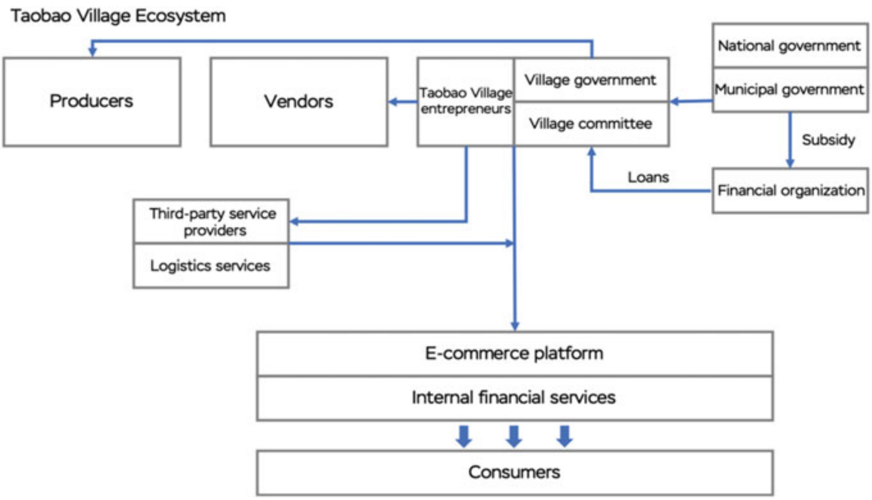

Fig. 8.2 A schematic structure of a Taobao Village (*Source* Comprised by authors)

Factors of the transition of a settlement into Taobao village:

1. Infrastructure development;
2. Development of a system of information exchange within a society;
3. State (municipal) development programs;
4. Inclusion in the regional community;
5. Soft regulatory system.

At the same time, Taobao villages have significant disadvantages:

- Employment and household income are almost entirely dependent on the economic cycle: in the event of a significant decline in demand during a recession, villages will quickly turn from wealthy to marginal;
- Shadow form of employment and doing business reduces revenues to the administrative budget and does not protect the workers' rights;
- The economic system of Taobao villages is designed for the development of one sector, without taking into account the need for the integrated development of territories;
- Regions characterized by extreme poverty do not have a chance to transform into Taobao villages due to insufficient human capital (especially in terms of lack of specialists) and unfavorable geographic location.

Porter's Diamond Model and the Structure of Taobao Villages

It is worth to mention the research that tries to analyze the organizational system of Taobao villages with Michael Porter's diamond model framework.[20] This framework helps to define the factors that predefine the emergence of Taobao villages and tries to predict their future general development with the instrument of clustering (Fig. 8.3).

Porter has introduced this model in his work "The Competitive Advantage of Nations",[21] where he tried to systemically explain the reasons for international competitiveness of different commercial branches. Porter has pointed out the importance of clustering of commercial spheres by arguing that the success of the firms depends on the performance of competitive firms along with other factors. These processes also affect value and supply chains.

Porter's diamond model describes six factors that influence competitiveness:

1. Factor conditions: labor and resources, human capital, and infrastructure;
2. Demand conditions that define intensive or extensive production policy;

[20] Lee, D., & Mueller, J. (2017). Junpu "Taobao" village – A validation of Porter's Diamond Model? *Journal of Asian Entrepreneurship and Sustainability, XIII*, 51–72.

[21] Porter, M. E. (1998). *The competitive advantage of nations: With a new introduction*. Free Press. Print.

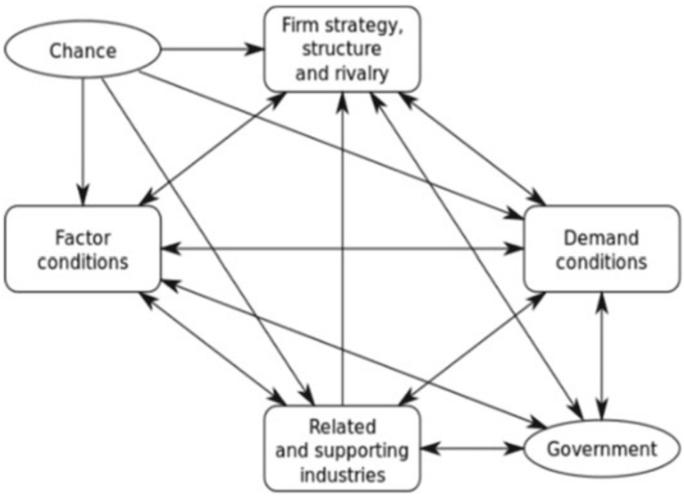

Fig. 8.3 Porter's diamond model (*Source* Porter, M. E. [1998]. *The competitive advantage of nations: With a new introduction*. Free Press. Print)

3. Related and supporting industries that define efficacy of production;
4. Firm strategy, its structure and rivalry;
5. Public (state and local) government that defines regional economic policy, regulatory climate, incentive programs for the industries, and fiscal policy;
6. Random events that pose risks and opportunities that cannot be controlled by a firm.

These factors define competitiveness of an industry in international economics.

According to the research from Ali Research center,[22] the average yield of a Taobao village business system is 15% countrywide with an average cost of starting an e-commerce enterprise of 200–3000 RMB depending on product specialization. State support programs co-finance half of the loan interest for microbusinesses, which makes business loans more affordable for the rural population. The research also indicates that those who previously worked in the sphere of production for large national firms (usually employed as workers, not managers) situated significantly far outside of their villages mostly tend to start a microbusiness. Thus, the rural dwellers gain an opportunity to learn basic business schemes and general business sense by working for large firms. Wholesale purchase from the factories where the workers are employed with

[22] In China's Taobao villages, e-commerce is one way to bring new jobs and business opportunities to rural areas. http://www.aliresearch.com/en/Opinions/Opinionsdetails?articleCode=21626 (18 September 2020).

the further release of the goods via e-commerce marketplaces is also a common way to run a micro e-business.

Impact of Local Regulatory Policies

The Chinese Communist Party provides incentive programs for e-commerce on municipal level. The size of the program heavily depends on the municipal budget, though there is a similar core structure of these programs for Taobao villages:

1. Provision of free (pay-free) access to broadband Internet connection;
2. Construction and access provision for coworking centers;
3. Credit co-financing;
4. Provision of e-commerce educational programs.

   Educational program lasts twenty days and is designed for groups of up to thirty students each. The modules include entrepreneurial and computer literacy, Internet marketing, contract and business law, accounting, and guest lectures held by the entrepreneurs from Taobao villages who managed to scale up their businesses and thrive. There are also special courses for those who want to scale up their microbusiness in the sphere of e-commerce to medium-sized business. Associates of large national companies are also inviting as guest lecturers. The national program sets an aim to provide this program for at least 100,000 e-commerce entrepreneurs. The same program was introduced to the entrepreneurs from Africa in 2014.
5. Service and repair of road infrastructure

Development according to Porter's diamond model.

Though the government tries to incentivize the development of more technologically sophisticated entrepreneurship in Taobao villages, many of those are occupied with online reselling of the goods bought wholesale from the nearby factories. However, it can be considered as a period pending further diversification of production. As businesses within a Taobao village develop, they inevitably fall into price war because of the monopoly of a supplier within its micro-market. Then, the resellers will be forced to lower their retail prices to the minimum, thus pushing them to seek other sources of supply. Finally, local reselling will be changed by more sophisticated models of diversified distant suppliers and own production line.

Factor Check for Chinese Taobao Villages

1. Factor conditions

   Proximity to the main regional transport infrastructure system (highways, airports, seaports, and river ports) is considered to be one of the major factor conditions. Moreover, Taobao villages are often located near deindustrialized territories where many former production sites are transformed into warehouses. This provides an opportunity for local entrepreneurs to use cheap warehousing services. Taking into account that offline retail service is not popular in Taobao villages (ratio of online trade to offline trade in Taobao villages is 10:1), proximity of production sites and warehouses drastically reduces logistical costs and thus increases revenue. Telecommunication infrastructure is provided by a broadband Internet connection that is partially or fully financed by the government. The development of financial services in Taobao villages is provided by programs of the People's Bank of China (national central bank). A high-risk rate of lending to startups is compensated by governmental and municipal financial guarantees (for instance, several local normative acts were introduced in Ningbo Province that regulate business lending in the sphere of e-commerce).

2. Structure of demand

   Demand is formed mostly outside Taobao villages themselves, while all of the Chinese provinces and some foreign countries where Chinese marketplaces are popular consume goods from Taobao villages. Demand is partly stimulated with the help of self-regulatory organizations that define trade policy for small e-commerce businesses in several provinces. For instance, self-regulatory organization of Ningbo Province has banned illegal or unethical copying of technical and design solutions with a penalty of 2,000 RMB. This regulation is aimed at stimulation of product diversification among Taobao villages.

3. Related and supporting industries

   Economic efficiency of a Taobao village is defined by the number of logistic firms that operate on the territory of a Taobao village and by the supply of outsource services—photo and video production, Internet and social media marketing, marketing strategy, and data analysis.

4. Firm strategy and competitive environment

   Taobao villages are defined by their original development strategy. New Taobao villages start with wholesale purchasing from one or several local vendors within their region. As Taobao villages grow and thus the amount of small e-commerce firms as well, price competition among retailers pushes them to choose the strategy of product diversification in order to avoid excess competition. The firms within a Taobao village usually use one out of two options—the development of internal production with an original or reengineered product range and procurement of a new product line from distant producers that demands business process reengineering in order to secure firm's price advantage. Thus, Taobao villages demonstrate a common pattern of business strategy development. Taking into account a communal type of business within a Taobao village, it is much more difficult to use different business strategies within a single village or even a single cluster of villages. Clusters of Taobao villages are formed out of a necessity to accumulate capital investments in new production. These clusters are aimed at production of new products and development of new business processes and strategies.

However, strategic development of Taobao villages is still in its early stage. For instance, there is no evidence on popular marketplaces of nationally popular brands that emerged within Taobao villages.

5. Regulation (government)

The main directions of governmental or municipal incentive programs concerning Taobao villages include:

1. Free access to a broadband Internet connection;
2. Free or heavily discounted access to co-workings and production sites;
3. Loan subsidies;
4. Free educational services.

According to the national principles of spatial development stated in No. 1 Central Document[23] (one of the national strategic documents of China published in 2015 and reviewed annually), the development of rural e-commerce falls under national economic development priorities. Moreover, the purpose of this statement lies in creation of modern physical infrastructure for further independent development of rural e-commerce: "to develop e-commerce, logistics, trade, and financial systems, as well as other branches to develop an integrated e-commerce system in rural areas". No. 1 Central Document of 2016 adds a new purpose of creation of an affordable system of logistics services to promote the development of rural e-commerce. No. 1 Central Document of 2018 adds a new purpose of e-commerce development in the regions that are by far have not embraced the tools of e-commerce.

However, governmental incentive programs toward e-commerce still have some blind spots. For instance, there are no quality and technical standards for products sold on marketplaces. Moreover, a system of digital traceability of products may help to solve some legal and technical issues. To add, the government may develop a data analysis system for rural e-commerce that can be used by Taobao village firms on a free or a heavily discounted basis (Fig. 8.4).

Porter's diamond analysis allows to state that formation and development of the new (for the country) economic spheres and branches happen not only on the basis of resources gives, but also on other factors that are independent from geography. That indicates that every territory has a chance to introduce

[23] The 13th five-year plan for economic and social development of the People's Republic of China. (2016–2020). https://en.ndrc.gov.cn/policyrelease_8233/201612/P020191101482242850325.pdf (20 September 2020).

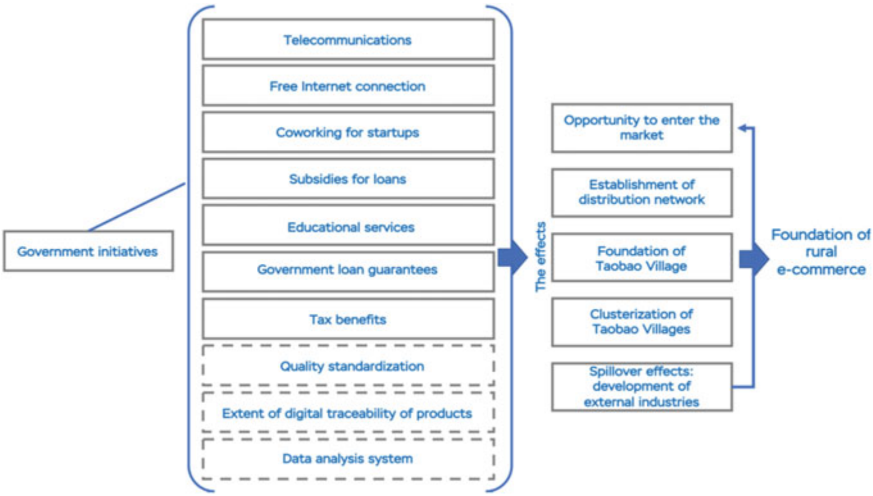

Fig. 8.4 Scheme of Taobao village processes (*Source* Comprised by authors)

a model of sustainable economic development. The case of Taobao villages proves that clustering allows to change not only global economic imbalances, but to also shorten socio-economic divide between urban and rural territories within a country, thus stimulating sustainable development with the help of human capital.

Effects of Taobao Villages Development Concerning Sustainable Spatial Development

1. The change of a production function for rural territories

Under a qualitative change in labor structure, migration of labor, and purpose of maximization of capital effectiveness, there is a change in labor effectiveness in rural territories, which creates potential for further special economic development.

2. Involvement of rural territories in national production chains

With the help of instruments of e-commerce, rural entrepreneurs can interact with distant producers, vendors, and consumers that helps them to integrate with national production and value chains. Thus, rural areas practically overcome development limits of rural space.

3. Brand development

Though firms from Taobao villages have not introduced any new popular brands by far, there is a chance to develop a brand by clustering of Taobao villages as a trade and production conglomerate and creation of "Made in a Taobao village" marketing brand that will help to ensure competitiveness of the brand.

4. Spillover effects in rural territories

Development of Taobao villages leads to technology and knowledge diffusion in neighboring territories, creating new development stimuli that help previously regular villages to catch up with the level of development of Taobao villages by the change in their knowledge production function.[24]

5. New infrastructure

The necessity of infrastructure development for trade and production cooperation leads to influx of investments in physical infrastructure—roads, telecommunications, production sites and warehouses, trade centers, as well as in service networks—consulting, education, and other services.

6. Influence of Taobao villages on gender equality

The phenomenon of Taobao villages has changed the structure of business and social relations. As rural territories are more prone to archaic traditional social relations in comparison with the urban territories, women do not enjoy equal rights, especially in economic terms. In case of Taobao villages, it is e-commerce that changes the structure of business relations—this sphere in Taobao villages demonstrates almost equal gender ratio (other spheres demonstrate a less liberal ratio of 1:3). The median age of female e-commerce entrepreneurs is 31.4 years against 47.7 for women occupied in offline sector.[25]

Around one-third of e-stores owners in Taobao villages are women. Around a half of those involved in value chains of e-commerce products are women. However, the most profitable subspheres (e-store management, data analysis, and logistics) are occupied mostly (80%) by men.

[24] Fallah, M., Wesley, P., Howe, J., Ibrahim, S., & Howe, W. (2004). *Knowledge spillover and innovation in technological clusters*. Proceedings of the IAMOT Conference.

[25] AliResearch. E-commerce for poverty alleviation in rural China: from grassroots development to public-private partnerships. http://www.aliresearch.com/en/Opinions/Opinionsdetails?articleCode=21763 (18 September 2020).

7. Influence of Taobao villages on economic growth

An e-store opening takes much less investments in comparison with offline stores. This enables rural people to test themselves as entrepreneurs. Taking into account governmental subsidies for startups, it is much easier for rural dwellers to dive into e-commerce. The minimal amount of business knowledge is provided for free by local educational centers sponsored by municipalities. Entrepreneurial skills define possible scale and profitability of business, but the officials have managed to minimize the entry barrier. Moreover, Alibaba Group has launched in 2014 a large support program for rural e-commerce. Around 30000 villages in 1000 counties took part in this program in 2018.[26]

Possible drivers for future development of Taobao villages.

1. Development of Smart Village concept on the core principles of Smart City concept;
2. Development of a database management system on a basis of a public procurement for an accelerated integration of local entrepreneurs in the e-commerce system through marketplaces.

Conclusions

To conclude, the following conditions define the emergence of Taobao villages in the region:

– An accessible and popular marketplace with a stable demand and price rate;
– Dense broadband Internet coverage (broadband wire connection and 4G (LTE) mobile telecommunication technologies;
– An efficient governmental and municipal business support programs for small businesses;
– A high density of rural population;
– Accessible logistics services;
– Assistance with registration of a firm and its reporting;
– A system of small business financing;
– A system of micro-loans;
– Access to key transport networks;
– Computer, financial, and entrepreneurial literacy of rural population.

Taobao villages function in the real economy providing physical products for mass consumption. Consequently, physical infrastructure is critical for their functioning.

[26] AliResearch. E-commerce for poverty alleviation in rural China: from grassroots development to public-private partnerships. http://www.aliresearch.com/en/Opinions/Opinionsdetails?articleCode=21763 (18 September 2020).

That is why only some provinces and counties provide proper conditions for Taobao villages.

Emergence and development of Taobao villages outside China are possible in developing countries with a middle or lower rate of income of the population together with a developed e-commerce consumer market (this indicator is used in Global Digital Economy Index, sub-index “digital consumers”): Indonesia, Brazil, Mexico, and Peru.

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CHAPTER 9

Prospects for the Transition of the EAEU to a Green Economy: Experience of the European Union for Green Growth of the Eurasian Economic Union and Conditions of Cooperation Between the EAEU and the EU

Yulia S. Kudryashova

Introduction

The key factor influencing the development of the economy is the environment. The concept of green economy is an integral part of the concept of sustainable development. As part of the transition to a green economy, sustainable development goals are achieved through balanced, efficient, and full-scale economic growth. Economic growth based on traditional sources is accompanied by irreparable environmental damage. The concept of sustainable development assumes that the foundation of economic growth should be environmental responsibility, which will also ensure progress in the social sphere. In these circumstances, the concept of sustainable development and the transition to a green economy become the most effective alternative. According to the green economy concept, economic decisions should be linked to the ecosystem, and natural capital and environmental services have economic value. In green economic theory, the economy is considered as a component of the environment where it functions.

The transition to a green economy is becoming particularly relevant not only as a tool for reducing economic costs, but also as an optimal solution

Y. S. Kudryashova (✉)
MGIMO University (Moscow State Institute of International Relations), Moscow, Russia

E. B. Zavyalova and E. G. Popkova, *Industry 4.0*,
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to the problem of global deterioration of the quality of natural resources and the environment. Eco-friendly technologies created in the format of a green economy not only reduce the negative impact on the environment, but also contribute to increasing the efficiency of resource use. In addition to the protection of natural capital, ecosystems, and biodiversity, the implementation of green projects will increase incomes and employment. Thus, green innovations have a complex positive impact on the economy, ensuring its sustainable development and preventing resource depletion. According to the United Nations Environment Programme (UNEP) definition, a green economy "leads to improved human well-being and social justice while significantly reducing environmental risks and problems" (United Nations Environment Programme, 2012). Many experts argue that in a green economy, economic activity can grow, but with less impact on the environment. Thus, it is possible to achieve a balance between economic growth and concern for the planet and people. In the context of sustainable development, the environment and economic growth cannot be seen as conflicting goals (Lavrinenko et al., 2019).

In the process of implementing green projects, the highest efficiency is demonstrated not by public, but by private financial institutions. The level of implementation of green technologies determines the company's place in international environmental ratings, which play the role of a reference point for foreign investors and affect the long-term investment attractiveness. Securities of companies that take into account environmental requirements are growing steadily, demonstrating a tendency to increase investment in the green economy. Products made using green technologies are in demand among consumers by indicating the degree of sustainability of the product on the label. The emergence of new system-forming industries based on the principles of a green economy contributes to a decrease in the concentration of national economies and differentiation of regional development, which results in an increase in the efficiency of all sectors of the economy. In 2018, the green economy reached 6% of global GDP, equaling the indicator of the extractive industry. The key direction of the green economy is the creation of the latest technologies in the field of energy saving. Energy accounts for 70% of greenhouse gas emissions and 50% of pollutant emissions. In developed countries, the share of renewable energy sources in electricity production is on average 22%.

The EU has a wealth of experience in achieving the sustainable development goals. Recycling of secondary materials, or resources, within the European Union is a central task in the quest for greening the European economy (Gregson et al., 2016). Innovations in clean technologies will reduce the cost of alternative energy sources, contributing to economic growth and strengthening the competitiveness of EU firms (Contia et al., 2018). Environmental tax reform as part of a new energy and climate policy package offers a way to allocate resources to sectors to promote a low-carbon technological revolution (Mazzanti & Rizzo, 2017). Today, the EU provides assistance to a number of post-Soviet states in the transition to a green economy.

The EAEU member states plan to create a common space in such areas as security, humanitarian cooperation, and the economy. Russia has introduced border inspection of goods due to re-export of sanctioned food products; this measure deprives the customs space of integrity (Vieira & Vasilyan, 2018). The EAEU has a significant potential for achieving the sustainable development goals, which is currently used to a small extent. For example, despite some progress in implementing the green economy concept, it should be noted that few Belarusian organizations are implementing their own green technologies (Zenchanka, 2017). The EAEU member states are experiencing negative consequences of Russia's economic problems (Pak, 2019). The main trends in expanding and deepening the partnership of the EAEU countries in the field of sustainable development include: cooperation in the field of eco-friendly technologies, scientific and technical modernization in order to reduce the negative impact on the environment, and improvement of joint infrastructure to help increase the efficiency of resource use.

The EAEU needs to compete with the EU's green projects. The EU refuses to engage in a dialogue with the EAEU because of Russia's desire for regional dominance and the expansion of protectionist measures (Kondratieva, 2018). Despite the fact that the sanctions regime is the main obstacle to the sustainable development of cooperation between the EAEU and the EU, there are a number of factors that can bring these organizations closer together economically, primarily joint projects in the field of green innovations. For example, in Russia, most of the jobs focused on cooperation with the European Union were created in sectors related to gas exports to the EU (Markandya et al., 2016). The EU and the EAEU have the potential to expand the volume of mutual trade, and it is also possible to jointly create an eco-friendly transport infrastructure (Tsvyk, 2018). The EAEU countries' own financial sources are insufficient, and the EU states are able to provide the necessary investments (Kirkham, 2016).

Methodology

The method of studying the green economy is similar to the method of ecological economics, since the economic value of natural resources is measured and their compliance with the concept of sustainability and equity is calculated. The transition to a green economy takes into account the costs incurred by government, industrial enterprises, and individuals that damage natural resources, and determines the degree of responsibility for such activities. The green economy method establishes interaction between the population and the environment and simultaneously seeks to harmoniously meet their needs. The green economy modeling method uses a broad and holistic approach to the study of the role of natural resources, their functions, and contribution to economic development.

In this work, we used empirical methods-operations in the study of documents of the organizations and the scientific literature devoted to them.

Methods-operations are techniques and operations used in the knowledge of reality in both theoretical and practical research.

Based on the narrative method, the author considered how plans for the introduction of green technologies into the production process are being implemented in the EAEU countries. Narrative or descriptive method based on written sources tells about historical events.

When analyzing the trends of sustainable development of the EAEU on the basis of effective economic growth, the analytical method of forecasting was used, as well as the method of writing a scenario. The analytical method made it possible to develop forecast expert information by building a model for the development of the green economy in the EAEU, establishing links and proportions between individual industries, and predicting the organization's activities. The scenario writing method is used for long-term forecasting. When using the scenario writing method, a logical sequence of EAEU activities in achieving the sustainable development goals was established to show how, based on the current situation, the introduction of green innovations can develop step by step.

Results

Eurointegration

In the European business community, environmental standards are the leading criteria for evaluating performance. Global reduction of emissions and promotion of an innovative energy system are among the top priorities of European countries. Recycling of secondary materials, or resources, within the European Union is a central task in the quest for greening the European economy. This is based on an environmental and geopolitical factor that separates economic growth from the consumption of limited material resources. Resource recovery within the EU is seen as a means of sustainable production and as a way to overcome resource dependence, which, from the point of view of European leaders, makes the EU vulnerable in foreign markets, especially as demand from non-Western countries for the same resources increases. It is expected that activities to restore European resources can stimulate the EU economy by increasing employment in the green economy (Gregson et al., 2016, 542). In this context, innovations in clean technologies will reduce the cost of alternative energy sources, contributing to economic growth and strengthening the competitiveness of EU firms (Contia et al., 2018, 2007).

In the European political literature, waste recycling is presented as a classic case of environmental modernization, as this activity creates thousands of green jobs within the EU in a new innovative sector that benefits the environment by conserving resources and appropriately minimizing and managing waste, as well as the economy by creating new forms of employment. These views are reflected in two major European policy statements on green growth and the development of the European green economy: the EU thematic strategy for waste prevention and recycling and the Roadmap to a Resource-efficient Europe, which set the EU on the path to becoming a recycling society by 2020. These documents consistently portray European recycling as a clean, green activity.

The current challenge for the EU is to reduce emissions by 40%, which is a prerequisite for achieving climate stabilization by around 2050. Environmental tax reform as part of a new energy and climate policy package offers a way to allocate resources to sectors to promote a low-carbon technological revolution. The EU‘s goal is to develop breakthrough technologies in the relatively short term, and large and targeted R&D investments will be required. Carbon pricing provides an initial and general incentive for industry innovation (Mazzanti & Rizzo, 2017, 114). The EU has an eco-industry with an annual turnover of 300 billion euros. The green economy concept contributes to the development of timber industries, such as harvesting and processing of raw wood, expanding the area of certified forests, and increasing the efficiency of forest management.

In particular, tariffs for energy from renewable sources are almost three times higher than those for energy obtained in the traditional way. This difference is explained by the high cost of implementing green projects, which are financed at high interest rates due to the long-term payback of renewable energy enterprises. The problem of insufficient funding is solved by placing government green bonds.

In the EU, Poland actively uses the practice of green bonds. In accordance with the Polish green finance policy, the proceeds will be invested in the creation of renewable energy facilities, the development of agriculture, the planting of forests, the construction of national parks, environmental transport, and waste disposal enterprises.

Denmark achieved the highest level of green growth, followed by Germany, Sweden, Latvia, and Italy. Successful green projects are being implemented in Finland, where active or zero-energy homes are being built. This technology allows buildings to consume only the energy that was generated by them independently. Bulgaria, Cyprus, Greece, and Malta show the lowest level of green growth (Lavrinenko et al., 2019, 1120).

However, manual labor continues to play a crucial role in many resource processing sectors in the EU. In fact, this activity, which is at the heart of the EU’s new green economy, is a new form of low-skilled, low-paid, dirty work, most of which is done by migrants.

In 2009, the European Union has started implementing the Eastern Partnership project, which includes Armenia, Azerbaijan, Belarus, Georgia, Moldova, and Ukraine. In 2015, the project “supporting the transition to a green economy in the Republic of Belarus”, funded by the European Union, was launched. The project aims to help Belarus generate economic growth using green principles such as environmental and efficient management of natural resources, production and consumption based on environmental sustainability, and green jobs. The project stipulates that pilot initiatives should be implemented in the field of waste and water resources management, biodiversity conservation, ecotourism, and the creation of environmental information centers. In 2015–2017, the EU has allocated 5 million euros to Belarus to finance the project of transition to a green economy. Priority areas for implementing the green economy are medicine, regional development, standardization, construction of electric transport, smart cities, energy-efficient housing, reduction of energy intensity, development of renewable energy sources, and production of organic products.

In Kyrgyzstan, the European Union funds the SWITCH-Asia program, which aims to create a green economy in Asia, sustainable consumption and production. The priorities of the green economy of Kyrgyzstan are effective management of water, forest and land resources, development of renewable energy sources, promotion of organic agriculture, and ecotourism. The leading sectors of the green economy of Kyrgyzstan, with the financial support of the EU, should be green cities and industry, environmental transport, and waste processing.

The EAEU

Created in 2015 the EAEU includes Russia, Armenia, Belarus, Kazakhstan, and Kyrgyzstan, and this organization unites 180 million people (the European Union and the Eurasian economic union, 2016, 26). The EAEU is designed to promote the creation of a large Eurasian partnership, which is a network of regional integration groups with coordinated development programs.

The strategic direction of the EAEU is to build a green economy as a model of sustainable development. The environmental problems of the EAEU countries can be solved only through effective economic development and a modernized real sector. The transition to a green economy is the main condition for solving environmental problems and sustainable development. Improving the quality of life of the population and the environmental situation can ensure quality improvement and updating of the technological base, and increase production efficiency and competitiveness. The creation of renewable energy sources is a key factor in ensuring energy security and sustainable development, along with economic growth. The transition to a green economy is particularly relevant in the context of volatile energy prices, reduced mineral reserves, high production costs, and unpredictable environmental costs of non-traditional energy resources.

In the medium term, the EAEU countries will have to work out an effective solution to such problems as changing energy supply routes, increasing energy consumption in cities, reducing energy resources in traditional fields, increasing legal requirements for environmental protection, aggravating the political situation in energy exporting countries, and reallocating investment in the development of non-traditional energy resources. At the same time, these factors can open up new economic opportunities for the EAEU, such as increasing energy efficiency and reducing the cost of renewable energy sources, creating innovative equipment for the production of renewable energy sources, developing resource-saving transport, introducing the latest technologies in solar and wind energy, and using agricultural waste as energy resources.

The largest share of the economies of the EAEU states is represented by industries with a negative impact on the environment. The growth of GDP in the EAEU is provided by mining and processing industries, not by the production of high-tech products. In particular, in Russia, 220 kg of petroleum products are spent on production with a cost of 1 thousand dollars and in Armenia—130 kg (Shenets, 2017, 77).

Deepening integration and cooperation of the EAEU‘s financial capital can form a green economy. In 2016, the EAEU developed the “Technologies for environmental development” platform, which defines the most important joint environmental projects. The goal of the platform is to ensure constant technological renewal and increase global competitiveness. To achieve the goals of sustainable economic development, common macroeconomic indicators have been developed for the EAEU countries, such as the level of public debt, the state budget deficit, and the rate of inflation (Tonkikh & Lytneva, 2017, 12).

The largest economy in the EAEU is represented by Russia, which carries out 84% of transactions within the organization, and contracts are mostly concluded between Russia and other EAEU countries (Koshkin & Novikov, 2015, 215). In the gross volume of Russia’s exports to the EAEU countries, the share of high-tech goods is 17% (the Eurasian economic union, 2017).

At the same time, economic sanctions imposed on Russia have reduced banks’ access to foreign markets, restricted capital inflows, and undermined investor confidence. The EAEU member states faced negative consequences due to problems in the Russian economy (Pak, 2019, 172). In the structure of foreign trade of the EAEU, mutual trade turnover reaches only 13% (Khapilin, 2016, 34).

European firms whose business strategies are based on sustainable development have brought interest in the green economy to Russia. Russian companies are trying to introduce world-class green technologies into the production process. The leading areas of green projects are reducing the use of carbohydrates in production and creating closed-loop technologies for which industrial waste is a valuable, reusable resource. There are a number of industries in which Russia is a world leader in the use of environmental green technologies. These include nuclear and hydro power, central heating, and public urban and rail transport. Industries that use green technologies are developing, such as renewable energy sources, the production of hot-briquetted iron, and the biological leaching of gold. In the Belgorod region commissioned a biogas station “Bacuri”. The plant uses pig production of the Agro-Belogorye holding as an energy source. The power capacity of the station is 500 kW, and it generates 3.7 million kWh of electricity per year (Proskuryakova, 2017, 76). In March 2019, the Russian company Resursosberezhenie KHMAO issued green bonds for the first time, which were included in the international register of green bonds (sustainable development and green investment, 2019, 18). The EAEU countries are jointly building major facilities, such as the railway in Yakutia, the highway in St. Petersburg, the Polotsk hydroelectric power station on the Western Dvina River in Belarus, and the modernization of Belaruskali.

Kazakhstan is taking active steps to transition to a green economy and has chosen seven main areas for this: renewable energy sources, energy conservation, organic agriculture, environmental waste management, efficient use of water resources, "green" transport, and careful attitude to ecosystems. In 2018, Kazakhstan allocated 73 billion tenge for the implementation of green projects, the total investment amounted to 0.12% of GDP. Kazakhstan has sufficient resources to create renewable energy sources, but today they produce only 1.3% of electricity.

The implementation of green projects in Kazakhstan began with the construction of wind farms, which partially solved the problem of reducing electricity imports and the deficit. The first green facility was put into operation in 2013; it was a Kordai wind farm. In this area, winds are constantly blowing, the speed of which is on average 20 m/s. In 2016, the Kordai power plant produced 160 million kilowatt-hours of electricity. Investments from Russia, Bulgaria, China, the United Arab Emirates, and Turkey were attracted to build renewable energy facilities. Part of the investment was in energy-saving technologies and reducing greenhouse emissions. In order to avoid the impasse of backwardness and lack of competitiveness in the transition to a green economy, the state needs to update existing infrastructure facilities and develop new ones. By 2030, it is planned to reduce the energy intensity of GDP, build new buildings and power plants, and upgrade the vehicle fleet by 80%. To achieve these goals, Kazakhstan intends to issue green bonds through the exchange of the Astana International Financial Center—Astana International Exchange (AIX). The issue of green bonds will increase the inflow of foreign investment in the field of green innovation. First of all, green bonds will be used to finance projects for the development of renewable energy sources, such as the production of eco-friendly transport, the construction of energy-efficient buildings, and the introduction of smart lighting. In particular, the Kaz PV consortium plans to finance the production of solar panels by attracting investments on the stock exchange AIX.

In accordance with the "state program for collecting (harvesting) and processing secondary raw materials in the Republic of Belarus", the first oil waste processing enterprise started its work in 2015. In 2013, the project "landscape approach to peatland management for multiple environmental benefits" was launched. The goal of the project was to promote a landscape approach to managing peatlands to conserve biodiversity, increase carbon stocks, and provide multiple ecosystem services with demonstration in the lake district landscape. In 2014, the project "conservation and sustainable management of peatlands in Belarus to minimize carbon emissions and help ecosystems adapt to climate change" was launched. This program is aimed at the conservation and effective use of Belarusian peatlands, and the application of innovations in climate mitigation and adaptation based on peatland ecosystems.

In 2014, the World Bank supported the "project of district heating of Belarus on biomass". The project consists of three components. The first component, "energy efficiency of district heating", includes a number of measures aimed at efficient use of energy in a number of district heating systems. It is planned to modernize existing thermal substations and build new ones in buildings with controlled temperature through the introduction of individual thermal substations, as well as the reconstruction or construction of district heating networks and the modernization of gas boilers with peak load. The second component, "biomass heat generation", includes the production of biomass boilers with a base load, small combined heat and power plants with biomass, and in some cities also wood-cutting equipment. The third component, "technical assistance", involves financing district heating companies participating in the project and supporting activities such as improving social accountability mechanisms and moving to energy-based biomass metric assessments.

Despite some progress in implementing the green economy concept, it should be noted that few Belarusian organizations are implementing their own green technologies. According to the National Statistical Committee in 2015, only 9.4% of organizations reduced energy consumption per unit of production, 4.6% of organizations processed industrial waste, water, or materials, 6.2% of organizations reduced energy consumption or energy loss, 1.9% of organizations improved the ability to process products after use, and 4.8% of organizations reduced air, land and water pollution, and noise (Zenchanka, 2017, 329).

Conclusions

The EU refuses to engage in dialogue with the EAEU because of Russia's desire to prevail in the organization and the use of protectionist methods (Kondratieva, 2018, 63). Nevertheless, the interdependence and complementarity of the EAEU and the EU allow expanding trade and economic partnership between the organizations. The volume of exports of the EAEU to the EU is 51%, the volume of imports is 41%, and therefore, the EU occupies a leading place in the export of the EAEU and the second after APEC in imports. The mutual trade turnover of the EAEU with the EU is in third place in terms of volume after the United States and China (Eurasian economic commission, 2017). The EAEU states recognize about 6 thousand EU standards for various goods, so they are exported to the markets of the Eurasian Economic Union without additional certification and control. The EAEU states supply raw materials and energy resources to the EU. For example, in Russia, most of the jobs focused on cooperation with the European Union were created in sectors related to gas exports to the EU: in particular, wholesale trade, transport (including pipeline), and mining (Markandya et al., 2016, 1348).

In turn, the EU can direct modern technologies and investments to the economic modernization of developing countries. The EAEU and the EU are potentially able to multiply the volume of mutual trade, as well as work together to create an environmentally friendly transport infrastructure (Tsvyk, 2018, 264). The EAEU's logistics hub is designed to link the EU, the Persian Gulf, and South-East Asia countries into a single transport corridor.

On the other hand, the EAEU countries need to carry out economic modernization, expand production in manufacturing industries, and introduce technological innovations. Today, it would be irrational for the Eurasian Economic Union to sign a free trade agreement with the EU, since the production of high-tech products in the EAEU is not able to compete with European counterparts.

Moreover, the transition to a green economy must take into account that the restoration of resources, regardless of the location and materials used, still requires manual labor. Work on segregation and sorting of materials is one of the most "dirty" and unskilled.

Building interaction should start with industry dialogues, which could be initiated by the EAEU. Priority areas of cooperation based on sectoral agreements could include logistics, technical regulation, customs administration, intellectual property protection, and general migration policy.

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CHAPTER 10

China's Direct Investment in Alternative Energy Sources in the EU

Inna V. Andronova and Daria S. Sokolan

Introduction

Over the past 30 years, China has managed to transform itself from a poor developing country into the second largest economy in the world, becoming a full-fledged competitor to the United States. Such rapid economic growth was accompanied by active development of production, industrialization within the country, and increased investment in the primary and industrial sectors of the economy. All of the above has led to the fact that China has become the world's leader in CO_2 emissions: in 2018, China accounted for 28% of the world's total CO_2 emissions (Global Carbon Atlas, 2020). As shown in Fig. 10.1, since 2008, China has increased its CO_2 emissions by 28% from 7378.5 megatons to 9428.7 megatons in 2018. At the same time, the United States and European countries reduced their emissions into the atmosphere by 9% and 14%, respectively, over the same period. From this figure, we can conclude that European countries are more efficient in reducing CO_2 emissions into the atmosphere. So, it is not surprising that in recent years, Chinese investors have become interested in the sector of alternative energy sources in the EU.

For a long time, the Chinese government has ignored criticism from developed countries urging China to pay more attention to environmental issues. This position is quite understandable, the Chinese government regarded such appeals from developed countries as a way to contain the economic development of developing countries (Ergenc, 2019). However, it should be noted

I. V. Andronova (✉) · D. S. Sokolan
Peoples' Friendship University of Russia, Moscow, Russia

E. B. Zavyalova and E. G. Popkova, *Industry 4.0*,
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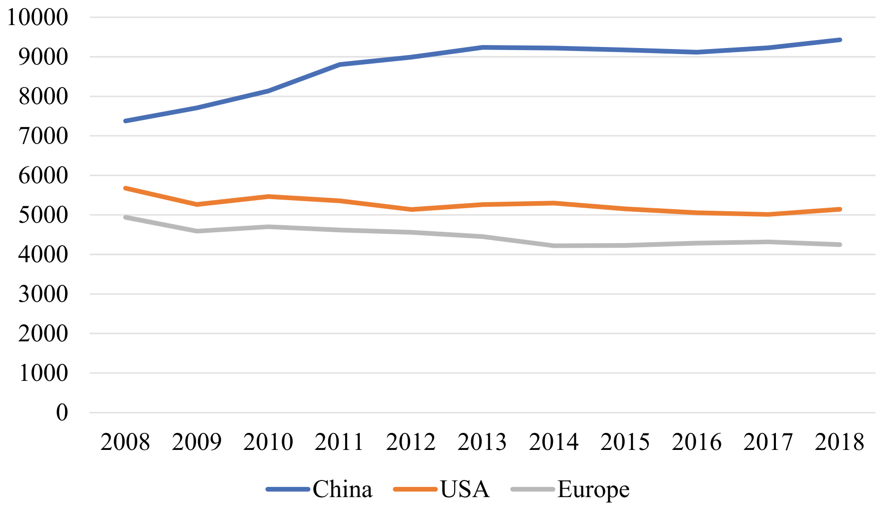

Fig. 10.1 Dynamics of CO_2 emissions in megatons per year in the United States and China for 2008–2018 (*Source* Compiled by the authors based on BP Statistical Review of World Energy [2019])

that in recent years the situation has changed and the Chinese government has almost completely reviewed its policy in the matter. This is clearly seen in the change in the sectoral structure of Chinese FDI abroad. If 10 years ago China actively invested in the oil extraction, coal mining, ores mining, and other heavy industries, today China is actively investing in the field of high technologies, including in the field of alternative energy sources (Andronova & Sokolan, 2019). As is well known, the developed countries of the EU are mainly concerned about the environmental problems and alternative energy. In this regard, the study of Chinese FDI in alternative energy sources in the EU countries is of particular interest to us.

Methodology

In the process of writing the article, authors used such empirical and theoretical methods as logical analysis, deduction, methods of generalization, and systematization. In addition, the authors used a statistical method and a graphical method to visualize the dynamics and structure of Chinese FDI in the EU.

Results

The Chinese government made first attempts to improve the environmental situation in the country in the early 2000s. The first law on renewable energy was passed in 2005 and later revised in 2009. The main purpose of the law was to increase the rate of use of renewable energy sources. Therefore, large Chinese companies have called for the active use of alternative energy through the establishment of feed-in tariffs and government financial support. In its 11 five-year plan (2006–2010), the Chinese government has set a target to increase the use of renewable and nuclear energy sources by 10% (Williams, 2014). Unfortunately, targets to increase the share of non-fossil energy were not met by the end of 2010. On June 12, 2007, the Chinese government decided to establish a National Steering Group to tackle climate change, energy conservation, and emission reduction. This group takes part in international negotiations and protects China's national interests by introducing international standards in industrial enterprises to solve climate problems (Xufeng, 2017).

More ambitious climate targets have been set by the Chinese government in just the past two years. In April 2019, Chinese President Xi Jinping said that the Belt and Road Initiative should not only stimulate global trade but should meet the criteria of "green and sustainable" (Molloy, 2019). At the end of September 2020, Xi Jinping announced China's goal at the UN General Assembly to meet to "peak CO_2 emissions by 2030 and achieve carbon neutrality by 2060" (McGrath, 2020).

China's commitment concerning to the environment is also confirmed by the fact that China's green bond market is one of the largest in the world. As part of the Belt and Road Strategy, China plans to issue One Belt One Road Green Climate Bond, which aims to refinance renewable energy, low-carbon and low-emission transport, and sustainable water development projects (Chan, 2018).

It is worth noting that China's desire to increase the share of renewable energy sources is also geopolitical. In this way, the Chinese government is trying to reduce the country's dependence on unstable regions that supply China with energy resources (Chiu, 2017).

Today, the Chinese government prioritizes investing in renewable energy sources not only because of external pressures, but also to solve the internal problem of air pollution. Since the renewable energy sector is most developed in the EU countries, it is not surprising why in recent years there has been an increase in Chinese FDI in this sector of the EU countries.

According to Fig. 10.2, until 2015, Chinese investors in the EU countries were more attracted by the traditional energy sector (FDI went to oil and gas companies). In 2008, the oil and gas sector of the EU countries accounted for almost 44% of all China's FDI in the EU (4.8 billion US dollars). In 2011, FDI in this sector of the EU countries reached its maximum: Chinese FDI accounted for more than 60% of all Chinese FDI in the EU countries (7.77 billion US dollars). In 2014, there was a significant increase in FDI in the oil and gas sector. By the end of the year, Chinese FDI in this sector accounted for 25% of all investments (6.62 billion US dollars). However, starting from 2015, the situation began to change.

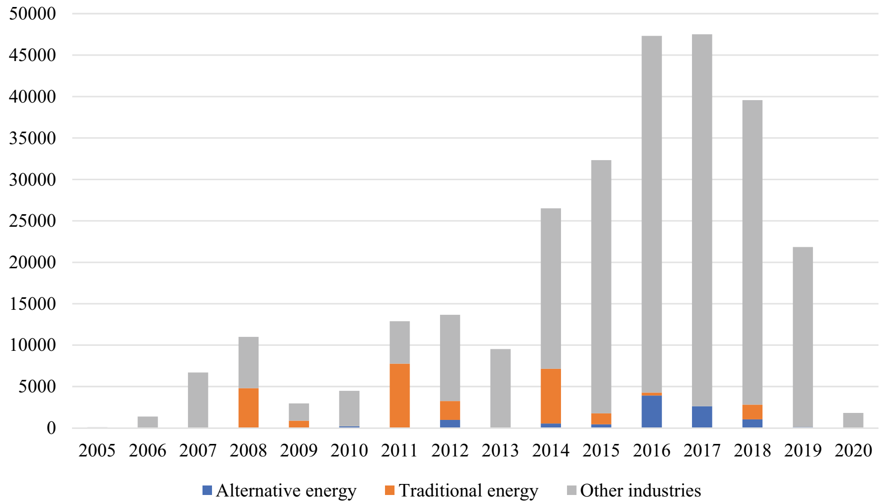

Fig. 10.2 Dynamics of the share of Chinese FDI in alternative and traditional energy in the EU countries for 2015–2020 (*Source* Compiled by the authors based on China Global Investment Tracker [2020])

The first Chinese FDI in the EU alternative energy sector was carried out in May 2010, accounting for 4% of the total Chinese FDI in the EU. Chinese investors have cut only one deal for 200 million US dollars in Italy. Moreover, in 2010, there was no FDI in the oil and gas sector. In 2012, there was a significant increase in investments in the alternative energy sector. By the end of 2012, FDI in this sector amounted to almost 1 billion US dollars (980 million US dollars), and their share in the total volume increased to 7.17%. However, despite the growth of FDI in this sector, the attractiveness of the oil and gas sector for Chinese investors remained high. In 2012, Chinese FDI in the traditional energy sectors of the EU countries was twice as high as in the alternative energy sector, amounting to 2.27 billion US dollars (16.61% of the total Chinese FDI in the EU). In 2014, there was another growth in Chinese FDI in the oil and gas sector: their share in the total volume increased to 25%, while the share of FDI in alternative energy sources fell to 2%. In 2015, the share of Chinese FDI in the oil and gas sector declined dramatically to 4.08%. A similar negative trend continued in 2016, when the share of FDI in this sector reached 0.74%, and in 2017, there was no FDI in the oil and gas sector from the Chinese side. The current trend can be explained by the fact that, since 2015, the Chinese government has actively proceeded to implement the strategy "Made in China 2025". In accordance with this strategy, the priority in making investments has shifted from the primary sector to the high-tech sector, including to alternative energy sources. In this strategy, it is important to pay attention to the fact that among the 10 new priority industries in which China plans to achieve world leadership, we can find such important sectors for the environment as energy-saving technologies, high-tech ships, and new materials. The implementation of this strategy was not long in coming, and already in 2016, the share of China's FDI in alternative energy sources rose to 8%, and investments in this sector amounted to a record 3.9 billion US dollars. In 2017, FDI in alternative energy sources decreased slightly to 2.6 billion US dollars. At the end of 2018, FDI amounted to only 1 billion US dollars. The decline in FDI in the sector of alternative energy sources was observed against the background of an overall decline in Chinese FDI in the EU during this period. In 2019, there was only one deal in the renewable energy industry worth 110 million US dollars.

Over the past ten years, China has cut only 20 deals in the field of alternative energy in the EU countries worth about 10 billion US dollars. Seven of the twenty deals were concluded under the One Belt and One Road Initiative. In eight out of twenty deals, Chinese investors bought more than 70% of the shares of European companies. The largest number of deals was made in the UK (5 deals), Germany (3), Italy (2), and Portugal (2). However, in terms of the amount of investments, Germany became the leader in attracting Chinese FDI in this sector, to which 3.6 billion US dollars was directed (Fig. 10.3). Greece took second place in terms of Chinese FDI (1.6 billion US dollars), and only in third place was the UK (1.4 billion US dollars).

Let's learn more about the largest deals of China in the EU countries in the sector of alternative energy (Table 10.1). First of all, it is worth starting with the largest deal in Europe in terms of value in the alternative energy sector of all time. In 2017, the Chinese state-owned China Energy Investment

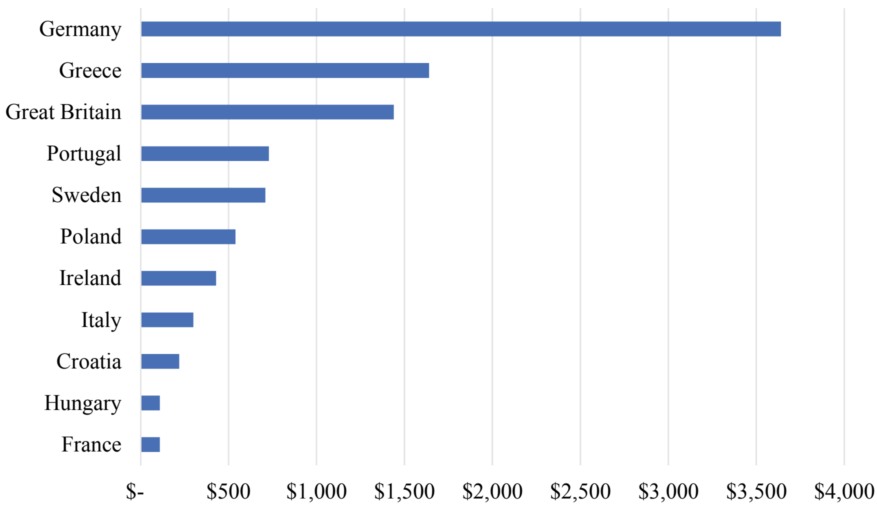

Fig. 10.3 Distribution of the amount of Chinese FDI in the alternative energy sector by EU countries for 2010–2020 (*Source* Compiled by the authors based on China Global Investment Tracker [2020])

Table 10.1 The largest deals of China in the EU countries in the field of alternative energy in 2010–2020

	Year	*Investor*	*Quantity in millions US dollars*	*Share size (%)*	*Transaction party*	*Country*	*BRI*
1	2017	State Energy Investment	1640	75	Copelouzos	Greece	+
2	2016	Beijing Enterprises	1590	100	EEW	Germany	–
3	2016	Three Gorges	1540	80	WindMW	Germany	–
4	2017	China Resources	740	30	Dudgeon Holdings	Britain	–
5	2018	China General Nuclear	710	75	Macquarie & GE	Sweden	–

Source Compiled by the authors based on China Global Investment Tracker (2020)

Corporation Ltd bought 75% of the shares of the largest Greek investment company Copelouzos Group. The deal was valued at 1.64 billion US dollars. Moreover, the deal was carried out within the framework of the One Belt One Road Initiative (BRI). China Energy Investment Corporation Ltd is the largest conventional and renewable energy company in the world and the largest coal producer in the world. It is important to note that the company was founded in November 2017; at the same time, this deal was made. Also, this deal was actively supported by the Chinese government.

The Copelouzos Group, in turn, is one of the largest investment groups in Greece, whose activities are related to energy, infrastructure, marketing, tourism, etc. The Chinese state corporation was more interested in the activities of the Greek company in the construction of wind farms and energy-saving installations. The cooperation between these two companies focused on improving the ecological situation (Copelouzos Group, 2020). As a result of the deal, the Chinese company gained access to four wind farms. Moreover, the Greek side was extremely interested in the deal and assumed that the deal would contribute to the development of three other wind projects of the company (Energypress, 2019).

The second largest renewable energy deal was concluded in 2016 in Germany between the Beijing Enterprises Holdings Limited (BEHL) and the German waste disposal company Energy from Waste (EEW). The Chinese company bought EEW for 1.59 billion US dollars. Beijing Enterprises is a Chinese state-owned conglomerate with core business covering city gas, water treatment, and solid waste treatment (Beijing Enterprises Holdings Limited, 2020). To date, the Chinese company owns foreign assets around the world: shares in water treatment projects in Malaysia, Australia, and Portugal, leading energy from waste projects in the Netherlands, Germany, and Luxembourg. Energy from Waste (EEW) is Germany's leading company for the production of electricity from thermal waste treatment. It owns 18 recycling and power plants in Germany and neighboring countries. It is also worth noting that the company has a significant share of 18% in the German waste-to-energy market (EEW Energy from Waste, 2020). As a result of the transaction, the Chinese company received 100% of the company's shares, access to 18 factories, as well as access to the latest technologies in the field of waste processing. For 2016, this deal was China's largest acquisition in Germany. For China, this is a very important deal, since about 7 billion tons of waste are buried in China, which needs to be recycled (Schuetze, 2016).

In June 2016, there was another major deal in Germany between China Three Gorges Corporation (CTG) and WindMW. The deal cost the Chinese company 1.54 billion US dollars, which allowed CTG to acquire a controlling 80% stake in the company. China Three Gorges Corporation (CTG) is a state-owned company specializing in hydropower and the development of new energy sources (solar, wind). It is the world leader in clean energy production (China Three Gorges Corporation, 2020). German company WindMW is engaged in the planning and construction of offshore wind farms (WindMW, 2020). Despite the growing panic in the EU about Chinese takeovers, the deal was approved by the German government. Until 2016, the American investment group Blackstone Group owned a controlling stake in the German company. The interest of the Chinese company is explained by the fact that China Three Gorges Corporation was interested in diversifying its activities and the desire to go abroad (Reuters Staff, 2016).

The fourth largest deal of China in the alternative energy of the EU countries was the purchase of 30% of the British Dudgeon Holdings in 2017. The buyer was a diversified conglomerate China Resources. The deal cost the Chinese conglomerate 740 million US dollars. Dudgeon Holdings is an offshore wind farm capable of generating clean energy for 410,000 UK homes (Dudgeon Offshore Wind Farm, 2020). Through this deal, the Chinese conglomerate plans to get the necessary experience and technology of offshore wind farms for their use in China. In addition, the Chinese company is interested in increasing its international status.

The fifth largest Chinese acquisition in the field of alternative energy in the EU was made between China General Nuclear Power Group and the Australian company Macquarie & GE. As a result of the deal, the Chinese company received a 75% stake in the Swedish wind farm. The deal was completed in July 2018 and cost the Chinese side 710 million US dollars. China General Nuclear Power Group is the largest nuclear power producer in China. The company's activities are focused on nuclear, wind, and solar energy (CGN, 2020). The Macquarie Group is an Australian investment company, and GE Energy Financial Services is the financial and technology investment department of General Electric (US company). As in previous operations, the Chinese company was interested in gaining access to technology and in this case also access to Europe's largest wind power project at the North Pole (Reuters Staff, 2018).

Analysis of the top five largest acquisitions of Chinese companies in the alternative energy sector of the EU countries showed the following:

- Deals in this sector are carried out by Chinese state corporations;
- Chinese companies are interested not only in obtaining technologies, but, also, in expanding areas of activities of national companies;
- The alternative energy sector of the EU countries needs financing; therefore, Chinese investments are actively supported even by the governments of European countries;
- The largest Chinese FDI goes to wind and recycled energy companies.

Conclusions

In summing up, it is worth noting that despite the existing criticism of the Chinese government's policy in the field of environmental protection, nevertheless, in recent years, significant steps have been observed to solve the environmental problem of CO_2 emissions. Over the past fifteen years, the Chinese government has already consistently introduced ecological goals into the five-year plans. These goals relate to increase the share of alternative energy in total energy consumption. Moreover, the Chinese government has ranked energy-saving technology in the top 10 promising industries of the "Made in China 2025" program. In addition to this program, we should not forget about the well-known initiative "One Belt One Road", which assumes close cooperation between China and other countries, not only in trade and economic terms, but also in the field of alternative energy. Over the past 10 years, China has made investments in alternative energy in the EU countries worth about USD 10 billion. China is interested in this sector, as it has ambitious plans for the future to reduce dependence on energy resources of other countries. China aims to become the world's leading high-tech producer in the near future, while increasing the share of alternative energy to 40%. Moreover, China is trying to solve the internal problem of accumulating waste that needs to be recycled. Over the past five years, public corporations in China have been actively investing in wind farms in EU countries, as well as in waste recycling companies. It should be said that in this sector there is practically no resistance from the governments of European states. European companies are not only supportive of FDI from China, but also expect further cooperation with their Chinese counterparts in the field of alternative energy.

On the one hand, Chinese FDI in alternative energy of the EU countries undoubtedly has a positive impact. Firstly, because alternative energy sector is constantly in need of money. Secondly, because China gains access to new technology. On the other hand, in the near future, China has every chance of ousting European companies in the field of alternative energy and taking the place of a global "green" power. This is certainly good for the environment; however, economically, European companies are losing their competitive advantages and giving way to Chinese ones.

Acknowledgments This paper has been supported by the RUDN University Strategic Academic Leadership Program.

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CHAPTER 11

India in the System of International Migration: Ecological Aspects of the Population Movement

Yulia A. Konovalova, Sayar Ahmad Reshad, Pason Abdul Jabar, Amar Mangal, and Yancha Tuasa Segundo Elías

Introduction

For the last 70 years, the global economy's landscape has undergone rather significant and deep changes. Fall of the Colonialism regime led to the development of the broad set of new sovereign states that have been suffering from the different and deep structural problems.

In fact, the scientific interest in the developing and less-developed countries of the South Asia has appeared only in the second half of the twentieth century. It needs to underline that scientific investigations of the second half of the twentieth century in regard to developing countries covered, mainly, issues of the Western Europe security in the economic area and the threaten of the ideas of communism. At the same time, there was the assurance that the developing countries just after the Colonialism regime's fall would follow in the footsteps of the Western political approaches and would develop in capitalist countries. Unfortunately, the host of economic development approaches and theories did not lead to the development of the unique and universal theoretical approach to the developing countries and the economic models that they have to implement.

It needs to underline that the fall of colonialism regime became the point of no return that caused not only economic reforms, but social, that were reflected in attempt to solve the problem of the demographic boom or demographic outburst.

Y. A. Konovalova (✉) · S. A. Reshad · P. A. Jabar · A. Mangal · Y. T. S. Elías
RUDN University, Moscow, Russia
e-mail: konovalova_yua@pfur.ru

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It is rather hard to underestimate and not to take into account the influence of the demographic outburst on the social and economic situation of the Asian countries that have been connected with the high growth of cities, high growth of ghettos and poverty. So the key task of the Indian government was to control the rate of the population growth. As the result, the almost uncontrolled growth of the population led to the migration, connected not only with the economic and social conditions, but the environment problem as the result of industrialization and lack of garbage utilization and the culture of nation.

Nowadays, it is rather important to understand and to take an attempt to find out reasons, background and consequences of the environment migration in India in connection with the economic security of the country.

Materials and Method

From the scientific point of view, there are a lot of investigations, articles, and books that are dedicated to the issues of international migration, social and economic problems, demographic aspects, and so on. There are a lot of scientific institutions that are specialized on the listed issues and developing countries, as well.

Issues of the developing countries, issues of international migration, and Indian Republic, as well, are emphasized in the works Yu. A. Konovalova (2018, 2019), G. N. Ochirova et al. (2019), N. V. Galishcheva (2018), E. A. Bragina (2015), and A. S. Lukyanets et al. (2020).

At the same time, it needs to underline and understand the fact that, there is a lack of Indologists in Russia, and there is a lack of scientific investigations dedicated to the social and economic problems of India, and the problems of integration of India into the global economy and international economic relations.

Issues of environment/ecological migration and the participant of the Indian Republic in the international migration process are emphasized in the works Ingrid Boas (2012), Nishikant Singh (2018), Meena Dhanda (2013), and Kunal Keshri (2020).

In spite of the presence of the scientific investigations dedicated to the issues of ecological/environment migration, it is rather hard to calculate correct and impersonal data and to develop the correct and actual results.

Results

International migration, as one of the types of international economic relations, is having more and more attention and role in the global economy.

At the same time, it is known that quantity and quality indicators of these types of international economic relations are re-estimating all the time in spite of the broad and advantage set of statistical tools and methods.

In accordance with International Organization for Migration (World Migration Report, 2020),[1] the number of international migrants by the first estimation of 2020 is about 272 million, and 75% of them are labor migrants. At the same time, the share of international migrants has to made up around 3.5%. By the estimation of IOM, the total number of international migrants could amount to 230 million people to 2050. Talking about the leading country by the indicator of total population and especially about India, this Republic has the biggest number of international migrants—in 2020, this indicator made up 17.5 million people. For the comparison, in 2017 this indicator made up 16.5 million people. Traditionally, developing countries prevalence in the directions of the Indian migrants.

According to the last Census of India, the number of immigrants who arrived to India during the period of 10 years (2001–2011) increased from 314.5 million people to 453.6 million people. Talking about the sex structure of arrived migrants it needs to say that in 2001 the total number of arrived women made up—221 million people, in 2011 this indicator increased to 312.7 million people. Factors that are in the basis of displacement by sexes are rather different (in 2011): Usually, they are connected with job-seeking, came to India after the birth, displacement with households, business issues, to get an education, to get married, other reasons.

One of the most significant characteristics of the Indian migration process for the period of 5 years (from 2012 to 2017, for example) is prevalence of immigration over the emigration, in 2017 this indicator made up (–2.4 million), number of international migration in India amounted to 16.6 million.

Analysis of the Indian emigrant abroad showed the prevalence of 9 determined countries as the key directions for the displacement for different reasons, and as usual, for the job-seeking: In 2015, this indicator made up 2.8 million people in Saudi Arabia, 2 million people in UAE, 1.27 million in United States, 0.76 million in Kuwait, 0.71 million in Oman, 0.06 million in Nepal, 0.6 million in Qatar, 0.35 million in Bahrain, 0.35 million in Singapore. One of the most popular and important factors that are laid in the reason for the Indian displacement is the low level of wages in the national economy (Konovalova, 2019).

Analysis of Indian emigration showed that in 1990 81.1% of Indian emigrants were accumulated in Asian countries, 43.41%—in Pakistan, 13.49%—in Saudi Arabia, 5.5%—in Nepal, 6.82%—in UAE; 7.9%—in European countries, 5.95%—in the UK, 9.19%—in North America, 2.48%—in Canada, and 6.7%—in the United States.

In 2017 proportion of Indian emigration by countries was the next one: The share of Asian countries made up 70.95%, the share of Australia made up 2.5%, of United States—13.9%, of Canada—3.6%, of Pakistan—11.3%, and of

[1] https://www.un.org/en/development/desa/population/migration/data/estimates2/estimates19.asp - World Migration Report, 2020 (Access data: 25.10.2020).

Nepal—2.7%. It means that the shift has happened to the direction of more developed countries.

Analysis of the international migrants' inflows into India showed that in the period 1990–2017 the share of immigrants from Bangladesh increased from 58.39 to 60.5%: Share of immigrants from Pakistan declined from 25.64 to 21.11%; Nepal—increased from 6.92 to 10.36%; Shri Lanka—2.29% - 5.07% (Table 11.1).

Talking about the directions and geography of the international migration it needs to say that the European and Asian countries accumulated 82 million and 84 million of international migrants, it is about 61% of the total global international migrant stock combined. Meanwhile, United State has been the main country of destination for international migrants since 1970, at the same time India stays the country of international migrants' origin. In 2018 India, China, Mexico, the Philippines and Egypt were the TOP-5 remittance recipient countries, although India and China were well above the rest, with total inward remittances exceeding USD 67 billion for each country (Table 11.2).

At the same time, the value of international remittances increased from USD 126 billion to USD 689 billion for the last 20 years and confirmed the fact that the international migration is the driver of development for the less-developed and developing countries. For the same period (from 2000 to 2020) the total number of international migrants increased from 150 to 272 million (in 1.8 times), and the share of international migrants to the total population increased from 2.8 to 3.5%. The share of female migrants is staying almost on the same level 47.5–47.9%. It has to be underlined that the majority of migrants do not cross borders and stay within the country or the region (about 740 million internal migrants in 2009). It means that the growth of international migrants has not been unexpected.

Since 2010 Indian Republic took the first place as the key global receiver of remittances. Of course, it can be connected with the great Indian population, integration of Indian population into the integration migration process, the status of the English language as the second official language in India beside the Hindi, and the broad set of social and economic problems of the national economy that made people move abroad.

In accordance with Internal Displacement Monitoring Centre (IDMC),[2] statistical data are categorized by 2 broad displacement causes: disasters, and conflict and violence. Meantime, Center confirms the challenges connected with differences between disasters and conflict as the immediate cause of displacement, and highlights the growing need to identify better ways to report on displacement in the context of multiple drivers.

[2] https://www.internal-displacement.org/sites/default/files/publications/documents/2020-IDMC-GRID.pdf—Internal Displacement Monitoring Centre, Global report on international replacement (Access data: 25.10.2020).

Table 11.1 Geography and dynamics of countries supplying migrants to India from 1990 to 2017 (people)

	Country of origin of migrants									
	Total	*Bangladesh*	*Brunei Darussalam*	*China*	*Malaysia*	*Myanmar*	*Nepal*	*Pakistan*	*Shri Lanka*	*UAE*
1990	7,493,204	4,375,155	16,220	18,165	12,295	85,706	518,212	1,921,278	281,720	9,940
1995	6,952,238	4,127,135	23,639	13,430	13,758	73,795	591,200	1,637,255	235,785	12,301
2000	6,411,272	3,879,114	31,057	8,695	15,220	61,884	664,187	1,353,231	189,850	14,662
2005	5,923,642	3,584,076	28,695	8,034	14,063	57,177	613,671	1,250,307	175,411	13,547
2010	5,436,012	3,289,037	26,333	7,372	12,905	52,470	563,154	1,147,382	160,971	12,432
2015	5,240,960	3,171,022	25,388	7,107	12,442	50,587	542,947	1,106,212	155,195	11,986
2017	5,188,550	3,139,311	25,134	7,035	12,317	50,081	537,517	1,095,149	153,643	11,866

Source Compiled from data https://www.un.org/en/development/desa/population/migration/data/estimates2/estimates17.asp—UN, Integration migrant stocks, 2017 (Access data: 25 October 2020)

Table 11.2 Top countries receiving remittances

2005		*2010*		*2015*		*2018*	
China	23.63	India	53.48	India	68.91	India	78.61
Mexico	22.74	China	52.46	China	63.94	China	67.41
India	22.13	Mexico	22.08	Philippines	29.8	Mexico	35.66
Nigeria	14.64	Philippines	21.56	Mexico	26.23	Philippines	33.83
France	14.21	France	19.9	France	24.06	Egypt	28.92
Philippines	13.73	Nigeria	19.75	Nigeria	21.16	France	26.43
Belgium	6.89	Germany	12.79	Pakistan	19.31	Nigeria	24.31
Germany	6.87	Egypt	12.45	Egypt	18.33	Pakistan	21.01
Spain	6.66	Bangladesh	10.85	Germany	15.81	Germany	17.36
Poland	6.47	Belgium	10.35	Bangladesh	15.3	Viet Nam	15.93

Source World migration report—2020. URL: https://publications.iom.int/system/files/pdf/wmr_2020.pdf (Access data: 25 October 2020)

In accordance with IDMC, countries of the South Asia region accumulated 9.5 million new displacements connected with disasters (2019), it is the highest figure since 2012.

In 2019 India took the first place as the region of new displacement because of disasters (5.02 million of 25.85 million). Much of the new displacement that has been in 2019 took place in the form of pre-emptive evacuations. Cyclones «Fani» and «Bulbul» caused more than 5 million in India and Bangladesh alone. India, China, and the Philippines are among the countries to record most disaster displacement worldwide each year. At the same time, disasters are not the only reasons for the displacement, for example, migration from Afghanistan to Bangladesh and from India to Sri Lanka has been connected with conflicts.

From 1947 and the period of industrial reform implementation, increasing of inflows of the rural population to the cities and the growth of ghettoes and ghettoes near-by-cities, the process of new towns and cities appearance activated.

Nowadays the absolute leader in terms of urban population is China (837 million), India took the second place (461 million), the third place—United States (269 million). Today India is leader in terms of rural population—893 million, China took the second place—578 million.

For the period from 1950 to 2018 total population of India increased more than in 3 times, and in 2018 made up about 1.3 billion (from the very beginning of twentieth century total population of Indian increased in 6 times, so it led to the increase of social and economic burden), the level of urbanization at the same period increased in 2 times and made up 34%. There are 5 mega polices in India today (2018), and one more 2 cities could get this status to 2030.

India has rather diversified system of urbanization, it means that the key feature of India is prevalence of small and middle cities and towns with the parallel decrease of big cities: Less than 20% of urban population are living in mega polices and more than 50% of urban population are living in cities with the population less than 1 million.

Such cities as New Delhi and Mumbai are administrative and financial capitals of India accumulated on themselves near-by-capitals territories and promoted the appearance not only ghettoes but the biggest agglomerations. At the same time, the key reason why such cities as Bangalore and Chennai attracted inflows of population is the status of innovation centers.

In accordance with the last Census of India in 2011, the number of towns amounted to 7933, the number of villages amounted to 640,932 (43.3 thousand of which are uninhibited, the number of households—249.5 million (Table 11.3).

Growth of total population and inflow of population to the cities and connected problems, from the theoretical point of view, are connected with the «vicious circle», the concept of which is in the connection between increasing of demographic indictors and the influence on the economic condition. It means that uncontrolled growth of population could lead to the additional burden on the national economy, social support, industrial environment and ecosystem, could lead to the environmental degradation, pollution of water and rivers, and so on.

The growth of Indian cities is connected with the internal migration from the Indian villages to the towns and cities as well, firstly, because of the low level of wages, living conditions, and unemployment aspects. Increase of the demographic burden on cities is leading to the degradation of living conditions, growing of the burden on the economic and social condition, on infrastructure, on sewage treatment plants, environment, garbage, and so on. At the same time, migration from villages to cities leads to the exclusion of land from the using, decreasing of agriculture production and the share of agriculture sector in the GDP of India, increasing of unemployment in villages, and so on. For example, as the result of industrialization and migration of population from villages to cities in the period from 1950 to 2015 the share of agriculture decreased from 60 to 14–15%.

India is not unfamiliar with heavy monsoon rains and floods, so the influence of the nature disasters and cataclysms on the Indian is one of the most important reasons for the internal migration called environmental migration, the number of which is rather hard to calculate correctly. Traditionally monsoon rains and floods affect the South and South-East side of the country.

In accordance with the last one, data of the first half of 2020 cyclone Amphan were the largest single displacement event in the first half of 2020, triggering 3.3 million pre-emptive evacuations in India and Bangladesh. And India is still the leader on the number of new displacements in the first half of 2020 caused by the disasters (2.6 million), the second one is Bangladesh (2.5 million), the third—Philippines (811 thousand).

Table 11.3 Dynamics of the urban population in India by determined cities (1950–2035; thousand)

	1950	*1960*	*1970*	*1980*	*1990*	*2000*	*2010*	*2015*	*2020*	*2025*	*2030*	*2035*
Ahmedabad	855	1,181	1,695	2,484	3,547	4,815	6,250	7,109	8,059	9,062	10,148	1,295
Bangalore	746	1,166	1,615	2,812	4,043	5,581	8,296	10,141	12,327	14,395	16,227	18,066
Chennai	1,491	1,915	3,044	4,187	5,332	6,593	8,506	9,677	10,971	12,336	13,814	15,376
New Delhi	1,369	2,283	3,531	5,587	9,384	15,692	21,988	25,866	30,291	34,666	38,939	43,345
Hyderabad	1,096	1,241	1,748	2,487	4,193	5,650	7,531	8,697	10,004	11,338	12,714	14,152
Kolkata	4,604	5,910	7,329	9,100	10,974	13,097	14,003	14,423	14,850	15,845	17,584	19,564
Mumbai	3,089	4,415	6,413	9,200	12,355	16,147	18,257	19,316	20,411	22,089	24,572	27,343
Pune	581	777	1,105	1,642	2,430	3,667	4,960	5,746	6,629	7,526	8,442	9,396
Surat	234	311	477	891	1,466	2,706	4,445	5,671	7,185	8,582	9,711	10,813
Other	18,346	25,142	35,252	51,102	71,328	95,150	123,072	140,657	160,961	182,309	204,448	227,565

Source Compiled from data https://population.un.org/wup/DataQuery/—UN, Population Division (Access data: 25.10.2020)
Notes https://population.un.org/wup/DataQuery/
Next step to determine the indicator - we select Annual Population of Urban Agglomerations with 300,000 or more in 2018 (thousands)
Then - we select Country - India
Then we select years from 1950–2035
And we get the table with the final results
Everithing is correct

Growth of the actuality and the importance of the climate changing issue is proved by the evolution of the global climate policy. In spite of the presence of many different climate changing policies, UN included issues of climate and environment in the list of Goals of development only in 2015.

In spite of the economic and social achievements as the results of industrial and economic reforms, for the last 10 years India has become one of the most uncomforting place for living, especially in relation to the urban issues. For example, in accordance with Environmental Performance Index India (2020) took the 168 position in these rating from 180 positions, it means that the situation is rather complicated.

Nowadays, air quality is the largest environmental threat to human health, unfortunately, in accordance with Environmental Performance Index (2020) India and Pakistan place last in this issue category, joined in the bottom tier by Bangladesh and Nigeria—all countries with enormous populations. At the same time, India's emissions continue to increase in spite of the fact that investments in renewable energy is growing. India still remains heavily reliant on coal-fired power generation to support its rapid urbanization and economic growth, which has resulted in high levels of air pollution and associated casualties. Moreover, India, China together emit more than half of the world's nitrogen pollution, they will need to make sharp increases in efficiency to reduce pollution. One of the biggest omissions is ineffective implementation and development of environment policy, no improvement in India's overall environmental performance over the past decade.

Conclusion

In conclusion it needs to underline the fact that process of migration in and out of India, as usual, is connected with different factors, such as social and economic conditions, interests to get marriage, to find a job, to get education, and so on. One of the most significant characteristics of the Indian migration process is connected with the factors of internal movement and the great role of climate changes and environment, such as disasters, monsoons, rains, and so on. At the same time, it is not hard to estimate the influence on internal migration caused by environment changes and factors on the economic condition of the region. In spite of the fact that the South and South-East region border with the international waters (bays and ocean) and influence of environment changes, States and Unions are included in the Indian GDP fully. One of the biggest omissions is ineffective implementation and development of environment policy, no improvement in India's overall environmental performance over the past decade. So it needs to pay much more attention to the efficiency of environment policy implementation.

At the same time, it needs to underline rather low level of environment culture and inadequate measures for the behavior culture development and implemented actions in these directions. Environmental pollution is almost traditional problem of the great agglomerations, such as Mumbai. Population growth and industrial development and output are the burden for the Indian territory that needs more radical actions to be saved. India is in the TOP-5 of CO_2 emissions (China took the first place– 28.8% of the stock volume of emission globally), the share of United States made up—14.5%, of EU—9.7%, of India—7.3%. During the period of 2017 – 2019, the growth rate of CO_2 emission increased by 1.1%. Growth of CO_2 emission, plastic goods and packaging, water and air pollution, and so on, connected with the GDP output growth and raw materials import and processing, but led to the ecological catastrophe, that needs immediate solution.

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CHAPTER 12

Global Challenges of the Beginning of the Digital Age and a Green Perspective for the Development of the Kyrgyz Republic's Economy (Institutional and Industrial Aspects)

R. Sh. Bazarbaeva, Natalia A. Brovko, and Marina V. Safronchuk

Introduction

The current global challenges discussed in this article are related, firstly, to climate change and critical environmental pollution, which gave rise to the concept of sustainable development. Secondly, the 4th industrial revolution and the beginning of a digital transition are unfolding in the world. At first glance, it would seem that these phenomena are not related. However, in the course of analyzing these problems, the authors saw a connection between them, both direct and indirect. First of all, these global processes change a person's life and affect his health and well-being. In particular, both vectors of global changes (natural and technological) affect the labor market, restructuring the structure of employment, at the first stage can reduce employment itself and the income of the population. On the other hand, the development and implementation of digital technologies is designed to solve human problems, taking into account his system of values. This article examines not only the consequences of climatic and technogenic changes in the Kyrgyz republic, but also attempts to develop some directions for solving these problems, taking into account the natural, economic, and geopolitical capabilities of this country at the present stage.

R. Sh. Bazarbaeva (✉) · N. A. Brovko
Kyrgyz-Russian Slavic University, Bishkek, Kyrgyz Republic

M. V. Safronchuk
Moscow State Institute of International Relations (MGIMO University), Moscow, Russia

E. B. Zavyalova and E. G. Popkova, *Industry 4.0*,
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The paper shows the results of the analysis of the impact of climate change. First of all, this is a reduction in freshwater reserves and used water resources, as well as disruption and reduction in agricultural production, primarily crop production in many countries of the world, shaping the problem of using traditional energy sources. Of course, all these and other issues are under the siege of UN programs for the implementation of the sustainable development goals, including financial assistance. But according to the authors, it is vitally important for the countries of the post-Soviet space to simultaneously find independent and nationally oriented directions and approaches to solving these problems, but necessarily using the developments of the institutional framework and the experience of the world community.

Climate change in the Kyrgyz Republic affects access to water resources, food supply (foodstuff), affect health and environment, land utilization. Based on expert estimates, this is expected that 95% of glaciers in the KR will disappear by 2100, which means that there will be a lack of water, both in the Kyrgyz Republic and in other countries that are located downstream of the rivers. The reduction in water flow in the Naryn cascade "will have a negative impact on hydropower production. Among other possible consequences, the melting of glaciers will increase the likelihood of floods and landslides" (Forum, 2013). According to preliminary estimates of experts, direct economic damage to the country each year in the water supply sector by 2100 will amount to USD 700 million, and in the agricultural sector—USD 70 million (Report of the UN, 2019).

The way out of this situation for many countries is to develop renewable energy industries, taking into account their geographic and country characteristics. The Kyrgyz Republic, according to the authors, could successfully develop solar and wind energy and create solar and wind farms. A useful example of the current trend is the joint project of Finland and the Estonian energy concern Eesti Energia—the Tolpanvaara wind farm in Finland with good wind conditions.[1] To organize and attract funding to Kyrgyz Republic, it would be possible to study the strategic experience of the European Union, embodied in the "European Green Deal" (Koutsokosta & Guseva, 2020). Within the framework of this strategic project, the industries needed for support are identified and mechanisms for their financing are developed. The Kyrgyz Republic could use this experience within the EAEU.

Due to the fact that the most important sector of the Kyrgyz economy is agriculture, which employs almost 32% of the labor force, there is a real danger of losing work for farmers. Moreover, one can hardly count on replenishment by imports, since such negative phenomena will affect many other countries—exporters of agricultural products—crop and livestock.

[1] V Finladiipostroyatvetroparkmoshnostiyu v 100 megavatt. energetika I promishlennost Rossii. (2020, September 14). Electronic resource. https://www.eprussia.ru/news/base/2020/95297.htm.

In modern conditions all over the world, the contradiction between the achievement of ecological balance and the development of the labor market is becoming more acute. There are two trends. On the one hand, environmental pollution has a negative impact on the labor market and employment. On the other hand, measures taken at all levels to improve the environment lead to the development of a market for environmental work, goods and services and contribute to the creation of "green jobs". With the emergence of such professions as, for example, "specialists in the field of solar and wind energy, organic agriculture, environmental managers, IT ecologists, environmental engineers, urbanists, etc." (Voikina & Potravny, 2018) green jobs are expected.

Agriculture is the main component of a green economy, aimed at meeting the needs of society, without jeopardizing the ability of future generations to use ecosystem products and services. For Kyrgyzstan, the development of organic or ecological agriculture, as a system that maintains soil and ecosystem health, and uses science and innovation to improve the state of the environment, offers great opportunities. It is important to understand that organic farming is based on technologies that make the most of the properties of self-regulating systems. In this regard, trained specialists who are able to create and manage these systems are very important. According to experts, the world market for organic agriculture products is constantly growing. The main consumers are the countries of Western Europe and North America. Kyrgyzstan, possessing sufficient areas of organic agricultural land (7565 hectares), water resources and inexpensive labor could become a supplier to these countries of such products as cotton, chickpeas, beans, apricots, medicinal herbs, prunes, walnuts, potatoes. However, the lack of modern technologies for cultivating land and improving the culture of agriculture does not yet provide an opportunity to develop this sector of the economy in the country. In addition, the regulatory and legal framework is imperfect, the system of inspection, certification and accreditation, database, marketing and monitoring is insufficient, and there is a low level of farmers' awareness. Digital farms and the platform method in agriculture could address these issues in the best way. For example, the creation of crop platforms, in which farms and agricultural holdings could participate, both with the participation of mixed capital (private and state), and with the participation of foreign partners (near and far abroad). At present, organic farms in the republic are represented only by three large agricultural cooperatives, ten organic aimaks uniting 23 villages, as well as 1,700 economic entities that could be involved in digital agricultural production. But here the question arises of specialists and the appropriate technology, which requires organizational efforts on the part of the state.

Provided that a targeted policy of transition to a green economy is carried out in the Kyrgyz Republic, economic, social, and environmental benefits can be achieved. During this transition, the jobs of individual enterprises will naturally be reduced or transformed, especially in those sectors that are most associated with the use of carbon. In Industry 4.0, it is being replaced by carbon plastic and carbon fiber, from which the blades of wind power plants and solar panels are made, as well as other super-strong and at the same time lightweight structures that are used in nuclear power and many other industries. By the way, the development of solar energy in the Kyrgyz Republic will also present an increased demand for composite materials. In most countries, such enterprises account for 10–20% of jobs.

At the same time, new markets, new businesses and jobs may emerge. As, for example, for the production of the same carbon fiber and other composite materials. It should be noted that within the framework of Industry 4.0, with the development of trends for renewable energy sources, carbon-free energy, and "green" fuels, form the demand for composite materials (Resolution, 2012). The composites market receives opportunities for rapid growth and with it the corresponding segment of the labor market. At the same time, the growth of industries using composite materials and replacing traditional materials (reinforced concrete and metals) is stimulated. It is important that these are strategic industries for the entire EAEU—in addition to all types of energy, these are aviation and space, shipbuilding, infrastructure, defense industry, etc. Thus, an intersectoral synergistic effect can be formed not only on the territory of the Kyrgyz Republic, but also within the commonwealth.

The main trends in green employment include: the formation of new areas of economic activity related to the preservation of the environment, the rational use of natural and energy resources, the reduction of greenhouse gas emissions, the introduction of environmental technologies, with the processing and disposal of waste, the production of environmentally friendly products—green entrepreneurship, and entrepreneurship in the field of environmental protection, which creates the conditions and prerequisites for the emergence of new green jobs.

The formation of an environmentally friendly and low carbon economy in modern conditions largely depends on the institutional environment, which can create favorable conditions for environmental and economic activities. At the national level, it is necessary to develop a national model of a green economy, taking into account the introduction of indicators of a "green" economy and its integration into the education system, fiscal institutions, etc. The developed national policy on the introduction of the concept of "green jobs" and "green entrepreneurship", their statistical measurement in practice, based on specific needs, and the use of data to forecast a macroeconomic green employment model is important.

It is known from ILO research (Towards a Green Economy, 2011) that a green economy can create up to 60 million jobs worldwide, which will reduce unemployment and help preserve the environment. In this regard, it is relevant to study the institutional problems of the development of the modern labor market and the policy of promoting employment of the population based on the principles of a green economy. We are talking about environmental employment, understood as an activity that generates income and does not contradict the legislation, as well as reducing the negative impact on the environment. This is a new type of employment associated with the elimination of accumulated damage, disturbed lands, processing of solid household waste, the introduction of environmental innovations, etc.

The concept of "green" jobs exists in terms of the implementation of the "UN Sustainable Development Goals" (Resolution, 2012), and has also become an important subject of the International Labor Organization (ILO). These documents focus on green professions, creating such jobs in agriculture, industry, services and management that meet the principles of decent work and contribute to the preservation and quality restoration of the environment. If we follow the goals of sustainable development of the UN, then in the Kyrgyz Republic there is a need for formal institutions (laws and other laws and regulations) that contribute to the development of a "green" economy, and from the economic point of view—the development of a waste-free economy.

The most important condition for solving all the identified problems in the new realities of the fourth industrial revolution is institutional transformation. The emergence and diffusion of technologies of the Fourth Industrial Revolution and the areas of their application must be accompanied by appropriate institutions, standards and norms. The most important are not the technologies themselves, but their impact on social and economic systems through the norms, rules, expectations, goals, organizations and incentives that shape people's behavior—behavioral institutions. This also includes infrastructure, taking into account new technologies, providing the flow of people and resources necessary for economic, political and social life (Schwab & Davis, 2019).

It is the government, through public organizations, the media and all levels of education, up to propaganda programs and actions, that should shape both green and digital thinking, strengthen the training of specialists in these areas, based on new realities. Then new specialists and engineers will well understand the need to use new materials and technologies, which will facilitate their conflict-free implementation. The technologies of Industry 4.0, designed to solve the considered problems, are based on artificial intelligence. In order to use these directions correctly, and eliminate fears in society about the displacement of human labor and intelligence by artificial ones, the government and non-governmental organizations need to disseminate the positive experience of developed market countries in the use of Augmented Intelligence and promote the results of scientific research on the need to use human potential along with digital to achieve high-quality economic growth (Acemoglu & Restrepo, 2018). It is also necessary to acquaint with the results of research on business sentiment in Industry 4.0, it is imperative to use human potential and create jobs with a flexible combination of digital intelligence and human skills (Bruno & Popkova, 2020).

Digital transformation challenges the labor market. But it does not consist in a sharp reduction in jobs, but in their large-scale replacement with new ones. So already now 30 new specialties appear only in connection with the introduction of artificial intelligence (Digital Intelligence, 2019), adding green jobs and with the development of alternative energy sources and other new areas. We are talking about the structural transformation of the labor market, which will gradually balance in the new conditions after the completion of the structural adjustment.

Another aspect of digital transformation is the need to use digital solutions only taking into account human interests from an economic and environmental point of view, for example, problems of inequality and ecology. This is something that was not decided in the era of the third industrial revolution. For this, it is necessary to put a human value system into the algorithm of digital solutions, which is considered by Klaus Schwab as an indispensable condition for digital transformation (Schwab & Davis, 2019).

Materials and Methods

The methodological basis of the study was the works of scientists on the problems of institutional changes and state regulation of the green economy. The institutional system, viewed as an integral system in the economy, has been studied at different levels: at the level of the institutional environment; the level of institutional agreements; the level of behavior of individuals. In the process of analysis, a systematic approach, structural and functional analysis and synthesis, the method of expert assessments, economic and statistical analysis of the results were applied.

Results

To assess the state of the institutional environment of the green economy in the Kyrgyz Republic, about 670 documents were studied, posted on the information and legal portal Toktom.[2] Among them are the Laws adopted by the Jogorku Kenesh of the Kyrgyz Republic (parliament of the Kyrgyz Republic), Decrees of the President of the Kyrgyz Republic, Resolutions of the Government of the Kyrgyz Republic, Orders of the Government of the Kyrgyz Republic, Strategies, Concepts, Programs, as well as documents of ministries and departments: regulations, rules, instructions, procedures (see Fig. 12.1).

The beginning of the transition to a green economy can be called 1998, when the UN General Assembly decided to hold in 2002 the International Year of Mountains and the First Bishkek Mountain Summit. Earlier, in 1990, 1991, 1994, 1997, programs were adopted to protect the environment and rational use of natural resources. Despite this, the real course toward sustainable development and green growth was taken only in 2013 with the adoption of the National Strategy for Sustainable Development of the Kyrgyz Republic for the period 2013–2017 and was further developed at a new qualitative level in the National Development Strategy of the Kyrgyz Republic for 2018–2040. It combines directions for the development of industry and agriculture, both

[2] Information and legal portal Toktom. Electronic resource. https://online.toktom.kg/Toktom/DocumentList/Page?documentListId=e0637b5d-a6dc-456b-b377.

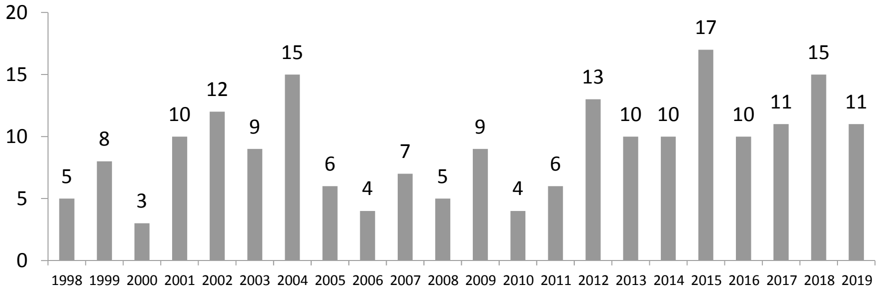

Fig. 12.1 Dynamics of changes in formal institutions of higher order in the green economy in the Kyrgyz Republic for the period from 1998 to 2019 (*Source* Compiled by the author R. Sh. Bazarbaeva based on materials of the Information and Legal Portal Toktom: https://online.toktom.kg/Toktom/DocumentList/Page?documentListId=e0637b5d)

on the basis of sustainable development, in particular, a green economy, and digital transformation (National Development Strategy, 2018–2040).

As can be seen from Fig. 12.1, 2015 and 2018 were the most productive in the development of concepts, strategies, and provisions. In 2018, the Concept of a Green Economy in the Kyrgyz Republic "Kyrgyzstan is a country of a green economy" was issued, approved by the Decree of the Jogorku Kenesh of the Kyrgyz Republic, and the Program of the Government of the Kyrgyz Republic for the period 2018–2022 "Unity. Confidence. Creation" was approved. Currently, the state policy on the implementation of the green economy is carried out in accordance with the National Development Strategy of the Kyrgyz Republic for 2018–2040 and the above-mentioned Concept of the Green Economy, the Program for the Development of the Green Economy of the Kyrgyz Republic, the Action Plan of the Program for the Development of the Green Economy in the Kyrgyz Republic for 2019–2023.

In the field of environmental protection, an institutional and legislative infrastructure has been created for the implementation of an effective environmental policy. At the same time, there is institutional inadequacy in sectoral national programs, which requires the introduction of rules and regulations, based on the principles and requirements of a green economy at the stage of planning, decision making, implementation, and monitoring. According to the authors, it is necessary to create a demand for the development of a green economy through digitalization—to create "green algorithms": to include the parameters of the need for "green" decisions in the value system included in the algorithm. Many documents mainly focus on environmental safety, with the exception of strategies for the development of the fuel and energy complex and agriculture, where specific measures for the development of green technologies are proposed.

To promote resource-saving, low-waste and waste-free technologies in environmental management, a unified intersectoral and regional policy is needed. Despite the fact that in 2009 the Concept of the State Regional Policy was adopted, which set the task of protecting the environment, flora and fauna in the country, in separate plans of socio-economic development (PSED) of districts, cities, aiylaimaks of the region, there are no sections on environmental protection. In other PSED measures are provided for the reconstruction of water treatment facilities of water utilities, provision of the population with clean drinking water, removal of solid household waste, but they do not have sufficient financial support. The joint work of the State Agency for Environmental Protection and Forestry under the Government of the Kyrgyz Republic (SAEPF) is important here and local self-government bodies (LSG) in the creation of formal institutions to stimulate the processes of introducing resource-saving technologies, institutions for the regulation of nature management, institutions for regulating the process of extracting natural resources, taking into account environmental protection. Practice has shown that part of the state authority for environmental protection must be delegated "to the localities", taking into account material and financial assistance, exactly through targeted transfers from the republican to the local budget, as provided for by the Law of the Kyrgyz Republic "On Local Self-Government", Article 20.

It is also important to work on improving informal norms and rules among state and municipal employees, entrepreneurs and the population (culture of behavior, environmental education, natural resource management).

The existing institutions in the environmental protection system are limited by the rules of payments for emissions and discharges that lead to environmental pollution. There is no clear definition of civil, criminal and administrative liability for damage to ecosystems. The legislation provides for reabilitation, but there is no information on the rules of financial surety for the proper closure of facilities. "The incentives for good environmental practice are in their infancy" (World Bank, 2018). In this regard, new rules are very important, which tighten environmental requirements when implementing investment projects; stimulating the development of green technologies through customs duties, green procurement and investment, the introduction of standards and procedures for environmental labeling of products; introducing biodiversity-friendly subsidies and other financial mechanisms. It can be both international and national projects with funding from both the state and private. In digital conditions, of course, one should use a block system (block-chain), and in particular the tokenization of green projects.

Thus, the solution of these tasks takes on a bilateral character. On the one hand, project financing and investment are needed. On the other hand, it is necessary to form an appropriate institutional environment in which such projects could be born and generate demand for them. For this, the "green" parameters of the economy must enter the consciousness, the mentality and the system of values of participants in the economic process—business, households, the state, government, and regulation.

In order to implement the strategy for the development of a green economy, the government of the Kyrgyz Republic allocates funds for measures for environmental protection, biodiversity and climate adaptation, research and development, corresponding to new challenges. The sources of financing are the funds of the republican budget—the expenses of ministries, departments (see Table 12.1), the local budget (expenses of local self-government bodies), the private sector, non-governmental organizations (NGOs) and donors.

As can be seen from Table 12.1, expenditures from the state budget for environmental protection as a whole have grown over 5 years, especially in 2016 and 2018. Almost half of the state expenditures referred to environmental protection were carried out by the State Agency for Environmental Protection and Forestry of the Kyrgyz Republic (SAEPF). Also, funds were allocated to the Ministry of Agriculture, Processing Industry and Land Reclamation and the Agency for Hydrometeorology under the Ministry of Emergency Situations of the Kyrgyz Republic. Research was financed to a lesser extent—about 7% (there were no expenses in 2018).

Unfortunately, it is difficult to find the financial statistics about donors assistance from more than 30 countries and organizations that provided grants to the Kyrgyz Republic for environmental protection. This is due to the fact that the Kyrgyz Republic does not have a centralized base of donors and the funds they spend, and there is no data that would allow assessing their contribution to environmental protection, biodiversity conservation and adaptation to

Table 12.1 Expenditures of the state budget for environmental protection (million soms)

Years	*2014*	*2015*	*2016*	*2017*	*2018*
Total	665.9	810.1	934.5	921.5	962.4
Combating environmental pollution	56.2	71.5	60.4	52.7	64.1
Natural parks and reserves	93.3	114.1	145.8	131.7	136.5
Animal protection	8.4	9.4	10.4	9.8	10.4
Plant protection	1.6	1.5	1.5	–	–
Antiepizootic measures	61.2	46.6	109.3	105.6	153.6
Veterinary diagnostics	109.3	107.2	150.8	134.6	245.1
Chemicalization, protection and quarantine of plants	42.5	60.1	88.8	85.9	132.2
Other biodiversity and landscape protection services	277.1	392.6	358.6	231.4	212.8
Research and development work related to environmental protection	6.7	7.1	6.3	6.3	–
Environmental issues not elsewhere classified	9.6	–	–	163.5	–
Other environmental protection services	–	–	2.6	–	7.7

Source Compiled according to the data of the National Statistics Committee of the Kyrgyz Republic: http://www.stat.kg/stat.files/din.files/vvp/

climate change. “The available information on the expenses of private enterprises allows us to analyze the data on the formal obligations undertaken upon receipt of the conclusion of the state environmental expertise in the relevant state management body” (Obzor, 2019).

The NGO sector in the Kyrgyz Republic is quite developed. Projects in the field of environmental protection are being implemented by non-governmental organizations. The eight major donors contribute 95% to the environment, with the UN agencies accounting for the largest share (48%). “In 2008, the United Nations Environment Program proposed the so-called ‘Green Economic Initiative’, where such priority sectors of the economy that need to be oriented toward green employment, such as clean energy, are identified; agricultural energy, including the use of renewable energy sources (RES) and sustainable biomass; sustainable agriculture, including organic farming; economic infrastructure; sustainable cities including planning, transport and green building”.

What will create the conditions and prerequisites for the formation and development of a green economy and the formation of new areas of green employment? Adhering to this UN initiative, the Government of the Kyrgyz Republic has taken a course to promote a green economy. Sectors of the economy such as sustainable tourism are identified as a priority for government support; green agriculture, industry and energy; sustainable city, low carbon and green transportation; natural ecosystems. The transition to “green” economic growth depends primarily on political and institutional conditions. With the emergence of a new direction of economic activity, such as green employment, it became necessary to study the relationship of labor market institutions with the problems of environmental preservation, rational use of natural and energy resources, production of environmentally friendly products, entrepreneurship in the field of environmental protection, etc.

The use of market mechanisms will allow green producers to enter the international markets of countries experiencing similar problems.

Conclusion

The Kyrgyz Republic has the starting conditions for the introduction of the “principles” of a green economy on a new technological basis. The future of the country’s economic growth, in our opinion, is associated with a green economy based on energy and agriculture. The latter has always been a defining industry in the Kyrgyz Republic. During the years of independence of the republic, the development of agriculture was rather difficult. On the one hand, there was a radical change in the structure of property, which entailed new forms of management, on the other hand, there was a decrease in investment activity, which was reflected in technical equipment, technological lag, low profitability of producers and the competitiveness of products. In this industry, according to the indicator of employment by type of economic activity, there is also a trend toward a reduction in the number of employed.

So, if in 1991 it was 700.6 thousand people (38.2%), then in 2018 it was 482.7 thousand people. (20.3%) (National Statistical Committee). At the beginning of 2019, more than 440 thousand operating economic entities were registered in agriculture, forestry, fishing, including about 333 thousand entities (75.6% of the total)—these are peasant (farmer) enterprises, 106.7 thousand subjects (24.2%)—individual entrepreneurs engaged in agricultural production (Collection, 2014–2018).

After the Kyrgyz Republic joined the EAEU, certain changes took place in the country's economy with the introduction of new rules and requirements for the export of agricultural and processed products. During this period, there were positive shifts in the growth rates of agriculture and the export of agricultural products to the Union countries. In 2018, the volume of exports of agricultural products increased to 46.8%, while the export of plant products of Kyrgyzstan to the EAEU countries increased by 37.7%, and food products—by 31% (Collection, 2014–2018). However, due to the low competitiveness of the products of domestic producers, the export of raw materials dominated. In connection with the strengthening of phytosanitary and veterinary control in the border areas, there was a decline in the production and export of livestock products.

The growth in the production of competitive organic products will serve as a tool for adaptation to climate change. The downward trend in employment in the next decade in the Kyrgyz Republic can only be solved by subsidizing the production of organic products and greening the labor market. It is necessary to mobilize the population through social networks, green windows, exhibitions of organic products and digitalization of farmers. The main environmental threat seems to be the further consolidation of the raw material development model, and therefore, a radical change in the model of economic development and modernization of the economy is needed. Active government intervention would stimulate participation in the process of business structures and the interest of the population. Also, to achieve energy efficiency, additional state economic and legal regulation is required regarding taxes, subsidies, investments, fines, etc. It should be borne in mind that the current maximum consumption-oriented market environment is incompatible with the radical imposition of green innovation. In addition, there are risks for the labor market when introducing renewable energy sources.

It may take time to achieve a balance between economic interests and environmental protection in the Kyrgyz Republic in the process of implementing the green economy concept. The greening of the labor market will go hand in hand with digitalization processes in the sectors of the economy. The experience of countries using digital technologies in agriculture could be useful for the Kyrgyz Republic. For example, traceability technologies in the agricultural value chain would solve the problems of creating organic products and strengthen the country's export potential. According to a study on the traceability of goods in the agricultural value chain conducted in the Central Asian region (Silvestrova & Kokareva, 2018), the introduction of a digital cloud platform that ensures food safety through the traceability of the system will allow enterprises to produce products that will meet global quality.

We are talking about a platform that combines new digital solutions operating on the basis of a distributed ledger (blockchain technology) and legal workflow. The main tools here are barcodes, an RFID device, a GPS tracking system. The use of ID tags provides information about the condition of the product, laboratory tests, information for the traceability of goods—details of production and logistics, dietary characteristics, information about storage conditions and labeling, product certificates, unique IDs (bar codes). The proposed system will allow not only to manage and ensure the integrity and safety of the chain, but also to create high-quality organic agricultural products in the Kyrgyz Republic.

For a more active introduction of digital technologies in agriculture in Kyrgyzstan, coordinated work of all stakeholders is required:

- government and local governments who need dashboards and a mobile app to validate data along the entire chain;
- entrepreneurs (farmers) for whom traceability of the supply chain and distribution statistics are important;
- research institutes (centers), educational institutions of the country, developing various technologies and teaching digital skills;
- direct consumers of products who access information about a product or service through a mobile application.

Thus, digitalization should be the key area that will determine the future of agriculture. In the future, digital transformation in this sector of the economy will open up new opportunities in which both farmers and consumers are equally interested. It seems that the development of a new agrarian technological policy of the country and growth in such related industries and directions as: "ICT, production of innovative agricultural machinery and equipment for precision farming; biological products (stimulants and fertilizers); improving the process of using mineral fertilizers and chemicals; development of seed-breeding centers; introduction of new educational standards into educational programs at universities, as well as in refresher courses" (Sadikova & Bazarbaeva, 2019).

Thus, it is necessary to form a relationship between solving environmental and climatic problems by introducing green technologies, including the formation of "green thinking" among the population, in the professional community and in regulatory organizations, and the introduction of technologies and materials of the 4th industrial revolution into the economic sectors. As a result, we can expect a synergistic effect in the development according to the D2D scenario—demand creates demand. For example, the demand for solving environmental problems through the use of alternative (renewable) energy sources creates a demand for super new materials technologies, the introduction of which, improving the performance of such facilities, contributes to the expansion of demand for their products and for themselves, which, in turn, boomerang demand on technologies and materials of Industry 4.0. Of course, these processes will accelerate the restructuring of the labor market and the achievement of new long-term equilibrium. In the development of these processes, the important role of the government of the Kyrgyz Republic should be emphasized. The developed activities and their sustainable financing within the framework of the Green Economy Development Program for 2019–2023 sets the vector of digital transformation in the Kyrgyz Republic. Its implementation structures demand, forms institutions and financing mechanisms, which is reflected in the complex on the labor market. First of all, its green segment is expanding adequately (Green Economy, 2019–2023).

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CHAPTER 13

Modern Regions on a Path of Sustainable Development: Financial Support of Industry 4.0 as the Basis of Environmental Safety

Svetlana V. Lobova, Aleksei V. Bogoviz, and Alexander N. Alekseev

Introduction

The contradiction between sustainable development and the transition to Industry 4.0 is particularly evident in the context of economic instability, particularly in times of pandemic and COVID-19 crisis, where resources are severely limited. There are two approaches to resolving this contradiction, which make it possible to maintain environmental security in the process of digitalization of the regional economy.

The first approach involves strengthening government regulation and introducing higher environmental standards for the introduction of advanced digital technologies. The advantage of this approach is the guarantee of environmental safety due to the mandatory requirements for it and state control of their compliance with the possibility of introducing a system of fines and other sanctions for enterprises that do not comply with the conditions of environmental standardization. The disadvantage of the approach is that high environmental barriers constrain the digital initiatives of enterprises and prevent the transition of the region to Industry 4.0.

S. V. Lobova (✉)
Altai State University, Barnaul, Russia

A. V. Bogoviz
Independent Researcher, Moscow, Russia

A. N. Alekseev
Plekhanov Russian University of Economics, Moscow, Russia

E. B. Zavyalova and E. G. Popkova, *Industry 4.0*,
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The second approach relates to de-regulation and activation of the market mechanism for ensuring environmental safety when digitalizing enterprises through corporate environmental responsibility. This approach allows the transfer of responsibility and costs for environmental safety from the state to private business, which is its advantage. At the same time, the disadvantage of this approach is the non-necessity of corporate environmental responsibility and the high risks to the environmental safety of the region when enterprises do not achieve mass responsibility.

The described approaches are not alternative, and when combined, a flexible approach to maintaining environmental safety in the process of digitalization of the regional economy can be formed, allowing combining the advantages of both approaches and overcoming their disadvantages, that is, providing the greatest efficiency. The combined approach is based on a combination of public and private industry finance 4.0.

However, according to the hypothesis put forward in this work, a universal ratio of public and private financing of the Industry 4.0 cannot be found, and it is necessary to find the optimal ratio for each individual type of region. The purpose of this work is to study the experience of sustainable development of modern Russian regions and to identify the optimal financial support of Industry 4.0 as the basis for environmental safety of various types of regions.

Literature Review

The sustainable development of the regional economy is discussed in the works of Anholon et al. (2020), Avery (2018), Leal Filho (2020), and Yadav and Shankar (2019). The transition of regions to Industry 4.0 and their digital modernization in modern business conditions are reflected in the publications of Grabar et al. (2019), Grishina et al. (2019), and Hervas-Oliver et al. (2020). Issues of state regulation of environmental safety are investigated in Bogoviz (2020), Inshakova, Baltutite et al. (2020), Inshakova, Goncharov et al. (2020) and corporate environmental responsibility issues in Popkova et al. (2021) and Popkova and Sergi (2019).

Nevertheless, existing sources of literature do not sufficiently disclose the issues of financial support of Industry 4.0 as the basis of environmental safety, do not offer recommendations on combining public and private financing of digitalization of the region's economy, and also do not take into account the specifics of regions of different types, which leads to the inconsistency and fragmentation of scientific data on the topic of sustainable development of modern regional economy. This work is focused on filling the listed gaps.

Materials and Method

In order to study the experience of regions of different types, this study uses the typology of the regions of Russia according to the criterion of the level and pace of socio-economic development, proposed by the Institute of Scientific

Communications (2021). In accordance with it, the following types of regions are identified:

- Parachutists: progressive regions with slow development;
- Rockets: advanced and accelerated developing regions;
- Racers: regions with great development potential;
- Turtles: regions lagging behind.

For each type of region, the regression analysis method determines the contribution of private investment and government costs to the financial support of Industry 4.0 to the environmental safety of the regions of Russia in 2020 using the data from Tables 13.1 and 13.2.

Based on the regression equations, the optimal ratio of private investment and government costs for the financial support of Industry 4.0 is determined, which allows ensuring the environmental safety of the regions of Russia.

Results

Regression statistics of the dependence of environmental safety on the financial support structure of Industry 4.0 in the regions of Russia in 2020 based on the data from Tables 13.1 and 13.2 are given in Table 13.3.

According to the regression statistics from Table 13.3, optimal ratios of private investment and public expenditure on financial support of Industry 4.0 are proposed in order to ensure environmental safety of different types of regions of Russia (Figs. 13.1, 13.2, and 13.3).

Based on Fig. 13.1, in 2020, at the current ratio, the share of private investments in the "parachutists" regions in Russia is 95.02% in the structure of industry financing 4.0. For optimization purposes, it is proposed to increase it to more than 99%.

Based on Fig. 13.1, in 2020, with the current ratio, the share of private investments in the regions—"rockets" in Russia is 96.67% in the structure of financing Industry 4.0, and in the "racer" regions—96.34%. In order to ensure environmental safety, it is necessary to abandon completely the transition to Industry 4.0.

Based on Fig. 13.3, in 2020, at the current ratio, the share of government spending in the turtle regions in Russia is 3.62% in the financing structure of Industry 4.0. For optimization purposes, it is proposed to increase it to 82.69%. The advantages of optimizing the financing structure of Industry 4.0 for sustainable development in terms of environmental safety of the regions of Russia are reflected in Fig. 13.4.

Figure 13.4 shows that the level of environmental safety due to the optimization of industry financing 4.0 in the "parachutists" regions increases from 58.13 points to the maximum possible 100 points (+72.04%), in the "rockets" regions, it increases from 59.63 points to 68.62 points (+15.09%), in the

Table 13.1 Financial support of Industry 4.0 and environmental safety in "rockets" regions and "parachutists" regions in Russia in 2020

Parachutists: progressive regions with slow development				*Rockets: advanced and accelerated regions*			
Region	*Private investments in fixed assets, million rubles*	*State expenditures on the introduction and use of digital technologies, million rubles*	*Environmental Safety Index, spoints 1–100*	*Region*	*Private investments in fixed assets, million rubles*	*State expenditures on the introduction and use of digital technologies, million rubles*	*Environmental Safety Index, points 1–100*
Leningrad Region	419,126	6,748.1	55	Astrakhan Region	95,658	3,792.9	62
Moscow Region	1,044,870	155,624.2	49	Belgorod Region	167,367	4,732.9	72
Murmansk Region	171,361	3,733.5	65	Voronezh Region	298,024	5,754.5	58
Nenets Autonomous Region	95,692	764.1	62	Ivanovo Region	37,992	1,910.1	63
Republic of Sakha (Yakutia)	381,147	8,560.8	55	Kaluga Region	108,251	4,818.2	66
Republic of Tatarstan	640,837	31,259.2	60	Lipetsk Region	155,038	5,716.9	57
Sakhalin Region	231,701	6,808.6	55	Republic of Crimea	199,821	3,657.2	53
Tyumen Region	2,121,342	54,100.6	64	Chelyabinsk Region	299,051	16,536.7	46

Source Compiled by the authors on the basis of the materials Green Patrol (2021), Institute of Scientific Communications (2021), and Federal State Statistics Service (2021)

Table 13.2 Financial support for Industry 4.0 and environmental safety in the "racers" and "turtle" regions of Russia in 2020

Racers: regions with great development potential				*Turtles: regions lagging behind*			
Region	*Private investments in fixed assets, million rubles*	*State expenditures on the introduction and use of digital technologies, million rubles*	*Environmental Safety Index, points 1–100*	*Region*	*Private investments in fixed assets, million rubles*	*State expenditures on the introduction and use of digital technologies, million rubles*	*Environmental Safety Index, points 1–100*
Altai Territory	115,369	5,291.0	69	Amur Region	339,934	3,009.4	55
Vladimir Region	90,085	4,726.3	57	Vologda Region	197,130	8,674.6	63
Jewish Autonomous Region	15,490	216.8	50	Kamchatka Territory	47,241	3,208.3	59
Irkutsk Region	359,197	13,670.5	43	Krasnoyarsk Territory	426,491	16,890.4	47
Kaliningrad Region	103,037	4,285.0	51	Magadan Region	35,797	1,386.3	65
Kemerovo Region	297,946	7,298.8	59	Komi Republic	114,630	6,235.0	65
Kostroma Region	26,194	4,814.0	65	Tyumen region without autonomous districts	302,945	13,864.8	64
Kursk Region	144,906	3,495.0	69	Khabarovsk Territory	161,488	7,778.6	50

Source Compiled by the authors on the basis of the materials Green Patrol (2021), Institute of Scientific Communications (2021), andFederal State Statistics Service (2021)

Table 13.3 Regression statistics of the dependence of environmental safety on the financial support structure of Industry 4.0 in the regions of Russia

Regression statistics		*Parachutists*	*Rockets*	*Racers*	*Turtles*
Multiple R		0.7057	0.6985	0.3842	0.5569
Elements of the equation: $y = a + b_1 \times x_2 + b_2 \times x_2$	Constanta	58.1679	68.6234	62.9970	64.0742
	Variable$b_1$for private equity investments (×1)	0.000005	– 0.00002	– 0.000004	– 0.00003
	Variable $b_2$at government costs for the introduction and use of digital technologies (x_2)	– 0.0001	– 0.0009	– 0.0008	0.00004

Source Calculated and compiled by the authors

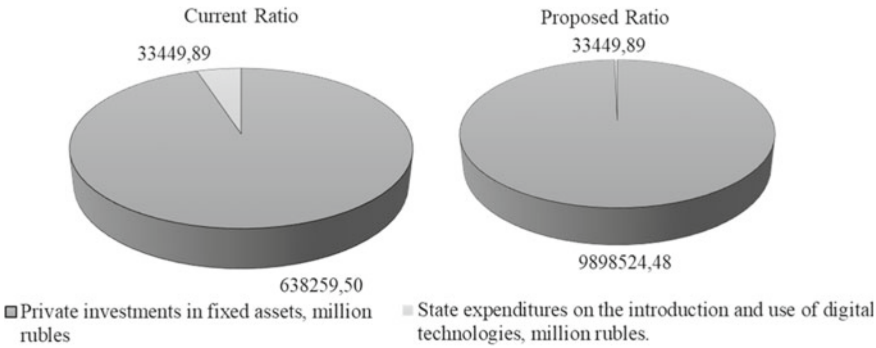

Fig. 13.1 Industry financing ratio 4.0 for environmental safety in paratroopers (*Source* Calculated and built by the authors)

"racer" regions, it rises from 57.88 points to 63.00 points (+8.85%), and in the "turtles" regions, it rises from 58.50 points to the maximum possible 100 points (+70.94%).

Conclusion

Therefore, it has been proved that in different types of regions, sustainable development in terms of environmental safety requires a specific optimal ratio of private investment and public spending on Industry 4.0. Recommendations on optimizing the financial support of Industry 4.0 in the interests of environmental safety are proposed for all selected types of regions of Russia.

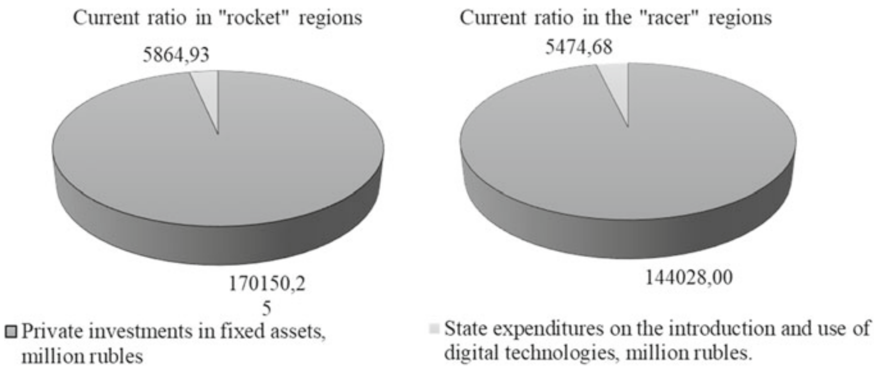

Fig. 13.2 Industry financing ratio 4.0 for environmental safety in "rockets" and "racers" regions (*Source* Calculated and built by the authors)

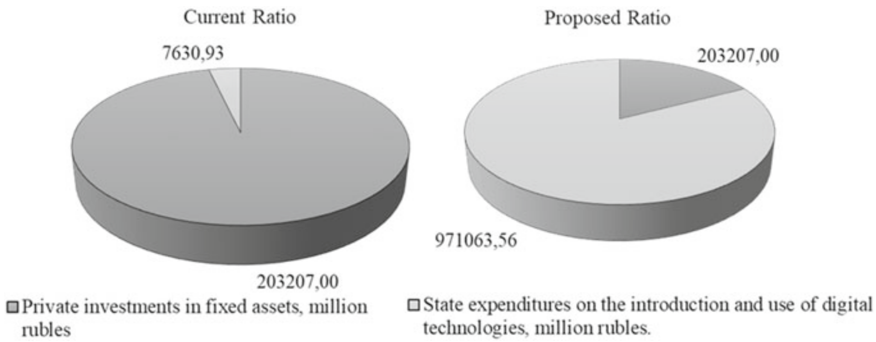

Fig. 13.3 Industry financing ratio 4.0 for environmental safety in turtle regions (*Source* Calculated and built by the authors)

The experience of the regions of Russia can be useful for the regions of other countries of the world, provided that they are similarly typologized according to the criterion of the level and pace of socio-economic development.

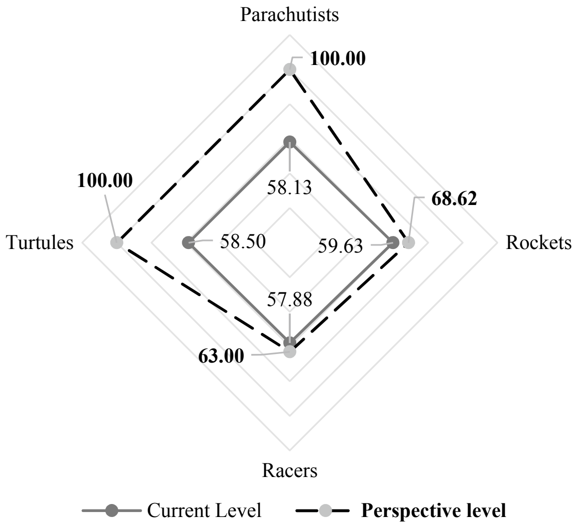

Fig. 13.4 Advantages of optimizing industry financing structure 4.0 for environmental safety of Russian regions (*Source* Calculated and built by the authors)

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CHAPTER 14

Digital Growth Points of the Region's Green Economy in Industry 4.0: Finance and Security Issues

Oleg G. Karpovich, Olga S. Diakonova, Elena L. Pozharskaya, and Vladimir V. Grigorenko

Introduction

The pandemic and the COVID-19 crisis have made major adjustments to the development strategies of modern regions as part of national economic systems. Digitalization, although it remained a strategically significant direction for the development of the regional economy, became secondary, while such areas as ensuring environmental security and accelerating economic growth came to the fore.

In this regard, the problem of finding prospects for the systematic implementation of all three strategic directions of the development of the regional economy was updated. Given the hierarchical nature of these areas, it is advisable to build a "tree of goals", in which the main goal is "green" economic growth (as a combination of crisis management and environmental safety), and as a task to achieve this goal is to activate digital points of economic growth

O. G. Karpovich (✉)
Diplomatic Academy of the Ministry of Foreign Affairs of the Russian Federation, Moscow, Russia

O. S. Diakonova
State University of Management, Moscow, Russia

E. L. Pozharskaya
Plekhanov Russian University of Economics, Moscow, Russia

V. V. Grigorenko
Kuban State Agrarian University Named After I.T. Trubilin, Krasnodar, Russia

E. B. Zavyalova and E. G. Popkova, *Industry 4.0*,
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based on Industry 4.0. Optimization of Industry 4.0 financing is proposed as a tool to solve this problem.

An obstacle to solving the problem is the lack of formation of scientific and methodological support. In particular, the very concept of green economic growth is new to economic science and needs fundamental study. In addition, there remains uncertainty as to which digital practices contribute to and which constrain the growth of the green economy. And finally, the requirements for domestic and external financing to boost the digital growth points of the region's green economy in the Industry 4.0 are unknown.

This work is intended to fill all these gaps. Its goal is to determine the promising digital growth point of the region's green economy in Industry 4.0, as well as clarify financing and security issues in the "goal tree" of the strategic development of the regional economy of Russia for the period until 2025 (until the end of the post-pandemic period).

Literature Review

A literature review of the study revealed a high degree of visibility in existing publications. Digital growth points of the modern economy and economic crisis management in Industry 4.0 are indicated by researchers such as Sergi et al. (2019a, b).

Financial aspects of enhancing digital points of economic growth are disclosed by authors such as Bolgova (2017), Guseva et al. (2019), Medentseva (2017), Popkova and Parakhina (2019), Sergi et al. (2019b, d, e), and Tarakanov et al. (2020). Experts such as Asongu and Odhiambo (2020), Montshiwa (2018), and Sreen et al. (2020).

However, there is no system integrity for the issues listed. The digital growth points of the region's green economy in Industry 4.0 are not specified, and the issues of financing and security when using these specific growth points are unknown. This study is intended to fill these gaps.

Materials and Method

In this work, it is proposed to interpret the scientific concept of the digital growth points of the region's green economy in Industry 4.0 as directions for the use of digital technologies (special software tools), which simultaneously accelerate economic growth (economic crisis management), and ensure environmental security in the region through the development of a green economy. As a methodological support for identifying and studying the digital growth points of the region's green economy in Industry 4.0, a regression analysis method is proposed.

Using this method, the regression dependence of economic growth at constant prices and the consolidated environmental index in the federal districts of the Russian Federation in 2020 (from Table 14.2) on the directions of using special software (from Table 14.1) is determined. The digital

Table 14.1 Share of organizations using special software at the level of regional economy (in federal districts) of Russia in 2020 in terms of use directions, %

Federal District of the Russian Federation	*For scientific research*	*For design*	*For automated management производством*	*For organizational, managerial and economic tasks*	*For financial settlement sвэлектронном виде*	*To access databases through global information networks*	*Editorial and publishing systems*	*Training programs*	*CRM, ERP, SCM—systems*	*Electronic legal reference systems*	*Other software tools*
Central	6.1	14.7	17.3	57.2	59.8	33.9	8.0	16.8	24.3	56.1	29.3
Northwest	4.4	14.8	17.4	58.2	59.4	31.7	6.3	16.8	21.8	59.5	28.2
Southern	4.3	11.9	15.0	53.0	55.9	30.1	6.6	14.7	17.9	51.2	28.2
North Caucasus	2.7	7.8	11.1	35.3	42.4	24.9	4.6	10.0	10.2	31.4	21.3
Volga	4.8	13.0	17.6	55.8	57.1	32.9	7.5	17.4	21.5	52.0	29.3
Ural	4.6	15.4	19.8	59.3	58.1	32.9	7.9	19.3	23.1	58.0	29.4
Siberian	3.3	10.7	14.5	52.9	56.0	31.2	5.5	15.8	18.2	51.0	28.0
Far East	3.3	11.5	15.2	53.1	57.5	31.8	5.5	15.3	14.9	53.6	28.9

Source Compiled by the authors on the basis of the materials of Federal State Statistics Service (2021) growth points of the region's green economy in the 4.0 industry are those software tools that show a positive regression relationship with both economic growth and the green economy.

In order to determine the prospects of activation of the identified digital growth points of the "green" economy of the region in Industry 4.0, their regression dependence on the volume of domestic and external financing is determined, as well as the required (target) amount of financing is identified for the universal implementation of the necessary directions of using special software in the regional economy of Russia until 2025 (until the end of the post-pandemic period).

Results

In order to identify the digital growth points of the "green" economy of the regions of Russia in Industry 4.0 in 2020, we will refer to the results of regression analysis of data from Tables 14.1 and 14.2 (Fig. 14.1).

According to Fig. 14.1, only three uses of special software have shown both positive regression relationship with economic growth and environmental safety: editorial and publishing systems (2.48 and 0.62), training programs (2.84 and 5.96), and electronic reference legal systems (1.18 and 1.02).

The prospects for accelerating the growth rate of the green economy in the regions of Russia on the basis of these digital growth points with their

Table 14.2 Economic growth, environmental security and financing of digitalization in the regions of Russia in 2020

Federal district of the Russian Federation	*Internal costs of implementation and use of digital technologies, million rubles*	*External costs for the implementation and use of digital technologies, million rubles*	*Economic growth at constant prices, %*	*Environmental Summary Index[a], points 1–100*
Central	1,365,467.4	351,592.3	2.9	76
Northwest	95,509.9	31,846.1	1.9	66
Southern	35,725.8	10,881.2	1.4	63
North Caucasus	12,405.5	1,396.8	0.4	65
Volga	141,721.1	35,180.5	1.9	67
Ural	76,775.0	29,328.4	5.3	64
Siberian	62,394.1	19,561.7	2.4	72
Far East	38,653.7	8,391.9	3.5	66

[a]Due to the lack of generalized statistics for federal districts, the data of the leading region for each federal district are indicated

Source Compiled by the authors on the basis of the materials Green Patrol (2021) and Federal State Statistics Service (2021)

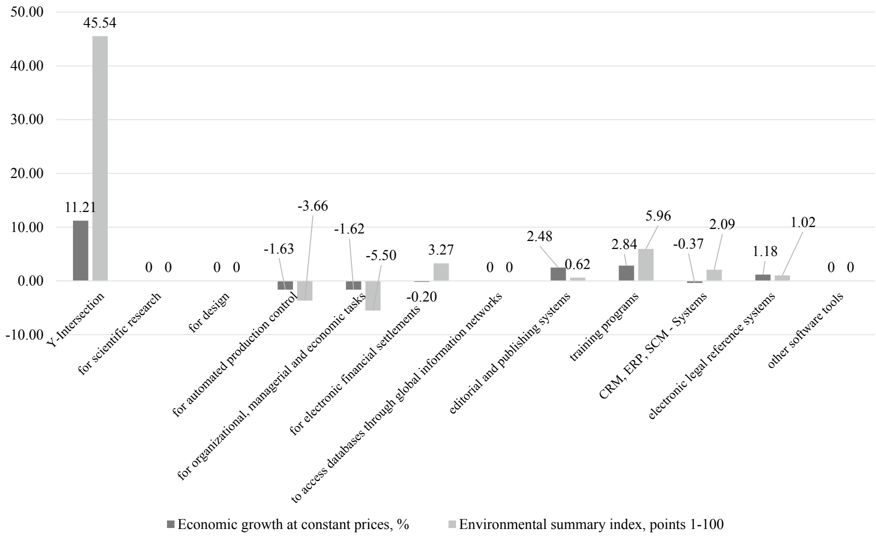

Fig. 14.1 Regression statistics of the dependence of economic growth and the environmental index on the areas of use of special software in the regions of Russia in 2020 (*Source* Calculated and built by the authors)

increase by 20% (the maximum of the achievable levels of progress until 2025) are shown in Fig. 14.2.

As shown in Fig. 14.2, with a 20% increase in the use of special software tools for access to editorial and publishing systems (up to 7.79%), training programs (up to 18.92%), and electronic legal reference systems (up to 61.92%) the economic growth rate in the regions of Russia in the period until 2025 rises by almost 10 times to 26.78% and the level of environmental safety increases by 44.72% to 97.50 points (becomes almost maximum). In order to determine the financial requirements for these results, refer to the regression statistics in Fig. 14.3.

In accordance with Fig. 14.3, external financing is prioritized, showing a positive regression relationship with all digital growth points of the green economy in the regions of Russia. The target funding is shown in Fig. 14.4.

According to Fig. 14.4, to accelerate the growth rate of the green economy in the regions of Russia based on digital growth points (an increase of 20%), it is necessary to increase the volume of external financing by 16.44% to 71,055.92 million rubles in the period until 2025.

Conclusion

Therefore, it was revealed that the digital growth points of the "green" economy of the regions of Russia in the 4.0 industry are such areas of use of special software tools as editorial and publishing systems, training programs,

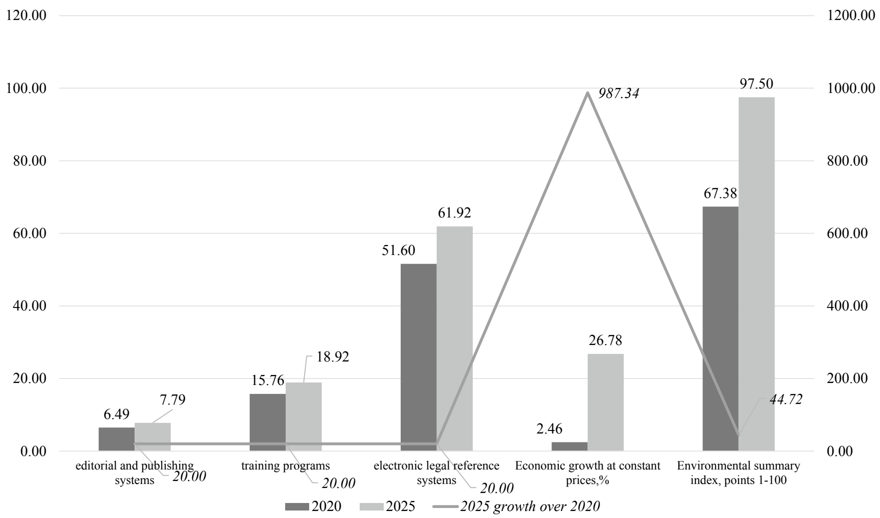

Fig. 14.2 Prospects for accelerating the growth rate of the green economy in the regions of Russia based on digital growth points until 2025 (*Source* Calculated and built by the authors)

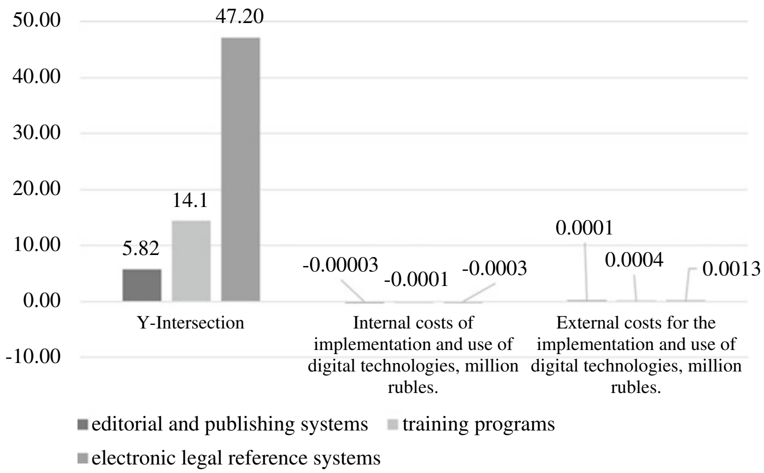

Fig. 14.3 Regression statistics of the dependence of digital growth points of the green economy in the regions of Russia on financing (*Source* Calculated and built by the authors)

and electronic reference legal systems. With the activation of these growth points (an increase in the activity of using special software in selected areas by 20%), the economic growth rate in the regions of Russia in the period until 2025 increases by almost 10 times to 26.78%, and the level of environmental

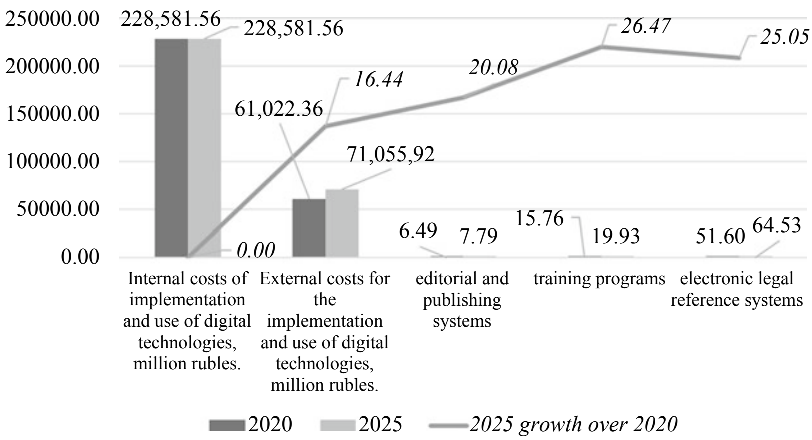

Fig. 14.4 Target amount of financing to accelerate the growth rate of the green economy in the regions of Russia based on digital growth points until 2025 (*Source* Calculated and built by the authors)

safety increases by 44.72% to 97.50 points (becomes almost maximum). For this, it is recommended to increase the volume of external financing by 16.44% to 71055.92 million rubles in the post-pandemic period.

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CHAPTER 15

Green Investments as a Vector of Growth of the Region's Economy in Industry 4.0: Payback Prospects and Contribution to Security

Galina N. Semenova, Natalya V. Falina, Oleg G. Karpovich, and Konstantin A. Dolonin

Introduction

The sustainable development goals make clear the need to balance social progress, economic growth, and environmental protection. To date, a one-sided view of sustainable development has emerged from the perspective of the impact of socioeconomic progress on the environmental situation. This view, in particular, is distributed at the level of the regional economy. At the same time, the opposite effect associated with the influence of the state of the environment in the region on its socioeconomic development remains insufficiently developed and not described in science.

Nevertheless, it seems that in Industry 4.0, the importance of the environmental situation for socioeconomic progress is equally important, which is the hypothesis of this study. The meaning of this (supposed) inverse dependence

G. N. Semenova (✉)
Plekhanov Russian University of Economics, Moscow, Russia

Moscow Region State University, Mytishchi, Russia

N. V. Falina
Kuban State Agrarian University named after I.T. Trubilin, Krasnodar, Russia

O. G. Karpovich
Diplomatic Academy of the Ministry of Foreign Affairs of the Russian Federation, Moscow, Russia

K. A. Dolonin
SSEU-Samara State University of Economics, Samara, Russia

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is that, with a favorable environmental environment in Industry 4.0, an influx of investment is achieved in the region and its economic growth rate is accelerated, which ensures the return (economic efficiency) of green investments. As a result, the economic security of the region is also determined by green investments, which determine the socioeconomic situation of the region in the national economy.

The fundamental novelty of the hypothesis put forward for modern economic science and practice should be emphasized, since, in accordance with the idea of green investments in the pre-digital era, they in most cases do not pay off (economically inefficient) and relate to the field of creating public goods by the state and business through corporate social and environmental responsibility.

The purpose of the research is to verify the hypothesis and justify that green investments represent the growth vector of the region's economy in Industry 4.0 and have significant prospects for payback and contribution to economic security. The study is conducted on the example of the regions of Russia with the most developed Industry 4.0 and includes the definition of alternative scenarios for the socioeconomic development of the regions of Russia depending on the volume of "green" investments.

Literature Review

Green investments as a special area of financial support for the development of socioeconomic systems are discussed in Ghosh et al. (2020), Skordoulis et al. (2020). Features of the growth and development of the region's economy in the 4.0 industry are disclosed in the publications of Bogoviz et al. (2019a, 2019b, 2019c), Inshakova et al. (2020), and Makar et al. (2019).

However, the ability of green investments to act as a vector of growth of the region's economy in the 4.0 industry environment has not been proven and practically not studied, as well as the contribution of green investments to economic security and the prospects for their payback (economic efficiency). This research is being conducted to fill these gaps.

Materials and Method

For research in this work, a sample of regions of Russia with the most developed Industry 4.0 (according to the criterion of the highest level of digitalization) was formed in 2020 (Fig. 15.1). The logic of testing the hypothesis put forward is to determine the regression dependence of GRP per capita (an indicator of the prospects for payback) on environmental protection costs (the volume of green investments)—should be positive, as well as the regression dependence of the depth of the underdevelopment whirlpool (an indicator of economic security) on environmental protection costs (the volume of green investments)—should be negative.

The statistical base of the research is formed in Table 15.1.

The depth of the "underdevelopment whirlpools" refers to the temporary measurement (in years) of the underdevelopment per capita in the region from GDP per capita in Russia. Positive values indicate the delayed development of the regions (the presence of "underdevelopment whirlpools"), and negative values indicate the advanced development of the regions.

Results

In order to determine the prospects for the return on green investments and their formation as a vector of growth of the region's economy in the 4.0 industry, refer to the regression curve in Fig. 15.2.

According to Fig. 15.2, with an increase in environmental spending in the regions of Russia with the most developed Industry 4.0 in 2020, the depth of their "underdevelopment whirlpools" decreases by 0.0001 years. Therefore, green investments contribute to ensuring economic security in the regions of Russia in 2020.

In accordance with Fig. 15.3, with an increase in environmental protection costs in the regions of Russia with the most developed Industry 4.0 in 2020, GRP per capita increases by 16,702 rubles. Therefore, green investments have significant payback prospects, that is, they are cost-effective and act as a vector of growth in the regional economy of Russia.

Based on the obtained regression curves, a scenario analysis of the prospects for overcoming the "underdevelopment whirlpools" in the regions of Russia was carried out through an acceleration of the pace of socioeconomic development (GRP per capita) for the period up to 2025. The realistic scenario involves an increase in the volume of "green" investments in actual prices by 1.5 times under the influence of inflation and under pressure of sustainable development priorities (Table 15.2).

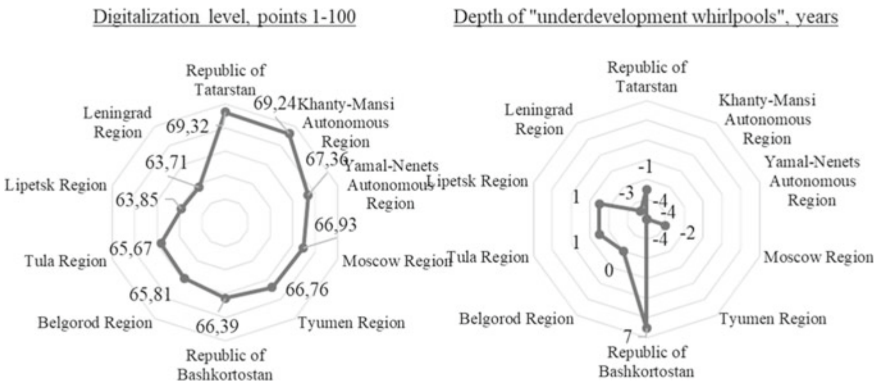

Fig. 15.1 Development level of Industry 4.0 and economic security in sampling regions in Russia in 2020 (*Source* Built by the authors on the basis of the materials of the Institute of Scientific Communications [2021])

Table 15.1 "Green" investments, GRP per capita and the depth of "underdevelopment whirlpools" in the regions of Russia in 2020

Region	*GRP per capita, rub.*	*Depth of "underdevelopment whirlpools", years*	*Expenses for environmental protection (in actual prices), million rubles*
Republic of Tatarstan	668,459.14	−1	26,841
Khanty-Mansi Autonomous Region	2,034,451.4	−4	31,623
Yamal-Nenets Autonomous Region	5,593,802	−4	19,447
Moscow Region	757,534.06	−2	43,705
Tyumen Region	1,971,419.5	−4	55,156
Republic of Bashkortostan	384,455.53	7	16,785
Belgorod Region	651,614.5	0	9,056
Tula Region	571,712.96	1	4,173
Lipetsk Region	612,864.08	1	9,626
Leningrad Region	819,336.1	−3	16,036

Source Compiled by the authors on the basis of materials from the Institute of Scientific Communications (2021), Federal State Statistics Service (2021)

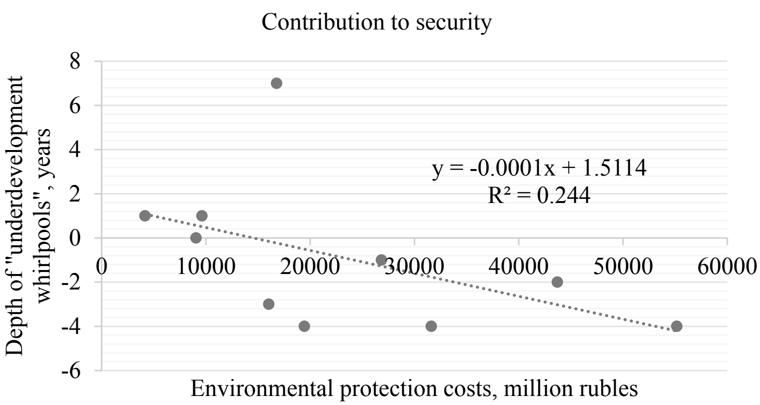

Fig. 15.2 Regression curve of the depth of "underdevelopment whirlpools" in the regions of Russia from their costs for environmental protection in 2020 (*Source* Calculated and built by the authors)

Figure 15.2 shows that in a realistic scenario, the "underdevelopment whirlpools" in the Republic of Bashkortostan was overcome. In the Belgorod region, the level of socioeconomic development remained at the same level (similar to 2020)—not lagging behind and not outpacing development (as on average in Russia: The depth of the "underdevelopment whirlpools" is

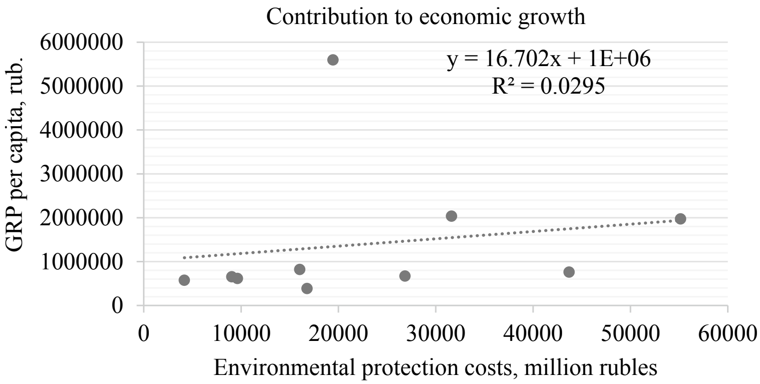

Fig. 15.3 Regression curve of GRP per capita dependence in Russian regions on their environmental expenditures in 2020 (*Source* Calculated and built by the authors)

Table 15.2 A realistic scenario of using green investments (*1.5) as a vector of growth of the economies of the regions of Russia in the conditions of Industry 4.0

Regions	*Depth of "underdevelopment whirlpools", years*	*GRP per capita, rub.*	*Depth gain of "underdevelopment whirlpools", %*	*Per capita GRP growth, %*
Republic of Tatarstan	−2.51	1,690,782.57	151.47	152.94
Khanty-Mansi Autonomous Region	−3.23	1,810,586.02	−19.20	−11.00
Yamal-Nenets Autonomous Region	−1.41	1,505,540.69	−64.86	−73.09
Moscow Region	−5.04	2,113,276.37	152.22	178.97
Tyumen Region	−6.76	2,400,158.27	69.05	21.75
Republic of Bashkortostan	−1.01	1,438,849.61	−114.38	274.26
Belgorod Region	0	1,245,214.97	0	91.10
Tula Region	0.89	1,122,881.17	−11.45	96.41
Lipetsk Region	0.07	1,259,495.18	−93.25	105.51
Leningrad Region	−0.89	1,420,084.91	−70.2	73.32

Source Calculated and compiled by the authors

Table 15.3 Optimistic scenario of using "green" investments (*4) as a vector of growth of the economies of the regions of Russia in the conditions of Industry 4.0

Regions	*Depth of "underdevelopment whirlpools", years*	*GRP per capita, rub.*	*Depth gain of "underdevelopment whirlpools", %*	*Per capita GRP growth, %*
Republic of Tatarstan	−9.23	2,811,528.53	822.50	320.60
Khanty-Mansi Autonomous Region	−11.14	3,131,004.38	178.44	53.90
Yamal-Nenets Autonomous Region	−6.27	2,317,550.18	56.68	−58.57
Moscow Region	−15.97	3,938,178.64	698.53	419.87
Tyumen Region	−20.55	4,703,197.05	413.77	138.57
Republic of Bashkortostan	−5.20	2,139,707.28	−174.32	456.55
Belgorod Region	−2.11	1,623,348.25	0	149.13
Tula Region	−0.16	1,297,124.78	−115.78	126.88
Lipetsk Region	−2.34	1,661,428.81	−333.90	171.09
Leningrad Region	−4.90	2,089,668.09	63.43	155.04

Source Calculated and compiled by the authors

0 years). In the Tula and Lipetsk regions, the depth of the "underdevelopment whirlpools" decreased by 11.45 and 93.25%, respectively (from 1 year in both regions to 0.89 and 0.07 years, respectively). Per capita GRP growth averaged 91.015.

The optimistic scenario assumes a 4-fold increase in green investment in actual prices under the pressure of sustainable development interests and the growing pressure of responsible consumption (Table 15.3).

Table 15.3 shows that the "underdevelopment whirlpools" in all regions have been overcome in an optimistic scenario and advanced development has been achieved. Per capita GRP growth averaged 193.31%.

Conclusion

The results of the study proved the hypothesis and, on the example of the regions of Russia, showed that green investments can and do act as a vector of growth of the region's economy in Industry 4.0, have significant payback prospects and contribute to ensuring the region's economic security, helping to overcome its "underdevelopment whirlpools".

The evidence base was the revealed patterns of an increase in GRP per capita and a decrease in the depth of "underdevelopment whirlpools" in the regions of Russia in 2020 as the volume of "green" investments increased. In order to completely overcome the "underdevelopment whirlpools" in the regions of Russia with the most developed Industry 4.0 in the period until 2025, it is recommended to increase the volume of "green" investments by 4 times to 92979 million rubles.

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Part III

The Regulatory Framework for Managing Climate Change in Industry 4.0

CHAPTER 16

Integration Mechanisms for Financing Green Economy in the Region in Industry 4.0 for Strategic Security: Public–Private Partnership vs. Clustering

Anna A. Skomoroshchenko, Bogdan S. Vasyakin, Lyudmila S. Samodelko, and Dmitry M. Kucheryavenko

Introduction

Financing for the green economy at the regional level has its particular characteristics, as it involves reliance on private investment compared to the predominance of financing from the national budget at the macroeconomics level and financing from international organizations at the global economic level. Involving private enterprise in financing a green economy is a challenge for public administration in the region, as it requires effective incentives for corporate environmental responsibility.

A. A. Skomoroshchenko (✉)
Kuban State Agrarian University Named After I.T. Trubilin, Krasnodar, Russia

B. S. Vasyakin
Plekhanov Russian University of Economics, Moscow, Russia
e-mail: Vasyakin.BS@rea.ru

L. S. Samodelko
State University of Management, Moscow, Russia

D. M. Kucheryavenko
Samara State Technical University, Samara, Russia

E. B. Zavyalova and E. G. Popkova, *Industry 4.0*,
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Most isolated enterprises are not inclined to place green investments or lack the resources to do so. Therefore, this work hypothesizes that integration mechanisms in entrepreneurship create the prerequisites for increasing the amount of financing for the development of a green economy in the region through the simplification of state regulation of corporate environmental responsibility (through the consolidation of regulatory objects) and the pooling of financial resources of enterprises in the region. The hypothesis also suggests that Industry 4.0 contributes to the best unlocking of the potential of integration mechanisms to stimulate the increase in financing for the development of the green economy in the region.

In order to carry out the most detailed and accurate research, this work examines the experience of the regions of one country—Russia, where such integration mechanisms of entrepreneurship as public-private partnership (PPP) and clustering prevail. The aim of the study is to determine the contribution of integration mechanisms—PPP and clustering—to the financing of the development of the green economy in the regions of Russia, as well as to develop recommendations for maximizing this contribution through the use of industry opportunities 4.0 in the interests of strategic ensuring the environmental security of the Russian regional economy.

Literature Review

Integration mechanisms in entrepreneurship, in particular public-private partnerships and clustering, are discussed in the publications of Akopova et al. (2020), Bogoviz et al. (2018), Bogoviz et al. (2019), Orlova et al. (2020), Popkova et al. (2017), Suglobov et al. (2020a, 2020b), Zorin et al. (2016). Conceptual and applied aspects of environmental security and green economy financing are disclosed in Agyabeng-Mensah et al. (2020), Narwaria (2019), Soewarno et al. (2019), Taleizadeh et al. (2020) and Weerasinghe and Ramachandra (2018).

Although the above-mentioned issues are sufficiently detailed, the problem of this research is not sufficiently studied due to gaps, firstly, due to a lack of knowledge of the specifics of financing for the development of the green economy at the regional level, secondly, to the ambiguity of the contribution of integration mechanisms in entrepreneurship to the financing of the development of the green economy in the region and, thirdly, to the uncertainty of the prospects for increasing financing for the development of the green economy in the region due to the opportunities of Industry 4.0. This research is designed to systematically fill the identified gaps.

Materials and Method

For a complete study of the regional economy of Russia, this research is carried out on the basis of data on federal districts, the index of the volume of environmental expenditures in which in 2020 is shown in Fig. 16.1.

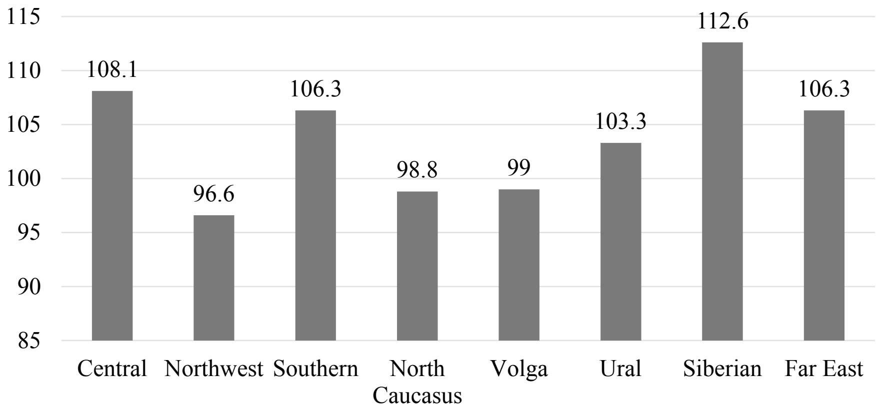

Fig. 16.1 Index of volume of environmental expenditures (in comparable prices compared to the previous year) in 2020, % (*Source* Calculated and built by the authors)

As shown in Fig. 16.1, there is an increase in the volume of environmental protection expenditures in most federal districts of the Russian Federation, which is 12.6% in the Siberian Federal District, 8.1% in the Central Federal District, 6.3% in the Southern Federal District and 6.3% in the Far Eastern Federal District. In the remaining federal districts in 2020, there was a decrease in the volume of environmental protection expenditures: by 3.4% in the North-West, by 1.2% in the North Caucasus and by 1% in the Volga Federal District.

The activity of integration mechanisms (PPPs and clusters) in entrepreneurship, environmental protection costs (as an indicator of financing for the development of the green economy) and the consolidated environmental index (as an indicator of environmental safety) in the federal districts of the Russian Federation in 2020 are shown in Table 16.1.

In the research part, the regression analysis method determines the effect of the number of clusters and the level of PPP development on the amount of environmental costs, as well as the contribution of these costs to the formation of a consolidated environmental index. On the basis of regression models, the optimization task is solved to determine the required increase in environmental protection costs to maximize (achieve 100 points) the combined environmental index (ensuring complete environmental safety) in each federal district, as well as to identify the required increase in the number of clusters and the level of PPP development.

Results

The contribution of integration mechanisms (PPPs and clusters) to green economy financing in the regional economy Russia reflects the multiple linear

Table 16.1 Activity of integration mechanisms, environmental protection costs and consolidated environmental index in the federal districts of the Russian Federation in 2020

Federal District of the Russian Federation	*Number of clusters, units (cl)*	*PPP development level[a], points (ppp)*	*Environmental protection costs, million rubles (Green)*	*Environmental summary Index[a], points 1–100 (SES)*
Central	15	98.6	152,904	76
Northwest	8	72.2	89,442	66
Southern	1	49.2	40,296	63
North Caucasus	2	37.4	10,103	65
Volga	15	98.7	121,421	67
Ural	5	93.9	101,896	64
Siberian	4	84.8	109,606	72
Far East	1	73.9	58,617	66

[a]Due to a lack of generalized statistics for federal districts, the data of the leading region for each federal district are indicated

Source Compiled by the authors on the basis of the materials (Federal State Statistic Service, 2021; Green Patrol 2021; Ministry of Industry and Trade of Russia, 2021; Ministry of Economic Development of Russia, 2021

regression model derived from Table 16.1:

$$\text{Green} = -43593 + 2271.32\text{cl} + 1506.80\text{ppp} \left(\text{multiple } R^2 = 0.9629\right) \quad (16.1)$$

According to the received model (16.1), with each new cluster, financing for the development of the green economy in the regional economy of Russia increases by 2271.32 million rubles, and with an increase in the level of PPP development by 1 point—by 1506.80 million rubles. Multiple correlation is high: 96.29%. The contribution of environmental protection expenditures to the formation of the consolidated environmental index in the regions of Russia in 2020 is reflected in Fig. 16.2.

According to Fig. 16.2, with an increase in environmental protection costs of 1 million rubles, the consolidated environmental index increases by 0.0001 points (correlation 51.78%: moderate). With the help of substitution, it was revealed that in order to ensure complete environmental safety (consolidated environmental index = 100 points), environmental protection costs should amount to 384,540 million rubles, their required increase in each federal district is shown in Fig. 16.3. The necessary increase in the level of PPP development (100 points in all cases, Fig. 16.3) and the number of clusters (Fig. 16.4) was also demonstrated.

As shown in Fig. 16.3, the largest increase in the level of PPP development is needed in the North Caucasus Federal District (167.38%).

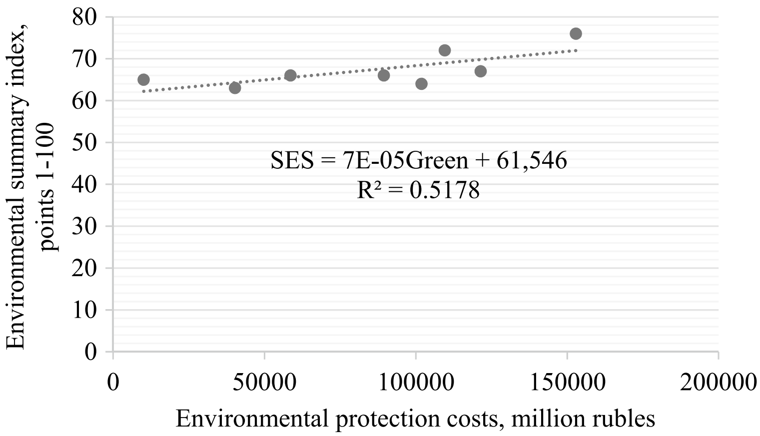

Fig. 16.2 Contribution of environmental protection expenditures to the formation of the consolidated environmental index in the regions of Russia in 2020 (*Source* Calculated and built by the authors)

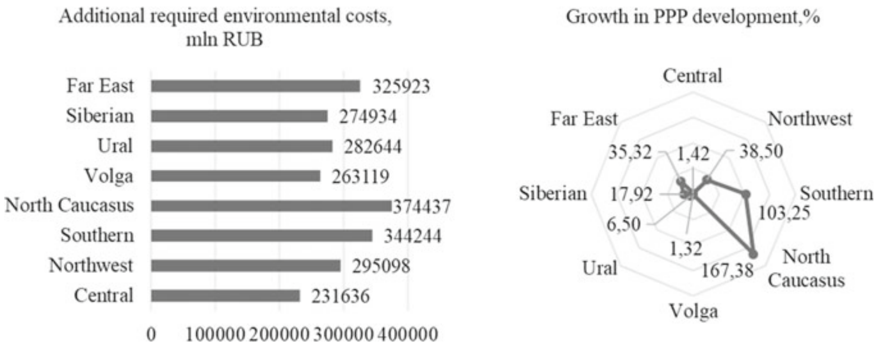

Fig. 16.3 The required increase in green investments and the level of PPP development to ensure environmental safety in the regions of Russia (*Source* Calculated and built by the authors)

As shown in Fig. 16.3, the largest increase in the number of clusters is also needed in the North Caucasus Federal District (118 pcs., +5785.34%). In addition to increasing the number of integration mechanisms for financing the development of the green economy in the regions of Russia, it is recommended to ensure their high-tech technology based on Industry 4.0 (Fig. 16.5).

Figure 5 shows that public administration bodies in the region on the basis of PPPs dictate environmental efficiency requirements to large private enterprise in the region under the PPP contract. Partner enterprises, in turn, place large-scale green investments as part of the execution of the contract. In

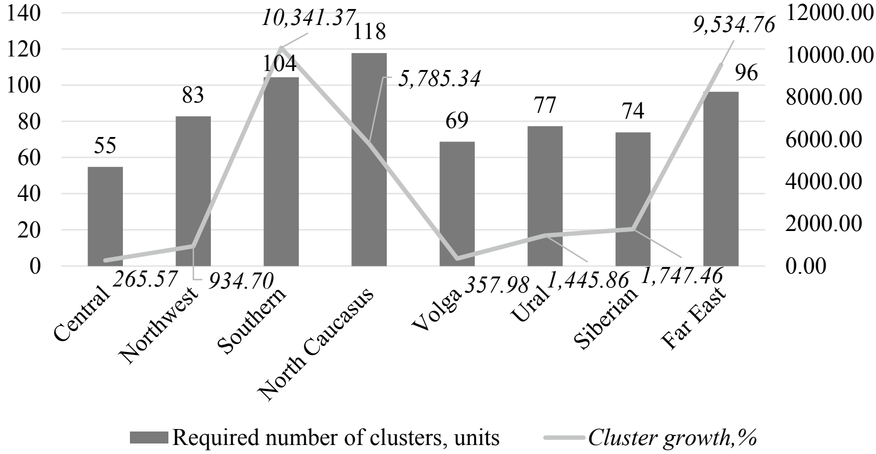

Fig. 16.4 Required volume and increase in the number of clusters to ensure environmental safety in the regions of Russia (*Source* Calculated and built by the authors)

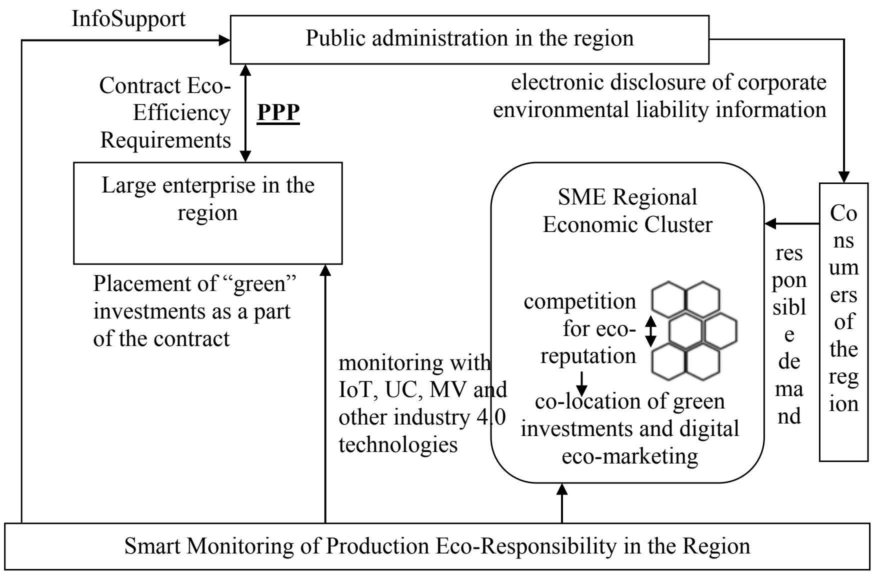

Fig. 16.5 High-tech integration financing mechanisms for green economy development in the region in Industry 4.0 for strategic security (*Source* Developed and compiled by the authors)

the regional cluster of small- and medium-sized enterprises, there is competition for environmental reputation, encouraging cluster members to place joint "green" investments and conduct digital environmental marketing of the cluster.

Public administration bodies in the region conduct "smart" monitoring of the environmental responsibility of entrepreneurship through the Internet of Things (IoT), unified communications (UC), machine vision (MV) and other Industry 4.0 technologies. They provide electronic disclosures of corporate environmental responsibility to consumers in the region, who thus present an environmentally responsible demand.

Conclusion

Therefore, both integration mechanisms for financing the development of the green economy in the region—both public-private partnership and clustering—are in demand and should be used in the interests of strategic ensuring the environmental security of the regional economy of Russia. This will make it possible to use both regulatory (in PPP) and market (in clustering) practices to stimulate environmental responsibility and place green investments in integrated entrepreneurial structures. To this end, targets for benchmarks and recommendations for leveraging Industry 4.0 to achieve high-technology integration financing mechanisms for green economy development in the region for strategic security are proposed.

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CHAPTER 17

The Impact of the "European Green Deal" on the Import of Natural Gas from Russia

Valerija S. Mincicova

Introduction

The active interaction of states within the framework of an already united and interconnected world economy is burdened by a number of global problems of our time. Their number is constantly changing, including the formation of a new technological structure, the beginning of the Fourth Industrial Revolution, and the entry into Industry 4.0.

The fourth industrial revolution was declared inevitable and mandatory at the World Economic Forum, and the development priorities of both TNCs and states for the next 10–15 years became obvious—that is, the development of digitalization, automation, big data, and its security.

But Industry 4.0 goes hand in hand with another major strategy for humanity—conserving the Earth's resources and improving the environmental situation, as well as ensuring welfare for all members of society. 6 of 17 sustainable development goals fixed in UN resolution "Transforming our world: the 2030 Agenda for Sustainable Development" of 2015 are directly related to the conservation of ecology and responsible attitude to nature, even more do so indirectly. In the same year 2015, 193 countries and 4 additional participants signed the Paris Climate Agreement.

In accordance with these documents, the European Union (EU) took the liberty of becoming a pioneer of climate neutrality, and by the end of 2019

V. S. Mincicova (✉)
Financial University Under the Government of the Russian Federation, Moscow, Russia

E. B. Zavyalova and E. G. Popkova, *Industry 4.0*,
https://doi.org/10.1007/978-3-030-75405-1_17

proclaimed the “European Green Deal”, creating a roadmap for changes with control points—years 2030, 2040, and 2050 (European Commission, 2019).

The European Green Deal does not imply complete decarbonization; it speaks of climate neutrality and a low-carbon economy. And such an economy is characterized by competition between energy suppliers and an effective balance between hydrocarbons and renewable energy sources (RES) (Lombardi & Gruenig, 2016).

The share of own energy production in the EU was 42%, while imports were 58% in 2018. 70% of the value of European imports is crude oil, 24% is natural gas, and 6% is coal. Natural gas is imported in the form of LNG—7% of total imports—and gaseous (pipeline) gas—17% of total imports (Eurostat, 2020).

Natural gas plays an important role in the EU electricity production, and 66% of it is imported—before Brexit (Lombardi & Gruenig, 2016). In 2018, 38% of natural gas was imported to the EU from Russia, the main supplier of this resource; another 24% of supplies were provided by Norway; 9%—Algeria; 8%—Great Britain; 7%—Netherlands; 4%—Qatar; 2%—Nigeria; the rest—other countries (PJSC Gazprom, 2019). The first three countries supply gas mainly through pipelines.

The history of gas supplies from Russia to the EU dates back more than half a century. For Russia, the sale of energy resources is one of the most important sources of foreign currency in the budget; for the EU, diversified deliveries of various energy resources from Russia are a guarantee of providing all member countries with energy, but also a significant risk of energy dependence. However, these relations are complicated by various factors; each side has its own interests and plans.

In this manuscript, the author proves the hypothesis that the “European Green Deal” will not stop the import of hydrocarbon energy resources into the EU, in particular natural gas from Russia, in the long-term period of the next 10 years.

Methodology

This hypothesis is proved in the time horizon until 2030 by 4 groups of arguments:

- The ratio of the cost of energy transition and the cost of energy imports, in particular, imports of natural gas, indicates the excess of the cost of the energy transition and the difficulty of finding funds to finance it;
- Difficulties and conflicts in the use of renewable energy sources and the existing infrastructure of electric power generation in the EU with underloaded capacities of gas power plants;
- Clustering of EU countries between the supporters of the “green deal” and its critics;

- EU orientation toward diversification of suppliers and types of hydrocarbon fuels through liquefied natural gas.

The study is based on statistical data from the European Commission (European Commission, 2019), Eurostat (Eurostat, 2020), expert estimates by Deloitte (Deloitte, 2020), Jacques Delors Institute (Pellerine-Carlin et al., 2017), Bruegel thinktank (Claeys & Tagliapietra, 2020), MILESECURE (Lombardi & Gruenig, 2016), and Russian natural gas exporters—PJSC Gazprom (PJSC Gazprom, 2019) and PJSC NOVATEK (PJSC NOVATEK, 2019).

An important caveat is that the data on volumes of natural pipeline gas exports to the EU from Russia are increased due to the sales accounting methodology of PJSC Gazprom. In PJSC Gazprom's natural gas export statistics, Turkey is traditionally included in the Europe direction—about 12% of all pipeline gas exports from Russia to Europe, although the latter is not part of the EU and, accordingly, is not involved in the EU's green deal. However, the Russian gas coming to Turkey through the Blue Stream, Turkish Stream, and the planned Southern Stream pipelines is mostly distributed further to the EU countries, so the author did not exclude these data from the general figures.

This paper presents the results obtained after modeling the realistic scenario of developing the natural gas exports from Russia to EU. These data allow us to correlate the cost of energy imports and the cost of energy transition.

The author also developed and expanded the idea of clustering EU countries on the basis of their attitude toward the Green Deal, as reflected in the work of Mata Perez, M. E., Scholten, D., Smith Stegen, K. "The multi-speed energy transition in Europe: Opportunities and challenges for EU energy security" (Mata Perez et al., 2019).

The popular idea of improving the EU's energy security through diversification of natural gas imports by importing liquefied natural gas (LNG) is considered from the point of view of the geographical structure of suppliers and the analysis of the nuances of using LNG.

The arguments for and against the hypothesis are considered. The latter are represented by two main factors: climate—objective—and politicization of the EU energy sector—subjective.

The study was conducted in the 2nd quarter of 2020 in the context of the development of the COVID-19 coronavirus pandemic, considering current data. However, statistical sources at the time of the study do not fully provide updated data for 2019, and forecast data for 2020 have a share of approximation. But the use of various theoretical, practical, and business news sources makes it possible to consider the content of the article relevant for use by interested parties.

Results

The essence of the "Green deal" is the formation of an economy that is less dependent on hydrocarbon sources and causes less harm to nature than its ability to self-repair, including zero CO_2 emissions by 2050—carbon neutrality of the continent. Decarbonization of the EU economy is mentioned in the roadmap only in the context of a proposal to introduce a special carbon border adjustment mechanism for some industries (without specification) in 2021 and a proposal to support zero carbon steel-making processes by 2030. The remaining actions relate to modernization of legislation, energy infrastructure, reduction of emissions into the environment, automation and smartization of energy supply processes, and environmental measures (European Commission, 2019).

As for the specific goals for 2030, the EU has stated a reduction in greenhouse gas (GHG) emissions of 40% or more from the 1990 level; up to 32% increase in the share of energy from renewable energy sources in energy mix (from 14,6% in 2018); and up to 30% or larger increase in energy saving. Moreover, the last point is not specified: it involves both increasing energy efficiency and getting rid of losses in networks, and increasing the productivity of power plants and energy sources.

Estimates of the cost of the "European Green Deal"—the program for transition to climate neutrality—vary depending on the time and source of the assessment (see Table 17.1).

The cost of the energy transition is estimated at the minimum of 1 trillion euros until 2030. This amounts to at least 100 billion euros annually, or 0.7–1% of EU GDP, starting in 2020. If the cost is closer to the Bruegel think

Table 17.1 Estimates of the cost of the "European Green Deal" (abridged table)

Author of evaluation	*Date of evaluation*	*Total cost*
European Commission	November 2016	€1.1–1.55 trillion
Notre Europe think tank (Jacques Delors Institute)	September 2017	€379 billion (includes only investments in low-carbon assets and infrastructure to comply with the Paris Agreement until 2030)
European Commission	December 2019	€2.6 trillion (€260 billion of additional annual investment * 10 years)
European Commission	January 2020	At least €1 trillion
Bruegel think tank	February 2020	€3 trillion (€300 billion of additional annual investment * 10 years)

Source Developed and compiled by the author based on previously mentioned sources (Claeys & Tagliapietra, 2020; European Commission, 2016; European Commission, 2020; Pellerine-Carlin et al., 2017) tank estimated value of 3 trillion euros, then these expenditures will amount to 2.0–2.5% of GDP annually for decades. Such a plan appears particularly far from reality against the background of the need to restore the EU economies after the crisis caused by the COVID-19 coronavirus pandemic.

For 7 years (2014–2020), the EU budget has allocated €420 billion for "sustainable development and natural resources"—an average of €60 billion a year—and in 2019—€65 billion, less than two-thirds of the required funding (Umbach, 2019). Moreover, representatives of the European Commission themselves talk about additional €260 billion annually (on top of €100 billion annually). Together, this will amount to €360 billion. That is, 6 times more funds than allocated today.

The author compared this cost estimate with the forecasted value of imports of natural gas to the EU for the same period until 2030 (Table 17.2).

Table 17.2 Calculation of the value of natural gas exports from Russia to the EU in the period of 2020–2030 in a realistic scenario

	Physical volume of export of pipeline natural gas from Russia to the EU, billion m³	*Predicted price of pipeline natural gas for 1 m³, dollars*	*Value of export of pipeline natural gas from Russia to the EU, billion dollars*	*Physical volume of LNG exports from Russia to the EU, billion m³ / mln tons of LNG*	*Predicted price of LNG for 1 m³, USD*	*Value of LNG exports from Russia to the EU, billion dollars*	*The total value of gas exports from Russia to the EU for the year, billion dollars*
2020	198.00	0.11	21.78	21/15.2	0.14	2.94	24.72
2021	219.02	0.14	30.66	21/15.2	0.13	2.73	33.39
2022	225.04	0.16	36.01	21/15.2	0.15	3.15	39.16
2023	231.23	0.19	43.93	28.9/21	0.19	5.491	49.43
2024	237.59	0.20	47.52	28.9/21	0.19	5.491	53.01
2025	244.12	0.22	53.71	42.8/31	0.20	8.56	62.27
2026	250.84	0.24	60.20	49.7/36	0.21	10.44	70.64
2027	257.73	0.26	67.01	49.7/36	0.22	10.93	77.95
2028	264.82	0.29	76.80	55.1/40	0.22	12.12	88.92
2029	272.10	0.30	81.63	62.1/45	0.24	14.9	96.54
2030	279.59	0.31	86.67	75.9/55	0.25	18.98	105.65
Total value of natural gas exports *for 11 years*							*701.66*

Source Developed and compiled by the author based on previous research, statistics of financial reports by PJSC Gazprom, PJSC NOVATEK, Deloitte (Deloitte, 2020; PJSC Gazprom, 2019; PJSC NOVATEK, 2019)

It is important to note that PJSC Gazprom exports gas to the EU from Russia in the form of pipeline natural gas, thus being the main supplier of gas to the European market, and NOVATEK in the form of LNG supplies from the Yamal-LNG and Kriogaz-Vysotsk projects and LPG. PJSC Rosneft has been negotiating on export of pipeline gas through Gazprom's capacity to BP in UK since 2017, and on exporting LNG since 2019, but they have not received either export license at the time of writing.

As a result of modeling the physical volume and value of imports of pipeline and liquefied natural gas to the EU from Russia for the period until 2030, the author concluded a total sum of $701.66 billion over 11 years (see Table 17.2).

The export of Russian natural gas estimated as $701.66 billion for 11 forecast years makes up 38% of all EU gas imports. Thus, the total value of imported natural gas from all the supplying countries under the improved realistic scenario for the period 2020–2030 will be about $1.85 trillion or €1.65 trillion. That means, that the costs EU countries would pay for gas imports for 11 years will amount to a sum comparable with the one required for the energy transition in the same time period, as estimated by the European Commission at 1–2.6 trillion Euro (see Table 17.1). Moreover, the cost of imported natural gas will be 1.57 times lower than the cost of the Green Deal estimated by the European Commission and 1.8 times lower than the cost estimated by the Bruegel think tank.

Against this background, the feasibility of a sharp energy transition and the rejection of the import of "blue" fuel seem inexpedient for reasons of economy. And the gradual simultaneous replacement of primarily coal, then oil, and oil products with natural gas (mainly pipeline) and renewable energy seems real and feasible.

Russian pipeline gas is attractive to EU consumers for a number of reasons:

- Deliveries of pipeline natural gas from Russia are non-seasonal and therefore stable;
- The specificity of the contracts Gazprom—European counterparties—is that they are long-term agreements with more stable prices in the event of sharp jumps in the markets for hydrocarbon energy resources;
- EU demand for natural gas is growing. Thus, according to the forecasts of PJSC Gazprom, the demand for natural gas in the EU will increase by 89 billion m^3 by 2035 as compared with the average demand in 2010–2018;
- The CO_2 tax for industries included in the European Emissions Trading Scheme in 2020 increased to €28 per 1 ton. This tax will increase (according to IMF forecasts, to a radical $75 per ton). Thus, coal-fired power plants are becoming unprofitable;
- Gas generation capacities in the EU are underutilized by 50% or more, which means that, provided relatively low gas prices are maintained, electricity will be produced at existing enterprises using "blue" fuel;

- Pipeline gas prices in PJSC Gazprom's long-term contracts are tied to oil prices, which means that since 2020 they have fallen sharply, which encouraged importers to fill underground gas storages (UGS) for future use. The spread of the pandemic, followed by a halt in production and a temporary drop in energy demand in the second quarter of 2020, also lowered the price of natural gas;
- The EU has reduced its own gas production: from 317 billion m^3 to 240 billion m^3 from 2010 to 2018. The Dutch Groningen field is planned to be completely closed by 2030 with a gradual decrease in production volumes from 2022 due to frequent earthquakes. Production is reduced in the UK and Germany. The only countries in Europe that have increased gas production are Ireland and Norway (not part of the EU). Consequently, import dependence is growing.

Italy (37% of all energy produced) and the Netherlands (35%) depend on natural gas as the main source of energy. At the same time, the maximum amount of renewable energy is used in Latvia and Sweden (39% each).

Deliveries to the EU are more attractive for Russian suppliers of pipeline natural gas (PJSC Gazprom) for the following reasons:

- Gas prices are less volatile in long-term contracts. For example, at the beginning of 2019, spot gas prices in Asia fell by 4–44%, so deliveries to Asian markets under spot contracts were less profitable than to European markets;
- For the European gas contracts of the Groningen model, there is a "take or pay" condition—the obligation of buyers to pay for a certain level of supply regardless of their need for raw materials (Chinkova, 2019);
- Deliveries of LNG from Russia's largest gas liquefaction field and plant, 50.1% of which is owned by PJSC NOVATEK and foreign investors—Yamal LNG—are seasonal due to the transportation of tanks along the Northern Sea Route.

In 2019, LNG imports to the EU amounted to a record volume of 76 million tons (106 billion m^3)—21% of all LNG produced in the world. Due to this significant growth, this type of fuel will be under close attention in the coming years. Despite the huge costs of energy and traditional resources for liquefaction, transportation, storage, and regasification of LNG compared to pumping it through gas pipelines, it is nevertheless being actively traded. This is mostly due to the compactness of the product and the possibility of diversification of suppliers, as well as a potential future economic pressure on suppliers of pipeline gas.

LNG is mainly supplied to the EU from Qatar (30 million tons in 2019 according to the Independent Commodity Intelligence Services—ICIS), Russia (21 million tons), and the United States (17 million tons). The sharp increase in LNG imports to the EU in 2019 was provided by the United States (73% increase in volumes) and Russia (52% increase). Inside the EU, Russian LNG is bought mainly by France, the Netherlands, and Spain.

European analysts see the competition between Russia and the United States in the EU LNG market as an opportunity to diversify energy security risks. Prices for LNG imported into the EU remain a corporate secret; there are opinions that Russian LNG is much cheaper due to the proximity of delivery and the active development of the Northern Sea Route. However, in a number of publications, one can find the converse statements. Of course, this competition is politicized and temporary, because after the recovery of Asian markets and production from the pandemic, the demand for LNG in this region will increase. Both the United States and Russia are extremely interested in diversifying their consumers, so tankers will head to China and Japan, and to new industrial countries—“Asian dragons”.

According to the observations of scientists at Delft University of Technology in the Netherlands, all 27 EU countries are divided into two camps (clusters)—those who focus on renewable energy and consider it a way to overcome import dependence and those who prefer reliable import supplies and set aside RES for later because of their instability and high cost (Mata Perez et al., 2019). The first group consists mainly of Western European countries; the second consists of Eastern European and Baltic countries (except Latvia), Ireland and Luxembourg.

The second group (cluster) of EU member states concentrates on ensuring their own energy security by diversifying the import of energy sources, both geographically and in terms of commodity.

And above all, a desire to move from coal and oil, as the most harmful primary energy sources, to natural gas. In 2015, the EU had 128 coal mines, providing more than 238 thousand jobs. Critics of the strategy, especially from Eastern Europe, say it will be financially difficult to help coal mining regions (Harvey & Rankin, 2020). According to the EIA, just the CO_2 emissions from natural gas processing are 1.37 times lower than from the processing of petroleum products and 1.84 and more times lower than from the processing of coal. Also, natural gas produces fewer fine particles, sulfur dioxide (SO_2), and nitrogen oxides during combustion.

The indicated cluster division into active supporters of the “Green Deal” and skeptics of its application further supports the author’s hypothesis about the impossibility of an early refusal to import Russian gas. Notably, an above-average growth rate of natural gas import into the EU is observed in the Netherlands, and an above-average growth rate of natural gas consumption in the EU is observed in Poland. Austria, France, Italy, Germany, Hungary, and the Netherlands extend long-term contracts and stabilize or increase imports of Russian gas (Chinkova, 2019).

Not only countries supporting the conservation of the carbon economy, but one of the EU leaders, Germany, is also striving to switch to natural gas to a greater extent. The climate cabinet in Germany outlined a strategy for the complete rejection of coal-fired power plants by 2038 (Bundesministerium für Wirtschaft und Energie, 2019).

In 2019, the share of coal in the total supply of primary energy (TPES) in Germany amounted to 22%, while natural gas amounted to a similar share of 23%. By 2022, it is planned to close 12 coal-fired power plants, and another 30 will be closed later. No rehabilitation is planned for nuclear energy. And all this means that the German dependence on natural gas will grow, especially since a large gas pipeline—Nord Stream—is already successfully operating, and project Nord Stream-2 is nearing its opening despite all the difficulties.

France plans to reduce its own consumption of non-renewable resources by 30% by 2030, halve the use of nuclear energy by 2025, and increase the share of renewable energy sources in TPES to 32% (Légifrance, 2015). However, 15% of TPES is provided by natural gas.

The two EU leaders are ready to spend €115 billion on the energy transition over the next two decades. €115 billion is 11.5% of the budget announced by the European Commission for the Green Deal. But are other EU countries, including those with a deficit budget, ready to provide as much as France and Germany? The obvious answer is no—especially in the context of an unprecedented drop in EU GDP by 3.5% in 2020 and the need to recover from the crisis caused by the pandemic, rising unemployment, and increased competition from Asia–Pacific countries in the markets for goods, services, and technologies.

Another fact confirming the hypothesis that demands for Russian pipeline gas in the EU in the next decade will continue and is likely to grow is as follows: liquefying natural gas, transporting it, and subsequent regasification require significant external energy consumption, which is associated with GHG emissions and heat transfer into atmosphere. Thus, if the European "carbon tariff" will be based on the level of atmospheric emissions from fuel production, as is planned, then pipeline gas will again benefit significantly.

The collision in the use of renewable energy—the cost and environmental unfriendliness of the production and design of solar panels and wind generators—is a "hidden carbon footprint". EROI (energy returned on energy invested) indicator for coal plants is 9:1, for nuclear 20:1, for solar panels 26:1, and for wind generators 44:1 (Pehl et al., 2017). At the same time, the authors of another study on the effectiveness of different energy sources give EROI values very close to renewable energy sources for gas and oil power plants equal to 20:1, hydroelectric power plants at 84:1, and bioethanol at 13:1. The least efficient in terms of this indicator is offshore shale oil processing with EROI of 4:1 (Hall et al., 2014). In response to such questions, for example, International Renewable Energy Agency (IRENA) claims that the use of bioenergy will be the "key" to the energy transition until 2030.

An objective negative factor influencing the growth of demand for Russian gas in the EU is global warming and warm weather in general. For example, after three years of continuous growth, the consumption of natural gas in the

EU in 2018 fell by 3.5% (by 20.1 billion m^3 in absolute terms) to 548.6 billion m^3 (PJSC Gazprom, 2019).

The subjective negative factor that can reduce the volume of gas purchases from Russia is political. An example of such events is the European Court's satisfaction of the Polish lawsuit against PJSC Gazprom regarding the restriction of the company's access to the full capacity of the OPAL gas pipeline in 2019. Some populists openly state that countries actively importing natural gas from Russia are "buying off military invasion" (Mae, 2020).

Another challenge is LNG competition. In 2019, the volume of LNG supplies to the EU countries from the Unites States, Qatar, and Russia also negatively affected the demand for pipeline gas. Total LNG imports increased by 69.4%. As a result, by early 2020, Europe had a record high level of gas reserves in UGS, including due to expectations of interruption of gas transit through Ukraine via the Urengoy-Uzhgorod gas pipeline. The share of LNG in the gas balance of Europe increased from 13% in 2018 to 21% in 2019 (PJSC Gazprom, 2019).

Conclusions

The main hypothesis of this study, that the EU's rapid energy transition from a hydrocarbon economy to a green economy will not be possible to occur under current conditions, is confirmed. The cost of an energy transition is comparable to the cost of importing natural gas for the EU over 11 years, while gas imports are much cheaper than the Green Deal itself, the EU's budgetary opportunities are very modest due to the designated positions of the countries from the cluster of the Green Deal skeptics. And the complexity of the search for funds will be compounded by the factor of the economic crisis caused by the COVID-19 pandemic, as well as by the increase in social tension in the second half of 2020.

The EU's "black" (oil-dependent) and "blue" (gas-dependent) economy, on the one hand, makes the European continent dependent on Russian gas, but on the other hand, makes Russia dependent on exports to the EU. And the political factor in these relations of the main players in the Greater Europe region will play an important role in the EU energy transition strategy.

Against this background, the author puts forward the theory of a smooth transition of the EU economy from a "black", oil economy through a gas, "blue" economy with a gradual replacement of oil products by pipeline and liquefied gas, which will require lower costs for the refurbishment of thermal power plants in comparison with the fundamental transition and construction of new plants working on RES, to a "green" economy, where renewable sources predominate.

This scenario is also evidenced by the fact that the "Green Deal" of the EU does not imply a complete transition to renewable energy in the next 10 years. And the "Green Deal" itself is in fact the formation of a carbon–neutral continent, not total decarbonization.

And this multiphase transition “black”—“blue”—“green” can be done in several ways.

First: All EU countries will move to a “blue” economy, based more on natural gas as the primary source of energy. And this process may be lengthened, because foreign trade in hydrocarbons is one of the oldest and most reliable global value chains that exist not only on the Eurasian continent, but throughout the Northern Hemisphere and even throughout the Earth.

Second: All EU countries will move to a more “blue”, gas-oriented economy. But this will be a temporary reorientation from coal and oil to natural gas until more RES and a greener economy are introduced. “Bluing” and “greening” of the economy will occur in parallel.

Third: The two EU clusters will be divided by their energy policy into a greener economy and a more carbon-based one, possibly a blue one, focused on generating energy from natural gas. That is, Western European countries (the first cluster of activists of the Green Deal) will introduce renewable energy sources everywhere, even to the detriment of other areas of industry, and despite the unpopular increase in the tax and tariff burden among the population and business, they will reorient their power grids to self-training, self-regulation, and full compliance with Industry 4.0. At the same time, underground storage of gas and oil will be filled in case of unforeseen situations. However, demand for hydrocarbon imports will decline in these countries. And the Eastern European and Baltic countries (with the exception of Latvia), Ireland and Luxembourg, belonging to the second cluster (skeptics of the Green Deal), will maintain existing relations with hydrocarbon suppliers while introducing spot projects involving renewable energy sources.

The third way seems to be most likely today based on the complex of the above circumstances.

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CHAPTER 18

Ecological Standards in the Real Estate Market of Russia in the Context of the Digital Economy

Irina A. Strelets

Introduction

Digitalization, with its positive and negative aspects, is now one of the most popular buzzwords in the economic thought. Thanks to digital technologies, the economic activity scales up, the frames of world markets become wider, and the significance of the real sector and of the money sector grows. Even the concept of "new economy" has been put into power to determine those enterprises in high technological sphere (Kelly, 1998). In general, the concept of digital economy is traditionally associated with the works by N. Negroponte (Negroponte, 1995) and D. Tapscott (Tapscott, 1995). Being the subject of research and discussion for years, the concept offered a variety of areas of research. The importance of new technologies as well as overall digitalization is obvious. At the same time, there is a widespread understanding that digitalization itself is not only a popular trend in economic research, but it should, first of all, serve the needs of the present and future generations. And it is very important to take into consideration their impact on the level of the ecological responsibility.

As we move further into the twenty-first century, we constantly approach the aims determined by the sustainable development goals initiatives, launched in the report "Our Common Future" published by the World Commission on Environment and Development in 1987. Green buildings are very important

I. A. Strelets (✉)
Moscow State Institute of International Relations (MGIMO University), Moscow, Russia

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in approaching these aims. In fact, green buildings and sustainable development are strongly interconnected. Since the idea of sustainable development supposes that all citizens of all countries should enjoy high standards of living, green buildings may be looked upon as an instrument to achieve the goal.

The concept of green buildings is very broad and nurtures many fields of research. Early works on green buildings generally focused on the benefits of green buildings and their perspectives (Bradley & Kibert, 2010; Kibert, 2004). Later, some authors studied the relationship between green buildings and sustainable development tasks (Sinha et al., 2013), the problem of transaction costs in green building (Qian et al., 2015), and new drivers and new problems in this sphere (Sui Pheng et al., 2014).

The purpose of this paper is to draw attention to the discussion concerning green buildings and green building rating systems and their application in different countries. Taking into consideration some scarcity of publications on the topic in Russia, this research provides the following contribution. At the macro-level, it determines some basic tendencies in the development of green buildings in the world and in Russia. It also analyzes rating systems that are implemented to stimulate further development of green buildings in Russia. At the micro-level, the paper formulates some recommendations for the firms and authorities who are involved in green building.

Methodology

This study employed a mixed method approach to investigate the relationships between green building, ecological standards, and main aims of the sustainable development in the context of the digital economy. The study was carried out on the following methodological basis: the systematic review analysis method when analyzing the current theoretical approaches; the comparative analysis method when analyzing different rating systems, their benefits, and week points; the methods of systematization and generalization when making conclusions and predictions.

In our analysis, we focus on the publications by Russian and foreign scientists, statistical data, and legal acts which serve as the information base of the study.

We aim to review research on the different green building rating systems and ecological standards in the real estate market. For the purpose of this study, our attention is focused on the Russian real estate market under the digitalization and those steps which can be taken to improve it.

Results

Green buildings have lots of benefits, which were described in many early researches (Kats, 2003). Besides direct effects (diminishment of negative effects on climate and environment), they can even produce spillover effects enhancing the productivity of their occupants by producing comfortable working conditions (Byrd & Rasheed, 2016). Now, these effects have become even more obvious. In accordance with the data of the latest annual report of the World Green Building Council (WorldGBC Annual Report 2018/2019), the number of green buildings around the world has been constantly increasing as well as the number of countries implementing the green building policy. The number of green buildings in Russia has increased from 20 buildings in 2013 up to 130 buildings in the first half of 2020.

All these processes demand implementing special standards and rating systems. At present, there is a variety of them (Suzer, 2015), including single-attribute green building rating systems (Energy Star Rating System, for instance) and multi-attribute green building rating systems (BREEAM, LEED, DGNB, Green Globes, LBO, etc.).

In the Russian real estate market, mainly the following international green certifications are used: BREEM, LEED, and DGNB. BREEM (BRE Environmental Assessment Method) is the most popular green building rating system in Russia. Having been launched in 1990 by the British company BRE (Building Research Establishment), it has become the pioneer in this sphere and the basis for many other green building rating systems. BREEM was the first green building rating system to enter the Russian market. Now, this rating system is widely spread in Russia, and approximately 72% of buildings certified in accordance with green standards have got BREEM certification (Knight, 2020). The second important green building rating system in the Russian real estate market is LEED (Leadership in Energy and Environmental Design). The factory for the production of railway bearings of the Swedish concern SKF (Tver region) became the first project in Russia with LEED certification. Now, approximately 27% of buildings certified in accordance with green standards in Russia have got LEED certification (Knight, 2020). DGNB (Deutsche Gesellschaft für Nachhaltiges Bauen) is the third green building rating system which is used in Russia occupying about 1 percent of all buildings certified in accordance with green standards (Knight, 2020). Thus, we see the dominance of BREEAM standards in Russia.

The choice of green building rating system depends on the specifications of the building project. For example, LEED strictly applies US standards. BREED accepts local standards.

Green Zoom is the first Russian ecological standard for buildings. It was formed on the basis of different international standards but it takes into consideration specific features and demands of the Russian market. In fact, it is a standard of energy efficiency in construction.

Green building standards are very important for all participants of the building process. They create a comfortable area for those who work in such buildings, improve the image of the building company and the image of the city, and attract tenants. The successful certification allows the company to be among the leaders of the industry. For example, business center Lighthouse and Juzhnie Vrata (both have got BREEM certifications) became winners of CRE Awards (Commercial Real Estate Awards) in 2013. In the United

States and in the European countries, the main factors affecting the demand for green standards are legislation and prices for energy, while in Russia they are competitive advantages, the image in the international market. At present, green certification in Russia is voluntary.

The government usually looks upon green standards as a way to introduce innovative technologies in construction. Sometimes the government provides green certification for the projects of the international level: Sochi-2014, FIFA-2018. Such projects help to form a green building tendency in construction.

Sometimes Russian standards are even more severe than international ones. For example, in accordance with Russian standards, minimum air consumption per person for rooms without natural ventilation is 60 cubic meters, while in accordance with American standards it is 30.6 cubic meters. So the compliance of national standards may facilitate the procedure of green certification.

In spite of the fact that the buildings are already successfully certified, some companies go further and improve their ecological characteristics even more. The office park Comcity (Moscow) offers a very good example of such behavior. Comcity has got LEED certification, but it goes on to improve its ecological image, using natural ventilation, external automatic blinds, cold storages, etc.

The structure of the green buildings market by segments in Russia is as follows (Table 18.1):

We see the strong dominance of office buildings among all certified green buildings both in Russia and in Moscow.

If we examine the structure of the green buildings in Russia certified by BREEAM and by LEED standards by segments, we can see the same tendency for the dominance of office buildings. 80% of the total amount of buildings certified by BREEAM standards and approximately 63% of the total amount of buildings certified by LEED standards are office buildings.

It is very remarkable that all certified by green standards office buildings are situated either in Moscow or in Saint Petersburg or close to them. There are

Table 18.1 Structure of the green buildings in Russia and in Moscow by segments, % of all green buildings

Segment	*Russia*	*Moscow*
Office buildings	39	80
Trading Buildings	24	11
Warehouse and Industrial Buildings	19	2
Residential buildings	2	–
Hotels	2	–
Other (data centers, athletic facilities, etc.)	14	7

CRE—Portal of Commercial Real Estate in Moscow and in Russia, available at: https://www.cre.ru/analytics/78471 (accessed 30 June 2020).

no such buildings in distant regions at all. The most important green office buildings in Moscow are Comcity, Romanov Dvor, Lighthouse, Ducat Place III, and some other projects.

The concept of green buildings is connected with the concept of smart homes and smart cities (Vrabie, 2019). The core characteristic of such projects is the overall use of communication technologies and networks, but they are supposed to be aimed at achieving the goals of sustainable development. Green standards are very important and very helpful in doing it.

There are a number of very successful and perspective projects in Russia.

The Production and Warehouse Complex of the German company Wilo in Noginsk is a very good example of successful green building certification (Green Zoom and LEED) and of a very high level of energy efficiency in construction. A number of modern engineering solutions were used in construction of the building: ventilation equipment with heat recovery systems, smart space heating with weather-dependent supply schedule, etc. Office building of the company in Noginsk is also organized in accordance with green standards: the office has a very economical light control system for LED lights with motion sensors. All materials used in the project meet the requirements of LEED.

Another example is Zheleznogorsk. It is the first city resort in Russia where smart city technologies are being introduced. The electronic system allows to control the garbage collection dynamics, to track the utility consumption, and to fulfill many other functions.

But there are still some problems connected with green building process. The main problem is costs. The cost of green buildings is much higher than the cost of traditional ones. And of course this is a serious obstacle for the rapid development of green buildings in Russia. Only big ambitious companies can afford green certification. Another problem is voluntariness of certification. Some countries have special legislation in this sphere. For example, in Canada, since 2005, all new government office buildings must be certified (LEED Gold); in the UK, since 2020, all new dwelling houses must meet the demands of the special Ecohomes standard.

Nevertheless, green buildings and green buildings standardization have good perspectives in Russia. While our internal demands and standards are likely to be implemented in regions, mainly for administrative buildings, international standards will be in great demand for certification of big office centers, innovative productions, and large projects.

The development of green building standards will stimulate the market of complementary goods that is the market of construction materials and technologies. It is very important to enlarge the innovative component of the materials and technologies.

Additional demands and standards are likely to raise the transparency of the work of the housing and utilities sector.

All these tendencies and positive changes will give us a real chance to live a safer and comfortable environment meeting best international quality standards.

Conclusions/Recommendations

Green buildings are very important as for the infrastructure development, so as for the achieving global aims of sustainable development. They offer the possibility to diminish the consummation of basic resources and improve the image of the city and of the region.

Analyzing the case of Russia, we may formulate the following basic conclusions and recommendations:

1. There is a strong tendency for the increase of green buildings in the country as well as of implementing green building ratings with the obvious dominance of BREEM.
2. Though Moscow and St Petersburg are still leaders in the sphere, there is an urgent need to develop green buildings in other regions.
3. At a micro-level, we recommend to invite specialists on green certification in the early stage of the projects of green building to avoid future possible negative effects, inconsistencies, and misunderstandings.
4. At a macro-level, it is necessary to take some steps to implement mandatory green certification at least for important projects and constructions.

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CHAPTER 19

Systemic Analysis of Economic and Legal Regulation of Foreign Trade Turnover of Energy Resources: Book Review

Agnessa O. Inshakova, *Elena I. Inshakova*, *and Elena G. Popkova*

Introduction

Springer International Publishing AG, part of Springer Nature, an international publishing company specializing in publishing academic journals and books indexed in the international citation and analytical scientometric databases, published the monograph "Energy Sector: A Systemic Analysis of Economy, Foreign Trade and Legal Regulations" in its 2019 Lecture Notes in Networks and Systems book series.

Given the interdisciplinary nature of this work of scholarship, its authors and editors are the scholars in the field of economic and legal sciences. The book was edited by Doctor of Economics, Professor O. V. Inshakov; Doctor of Law, Professor A. O. Inshakova; and Doctor of Economics, Professor E. G. Popkova. The team of contributors comprises the scholars from the leading Russian academic schools: Doctor of Economics, Professor L. Y. Bogachkova; Doctor of Economics, Professor A. V. Bogoviz; Doctor of Law, Doctor of Economics, Professor A. I. Goncharov; Doctor of Economics, Professor O. V. Inshakov; Doctor of Law, Professor A. O. Inshakova; Doctor of Economics,

A. O. Inshakova (✉) · E. I. Inshakova
Volgograd State University, Volgograd, Russia
e-mail: gimchp@volsu.ru; ainshakova@list.ru

E. I. Inshakova
e-mail: inshakovaei@volsu.ru

E. G. Popkova
Plekhanov Russian University of Economics, Moscow, Russia

E. B. Zavyalova and E. G. Popkova, *Industry 4.0*,
https://doi.org/10.1007/978-3-030-75405-1_19

Professor E. I. Inshakova; Candidate of Law I. P. Marchukov; Doctor of Economics, Professor E. G. Popkova; and Doctor of Law, Professor E. E. Frolova.

In the course of drafting and releasing the book, one of its editors, Merited Scholar of the Russian Federation Oleg Vasilievich Inshakov, passed away. He was a teacher, friend, and mentor for many contributors of the book. Therefore, they have reached the decision to get the book published as a tribute to the memory of Professor Inshakov.

The appearance of this monographic series is substantiated by the need to solve a number of problems, both theoretical and practical. By applying economic and legal methods and means, solving this kind of problems will be aimed at aftermaths of energy crises, power systems destruction, uneven distribution of energy resources and "energy hunger" in certain regions, lagging behind technological development, and integration of the energy sector. One cannot overlook the fact that the share of the Russian fuel and energy sector in the total volume of cross-border energy resources circulation and the dynamic development of international cooperation in the energy sector determine the relevance of addressing the research to the problems of improving legal regulations that can balance the interests of all participants in the public relations—business entities of producing countries, suppliers, consumers, and transit countries of energy resources.

Thus, the monograph is a comprehensive economic and legal research into theoretical and practical aspects of increasing energy efficiency (Popkova et al., 2019a); issues of self-motivation in energy saving by business entities within the framework of their corporate market responsibility and regulatory mechanisms of motivation for energy conservation (Popkova et al., 2019b); civil law regulations of foreign trade in energy resources between economic entities of the Russian Federation and member states of such international integration associations as the CIS, the EAEU, the EU, and BRICS (Inshakova et al., 2019b; Inshakova & Marchukov, 2019a).

The authors have revealed non-compliance of national foreign economic regulations with the international norms and standards and subsequently substantiated the need for eliminating the current gaps in legal regulations impeding their application.

In this regard, the monograph presents a comprehensive study of the civil law aspects of regulating foreign trade in energy resources as well as the system and sources of legal regulation in this sector. The book also includes a study of contractual structures applied to legalize international trade in energy resources by Russian companies. It dwells on the approaches to the contents of foreign economic agreements for the supply of energy resources, the effects of international legal organizations and associations in the development of civil law regulation of foreign trade in energy resources, and points out to the development priorities of the civil law regulation of the foreign trade in energy resources of the Russian Federation and the EU, as well as the BRICS member states.

Materials

The legal framework for the work is represented by the current legislation in the field of civil, business, and international private law governing international trade relations in the energy sector, emerging within the framework of international integration associations, with the Russian Federation participation or partnership (BRICS, EU). The legislation that constitutes the normative basis of the book includes the actual international regulatory legal acts (General Agreement on Tariffs and Trade of the WTO (GATT), the Convention on the Law Applicable to Contractual Obligations, etc.), domestic regulatory legal acts adopted mainly at the federal level (the key regulatory legal act is the Constitution of the Russian Federation, codified regulatory legal acts, such as the Civil Code of the Russian Federation, the Land Code of the Russian Federation, the Town Planning Code of the Russian Federation, etc., Federal Laws and by-laws adopted in their development: decrees of the President of the Russian Federation, decrees of the Government of the Russian Federation) and their projects, program documents (Energy Strategy of Russia for the period up to 2030, etc.), as well as regulations of the BRICS countries and the European Union, including its member countries.

The theoretical basis of the research was formed by the scientific developments of the leading researchers who are the authors of the monograph being analyzed: L. Y. Bogachkova, A. V. Bogoviz, A. I. Goncharov, O. V. Inshakov, A. O. Inshakova, I. P. Marchukov, E. I. Inshakova, E. G. Popkova, E. E. Frolova, etc.

The analysis of existing sources that form the basis of civil regulation of foreign trade turnover of energy resources and their significance for the development of modern foreign economic activity of the Russian Federation has been the focus of attention of scientific research by S. S. Alekseev, L. P. Anufrieva, A. V. Asoskov, V. A. Bagaev, V. N. Borisov, V. A. Bublik, N. V. Vlasova, N. G. Vilkova, O. A. Gorodov, A. O. Inshakova, V. A Kanashevsky, G. V. Kochetov, P. G. Lakhno, I. P. Marchukov, V. V. Romanova, and D. P. Strigunova.

The economic factors as well as the main problems affecting the development of foreign trade turnover of energy resources have become the subject of analysis by such researchers as G. V. Ageev, A. M. Belogoviev, V. V. Bushuev, A. I. Goncharov, D. V. Gribanov, A. S. Ivanov, O. V. Inshakov, A. O. Inshakova, E. I. Inshakova, A. A. Makarov, I. E. Matveev, A. Ya. Ryzhenkov, V. P. Udalov, and D. P. Frolov.

The significance and role, methods of participation and influence on the development, improvement and unification of civil legal regulation of foreign trade turnover of energy resources of international legal entities (TNCs and international organizations), and international integration associations (EU and BRICS), which are the main and top-priority foreign economic partners of the Russian Federation, are considered in the works by M. M. Boguslavsky, K. M. Belikova, N. G. Vilkova, L. E. Grishaeva, I. V. Gudkov, A. V. Dedenkulov,

A. O. Inshakova, N. Yu. Kaveshnikov, S. V. Kozlov, Yu. M. Kukushkina, P. G. Lakhno, I. P. Marchukov, I. N. Pavlova, R. N. Salieva, S. A. Utkin, A. V. Shiyanov, etc.

The empirical basis of the work involves materials of contractual and judicial practice, official statistical reports of authoritative international organizations, information resources of the largest oil and gas companies, etc.

Methods

The methodological basis of the study is a systems evolutionary approach implemented with both general scientific (analysis, synthesis, classification, induction, deduction, abstraction, formal-logical, structural and functional, temporal and spatial methods, etc.) and special scientific research methods. The interdisciplinary nature of the analyzed work predetermined the use of two groups of special scientific research methods: legal and economic. As part of the special scientific legal methods, the authors apply comparative legal, formal legal, functional, analytical, procedural dynamic methods, method of interpretation of law, etc. The special scientific economic methods involve comparative and documentary analyses, conceptual and graphic modeling, statistical, econometric and SWOT analysis, etc.

Results

In foreign trade, energy resources are a transnational product, which implies the complication of emerging legal relations by a foreign element and the involvement of another legal system. Such state of affairs reflects the relevance of studying the issues of applicable law that inevitably arise before the settlement of conflicts and have a significant impact on the content of the foreign trade contract. The contributors of the book deal with the problem of carrying out a comprehensive review of substantive law at a single international and national level, the domestic settlement of conflicts in the field of foreign economic activity, international trade, and judicial practices in the energy sector.

At the present stage, one cannot ignore the growing effects of economic and legal integration, which acts as the starting point for the essential legal unification of all legal regulation levels when analyzing the prospects for developing the legislation in the field of the power industry. Hence is the obvious need for studies of international integration forms of cooperation and the legal foundations of foreign trade energy relations developed as a result of their activities. In terms of the Russian national law and economy, international integration associations involving the Russian Federation, such as the CIS, the EAEU, and BRICS are of particular interest in this line of research. Moreover, it is crucial to be aware of priority development trends, systems, principles, and the essence of the legal bases for international integration unions—Russia's largest foreign economic partners, the prominent representative of which is the

EU. The study of the current legislation, program acts, judicial and contractual practices, customs and trade procedures specific to the field of foreign trade in energy resources, has enabled the authors to formulate proposals for the development, improvement, and unification of civil law regulations of the mandatory norms in contractual relations between business entities of the Russian Federation and the CIS, the EAEU, the EU, and the BRICS member states.

Relations arising among participants in the process of national energy resources international movement need to be contractually structured. Therefore, particular emphasis in the monograph is put on the study of the current legal regulation, the major trends of their development, as well as the principles and mechanisms for unifying foreign trade contractual relations of the Russian Federation in the field of international turnover of national energy resources.

Foreign Trade Activities and Turnover of Energy Resources: Concepts, Legal Foundations, and Contracting Frameworks

The first part of the monograph "Foreign Trade Activities and Turnover of Energy Resources: Concepts, Legal Foundations and Contracting Frameworks" points out to the significance of the civil law foundations in the foreign trade turnover of energy resources for the socio-economic modernization of the Russian state and reveals the sources that contain the rules and regulations governing this sphere of international business as well as doctrinal classifications of legislative acts constituting an array of foreign trade legal regulation in the energy sector.

The contributing authors consider the confines of applying provisions of the 1980 Vienna Convention on Contracts for the International Sale of Goods to a foreign trade agreement for the supply of energy resources and provide practical recommendations regarding the content of the contract in terms of establishing an appropriate way to exclude the application of the Vienna Convention provisions to the contractual legal relationship in question (Inshakova & Marchukov, 2019b).

The book uncovers the impact of international organizations on the development of an array of national civil law regulations in the field of energy trade. In the course of their study, the authors arrive at the conclusion that the international contractual practice exercised in the Russian Federation in the field of foreign trade in energy resources has developed against the background of the existing extensive substantive and conflicts-of-laws legal bases, which includes not only civil law, but also the norms of administrative, export, foreign exchange, customs, and tax legislation (Inshakova & Marchukov, 2019c).

Factors That Determine the Development of Foreign Trade Activities in the Energy Sphere and of Its Economic-Legal Regulation

The second part of the book "Factors that Determine the Development of Foreign Trade Activities in the Energy Sphere and of its Economic-Legal Regulation" deals primarily with innovation as an integral prerequisite for the development of modern foreigntrade in energy resources and its legal regulation. The authors note that innovative activities in the energy sector are manifested in introducing the latest highly efficient technologies and equipment, in applying advanced successful global experience, in improving the environmental friendliness of production and raw materials processing, in switching to modern kinds of raw materials and fuels, as well as in developing power system based on the use of alternative and renewable energy sources (Inshakova & Goncharov, 2019).

The present section of the book identifies the key factors of energy conservation self-motivation within the framework of corporate market responsibility of business entities and offers practical recommendations for its development (Inshakova et al., 2019b). In the monograph contributors' view, the proposed practical recommendations for improving the regulatory mechanisms of motivation for energy conservation will enable to achieve much greater economic and, more importantly, environmental efficiency, providing a long-term result.

One of the chapters in the section emphasizes the global trend in favor of reducing energy intensity and increasing energy efficiency (EE) of the economy and reveals the correlation between this process and the countries' global competition. It rationalizes the key role of technological energy saving in reducing energy intensity and increasing the EE of the economy and points out to the need for the institutional, including legal, ensuring of the Russian Federation involvement in various forms of international collaboration (Popkova et al., 2019a).

Authority of International Legal Entities and Integration Unions on the Development of Civil Legal Regulation of the Foreign Trade Turnover of Energy Resources

The third part of the monograph "Authority of International Legal Entities and Integration Unions on the Development of Civil Legal Regulation of the Foreign Trade Turnover of Energy Resources" presents the study on the role of international organizations and integration associations actively involved in the processes of developing, improving, and unifying civil law regulation of the energy resources foreign trade turnover. The authors identify possible legal forms of such organizations' involvement in the foreign trade of energy resources in accordance with the current Russian legislation, among which TNCs, as the authors suggest, play the major role. It is due to TNCs' activities that the integration processes of developing and liberalizing energy regulation intensify. As a result, the role of international private contractual practice—international commercial law of legal entities—energy companies is growing and its foundations are being laid (Inshakova et al., 2019a).

Within this section, the book contributors study and analyze the main lines of developing the common energy law of the European Union, the ways of developing the legal regulation of foreign trade in energy resources in the CIS and the EAEU, as well as the member countries of the BRICS international integration association.

In the course of studying the priority areas of the CIS and the EAEU energy policy, the authors conclude that, while establishing a common energy regulation of the CIS countries, the emphasis should be placed on its harmonization, by developing program framework acts. As for the EAEU, the authors provide some evidence that the unification of norms by concluding bilateral and multilateral agreements and the development of legally binding standards will be a more effective method (Inshakova et al., 2019c).

Further on, the section analyzes civil regulation of foreign trade in energy resources in the BRICS member countries. It elaborates on the extent of unifying civil regulation of foreign trade in energy resources of the BRICS countries based on the Vienna Convention on Contracts for the International Sale of Goods by studying the national legislative as well as conflicts-of-laws bases for foreign trade regulation in the BRICS member states.

The authors note that the agreements operating within the framework of the BRICS integration association are, in essence, program acts that establish only general directions for developing cooperation among the participating countries, and do not contain specific provisions of the civil law regulation of foreign trade relations in the energy sector (Inshakova & Marchukov, 2019a).

Conclusion

The analysis of the effectiveness of the current general legal energy policy models in numerous countries, the legal methods, and means applied to implement it as well as establishing the unified energy regulation is an important research task of great practical value for the socio-economic modernization of the Russian Federation and other energy powers.

As a major result of the undertaken interdisciplinary research, the monograph summarizes the proposals on elaborating, improving, and unifying the civil regulation of commitment in the field of international trade in energy resources and provides guidelines for drafting foreign trade contracts in the energy sector.

The presented research is, by all means, of applied nature and is not limited to solving theoretical problems alone. It provides clear evidence that current foreign economic regulation of the energy sector cannot be confined solely to domestic methods of a single country (Inshakov et al., 2019). The processes of economic globalization, internationalization, and liberalization of the energy sector, as well as mutual integration of the fuel and energy complex of various states are based on close interstate cooperation, including the field of law-making of international organizations and integration associations. The researchers contributing their work to the monograph have closely studied and commented on all the elements of the legal regulation system of foreign trade turnover in the energy sector, both general and specific legislation, including unified norms of international legal regulation, strategic and framework acts, norms of national legislation, as well as soft law, recommendatory, and technical standards.

The team of authors has expressed the hope that the study will contribute to the sustainable development of the economy and socio-economic modernization of the Russian Federation.

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Part IV

Ongoing Industry 4.0 Climate Change Combating Initiatives

CHAPTER 20

Corporate Practice of Implementing Measures to Combat Climate Change in the Russian Oil and Gas Companies

Evgeniya A. Starikova and Ellina A. Shamanina

Introduction

For the first time in the history of the World Economic Forum (WEF), environmental problems occupy a leading position in the field of risk analysis of the long-term impact of socio-economic development in countries around the world. According to the WEF, the top 5 key risks include—issues related to deforestation, loss of biodiversity, natural disasters, man-made environmental disasters, as well as the problem of climate change—in particular, global warming—which today is becoming more and more acute, requiring urgent measures to resolve it.

According to the estimates by one of the largest insurance companies in the world—Swiss Re—by 2018, global damage from natural disasters amounted to USD 165 billion (Swiss Re Institute, 2019). According to the Thomson Reuters report, more than 200 of the world's largest companies from various sectors of the economy note that the increase in risks associated with climate change over the next five years will result in losses of about USD 1 trillion for them (Green, 2019).

By the end of the century, the global temperature rise is predicted to be possibly 3.2 °C, primarily due to increased air pollution. Climatologists note that limiting it to the target of 1.5 °C, as stated in the United Nations Framework Convention on Climate Change (IPCC, 2018; UNFCC, 2006),

E. A. Starikova (✉) · E. A. Shamanina
Moscow State Institute of International Relations of the Ministry of Foreign Affairs of the Russian Federation, Moscow, Russia

E. B. Zavyalova and E. G. Popkova, *Industry 4.0*,
https://doi.org/10.1007/978-3-030-75405-1_20

it is possible only by reducing carbon dioxide emissions down to 25 gigatons by 2030. However, in accordance with the commitments to reduce CO_2 emissions, which the world community has undertaken, this figure is much higher—56 gigatons by 2030, more than twice the required standard (Emissions Gap Report, 2019).

It is expected that by the middle of the twenty-first century, the challenges associated with climate change may pose a serious threat to the preservation of the status quo and may lead to fundamental changes in the way of life of the world's population. Already today, many organizations plan their activities taking into account "climatic" risks, such as a shortage of drinking water sources and the need to use expensive and unreliable energy sources (WEF, 2015).

Methodology

The methodology is based on a theoretical and statistical analysis of the peculiarities of the development of the practice of implementing measures in the corporate sector in Russia to combat climate change. It takes into account the state policy in the field of environmental protection and analyzes the problems and prospects of adaptation of the Russian oil and gas industry to environmental problems.

When analyzing the data, a qualitative approach was used, well suited to the development of the theoretical part of the study. Initially, foreign sources were analyzed to obtain the necessary understanding regarding environmental problems, in particular the reports of international organizations. This analysis served as the basis for revealing the climate agenda, its main directions, and also allowed demonstrating the alteration that has occurred in the study of climate changes over time.

The depth and reliability of the research findings are ensured by the use of both a systematic approach and other general scientific methods of cognition, such as methods of grouping, generalization, methods of classification, induction, deduction, analogy, comparison, and formalization. The study also used descriptive methods based on the collection and study of the development of public–private partnership mechanisms in Russia.

The statistical data presented in the study were collected and evaluated based on the method of statistical observations using relevant international and Russian databases, in particular, materials from the World Bank, the United Nations, the Analytical Center for the Moscow Government, the Institute of Energy of the Higher School of Economics, the Institute of Natural Monopolies, and analytical materials and reports of Russian companies in the oil and gas industry, namely Gazprom, Lukoil, and Rosneft.

Regulatory documents and decrees related to the development of mechanisms for environmental protection and reduction of greenhouse gas emissions also formed the methodological foundation of the work.

Results

In 2015, the heads of seventy-nine large TNCs with a combined turnover of over 1.2 trillion dollars representing 20 sectors of the economy, with the support of the World Economic Forum, signed an open letter urging leaders of states to take concrete action in the field of combating climate change (WEF, 2015).

Many scientists have repeatedly noted that carbon dioxide released into the atmosphere along with the emissions of operating industrial enterprises is the main anthropogenic factor that enhances global warming. According to the annual report "BP Statistical Review of World Energy", the global total volume of CO_2 emissions, having increased by 2%, reached about 34 billion tons by 2019. The countries of the European Union made the largest contribution to the reduction of emissions. On the other hand, emerging markets caused an increase in carbon dioxide emissions. In particular, China and the United States took the leading positions in terms of emissions—28.8% and 14.5% of the global share, respectively. Russia accounted for a 4.5% share (Statistical Review of World Energy, 2020).

By this year, according to the UNFCCC Global Climate Change Progress Report, 71 countries and 11 regions, which account for about 15% of global greenhouse gas emissions, have long-term targets for achieving zero emissions (net-zero emissions) (Emissions Gap Report, 2019), which was established as an integral part of achieving the conditions of the Paris Climate Agreement, which replaced the Kyoto Protocol in 2015–2016. Working in this direction, the remaining 85% of the countries also need to rethink their national strategies, along with supranational plans to combat environmental degradation.

A fairly significant part of the world community, in which the G20 member countries also take a significant share, are already showing interest in eliminating environmental risks, and are also taking initiatives in the development of a low-carbon economy. These initiatives include:

- Creation and application of technologies for capturing and storing hydrocarbons;
- Establishing low-carbon hydrogen supply chains;
- Development of programs, strategies to ensure the availability of raw materials necessary for the transition to a low-carbon economy, etc. (WEF, 2020).

The resurgence of the environmental agenda could not bypass Russia either. Over the past few years, Russia has seen an increase in the use of various environmental policy instruments. In particular, among large-scale government programs and bills, one can single out:

- State program of the Russian Federation "Environmental protection" (Judicial & regulatory acts of the Russian Federation, 2020) for the period up to 2024, as well as the Federal Law "On environmental protection" dated 10.01.2002 N 7-FZ (Official Internet Resources of the President of Russia, 2002), which, among other things, regulates the implementation of the best available technologies (BAT) aimed at comprehensive prevention and (or) minimization of negative impact on the environment.
- Decree of the President of the Russian Federation of September 30, 2013, No. 752 "On Reduction of Greenhouse Gas Emissions" (Official Internet Resources of the President of Russia, 2013) pursuant to the "Climate Doctrine of the Russian Federation" approved by the Order of the President of Russia of 2009 (Official Internet Resources of the President of Russia, 2009).
- Decree of the Government of the Russian Federation on solid municipal waste management and amendments to the Decree of the Government of the Russian Federation of August 25, 2008, N 641 (as amended on December 15, 2018) (The Russian Government, 2016).
- In 2019, the State Duma of the Russian Federation adopted the Federal Law "On Amendments to the Federal Law No. 35-FZ" "On the Electricity Industry". The amendments introduced not only introduce the very concept of microgeneration, but will allow private owners to donate (sell) surplus electricity generated by solar panels and wind generators to the general grid (Tikhonov, 2019).
- State program of the Russian Federation "Energy efficiency and energy development (for the period up to 2035)". In terms of the amendments that were introduced, it should be noted that the trajectory of a decrease in the energy intensity of GDP by 40% compared to the level of 2007 should be noted. This reduction is planned to be achieved through the introduction of technological innovations, as well as due to structural economic reforms (Kokorina & Korppo, 2014).

In turn, 2019 became the period of ratification of the "Paris Agreement on Climate", to which Russia joined in 2016. In accordance with the principle of national contributions, Russia set a "target to reduce greenhouse gas emissions by 2030 to 70–75% of 1990 level, subject to the maximum possible level of the absorptive capacity of forests" (The Russian Government, 2019a, 2019b). It should be noted that Russia is one of the countries that managed to reduce greenhouse gas emissions by 32.4% in 2017, which is lower than the 1990 level. Such a decrease is associated not only with the economic recession of the 1990s, but also with the active action in the field of energy modernization and energy conservation in industrial sector, agro-industrial sector, transport and housing, and communal services (IPEM, 2016).

Among the program documents within the framework of the implementation of the Paris Agreement on climate, the National Action Plan for the first stage of adaptation to climate change for the period up to 2022 should be included. This plan defines measures of an institutional, organizational, and methodological nature, aimed at the formation and implementation of management approaches to adapt to climate change at the federal and regional levels. The targets of the programs being developed should be to reduce the vulnerability of the population, economy, and natural objects to the consequences of climate change, as well as to expand the capacity to resolve emerging problems. Among others, it is planned to develop strategic plans that will regulate activities in the fuel and energy sector and in the Arctic zone of Russia (The Russian Government, 2019a, 2019b).

However, at present, carbon regulation in Russia is in its infancy. In general, CO_2 emissions are not regulated at the state level, and the development of a system for collecting payments for emissions is still an open issue that requires an appropriate solution. However, the "draft version" of the low-carbon development strategy for Russia was published for the general public in March 2020 (Ministry of Economic Development of the Russian Federation, 2020). Also, it is likely that by the end of 2020 the drafted Federal Law "On state regulation of greenhouse gas emissions gases" will be adopted.

Despite the fact that Russia is one of the five leading countries with the largest volumes of greenhouse gas emissions along with China, India, the United States, and some EU countries, it has quite wide opportunities to reduce the negative impact on the environment through energy efficiency programs, to stimulate reduction of hydrocarbon emissions, etc. (Lukoil, 2019; *The Moscow Times*, 2019). So, for the period 2012–2020, in Russia, there has been a tendency to reduce the scale of environmental pollution. In 2020, the index of environmental pollution "Pollution Index", which is presented in the global statistical database Numbeo, for Russia amounted to 67.79, which is 41.88 points less than in 2012, when the indicator was at 104.67 (Numbeo, 2020).

The report of the Analytical Center for the Government of the Russian Federation notes that the makeup of greenhouse gas emissions in the country has been distinguished by its stability for several decades. In particular, most of the CO_2 emissions are from the energy and industrial complex (Table 20.1) (Analytical Center for the Government of the Russian Federation, 2019).

The extractive industry is a major pollutant. In particular, the share of greenhouse gas emissions in exploration and production of the largest Russian oil and gas TNCs ranges from 40 to 70% of the total emissions (Skolkovo, 2020).

The largest foreign corporate players in the energy sector, responsible for most of the greenhouse gas emissions, have long been transforming their own business models, following market signals, as well as under pressure from the government regulator and tightening demands from institutional investors. These companies set goals to decarbonize their industries (reduce greenhouse gas emissions) by increasing investments in renewable energy sources, biofuels and CO_2 capture, increasing energy efficiency, increasing the share of green

Table 20.1 Greenhouse gas emissions in Russia, 1990–2017

	Emissions, bln t				*Share, %*	
	1990	*2000*	*2016*	*2017*	*1990*	*2017*
Energy production	2.57	1.51	1.66	1.7	80.6	78.9
Manufacturing industries	0.28	0.2	0.22	0.23	8.9	10.8
Agricultural sector	0.28	0.13	0.12	0.13	8.7	5.9
Waste	0.06	0.06	0.09	0.09	1.8	4.4
Total (excluding LULUCF)	*3.19*	*1.9*	*2.09*	*2.15*	*100.0*	*100.0*

Source Analytical Center for the Government of the Russian Federation (2019)

projects in company portfolios, tightening control over methane emissions, and in some cases resorting to the sale of oil and gas assets (Ermolenko, 2017).

For example, Shell, Total, and ENI have created separate divisions to manage projects and investments in green and renewable energy. According to the estimates of the International Energy Agency (IEA), in 2018 the share of investments in renewable energy sources, hydrogen and related projects, which were provided by such world famous oil and gas players as BP, Shell, Total, ENI, and Equinor, amounted to about 3–5% of total investments of these companies (International Energy Agency, 2020). However, according to the agency, currently oil and gas companies allocate only about 1% of total costs for these purposes, primarily on projects in the field of solar and wind energy (International Energy Agency, 2020).

Thus, it is natural that under pressure from the regulatory environment and taking into account the tightening of legislation in European countries, in the Russian business community, the climate agenda and the problem of reducing the carbon footprint are most relevant for large public TNCs that attract foreign investment, loans from foreign banks, and have foreign shareholders (Skolkovo, 2020).

In this regard, it seems quite reasonable to assume that companies operating in the fuel and energy sector of Russia are most interested in the development of a low-carbon economy and scientific and technical support (e.g., through the introduction of resource-efficient technologies) to protect the environment of our country. Consider the cases of three Russian transnational players in the oil and gas market on this issue.

Lukoil: Lukoil is one of the largest Russian oil companies. Within the framework of the implemented corporate "Policy in the field of industrial safety, labor protection and the environment", as well as the "Program of environmental safety" (for the period 2019–2021), the company is carrying out a set of measures to reduce the harmful effects on air and water resources, and to support the biodiversity of terrestrial and sea ecosystems (Lukoil, 2019).

Based on the results of the measures implemented for 2019, Lukoil managed to reduce emissions of harmful substances polluting the atmosphere by 7.2% as compared to 2018. Moreover, by maintaining and improving the management system in relation to adaptation to the modern climate agenda, the company was able to reduce their direct greenhouse gas emissions to 3.3% in 2019 as compared to 2016, in accordance with the set goal. A large share (about 36 billion rubles or 40% of the total expenditure) of the Environmental Safety Program aims to implement measures to improve the "rational use of associated petroleum gas" (APG) (Lukoil—Summary Report, 2019). So, for the period 2017–2019, the total volume of APG flaring decreased from about 575 million to 309.5 million cubic meters (Fig. 20.1) (Lukoil, 2019).

An indicator of Lukoil's involvement in climate issues, in particular in the fight against global warming, is the revision of the forecast for the long-term development of the global hydrocarbon market until 2035. The new version is based on three scenarios, namely Evolution, Equal Opportunities, and "Climate", the prerequisites for the development of which are based on the adoption by the world's leading economies of measures to achieve the main goals of the Paris Agreement on Climate (Lukoil Oil Company, 2019). Summarizing all three scenario approaches, we can single out the main directions of the world energy development identified by Lukoil:

- Limitation of greenhouse gas emissions into the atmosphere;
- Fulfillment of the goals of the Paris Agreement, including in terms of keeping the global temperature below 2 °C by 2100;
- Reducing the imbalance in the level of energy consumption between developed and developing countries;
- Global distribution of renewable energy sources and technologies for capturing, utilizing, and storing hydrocarbons (Lukoil Oil Company, 2019).

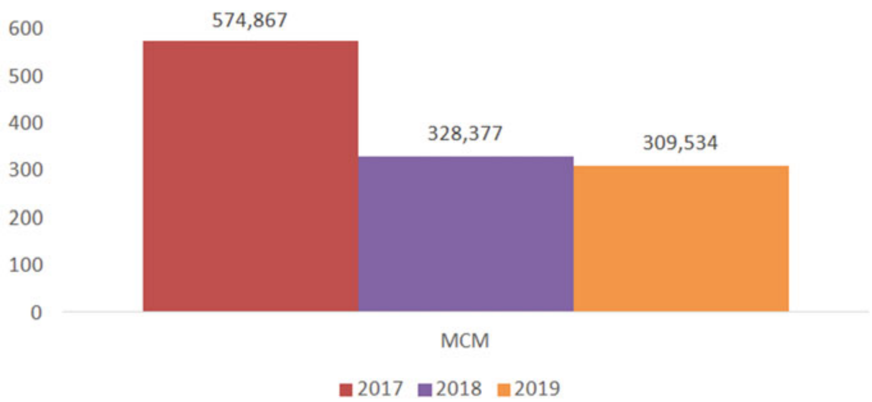

Fig. 20.1 Total volume of flaring of APG (hydrocarbons), MCM (*Source* Lukoil [2019])

It is worth noting that the need for oil and gas resources is primarily due to their high degree of availability for most countries. According to Lukoil's sustainable development report, further improvement and development of digitalization processes can serve as a basis for the transformation of the oil and gas industry through the introduction of innovative technologies that contribute to the development of "new" energy in terms of reducing the harmful impact on the environment.

Gazprom: It should be noted that the use of natural gas, which a priori has "environmental advantages" over oil, can provide some progress in achieving the UN Sustainable Development Goals and the Paris Agreement on climate, thereby contributing to the low-carbon development of the Russian economy and the economy of countries importing Russian gas.

Russian gas giant Gazprom is currently implementing the best available technologies and working to reduce the carbon footprint of its products. For example, greenhouse gas emissions from Russian gas supplies via the Nord Stream and Turkish Stream pipelines are more than three times lower than the supply of liquefied natural gas (LNG) from the United States to Europe (Sputnik News, 2020). According to the corporate sustainability report, greenhouse gas emissions in the Gazprom Group in 2019 decreased by 3.52 million tons of CO_2 equivalent, or 1.5%, as compared to 2018 (Gazprom, 2020).

In accordance with the new plan of the government of the Russian Federation for the development of the hydrogen economy, from 2024 Gazprom announced its intention to produce hydrogen with zero emissions ("pure" hydrogen). This government plan provides a roadmap for economic and energy development in the coming years, which envisages that hydrogen will play a more prominent role in the structure of Russian exports in response to changing attitudes toward oil and gas in many countries of the world that are currently the largest importers of hydrocarbons. The government also plans by the end of 2020 to develop a concept for the development of the hydrogen sector in Russia, as well as a system of incentives for launching pilot projects using hydrogen. Hydrogen is believed to be a promising fuel in the global energy market and, according to the Hydrogen Council, by 2050, hydrogen could account for about 18 percent of global energy consumption (Korobkova, 2020).

According to the aforementioned government plan, in 2021, the Russian gas giant will build and begin testing a methane-hydrogen turbine next year, and by 2024, it will also explore various uses of hydrogen as a fuel. At the same time, in addition to Gazprom, other Russian TNCs are interested in participating in the so-called hydrogen initiatives: in 2024, Rosatom State Corporation will begin testing hydrogen as fuel for trains. The largest Russian private gas company Novatek is also showing interest in the hydrogen project (Korobkova, 2020).

Rosneft: The key focus of the Russian oil industry leader Rosneft in reducing greenhouse gas emissions over the past decades has been the reduction-associated gas flaring, increasing energy efficiency, and reducing hydrocarbon losses in the company's key production processes. Since 2006, a constantly expanding gas investment program has been in effect, aimed at increasing the utilization of associated petroleum gas. Within the framework of the Kyoto Protocol and with the participation of the World Bank and a number of European government funds, Rosneft successfully implemented three joint implementation projects from 2006 to 2012 to reduce the flaring of associated petroleum gas. This allowed reducing annual CO_2-equivalent emissions by 2 million tons (Rosneft, 2019).

In 2019, Rosneft became one of the leaders among oil and gas TNCs participating in the international climate rating CDP (Carbon Disclosure Project). Based on the results of an independent assessment, Rosneft was assigned a "B" category rating—the highest among Russian oil and gas companies and two levels higher than the average rating of European companies—participants. In addition, Rosneft's corporate governance practices and activities related to the reduction of greenhouse gas emissions were assessed by the CDP on the 'A' scale (Rosneft, 2020).

At the same time, based on a deeper analysis of the activities of the three largest Russian companies in the oil and gas sector, it becomes obvious that the companies in this industry are currently not too interested in the development and widespread use of renewable energy sources (RES) in Russia. In particular, according to representatives of Gazprom, subsidizing renewable energy sources can have a serious impact on the global energy sector and can compete with natural gas. At the end of 2017, the development of renewable energy sources was an important concern among the risks affecting the achievement of the company's strategic goals. On its website, Gazprom notes that it supports the use of alternative energy sources only in economically and technically sound conditions. As for Rosneft, the development strategy until 2022 presented by the company in 2017 does not include any plans for the development of renewable energy sources among the priority areas.

Conclusion and Recommendations

Based on the updated global agenda and taking into account the expansion of the challenges and threats formulated within this agenda, a fundamental revision is currently taking place. The beginning of a restructuring of the foundations of the functioning of the world economy by strengthening the environmental component in it is happening, as a result of increased awareness for urgent solutions to present environmental and climatic problems.

In this context, there is an increase in interest from corporate actors regarding the formation of a global climate risk management system. The tendency for the formation of a new ecosystem of relations between the corporation and various groups of stakeholders is becoming more and more obvious. Pressure from investors and the state regulator is becoming an increasingly important factor in terms of transforming corporate behavior practices toward greater environmental sustainability. Selected corporate social responsibility activities by companies represent an important step by private sector players in response to climate risks and challenges. However, the scale of this activity still does not seem to be sufficient: the efforts of transnational businesses in the fight against climate change must be a broader and more strategically coordinated at the level of the entire corporate sector and entire industries.

Following the global trends in environmental sustainability, some steps have been taken by the Russian energy sector companies in this regard. However, it cannot be said that there is a serious transformation of business models, which is demonstrated by some foreign companies—giants of the oil and gas industry. Separate projects in the field of "clean" energy are being implemented (e.g., hydrogen projects), with particular emphasis on reducing the flaring of associated petroleum gas. Nevertheless, in most cases, there is a shortage of investments or a complete lack of interest on the part of Russian oil and gas TNCs in the development of renewable energy in Russia, which is perceived by these companies as a competing industry. There are practically no investments in biofuels and CO_2 capture and in increasing the share of "green" projects in company portfolios. In contrast, Western corporations sometimes seem to take radical steps in their sustainable development strategies.

In this regard, it seems appropriate to recommend Russian players in the oil and gas sector to invest in the latest "green" technologies by entering into a strategic partnership with relevant Russian ministries (Ministry of Natural Resources and Environment, Ministry of Industry and Trade, Ministry of Economic Development, Ministry of Digital Development, Communications and Mass Media, Department of Energy and Ministry of Health). Also, in order to reduce risks within their own production processes, individual corporate players should make "green" investments and implement projects in the field of environmental sustainability on the basis of partnership agreements with other Russian companies in the extractive industry (e.g., with TNCs representing the ferrous and non-ferrous metallurgy industry—"LROSA", "Norilsk Nickel", "UC Rusal", "Severstal," and others), as well as with the largest Russian IT companies in terms of financial assets—"Rostelecom", "Rostec", "MTS", "Megafon", "Kaspersky", "Mail.ru Group", "Yandex", "VimpelCom". In the long term, such measures would help create a "common value" for the state, society, and business, as well as strengthen the corporate stability and competitiveness of Russian oil and gas companies in world markets.

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CHAPTER 21

Digital Transformation of Open-Pit Coal Mining in Russia

Victor I. Efimov and Natalia V. Efimova

Introduction

Coal mining is one of the oldest industries in the world; specifically, it was one of the main drivers of the industrial revolution in Europe in the nineteenth century, being the most available source of energy. Having such a long production history, coal mining and other industries passed through several stages of deep technological changes and continue to develop due to the continuous innovation process. The next phase of technological progress of the industry will be digitalization, the process largely spread in the modern society.

As an extremely capital-intensive production coal mining growth is hindered by growing competition from other fossil fuels, especially gas, and renewable energy sources, as well as it is running under the pressures of governmental policies pursuing more efficient and environment friendly energetics. Moreover, as the global economy and trade growth slow down, followed by slumping world energy demand, coal mining industry is the most vulnerable to these sluggish trends. According to the forecast of the International Energy Agency, in 2020, the world coal demand will fall by 8% from 2019 (IEA, 2020). Even before the COVID-19, the world coal market had little perspectives, judging by the projections for the demand made in 2018

V. I. Efimov (✉)
National University of Science and Technology MISIS, Moscow, Russian Federation
e-mail: v.efimov@msk.sds-ugol.ru

N. V. Efimova
Moscow State Institute of International Relations MGIMO, Moscow, Russian Federation

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that it would continue to increase slightly at annual rate of about 0.8% taking its pick in 2020 and would slowly go down, giving space to gas and renewable energy sources (Degtyareva & Efimova, 2019). Still, the world coal market has failed to recover and the demand kept on declining after its highest point in 2014.

One of the significant factors that hamper growth of the world coal consumption is the rise of decarbonization policy, promoted by many countries, along with proliferation of the ecological regulations. In accordance with the Paris Agreement on climate change of 2015, a lot of countries committed to reduce their greenhouse gas emissions mostly by increasing usage of renewable sources of energy and cutting off coal energy generation. In the UK, a consultation process has been launched to promote by 2025 rules, forcing to close coal-fired plants without carbon capture technology. France demonstrated its intention to close such enterprises by 2021. Canada is set to remove coal from its energy mix by 2030. Germany, the largest coal producer in Europe is also going to finish its coal phaseout by 2038. The recent global coal demand decrease inevitably has led to fall in prices and loss of profitability of the coal companies.

In spite of such negative tendencies, coal miners will get new chances to optimize their extraction, transportation, and processing operations due to the new digital technologies. On the ground of lack of knowledge and financial uncertainty, most of coal miners have been reluctant to introduce "smart" machines and digital engineering solutions up to the last. However, innovations, born in the fold of digitalization, such as cloud, Big Data, Internet of Things, mobile technologies, virtual and augmented reality, and artificial intelligence, may be the only way for coal companies to get out of crisis and to increase competitiveness. Implementation of "Industry 4.0" principles means more efficient and quicker interrelated operations during the whole value chain, informational transparency, decentralization of decision making, and technical augmentation. Digital technologies open up new horizons for training of specialists, working in the mining industry.

The most widespread areas of digitalization in the coal mining industry are automation and robotics, Big Data, IoT, real-time data, 3D-printing, artificial intelligence, and virtual reality mine training. As for automation it is more often used for the movement of extracted rock in open-pit mines for the reasons of "long-lasting haulage roads and simple implementation of communication infrastructures such as GPS and LTE" (Barnewold & Lottermoser, 2020).

In spite of countries that opted for the decarbonization of their economy and are been taking off coal from their energy mix, for Russia coal continues to be a strategic fuel, a vast deal of which, comprising 51%, is shipped for export (Tarazanov & Gubanov, 2020). According to the new "Program for the coal industry development until 2035", adopted on the 13th of June of 2020, the coal production will increase to 485 million tons in 2035 from 439.3 million tons in 2018.

However, both politicians and business society are aware of how important and vital for the industry modernization is, which implies full-scale renovation of production capacities and development of transport infrastructure (Efimova & Fillimonov, 2020).

At the top of the countries that have advanced in implementing programs for digital transformation, known as “Industry 4.0”, are Japan, United States, Germany, UK, Netherlands, South Korea, and Sweden. In Japan, it is popular the idea of building “Society 5.0”, and they were going to demonstrate that with new technologies in 2020 (Plakitkin & Plakitkina, 2017).

The Russian replica of foreign “Industry 4.0” programs is the National Technological Initiative that has been introduced since 2014. It is a long-term interdepartmental private–public partnership project of promotion of prospective markets on the basis of hi-tech solutions. The paper on technology roadmap “Technet”, elaborated within the National Technological Initiative, was approved by the Presidium of the Presidential Council for Economic Modernisation and Innovations in February 2017 and paved the way for the governmental program “Digital Economy of the Russian Federation”, included in the list of the main Russia’s directions of development until 2025. Any industry, including coal miners, can benefit from the measures provided by this program.

Today’s coal mining companies have accrued a range of top-priority issues which they will have to solve in the nearest future:

– Increase in operations’ efficiency by collecting and rational use of the data;
– Wider implementation of innovations, including digital new technologies, used in other sectors;
– Development of new environmentally friendly technologies;
– Reduction of energy consumption and greenhouse gas emissions;
– Development of management systems of end-to-end processes, usage of instrumentation along with engineering and applications software, as well as platforms for accumulation and visualization of multi-sourced data.

The end-to-end management systems are of a specific value, as they integrate traditionally separate operations of extraction, processing, and transportation in a single process. It is estimated that the integration of logistical chains will cause a 20% increase in efficiency (GIZ, 2019).

Automation, digitalization, and new technologies permit operators and technical specialists to get immediate access to all the necessary data on productivity, machinery state, production conditions, and environmental risks, enabling operative decision making, increasing efficiency of work, and providing better protection of the environment (Burtsev et al., 2017). The new technologies also have positive effect on workers’ safety and attractiveness of work for the next generation of workers.

Methodology

The authors put forward a hypothesis that in the view of unprecedented growth of scientific and technical experience in the beginning of the twenty-first century and of the heavy consequences of the actual economic crisis for the Russia's coal mining industry, it is crucial to take the path of digital transformation to prevent its further degradation. The underlying idea of this article is to explore mostly advantages of the digital revolution for the coal mining industry of Russia, to find out the most fruitful new technologies already having the positive technical, social-economic, and environmental effects not only for coal companies, but for the whole society. Another important assumption is that the implementation of autonomous hauls in open-pit coal mines has certain positive effects such as lower costs, safer work, and less damage to the environment.

The main methods used in this research are content analysis of the corresponding literature and generalization of the data collected. The article is divided into two logical parts. In the first part, observations are based on the research of multiple sources, including scientific publications of Russian and foreign authors, official reports of the International Energy Agency and analytical reviews, and materials of consulting agencies and coal business associations. In this part, quantitative data are basically used to justify the conclusions on the current world coal market tendencies and on the progress of digital technologies in the coal mining sector. Quantitative data, wherever it appears in this article, are used to provide the objective examination of the problems.

The second part of the article is mostly based on primary sources. It contains the case study of the Russian coal company of "SUEK", one of the pioneers of technological development of mines in Russia, which is an example of successful implementation of autonomous haul system in open-pit mines. Several mathematical calculations are made to justify technical, economic, and social efficiency of automated haulage technology in comparison with traditional methods of rock transportation within open-pit mine. For instance, to estimate the increase of automated haul productivity on the annual basis, the total hours of haul operational work with driver in the cabin is deducted by hours needed for lunch time and personal needs and then added to the working time in traditional mode.

With data on haul tonnage known, an additional annual volume of coal shipment can be found, and finally, if multiplied by price, it results in additional annual turnover. Similar logic is used in execution of other available calculations referring to the impact of the technology on the labor costs, savings derived from the extended life cycle of tires.

Results

Open-pit mining process consists of a range of stages: exploration, extraction, transportation, and restoration. Engineering solutions and application software designed on the basis of digital technologies are desirable within any stage of coal mining process. For example, the exploration and extraction activities can be supported by 3D geological modeling programs, providing creation of 3D virtual scene and enhanced analysis based on the multiple-sourced data, generated by Geographic Information System. Some of the programs are designed for geological exploration and extraction works and make it easier to monitor rock fluctuations and underground water flows and to predict landslides and unwanted damage to the environment. Advancement of photogrammetry and laser scanning enabled collecting data into point cloud, a technology that let to significantly reduce file size and immediately generate geological data, used to build and analyze 3D models. The future of 3D modeling is its further development toward automatically built models, while today it is made in cooperation of man and machine (Pan et al., 2020).

At the stage of land restoration, there are also wide opportunities for implementation of digital technologies. Exploitation of open-pit mines causes soil erosion and deterioration of hydrological structure. To prevent negative consequences for the environment, once mining is completed works to return land to productivity should be done. Earlier in the past, satellite images or airplane mapping were used to control land restoration progress. Both methods suffered from deficiencies. Satellite imagery lacked high resolution, needed for the purposes of spatial supervision; aerial surveys were costly.

Nowadays, these methods are out of competition with development of so-called unmanned aerial vehicle systems using drones, which deliver high-quality spatial photogrammetry at relatively low cost (Carabassa et al., 2020). The images received are suitable for detailed supervision of landscape restoration processes. Digital maps can be easily integrated with Geographic Information System used for quantitative analysis of the environment and spatial dynamics (Taylakov et al., 2016).

An important achievement of digital transformation is comprehensive management systems that integrate all the stages of value chain, covering all the coal business processes, from mine to port. One of the successful stories is the Roy Hill iron ore mining project, realized in one of the biggest pits of Australia that tied together a processing plant in West Australia's Pilbara region, a heavy haul railway from the mine to the port facilities in Port Hedland and the Remote Operations Center in Perth. Data collected by the Center allow to both analyze the whole logistic chain and assets and optimize complex systems, resulting in higher productivity.

Another example of highly integrated mining value chain is the company of Vale Brazil, the third biggest mining company in Brazil and the leader of the world ore mining industry. Before the digital transformation, all the company's traditional mining processes such as planning, drilling, explosive works, and transportation were executed separately making it impossible to align data on different operations and to efficiently control the whole business. Due to the reforms, the workers of the company can receive immediately all the necessary data, which implies several advantages for the company like increased operational procedures productivity, better working conditions, lower costs on intellectual property, human resource optimization, and asset management improvement. The reforms allowed to save about 50 million dollars (GIZ, 2019).

An Overview of Autonomous Hauls Usage in Open-Pit Mines Abroad

Autonomous haulage systems in open-pit mines are one of the fast growing trends of digital transformation. First attempts to introduce driverless hauls were made in the mid-1990s by the mining company Rio Tinto in cooperation with Comatsu, followed by Codelco and Caterpillar in 2005–2007. Nevertheless, for a long time, the commercial application of this technology was postponed taking up its actual high pace only for the last 2–3 years, mostly because of the expansion of communications and data transfer systems, sensor and detector technologies, spurred by information technologies, which allowed to substitute man with artificial intelligence (Sobolev, 2020).

Automated route planning and driving of a haul with wide opportunities to collect and process data and to predict traffic situation, as well as 7/24 hours of continuous working without stop, allow to increase productivity of machines, extend hauls and tires operating life, and reduce industrial accidents due to the absence of drivers in the cabin.

The three main factors that determine economic efficiency are: prices on the minerals extracted, cost and volumes of production, and sales. For coal producers, operating on highly competitive market, it is reasonable to seek for optimal levels of production, so that it would not affect prices. That is why, the only means of making high profit is cutting costs, in particular labor costs. Therefore, mining companies prefer automation as one of the means to increase economic efficiency (Bellany & Pravica, 2011).

The total number of driverless hauls in operation in open-pit mines worldwide accounts for 500 units. In February 2020, among the leaders of usage of these kind of vehicles were Australia with 369 units or 80% of the world fleet, Canada (39), Chile (18), and Brasil (14). The market is demonstrating extremely high growth, with the surplus of 32% above the level of 2019, and it is estimated to be tripled by 2023 (MiningTechnology.com, 2020). The main drivers of the markets' high growth are mining companies BHP, Fortescue Metals Group, Rio Tinto and Hancock Prospecting (Australia), Suncor Energy and Canadian Natural resources (Canada). The main haul suppliers are Komatsu and Caterpillar, providing 93% of the world shipments. The most experienced companies of the world using automated technologies in open-pit miming are shown in Table 21.1.

Justification of viability of using automated technologies in Russian open-pit mines. The case of SUEK, Plc.

The necessity of using automated technologies in open-pit mines is derived from three paradigms (Klebanov, 2020):

Table 21.1 World experience in the field of automated technologies in open-pit mining

Mine	*Country*	*Explication*
RIO Tinto «Mine of the Future»	Australia	73 automated hauls Komatsu and railway transport
RIO Tinto Gina Rinehart's Roy Hill	Australia	Automated hauls
Alberta Mining Corp	Canada	Automated hauls
BHP Billiton, Dean Dalla Valle	Australia	Automated hauls and drilling machines (Atlas Copco)
BHP Billiton Meandu coal mine Newman iron ore mine	Australia	Automated hauls
Fortescue Mining Group	Australia	Announced 45 automated hauls CAT 793 in use
Codelco	Chile	Automated hauls Komatsu
Anglo American	RSA	Hinged automated hauls block (10 units)
Alrosa	Russian Federation	Usage of remote-controlled machinery

1. Industrial and environmental safety;
2. Economic viability;
3. Socioeconomic factors.

Industrial and environmental safety implies the absence of man in the cabin which eliminates the human factor. Personnel do not work in severe environmental and climate conditions and are not exposed to accident risks incidental to driving a vehicle or risks of professional diseases.

Economic viability is achieved due to such factors as:

– More efficient use of hauls: For instance, the effective operational time for a haul with a driver is from 5500 to 6000 hours a year. Automated haul's operational time is 1000 hours more because there is no need for lunch time, no personal needs, and no intervals between shifts, and stand-by time in wait of shipment is minimum (Fig. 21.1).
– Reduced payroll budget: With automated hauls control and manipulation of, for example, 5 vehicles will require 20 drivers a working day with three shifts. Exploitation of these 5 vehicles in automated mode can be supported by two remote operators, two engineers, and one or two stand-by operators/engineers.
– Annual growth of production per haul: With the surplus of 1000 working hours per year, provided that the load/unload time is half an hour, a 130-tons haul will move additional 52,000 tons of coal. If the price of 1 ton

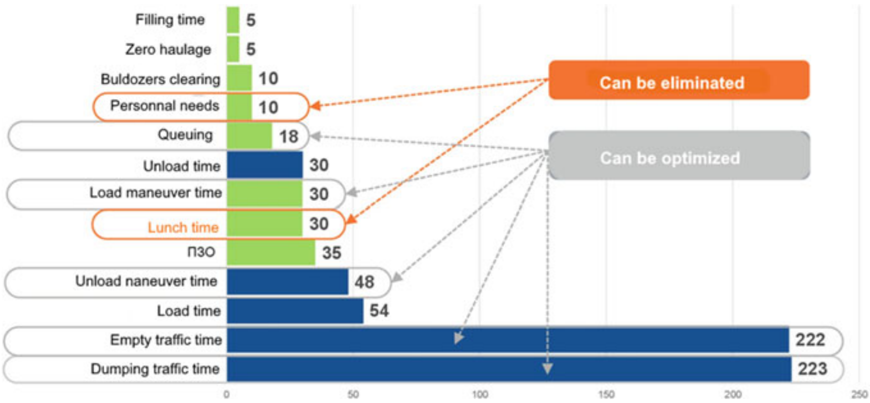

Fig. 21.1 Analysis of haul operations (*Source* Klebanov [2020, p. 9])

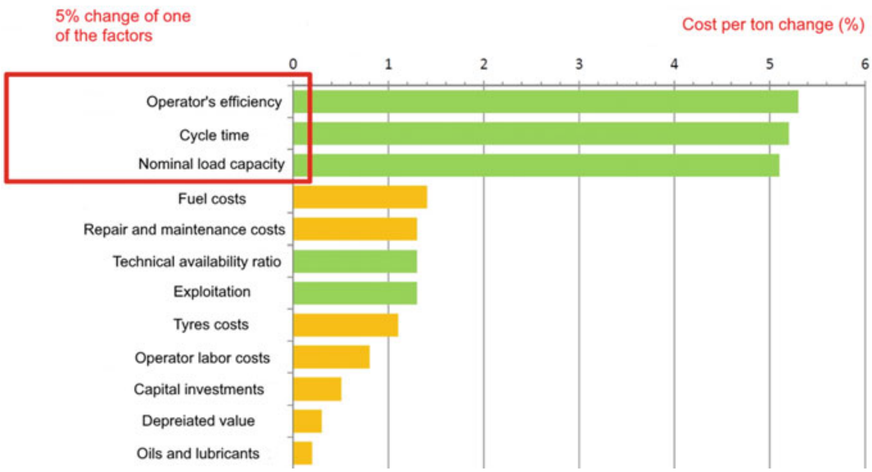

Fig. 21.2 Relation between cost per ton variations and optimization of production factors, relevant for economic efficiency, % (*Source* Klebanov [2020, p. 11])

of coal is, for example, $30, the additional surplus value will be $1.5 per ton.

– Increased life cycle. The operational life of one set of tires is about 5000 hours. Usage of automated hauls allows to extend the life cycle of tires to about 7500 hours due to more careful exploitation. If the price of a set of tires is, for example, $70,000, the result will be $35,000 of savings.
– Increased efficiency of haulage: The relation between cost per ton variation and optimization of production factors, relevant for economic efficiency, is shown in Fig. 21.2.

– Cutting costs: While automated haulage system is operated without man participation, it is possible to increase the angles of the slopes of pit sides; the pit sides' stability is subject to remote control by means of radar systems. Among the other factors of the cost reduction are: less haul road width, higher traffic speed, lower infrastructure expenditures while providing life activity of employees in outlying and hard-to-reach regions of the mined mineral deposits.
– Dispatch control and optimization: Remote control and management of traffic and queues, and prevention of potential crashes contribute to increase in productivity of mining haulage fleet.

Socioeconomic factors are closely related to high stuff turnover. For instance, at the open-pit mine of "Zarechniy", situated in Kuzbass Region, in 2017 worked about 25% of drivers with working experience of less than a year, and by the end of 2018, the share of such drivers was 75%. To reduce the stuff turnover, it is necessary to increase wages, prepare new employees in a quick and qualitative way, and build accommodation facilities for them, especially in outlying regions.

Industrial safety, socioeconomic factors, and economic viability together call for implementation of automated technologies in open-pit mines.

Stages of Digital Transformation and Automation of Mining

With its positive effects on the efficiency and industrial safety, the digital transformation of Russian coal companies has passed a long way of development that can be divided into 5 main stages.

The first stage is "Detectors and GIS autonomous products", the implementation of which resulted in increase of an average mining and transport equipment capacity load by 8%, extension of tire life by 7–15%, allowed to prevent accidents and to digitize mining and geological systems (Efimov & Krotikov, 2013).

The second stage is "Monitoring and statistics", which embraced the achievements of the first stage, contributed to reduction of fuel requirements by about 10%, rise in haulage productivity by 15%, and growth of the technical availability ratio by 4% (Rybak et al., 2017a).

The third stage "Optimization and integration" resulted in 10–15% surplus of the mining equipment productivity, more stable quality of coal, the productivity of drilling machines increased by 15–20%, while the cost of drilling went down by 2–7% (Rybak et al., 2017b).

The fourth stage "Predictive analysis", based on the achievements of the previous stages, enabled prediction of accident risks, which implies modeling of optimal technical and economical processes and preliminary handling operations examination with the aim to make a production forecast, from extraction works to coal refining.

The final fifth stage is "Robotics", during which the productivity has boomed as a result of advancement of geological technologies performance. The stage of Robotics implicates the shift to manless technologies, which has become reality owing to the experience of the previous stages.

The modern digital mining enterprise includes:

1. Automated design and planning of mining works, digital twin technologies;
2. Unmanned aerial vehicles in open-pit mining operations;
3. Quality management;
4. Automated management system for mining and transport complexes;
5. MES system for refining of row materials;
6. Management of industrial safety;
7. Dispatch and control system of open-pit and underground mining operations;
8. Accidents prevention;
9. Mobile working places;
10. Stuff positioning;
11. High-tech wireless data transfer and high-accuracy navigation systems;
12. Radars to control stability of pit sides;
13. Control of shovel teeth wears.

There are much more items needed for a modern progressive enterprise than listed above. Some of them can be seen in detail on the example of the autonomous haul BELAZ-7513R of the mining company SUEK, Plc. (Klebanov, 2020).

Autonomous haul BELAZ-7513R.

Functions and capabilities:

- Autonomous route following;
- Environment scanning;
- Autonomous load maneuver;
- Autonomous unload operation in specified area according to the stated order;
- Remote management capability.

Robotic portable management system is shown in Fig. 21.3. It consists of basic board computer ("BC-01"); sub-systems: executive sub-system (ESS), diagnosis sub-system (DSS), scanning of environment sub-system (SESS),

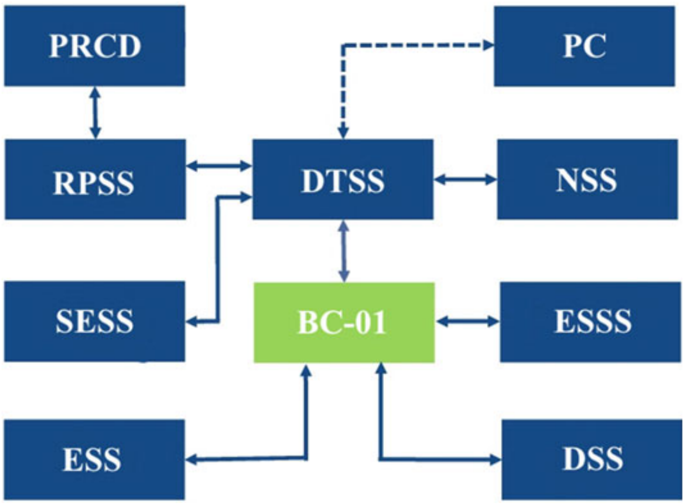

Fig. 21.3 Elements of portable robotized management system (*Source* Klebanov [2020, p. 24])

emergency stop sub-system (ESSS), remote presence sub-system (RPSS), navigation sub-system (NSS), and data transfer sub-system (DTSS); and portable devices: remote control desk (PRCD) and computer for setting up operations (PC).

Functions of Sub-Systems and Elements of the System

Basic board computer "BC-01" enables automated execution of haul's main technological cycle and its remote command in the software RoboD.Truck.

Executive sub-system is used to handle haul's work: for instance, to control engine start and stop, engine speed, electric traction drive, pivoting motion of front wheels, break system, dumping mechanism, and other equipment.

Diagnosis sub-system provides trouble-shooting, transfer of error messages and information about hazardous modes of operation to the basic board computer, data transfer to the haul's electronic dashboard, and electrical switching.

Scanning of environment sub-system is aimed at collecting data on current situation, obstacles, and other vehicles; the collected data are used for building and refining of environment models (so-called local maps).

Emergency stop sub-system function is to stop haul's engine and to activate park break in case of the basic board computer failure, to activate the bottom of emergency stop on the haul's board, on the RCD, as well as autonomous and remote operation of warning mode light.

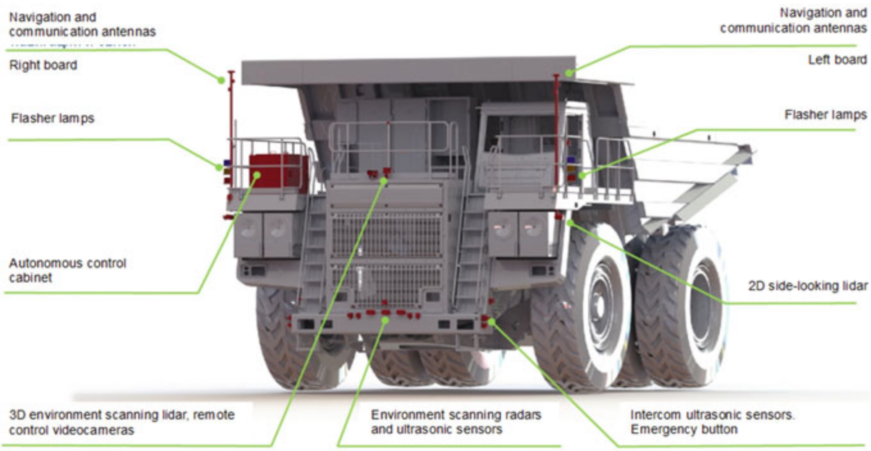

Fig. 21.4 One of the schemes of placement of the equipment on the haul BELAZ-7513R (*Source* Klebanov [2020, p. 27])

Remote presence sub-system provides operator with visual control of traffic situation during route following and maneuvering in real-time mode with attendance of board video cameras in automated and remote modes, as well as exchange of voice messages through loudspeaker communication equipment.

Navigation sub-system enables highly precise coordinates definition and haul's direction, used in algorithm of autonomous route following.

Data transfer sub-system is designated for data commutation between the basic board computer and operator's equipment through high-speed wireless channel.

Portable remote control desk helps operator to manipulate a haul by joysticks, buttons, and tumblers at a distance of up to 1000 meters along the line of sight and to control the state of the board systems.

Portable computer enables operation of automated hauls and setting up of the basic board computer.

One of possible schemes of placement of the equipment on a haul is shown in Fig. 21.4.

Conclusions

The current situation on the world coal market and the actual technological state of Russian coal enterprises with high depreciation rates and weak financial state call for deep technological changes following the global trend of building "Industry 4.0". Governments and businesses are taking action to develop innovation infrastructure to boost digital transformation processes. Introduction of new technologies is considered as one of the most advantageous for coal businesses ways to get out of the current crisis, to improve performance, and to gain competitiveness. Digital transformation of mining covers the whole set of coal enterprise functions from marketing and production to sales and mining cycle from mine design to mined-land reclamation. It produces changes in both operational processes and infrastructure of enterprise. There are three main drivers of the development of a modern production system, based on digital technologies: changes in consumer demand derived from higher industrial and environmental safety, advancing technologies and growing competition. Introduction of digital technologies contributes not only to the rise in productivity, economic efficiency, and other positive effects of environmental and social nature but also to the higher company's value.

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CHAPTER 22

Formation of Strategic Management in the Conditions of Global Ecological Threats

Abdulmuslim M. Abdulmuslimov, Abdusalam A. Hozhokov, Ahmet R. Mirzaev, Gilyan V. Fedotova, and Yusupdzhan A. Yuldashbaev

Introduction

The systemic crisis of the last 30 years in many national republics, specializing in agricultural production, has led to the fact that the production base has decreased, agro-ecological conditions have worsened, and the areas of pastures for grazing animals have decreased. All these processes reduce the overall national food security and act as background to the worsening of standard of living in the country. In this situation a comprehensive program for the development of livestock industries aimed at the progressive implementation of the measures with clear target indicators of strategic developments needed.

A. M. Abdulmuslimov · A. A. Hozhokov
Federal Agrarian Scientific Center of the Republic of Dagestan, Makhachkala, Russian Federation

A. R. Mirzaev · Y. A. Yuldashbaev
Russian State University, Moscow Agricultural Academy named after K.A. Timiryazev, Moscow, Russia
e-mail: zoo@rgau-msha.ru

Y. A. Yuldashbaev
e-mail: zoo@rgau-msha.ru

G. V. Fedotova (✉)
Volga Region Research Institute of Production and Processing of Meat and Dairy Products, Volgograd, Russian Federation

Plekhanov Russian University of Economics, Moscow, Russian Federation

E. B. Zavyalova and E. G. Popkova, *Industry 4.0*,
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In this regard in the Republic of Dagestan, a new Strategy for the Sheep and Goat Breeding Development until 2025 was developed and sent for approval to the Ministry of Agriculture of the Russian Federation, instead of the previous one, that was in force until 2020. The peculiarity of the new document will be the definition of the priority goals, objectives, and promising ways of sustainable development of the industry, economic efficiency, environmental safety, and social acceptability. The document is aimed at creating favorable conditions for the modernization of the sheep and goat breeding industry in the republic—a key priority of the agro-industrial complex development. In addition, this document is aimed at the provision of the most complete and rational use of the natural, climatic, and economic potential, that preserve the traditional way of life of the rural population and restore social infrastructure in the countryside.

The strategy involves the solution of the most important socio-economic problem—providing the population with high-quality food mainly through its own production, achieving food independence, saturating the market with high-quality mutton, and increasing its export potential. The meat industry of our country has great potential not only to meet the needs of the domestic market, but also to expand exports. Efficient industrial production of meat and meat products allows us to obtain a high-quality product that is competitive in price and demanded on world markets.

The implementation of these tasks is achieved primarily through a more complete and comprehensive use of favorable soil and climatic conditions, wide involvement of qualitatively new factors in intensification processes, absorption and application of scientific developments in production, ensuring the effective development of the industry in the republic. The implementation of this Strategy will give the republic an opportunity to increase the number of small cattle in agricultural organizations by adjusting the selection and breeding work and provide the region with additional jobs (Fig. 22.1).

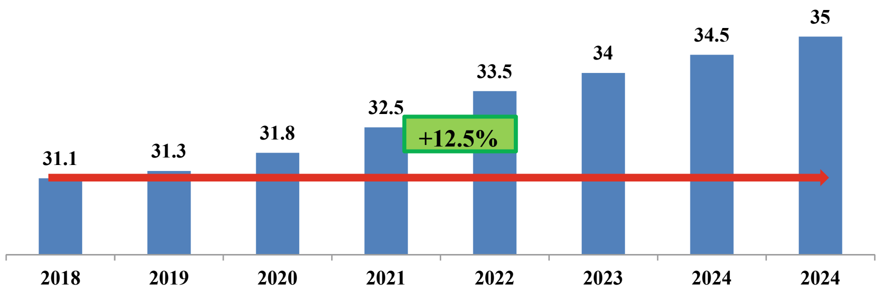

Fig. 22.1 Forecast of production of sheep and goats for slaughter in the Republic of Dagestan (slaughtering weight, thousand tons)

In accordance with the established target indicators for the development of the industry, it is planned to increase the production of raw meat to 35 thousand tons by 2025, which is 12.5% more than in 2018.

Materials and Method

The deterioration of agro-climatic agricultural conditions in many territories attracts the attention of not only the Russian, but also of the world community. This problem is under the scrutiny of the scientists from many countries who are trying to assess the scale of the impending environmental catastrophe, calculate the amount of economic damage, and propose new solutions to existing problems. International supranational organizations are also puzzled by the prevailing conditions of farming in many territories, the loss of the fertile soils and the disappearance of many species of flora and fauna due to the anthropogenic impact on the environment. Among the scientists dealing with environmental threats are works of the following researchers (Date set, 2020; Decree of the President RF, 2020; Ermolaev, 2011; Fedotova & Slozhenkina, 2020; Kokorin, 2016; Rusakova, 2015; Yledov, 2013).

The development of livestock industries both within the world economy and within individual countries and territories has been studied by many scientists who emphasized the importance of these industries in solving problems of food security and independence. In addition, these issues have been resolved in the form of normative legal acts of an official nature and adopted for implementation in individual states. Among the most famous authors and documents are the following (Baimukanov et al., 2019; Decree of the President RF, 2010; Fedotova et al., 2020; Gorlov et al., 2018; Karamayev et al., 2019; Sectoral target program, 2011; Shakhmurzov et al., 2018; Shuvarikov et al., 2019; State program, 2012; Yuldashbayev et al., 2019).

A large number of approved official documents in this industry and published works emphasize the relevance and importance of this issue and the search for ways to solve the problem of providing the population with animal food products in the current conditions of socio-economic development.

Results

The consequences of climate change cannot be completely avoided, but it is possible to slow down their development and adapt humanity to them. For this purpose, many countries have prepared and are implementing international agreements to combat negative climatic manifestations and reduce the industrial load on the environment. Humanity must be aware of the severity of the problem and its global consequences for future generations.

There are national republics on the territory of the Russian Federation, the main occupation of the population of which is agricultural production. One of these regions is the Republic of Dagestan, territory of which has a complex landscape terrain of the Greater Caucasus Mountain Range and the

Caspian Depression with a total area of about 50.3 thousand square kilometers, about 2693.9 thousand hectares of which are occupied by pastures and hayfields. Animal husbandry is represented by such industries as sheep and goat breeding, since these animals in particular graze well on the slopes of the mountains and endure the hauls.

In the republic, sheep breeding has a specific nature, which cannot be found in any other region of Russia—a distant-pasture system of animal husbandry. The peculiarity of this system is that twice a year animals are headed from summer pastures to winter pastures and back, according to established routes and schedules. Often it is necessary to move animals over distances of up to 570 km, which additionally burdens the industry with financial costs and losses of animal husbandry during trailing. Therefore, this feature of farming in a given area should be separately taken into account when forming and allocating support from the federal budget.

The transfer of sheep from some seasonal pastures to others is caused by the fact that the load on winter pastures in the Caspian Depression is 2.5–3 conventional sheep heads per 1 hectare at a rate of 0.7–1 head. Leaving a large number of sheep on winter pastures (of Caspian Depression) leads to their further degradation and transformation of pastures into mobile sands. At the same time, mountain alpine and subalpine pastures with a variety of vegetation remain unused, and it is impossible to leave the livestock in the mountains in winter due to the harsh mountain climate and the inability to procure a sufficient amount of forage for the winter.

The main sheep breeds recommended by scientists-breeders and practitioners for breeding in the natural and climatic conditions of the republic are *the Dagestan mountain*, *Lezghin*, *Andean,* and *Tushinsky* breeds, which are most adapted to the harsh conditions of the mountains and are able to overcome a long distance when moving from one seasonal pasture to another, and also Grozny merino, bred for breeding in the hot, extremely arid climate of the Caspian Depression. The listed breeds of sheep are to be bred and the number of livestock is to be increased, which is stipulated by the developed strategy (Fig. 22.2).

According to the presented data, we see that by 2025 it is planned to increase the total number of sheep and goats to 5000 thousand heads, which will make by 5.12% more than in 2018. The republic takes the leading position in the production of mutton among the regions of the North Caucasus Federal District, and in the in the entire country. The popularity of this type of meat is low in Russia, but recently there has been an increase in the export of this meat to Muslim countries (Fig. 22.3).

As shown in the Fig. 22.3, Russian sheep meat exports are quite unstable, which is primarily due to the lack of a stable production base. However, the demand from a number of Muslim countries (Iran, Saudi Arabia, Kuwait) for Russian mutton dictates the need to increase the potential of this livestock sector and restore the previous production volumes, especially in the national southern regions of Russia. As the experience of Soviet livestock

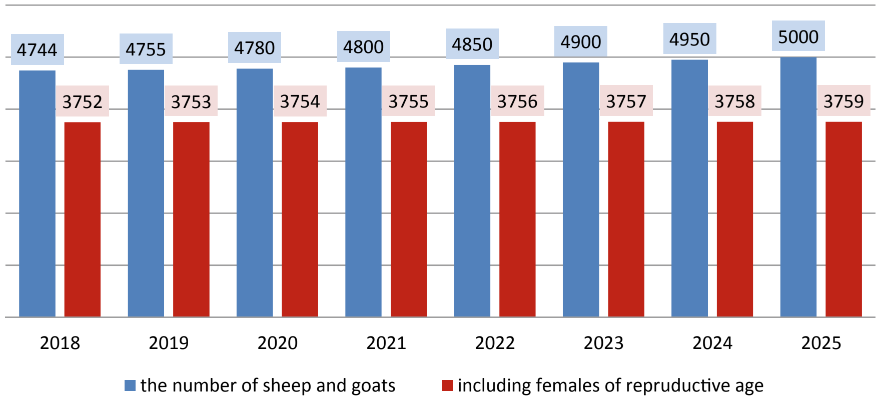

Fig. 22.2 Prognosis of the number of sheep and goats in the Republic of Dagestan (thousand heads)

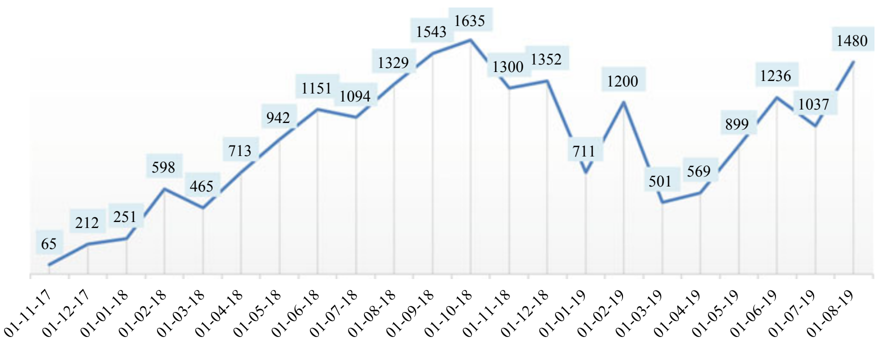

Fig. 22.3 Dynamics of the volume of Russian exports of mutton, tons

breeding shows, sheep breeding was a fairly promising industry due to the high turnover rate and high both meat and greasy, dairy, and wool productivity. During the Perestroika period of the 1990s, due to the lack of funding for the agro-industrial complex, this industry, due to its unpopularity with most of the population, got into a crisis situation. As a result, by the beginning of the 2000s, there was a sharp decline in the number of sheep from 69.2 million heads (a record in 1962) to 14.8 million heads in 2000. Only in the current decade, with the improvement of the situation in agriculture, this figure began growing slowly—from 19.6 million heads in 2010 to 24.49 million heads in 2018. Only 17% of this amount is accounted for by agricultural companies, while the main part (46%) is kept in households, 37%—in peasant (farm) households. Because of this, difficulties arise with statistics and reporting at the Ministry of Agriculture of the Russian Federation.

As mentioned above, the first place in the industry of animal husbandry is occupied by the Republic of Dagestan (4.3 million heads, despite a sharp drop compared to 2017—5.33 million heads), accounting for 20.4% of the total Russian cattle. In Dagestan, both meat and wool and just wool animals are actively raised. The second place is taken by the Republic of Kalmykia. The third is the Stavropol Territory with a livestock of 2 million heads (9%, a decrease compared to 2017—2.263 million heads).The region has a large number of good pastures, rich water resources, and mild natural conditions, which provide ideal conditions for the selection of almost all valuable small cattle. It can be noted that the number of regions with a population of one million includes the Astrakhan, Rostov and Volgograd regions, the republics of Karachay-Cherkessia, and Tyva. A growing livestock is observed in the KBR, Altai, Transbaikalia, Bashkortostan, Tatarstan, Khakassia, Orenburg, and Saratov regions.

In recent years, Russia has been sending for slaughter about 200–222 thousand tons of sheep and goats in live weight, of which about 32–34 thousand tons of meat are produced, which is an insignificant percentage of the total share of the country's production (10.64 million tons in 2018). However, according to estimates, no more than 20–30% of all mutton produced by Agrifood Strategies is supplied to retail; the rest is consumed by the farms themselves or their neighbors. The popularity of mutton among the population of Russia is low, which determines its high level of export to the countries of the East and Asia. It can be noted that mutton is a strategic animal husbandry product that provides the industry with a fairly stable international food market, so it is necessary to pay special attention to the development of this industry in the southern regions of Russia.

The strategy for the development of sheep and goat breeding in the Republic of Dagestan requires a certain financial support included in the presented project (Fig. 22.4).

As shown in Fig. 22.4 the total need for financing the main measures of the Strategy is 5955.8 million rubles, which is provided mainly at the expense of the federal budget and funds of the producers of agricultural products themselves. The Draft Strategy defines the main measures to develop and maximize the potential of the industry on the territory of the republic. The main activities are aimed at developing 7 areas, for which the amount of funding is clearly indicated, but the sources are not identified.

Conclusion

At the end of this study, we note that the implementation of strategic planning in various sectors of the national economy requires careful planning of the production process and financing of activities. It is necessary to clearly define the goal and objectives of the implementation of strategic priorities and identify specific sources of funding for activities.

Sheep and goat breeding for the Republic of Dagestan can become a locomotive direction for the development of the agro-industrial complex of the region, since the products of this industry are very popular and have broad

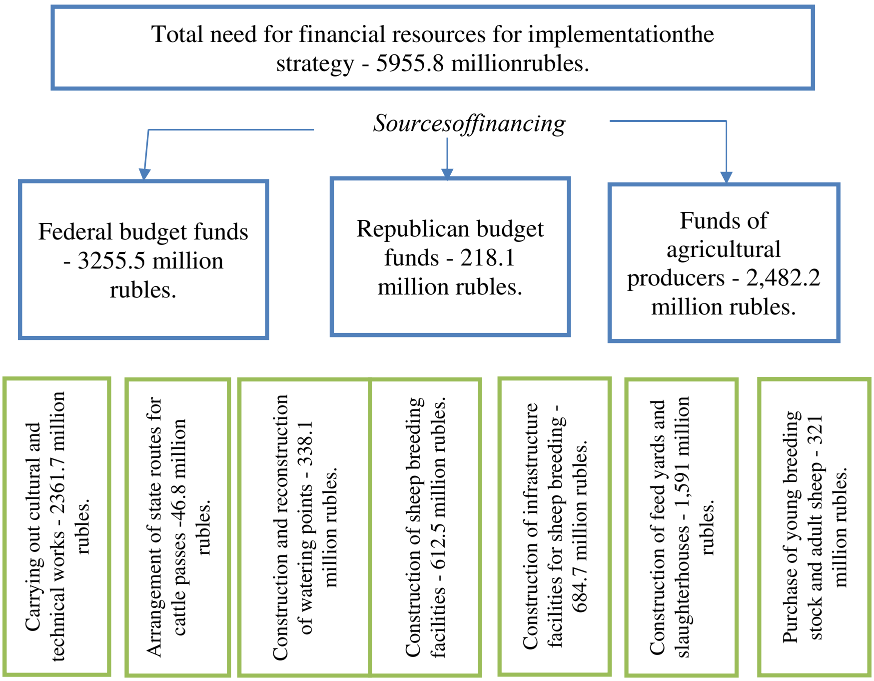

Fig. 22.4 Total-funding requirements for implementing the strategy

prospects for supplies to the international food market. In addition, the development of traditional branches of agricultural production in the national republics of the South and Caucasus of Russia will create preconditions for improving the quality of life of the population in rural areas.

For the successful implementation of the planned Strategy, it is first necessary to comprehensively approach the solution of the problem of growth in the number of small cattle in the context of a deteriorating environmental situation and degradation of pastures for grazing livestock. Certainly, selection and breeding work on farms should be carried out taking into account all regulatory requirements and the level of permissible load on the cattle grazing area. Only with such an approach will a long-term perspective of the industry's development be possible in the face of the growing crisis challenges of modern society.

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CHAPTER 23

The Role of Social Cohesion in the Implementation of National Strategies of Climate Change Struggle

Liudmila V. Alieva, Lidia V. Antonova, and Tatiana G. Khrishkevich

Introduction

Nowadays it is impossible to deny the fact of environmental decline all over the world and the influence of global climate change on all regions of the planet and its population. Showers, floods, draughts lead to human losses, agriculture loss in the region of natural disaster, material damage to infrastructure, residential, and office buildings and they demand additional public expenses worth a billion. For example, the flood on the River Elbe in August 2002 demanded from the German government 10 billion Euros allowance. The flood damage in the Irkutsk region in the Russian Federation at the end of June 2019 was estimated at 35 billion rubles, and the allocation of this sum from the budget can compensate only for the sustained losses. In some cases even allocation of funds in compensation for it cannot solve the ecological problem. Thus because of forest fires in Siberia in 2019 tens of millions of tons of carbon dioxide were thrown away to the atmosphere of the Earth, which precipitate global warming and the struggle against the aftermath of this disaster will require not only time and material input on behalf of the state, but it will also require the awareness of the necessity of public involvement in reducing the scale of climate problem. After the fires the airline company S7 launched the initiative entitled "We are Siberia" which is implemented under the motto "Let's plant 1,000,000 trees together". This project is aimed at drawing public attention to the problem of fires in Siberia and in the Far East.

L. V. Alieva (✉) · L. V. Antonova · T. G. Khrishkevich
Pskov State University, Pskov, Russia

E. B. Zavyalova and E. G. Popkova, *Industry 4.0*,
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Consequently, the research interest in the problem of environmental protection and insurance of ecological safety, as well as to the role society cohesion plays in implementation of the public strategies of struggle with the climate change is well-grounded.

The theme of social cohesion in various aspects nowadays draws the attention of sociologists, political analysts, anthropologists, and historians (Alieva et al., 2019). In research discourse of the problem of social cohesion the term "social and ecological cohesion" is employed (Cook & Swyngedouw, 2012, p. 1960). In light of growing awareness by the global community of global climate threats and the danger of more frequent and large-scale local natural disasters international organizations call for promoting ecological values on different levels. In public and scientific discourse the problem of social consequences of climate changes is often discussed, matters of topical interest concerning the levels of development of social responsibility and involvement of every member of the society in the solution of the problems the planet is facing are being debated. The reports of the International Federation of the Red Cross "Reports on Global Catastrophes" are published annually and in recent years such notions as "social cohesion", "community", "partnership and collaboration", "inclusion and trust" have been highlighted in the context of preventing natural disasters and liquidating their consequences.

After the signing in 1997 of Kyoto Protocol in some countries in the framework of international agreements national strategies of struggle against climate changes have been adopted. The British parliament adopted the act in 2008. In Germany the main legal regulating instrument is the Law on Renewable Energy Sources (2000, 2004, 2009, 2012, 2013, 2017) which was amended several times. Russia took an active part in the first stage of commitment on Kyoto Protocol in 2004–2012. On December 17, 2009, the Climate Doctrine of the Russian Federation was adopted. Since 2017 the document of strategic planning in the sphere of insuring national security of the Russian Federation that determines the main challenges and threats to ecological safety, goals and tasks and mechanisms of state policy implementation in the sphere of ecological safety is the Strategy of ecological Safety of the Russian Federation up to the year 2025. The success of the implementation of these programs to a great extent depends on the efficiency of state and society interaction in the struggle against climate changes.

Methodology

The study of the role of social cohesion in state strategies of struggle against the climate changes in Russia, Germany, and Great Britain at the present stage is based on the principles of new multi-disciplinary branch of science that integrates the achievements, subject matter, and research instruments of sociology, political science, history, and other disciplines, studying the influence of human beings on the environment. This branch of science is ecological history. Among contemporary researchers the interest in anthropogenic disasters is growing that stipulates further study of the role of the society in making political decisions. Multi-disciplinary character of the methodology allows to study in complex value paradigms, social and cultural aspects of the problem of climate changes, and the problem of society participation in fighting against climate change is related to them.

Results

European experts point out the following threats to social cohesion in connection with climate change: intensive migration of the population, an increase of unemployment, water pollution and famine, increasing health risk. “White Paper” of the Commission of the European Communities (“Adapting to climate change: Towards a European framework for action”) adapted on April 1, 2009 underlines that climate change will lead to social impacts and in first place, the vulnerable segments of the population: The elderly, disabled, low-income households are expected to suffer more (White Paper, 2009, p. 3).

Much attention is paid to the problem of cohesion and environmental protection on the European level. In November 2018 the European Commission for Sustainable Equality initiated by the Socialists and Democrats in the European Parliament published a report “Sustainability and Social Cohesion”, one of the chapters of this report is dedicated to socio-ecological progress. The authors of the report remark that ecological problems are to some extent social and ignoring the correlation between them cannot promote sustainable development. Draughts, decrease of yield capacity lead to an increase in prices which in its turn influences the budget of low-income households. In the society where the rich way of life prevails in mass culture and the poor try to imitate it though they do not have enough money there appear problems which impact the environment. The strategy based on the principles of social justice can solve the problem; the strategy is to strive to dismiss social inequality and result in ecological progress (Nachhaltigkeit und Sozialer Zusammenhalt, 2018, p. 140).

In 2007 British Foreign Minister M. Beckett raised in the UNO the issue of climate change impact on the sphere of international and domestic safety. In this aspect the most vulnerable ones are the developing countries because fast population growth, huge dependence on agriculture, rapid urbanization, underdeveloped infrastructure, and lack of resources are typical for them. In prospect climate change can lead to aggravating the problem of poverty and social inequality, sharp conflicts caused by lack of water and supply. Nowadays it is recognized at European and global level that climate catastrophes may lead to social outbreaks, political crises, and war conflicts even in stable regions of the world (Leroy & Gebresenbet, 2013).

The above-mentioned British law of 2008 determines the strategy of reducing greenhouses gases by 2050, it creates the necessary structures for regulating this process, and it sets up the requirements that must be met.

Besides the intricate complex connected with the solution of a set of administrative and legal problems, it also puts up the question of fair distribution of the burden, degree of participation in this project of people, industrial enterprises and communities. It is very difficult to set up the mechanism of GHG allowance allocation according to the principle of equal input. It is supposed that with the help of this law the burden from poorest strata of the society will be lifted, because they consume less energy and as a result they produce less harmful exhaust fumes. At the same time buying expensive equipment for GHG reduction, recycling, and waste management demands huge investments that can lead to increase of prices on some commodities and fuel. Consequently, such a crucial problem for Britain as fuel poverty (when a household spends more than 10% of their income on fuel bills) will become more acute. And it is obvious that in this case low-income households are going to suffer more, which in its turn creates the threat of increasing social distance (Stallworthy, 2009, pp. 432–434).

British researchers notice the connection between the environmental problems, the process of urbanization and level of social cohesion. At first sight disasters threaten equally people from different social strata, but in practice we witness socio-ecological inequality, i.e., those who live in poor deprived areas as a rule are more prone to risks if disasters strike. Some of the reasons can be living on a potentially dangerous territory, poor housing conditions, problems with property insurance and health insurance, and many others. That is why such categories as equality/inequality and exclusion/inclusion which are traditionally used for measuring social cohesion prove to be relevant for evaluating ecological vulnerability. In these conditions the increase of the cohesion level is regarded as a way of preparing for crisis situations. Assistance in disaster clean-up operations (in case of extreme weather conditions), establishment of relationships between the society and the state in the ecological sphere is possible with the help of local communities. Inclusion of all the members of the community in social life, active environmental citizenship, and internal relations based on principles of partnership and equality may guaranty efficient solutions of a wide range of social problems (Dobbernack, 2014, pp. 17–21), including the problems connected with the environment. There are different ways of ensuring socio-ecological cohesion and social stability following from this. There may be some sets of actions: universal implementation of eco-friendly technologies, GHG reduction, changing individual habits and refusal of the values of throw-away society, as well as complex programs of social reforms and changes in the sphere of ecological law (Cook & Swyngedouw, 2012).

In Germany, social problems are interwoven with the interconnected spheres of life: environmental protection, climate control, and the necessity of transition of renewable resources of energy. Germany became one of the first states where the Electricity Feed-in Act was adopted in 1991. Throughout 2000–2019 the process of improving the legislation was underway and the acme of it was the Climate Action Plan adopted by the federal government in

November 2016. This made Germany the first country to elaborate a long-term strategy on climate change stipulated by the Paris agreement of 2015. Besides the traditional measures (such as the reduce of GHG reduction by 55% by 2030), the plan stipulates the process of monitoring and the participation of the public in solving ecological problems. The plan highlights that social agreement is the most important premise for implementation of the climate protection policy, because it will require additional social costs. (Klimaschutzplan, 2016, p. 30) According to the government, it is impossible to achieve these ambitious goals without solidarity, taking into consideration that reforms will encompass all the spheres of life: starting with public transport fare and up to substitution of heating system. According to the estimates of the German Ministry of Finance the governmental set of measures to protect the climate will cost the budget 54 € billion in the time period up to 2023. To achieve a wide public acclaim of the measures on implementing the climate plan the government suggests the key principles: "equity, availability and efficiency".

In Germany politicians, economists, and scientists discuss the interconnection of the society cohesion and climate situation. The problem takes an important place in the political discourse of the left-wing and ecological parties. Environment protection agenda is always in the program of the party Alliance 90/The Greens which is traditionally very influential in Germany. The sections dedicated to climate protection are in the treaties of the ruling coalitions. In particular, the treaty of CDU/CSU—the Social Democratic Party of Germany (SPD) in 2013 correlates the implementation of a complex ecological program with the necessity to elaborate new professional requirements and qualifications for the employees of the future (Deutchlands Zukunftgestalten, 2013, p. 118).

The key point of the discussions of the German researchers on the role of social cohesion is the perspectives of sustainable development (Ihme, 2010, pp. 1–28). The authors highlight that its pledge is the equal relation to three dimensions: the ecological, economical, and social ones. Taking into account that the state of the environment is the main obstacle on the way to sustainable development, the refusal to solve the problem in a complex way threatens all the other elements. The integrated approach must include compromises between goals and the pursuit to deescalate conflicts between them. When reaching social harmony special attention must be paid to innovations that expand technological and organizational knowledge of the society and diminish conflicts. The ability to generate knowledge is the key premise for the possibility in principle of unlimited economic growth in its connection with social capital. The researchers have a similar treatment of the problem, they point out that sustainability must be equitable at present so that it can guarantee safety to future generations (Blazejczak & Edler, 2004, pp. 10–30). At the same time, when dealing with the issues of social cohesion researchers pay a lot of attention to studying the phenomenon of climate change and its influence on the environment.

In spite of the state measures taken in the Russian Federation to deal with climate change and adaptation of branches of the economy to adverse climate change experts state that a threat to ecological safety of the country exists. The maintenance of environmental safety is ensured on the highest level in Russia. In the Strategy of ecological safety in Russia the state policy in the sphere of ecology is regarded as a part of domestic and foreign policy of the Russian Federation which is implemented by federal state government bodies, government bodies of the constituents of the Russian Federation, and by local government bodies. The society also gets its place in the implementation of the state strategy to counter climate change. Non-governmental organizations can participate in the implementation of the state policy in the sphere of maintenance of ecological safety according to the legislation of the Russian Federation. However, the participation of the society in the implementation of this crucial strategy is not obligatory, even as the Strategy does not imply society cohesion to counteract climate change.

The Treaty of the President of Russia of 7 May 2018 # 204 “On National Goals and Strategic Tasks of the Development of the Russian Federation up to 2024” gives a list of twelve directions of strategic development, and among them there is the National Project “Ecology” that justifies to the efforts of balanced resolutions of socio-economic and ecological goals that corresponds to the principles and goals of sustainable society development adopted by the global community for the period of 2016–2030 at the UNO Summit in September of 2015. The National project “Ecology” unites eleven federal projects: “Complex system of MSW management”, “Infrastructure for waste management of hazardous wastes, class I-II”, “Clean Country”, “Clean Air”, “Revitalization of the Volga River”, “Clean Water”, “Preservation of the Lake of Baikal”, “Preservation of Biological Variety and Development of Ecological Tourism”, “Preservation of Unique Water Bodies”, “Introduction of the Best Available Technologies”, and “Preservation of Forests”. Highlighting the principal aspects in the whole problem of counteracting climate change makes us think about the difficulty of choice that every citizen has to make what their priorities are: to preserve the Lake Baikal, to revitalize the Volga River or recycling of waste.

Experts say that the situation in Russia is unique, first of all, because of dependence on export of fossil fuels and energy intensive manufactured goods. They highlight that the main incentive for cutting emission in Russia must be economic diversification under conditions of potentially diminishing demand for hydrocarbon resources in the world. Following these goals by December 2019 in the Russian Federation the strategy of long-term development with a low rate of greenhouse gas emissions up to 2050 must be elaborated and adopted by the government. At the same time the work is underway on elaborating the project of national plan of economy adaptation to adverse climate change.

One can speak with confidence that the measures to counteract climate change taken by the Russian Federation won’t achieve considerable success because the above-mentioned documents, strategies, and events aim at counteracting the aftermaths of climate change and not at discovering the causes of climate change and elaborating preventive measures to increase efficiency of human–nature interaction. The statement of Gennady A. Zyuganov seems to be of crucial importance in which he said that to achieve victory in any struggle one needs society cohesion, resource mobilization, and acquisition of the latest technologies.

Conclusion

Thus one can come to the following conclusions. Firstly, socio-ecological agenda is an integral part of the contemporary political discourse that stresses the timeliness of the problem discussed in this article. Secondly, climate change is a reason for elaborating new economic policy in the countries that are aware of the importance of the climate change problem. Thirdly, global climate changes and natural disasters caused by them contributed to the eternal problem of social disparity one more aspect—the ecological one. Fourthly, the increase of the level of social cohesion must contribute to the adaptation to the changing environment, mutual assistance in case of emergency, overcoming material and psychological risks connected with climate change. Finally, to achieve cohesion means to create a basis for balanced and sustainable development in future. Nevertheless, for transferring to territories' sustainable development one needs to review the existing technology-related conception of development of economic branches. It is necessary to form a new conception of the society development based on the study of socio-economic and ecological problems, retrospective analysis of landscape state, and long-term projections of the expected aftermaths of agricultural activities on the state of the main components of the territory under consideration.

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CHAPTER 24

M&E of Environmental Standards Compliance

Hans-Martin Boehmer and Yury K. Zaytsev

Introduction

Running business often assumes compliance with the social and environmental commitments as a part of the regulation, contract, or the condition for obtaining the license or credit. The most complex standards are usually associated with environmental commitments.

Reporting environmental and social standards compliance is an accountability mechanism helping to engage with a wide range of stakeholders, including employees, consumers, investors. It helps to contribute to ongoing dialogue with them. Ex-ante or ex-post evaluation in the form of reporting could serve as a direct communicative tool.

So, reporting can be a tool for communicating the economic, environmental, and social opportunities and challenges of corporations to stakeholders while addressing their potential and real inquiries. The openness develops trust and confidence.

In the modern sense, M&E of environment and social standards is reflected in business CSR practices, associated with non-financial reporting of

H.-M. Boehmer
School of International and Public Affairs, Columbia University, New York, NY, USA

Y. K. Zaytsev (✉)
MGIMO University, RANEPA, Moscow, Russia

E. B. Zavyalova and E. G. Popkova, *Industry 4.0*,
https://doi.org/10.1007/978-3-030-75405-1_24

a company in the field of sustainable development (the so-called triple bottom line).[1]

Basically, the publication of non-financial statements is a voluntary business initiative. However, in some EU countries (Scandinavian countries, France, Netherlands) some businesses, including state-owned enterprises (SOE), have to provide CSR reporting on a mandatory basis.

Most of the world-famous and large-cap companies regularly issue non-financial reports. The world's largest database of corporate non-financial reporting is the International Register of Non-Financial Reports Corporate Register. At the beginning of 2011, the register contained more than 30 thousand reports from over 7,500 companies (CorporateRegister, 2020).

From business perspective CSR projects are launched to keep the loyalty of the clients. That is why CSR projects implemented by business often complement the activities of the national governments and international institution in the field of public goods creation. CSR are often associated with implementation of international principles, regulating socially responsible finance, recommended by the World Bank, IMF, and the regional development banks (such as Equator principles, Global reporting initiative (GRI), and UN Global Compact).

Methodology

The methodology of research paper is based on critical overview of environment standards compliance M&E practices. To do this the paper focuses on critical review of the main international practices in this field. To achieve the goal of the paper, such methods as content analysis, benchmarking, logical analysis were used.

Research Results

M&E of Environment Standards Compliance in Business Practice

Different companies affect environment in a different way. However, according to Green peace, the most dangerous is oil-extracting business. There are several areas of oil companies activities having the impact on the environment. In the process of exploration for oil fields, territories are often cleaned up, which may entail partial or complete destruction of the flora. Second, when drilling, there is a risk of drilling fluids entering the ecosystem. Third, in the process of oil refining, harmful substances are released into the atmosphere, as well as the leakage of oil pipelines is possible, which has an adverse effect on

[1] Triple bottom line (TBL), in economics, believes that companies should commit to focusing as much on social and environmental concerns as they do on profits. TBL theory posits that instead of one bottom line, there should be three: profit, people, and the planet (Investopedia, 2020).

the environment. Fourth, during transportation, oil gets into the waters as a result of bilge water pumping by tankers or in the process of unloading a ship.

What is more, energy and mining companies often demonstrate most socially and environmentally responsible behavior in their home countries and abroad. Nowadays more than 40% of mining companies' CSR programs is implemented abroad (CECP, 2019). So, the CSR projects of energy companies are mainly associated with the environmental protection, health, and education. In 2018 a significant proportion of the funds was spent by international business as a whole goes to finance the projects for heath and social services (27%) and community and economic development (22%) (CECP, 2019).

M&E of business compliance with the environmental standards is vital for private sector because of several reasons. First, by tracing its environmental and social performance business gets position of socially and environmentally responsible market participant. Second, M&E practices expand the options of increase in openness, transparency, and accountability. Third, M&E practices often serve as business confidence tool, which helps to increase the loyalty of a wide range of stakeholders. Fourth, social and environmental reporting improves corporate reporting in a whole and increases corporate ratings. What is more, stable positions in international corporate ratings often help business to be more attractive for investors.

Reporting practices very across the companies and across the countries. Some governments have appropriate regulations on using reporting standards and covering particular topics in reports (UK, and some EU countries). Others (United States) allow their private sector pursuing their own objectives.

The comprehensive report reveals information on the company's activities in three areas: economic, social, and environmental. Depending on the interpretation of the concept of CSR, they can be called in a different way (Zavyalova et al., 2020). The first non-financial reports of European companies mainly dealt with the environmental aspects of their activities (Zaytsev, 2017). Regular preparation of non-financial reporting allows the company to establish a system of annual monitoring of environmental and social performance indicators as part of the collection of data for reporting process.

There are a lot of difficulties associated with measuring long-term effects from the implementation of environment protection programs at the macro-level. Environmental protection measures' impact is difficult to identify and specify at macro-level for such macro-indicators as GDP, life expectancy at birth, etc.

However, there are some examples of measuring micro-level effects at the level of individual companies, associated with environmental standards implementation. For instance, energy savings by Lukoil in the amount of 1.6 billion kW allowed the company to reduce its electricity costs by USD 75.1 million during the period of 2006–2010 (Lukoil, 2011).

The reasons of difficulties, associated with measuring the environmental standards impact often deal with a lack of consistency and quality of statistical information, including the shortage of systematic and consistent observations of specific environmental and social parameters, volatility of data over time, etc. (Gertler et al., 2011).

What is more different environmental programs could have different goals. Some of them could be linked with strategic business goals. Others could address the interests of business' internal and external stakeholders. The reporting and evaluation research also depend on political conditioning.

Impact evaluation practices are wide spread when it comes to social and environmental investments (SEI) that ensure social equilibrium and the reproduction of natural complexes. The practices are popular among mining companies to meet the requirements of environmental and labor legislation. The assessments identify ecological effects and the pressure exerting on the environmental systems. These measures reflect the change in environmental fines and payments, a change in energy consumption, a more rational use of resources at the enterprise (Ruffer & Wach, 2013).

International Organizations' Provisions on Environmental Standards M&E

International organizations' practices on environmental standards M&E are often associated with non-financial reporting. The first international experience in the preparation of non-financial reporting can be attributed to 1970s. Over the past 30 years, various standards and guidelines for social reporting have been developed, such as ISO14000, SA 8000, OHSAS1800, AA1000, Global Compact, GRI. The significant growth was registered over the past 10 years. Currently the electronic database CorporateRegister.com contains over 16,000 reports of over 4,000 different companies from more than 100 countries (CorporateRegister, 2020). Some of the key international initiatives are discussed below.

The Global Reporting Initiative (GRI)

The Global Reporting Initiative (GRI) was created in 1997 by the Coalition for Environmentally Responsible Economies (CERES) in cooperation with the United Nations Environmental Program (UNEP). The main idea behind the initiative establishing universal practices of business sustainability reporting. It was planned to provide comparison to financial reporting in terms of reliability, timeliness, and verifiability. To this end GRI has become multi-stakeholder initiative embracing business, not-for-profit organizations, and governments from different countries all over the world (GRI, 2020).

The elaborated guidelines (or manual) of reporting on the economic, environmental, and social issues are disseminated globally and are used by companies on a voluntary basis. Thus, the manual is intended to raise business' reporting standards on its contribution to sustainable development.

According to the GRI data, out of 500 global companies in the world today, about 80% use the GRI Guidelines when preparing reports in the field of sustainable development. The advantages of the GRI Guidelines include: use

Table 24.1 GRI indicators

Category	*Aspect*	*Indicators (examples)*
Economic indicators		
Direct economic impacts	Consumers Suppliers Staff Sources of capital State and public sector	EC6. Payments to sources of capital, broken down by interest on liabilities and loans, and dividends on all types of shares, indicating any dividend arrears All types of liabilities and loans should be considered, not just long-term ones EC7. Increase/decrease in retained earnings at the end of the period
Environmental indicators		
Environmental impact	Raw materials Energy Water Biodiversity Emissions, discharges, and waste Suppliers Products and services Compliance with regulations Transport General	EN1. Total raw materials used, excluding water, by type (the definitions of the types of raw materials. Provide usage data in tonnes, kilograms or volume units) EN2. The proportion of raw materials that are waste (recycled or unprocessed) from sources external to the organization (this refers to both consumer waste, recycled and industrial waste. Give data in tonnes, kilograms, or volume units
Social indicators		
Organization of work and decent work	Employment Relationship between staff and management Occupational health and safety Training and education Equal opportunity and diversity	LA1. Distribution of labor force, where possible, by region/country, status (employees/non-employees of the organization), type of employment (full/part), contract (fixed-term / indefinite) Also include in the report the workforce shared with other employers (e.g., rented from temporary staffing agencies) by region/country LA2. Total number of jobs created by the organization and average employee turnover, by region/country

Source Compiled by authors

by organizations of all sizes, industries and locations; comparison of reports with each other, etc. (GRI, 2020).

The GRI Guidelines are supplemented by industry annexes that provide guidance on their application in the context of specific industries, as well as performance indicators specific to these industries (Table 24.1).

UN Global Compact on Social Responsibility

The idea of a Global Compact on Social Responsibility was launched in 1999 in order to address social responsibility reporting issues. With its ten reporting principles the UNGC covers such issues as protection of human rights, labor relations, environmental protection, anti-corruption provisions (UN Global Compact, 2020a, b).

The participation is voluntary, but the initiative is designed to meet the needs of all types of businesses. As the members of the UNGC, the company commits to embody the principles into its business strategy and corporate culture.

United Nations Environment Program Finance Initiative (UNEP FI)
In 1991 a group of banks (such as Deutsche Bank, HSBC Holdings, Natwest, Royal Bank of Canada and Westpac) joined the United Nations Environment Program (UNEP) in order to raise the international awareness on environmental issues in the financial sector.

Later, in 2003, the UNEP IFI merged with the Insurance Industry Initiative. This resulted into the UNEP Finance Initiative. More than 300 organizations have joined the UNEP Finance Initiative.

Equator Principles
The Equator principles also include ten principles as a framework to manage project finance credit risks associated with environment and social issues. The principles are based on IFC principles. They are applied when the project capital costs make at least US USD10 million (Equator Principles, 2020). The principles are accepted by private sector on voluntary basis. In 2003 the Equator principles were signed by ten banks.

The main idea of accepting these principles is to demonstrate that the projects are designed in a socially responsible manner and in accordance with sound environmental management practices.

National Practices

When it comes to international practices of environment standards compliance, it should be noted that mostly the EU countries and United States have made a greatest progress in advancing national regulation practices enforcing compliance with environmental standards.

All the countries have their own regulatory institutions. However unlike in United States, in EU countries environment standards compliance is associated with compulsory activity of the private sector, which are prescribed by the regulation. In United States environment standards compliance is often considered by the business as a part of its CSR, undertaken on its own initiative.

The Corporate Social Responsibility (CSR) team in the Bureau of Economic and Business Affairs at the Department of State supports sustainable development principles in the United States and abroad. In order to ensure compliance with environmental standards, it provides methodological recommendations on compliance with national and international CSR standards including those, which relate to environment protection, natural resource management (US Department of State, 2020). However, the form of environment and social reporting is open in United States. Thus, the Bureau is entitled to observe general guidelines compliance.

EU companies are traditionally less active in the field of CSR. Charity is not as popular in Europe as it is in the United States. This is due to the level of tax burden, which significantly exceeds the American counterparts. However, they are more coherent and committed to following the rules, established at the national and subnational level. Thus, European companies take part in philanthropic activities primarily through legally binding mechanisms.

Conclusion

The article covers several issues dealing with international organizations' provisions on environment standards M&E, national governments' practices in the field of as well as business environment standards compliance M&E practices. All of the stakeholders have their own interests in the field of sustainability results reporting.

Most of the international organizations and NGOs insist on private sector compliance with a set of rules on reporting in order to make it to achieve the right outcomes. However, business often has its own goals with respect to different stakeholders. Thus, the outcome-based set of standards, monitoring and reporting modes often depend on these goals. What is more, detailed requirements are too burdensome for many national governments, who have their own standards.

However, CSR reporting is a tool that helps strategically link disparate and isolated corporate functions—finance, marketing, research and development. It provides an impetus for internal communication and communication processes that would not otherwise arise. The report process identifies potential problem areas—and unexpected opportunities—in supply chains, communities, government relations, and reputation and brand management. The reporting allows an organization to anticipate potentially negative developments before they become unpleasant surprises.

Social and environmental reporting is indented to reveal social and environmental contribution of business and of its products and services. Such an assessment is important for a wide range of stakeholders interested in business' environmental and social mandate.

Reporting practices themselves contribute to reducing the volatility level and uncertainty in corporate sector. The disclosure of environmental and social information for active and perspective investors improves the financial stability of the company and economic sector as a whole.

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CHAPTER 25

Green Industrial Policy in the Context of Industry 4.0

Maksim V. Petrov, Vasily N. Tkachev, and Anastasia V. Buniakova

Introduction

Industrial policy as a method of state influence on the dynamics and structure of industrial production in the country has recently attracted increased interest from politicians and experts. After the failure of the liberal Washington consensus, which rejected its necessity, and the global crisis of 2008–2009, which showed the imperfection of market mechanisms for regulating the economy, industrial policy, as well-known American economists aptly put it, is "back in fashion" (Greenwald & Stiglitz, 2013: p. 43). The possibilities of its application are actively explored in the context of finding new ways to ensure sustainable socio-economic development of countries in the context of large-scale modern challenges.

One of the most difficult and responsible challenges facing all countries is the deterioration of the natural and climatic conditions of existence as a result of the increasing anthropogenic impact. It manifests itself in climate change, pollution of the environment, degradation of natural ecosystems, and other negative consequences that can cause irreparable damage to the natural environment of human habitation. The growing awareness of the importance of environmental threats led to the emergence in the 2000 s of the concept of "green industrial policy" (GIP)—type of industrial policy that promotes environmental friendliness of production and the transition to a green economy.

M. V. Petrov (✉) · V. N. Tkachev · A. V. Buniakova
Moscow State Institute of International Relations (MGIMO), Moscow, Russia

E. B. Zavyalova and E. G. Popkova, *Industry 4.0*,
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The GIP concept, promoted by the UN, the World Bank, and other international organizations, is now being integrated by many countries into national development strategies.

The fourth industrial revolution, leading to the transition of the world economy to a new technological order based on the widespread introduction of digital technologies (Industry 4.0), creates both new opportunities for improving the state of the environment and the risks of its further degradation. Although the environmental effects of Industry 4.0 are currently not completely clear, nevertheless, even now, states must predict and take them into account when shaping their industrial, environmental, scientific, and technical policies. This article will examine the prospects for using the GIP to manage the environmental impact of digital transformation of the economy. Particular attention will be paid to the analysis of the GIP in Russia.

Methodology and Literature Review

The analysis of the prospects for using GIP to regulate the impact of Industry 4.0 on the environment involves the study of the following issues: (a) environmental consequences of digital transformation of the manufacturing sector; (b) the theoretical basis for the implementation of the GIP to manage these impacts; (c) the possible goals and content of GIP in the context of Industry 4.0; (d) the possibility of using GIP tools in Russia.

The main research method in the proposed article is the analysis of academic literature, materials of international organizations and other publications on the above issues in order to identify possible gaps in knowledge and develop our own conclusions and recommendations. Quantitative methods were not used due to the obvious lack of statistical information allowing establishing causal relationships between the measures taken by governments to regulate the processes of digitalization of production and the state of the environment.

The number of publications on the issues considered in the article, although still relatively small, is growing rapidly. The papers (Bonilla et al., 2018; Gabriel & Pessl, 2016; Ghobakhloo, 2019; Oláh et al., 2020; Tim et al., 2018) provide an overall assessment of the impact of Industry 4.0 on environmental sustainability. Among the publications evaluating the impact of individual digital technologies on environmental performance of manufacturing sector, we note (Carvalho et al., 2018; Ford & Despeisse, 2016; Jabbour et al., 2018; Li et al., 2020).

Among the works that consider the theoretical aspects of GIP, including the rationale for policy and its possible content, we will highlight the following: (Altenburg & Rodrik, 2017; Cosbey, 2013; Harrison et al., 2017; Isachenko & Il'yagueva, 2019; Lütkenhorst et al., 2014; Rodrik, 2014). In addition, there are a number of studies evaluating the practice of implementing GIP in various countries and industries. Practical approaches to GIP design are summarized in the material (UNEP, 2016). However, very few publications analyze the features of GIP in the context of Industry 4.0. Recently, works on industrial policy during the digital revolution have appeared in the Russian literature (see, for example [Tolkachev (Ed.), 2018]), but they do not touch on environmental aspects.

Results

The academic literature is dominated by moderately optimistic views about the nature of the impact of Industry 4.0 on the environment. Most authors believe that the overall balance of its environmental effects will be positive. However, it is usually emphasized that any estimates in this area are only approximate, since the main technologies of Industry 4.0 are still being developed (Bonilla et al., 2018; Oláh et al., 2020).

First, digitalization and automation of traditional industries makes it possible to reduce their resource intensity, reduce waste generation and greenhouse gas emissions, facilitate recycling of secondary raw materials, and encourage the transition to a circular economy (Gabriel & Pessl, 2016; Jabbour et al., 2018; Oláh et al., 2020). Second, the development of 3D printing and other additive technologies makes it possible to create new customized production facilities with low waste and simplified logistics chains (Ford & Despeisse, 2016; Niaki et al., 2019). Third, the introduction of information technologies that allow processing large amounts of data contributes to improving the effectiveness of environmental management in corporations (Gbebedo et al., 2018).

Researchers associate the possible negative environment impact of Industry 4.0 primarily with the expected growth in production and consumption of goods and services, the cost of which will fall due to new technologies, with an expanding energy consumption for the operation of energy-intensive digital infrastructure, peripherals and 3D printers, as well with an increase in the risk of technological disasters as a result of failures of digital production control systems (Bonilla et al., 2018; Kiel et al., 2017; UNIDO, 2017). It is noted that the main risks to environmental sustainability are associated with the initial stages of the formation of Industry 4.0, when new technologies will only be developed (Oláh et al., 2020).

The depth and ambiguity of the impact of Industry 4.0 on the environment and other aspects of human life increase the importance of its state regulation. Governments have a variety of capabilities to do this, including GIP tools.

Turning to the discussion of GIP, as a first step it is necessary to clarify what this policy is, what are the rationales for its implementation and possible content. This is all the more important because there is no generally accepted theoretical understanding of GIP (this remark fully applies to the concept of industrial policy). The diversity and inconsistency of interpretations of GIP is manifested in the presence of numerous definitions of this concept, reflecting the different opinions of the authors about this policy.

Lütkenhorst et al. (2014: p. 1) offer a broad definition of GIP as "any policy measure aimed at aligning the structure of a country's economy with the needs of sustainable development within established planetary boundaries". The authors note that GIP is an independent direction of public policy, different from traditional industrial policy. Pegels (2014: p. 6) gives a similar interpretation of GIP, emphasizing the GIP's focus on stimulating green growth of economy: "green industrial policy is government intervention to hasten the restructuring of the economy towards environmental sustainability". Such definitions, which make it possible to attribute almost all environmental measures of the state to the GIP, have a serious drawback: they do not allow setting the boundaries of the GIP in any clear way, in particular, to differentiate it from the government's environmental policy. This makes it much more difficult to study GIP as an economic category.

Cosbey (2013) offers a narrower interpretation of GIP, describing it as any policy that supports the development of industries that produce green goods, or goods that have better environmental performance in operation than their competitors (e.g., electric vehicles or biofuels); either directly used to solve environmental problems; or produced using technologies that have environmental advantages. Hallegatte et al. (2013: p. 8) defining IP specify that it includes only tools for targeted (nonneutral) support for manufacturers who produce environmental products or use clean technologies are included.

Altenburg and Podrik (2017: p. 11) define GIP as "any government measure aimed to accelerate the structural transformation towards a low-carbon, resource-efficient economy in ways that also enable productivity enhancements in the economy". Thus, the authors emphasize that the GIP should solve not only environmental, but also economic tasks to improve production efficiency through the introduction of modern energy and resource-saving technologies. This is important for understanding the difference between GIP and environmental policy, where economic goals are not the main one.

In this article, "green industrial policy" refers to a set of state measures aimed at supporting industries, economic activities, and technologies, the development of which contributes to the growth of productivity and competitiveness of industrial production and at the same time reduce the negative impact on the environment. GIP is one of the main directions of modern state industrial policy designed to support environmentally oriented economic growth. GIP measures are necessary both to ensure environmental sustainability in the process of modernization and structural adjustment of manufacturing, and to achieve economic effects by encouraging the introduction of resource-saving environmental sound technologies that decrease production costs.

The proposed definition excludes from the scope of GIP direct regulatory measures applied in environmental policy (payments and quotas for emissions/discharges, environmental standards, etc.), which are primarily intended to limit the negative impact of economic activities on the environment, and not to support the development of new industries and technologies. This allows us to at least define the boundaries between GIP and environmental policy, although it is clear that these boundaries are conditional.

The literature provides various justifications for the need for GIP. All of them are associated with various kinds of failures, violations in the functioning of market mechanisms, the correction of which requires state intervention. An example of market failure is environmental externalities, usually cited as one of the main rationale for GIP (Pegels, 2014; Rodrik, 2014). Due to externalities, the public benefit of private investment in environmental protection exceeds the economic benefits of investors themselves, which may result in a reduction in such investments. The state can help internalize positive externalities through subsidies, tax incentives, and other financial support tools for investors.

Other justifications for the GIP include the need to support environmentally friendly infant industries until they reach a certain scale and gain production experience, informational externalities arising from investments in R&D and new technologies, capital market imperfections, which makes it difficult to raise funds to finance environmental projects, the need to coordinate private and public investment in related industries and infrastructure (Cosbey, 2013; Hallegatte et al., 2013; Lütkenhorst et al., 2014; Pegels, 2014).

Along with the arguments in favor of the GIP, there are also arguments against it that cast doubt on the possibility of a successful GIP. Rodrik (2014) cites 2 such reasons: the insufficient quality of information available to public authorities when designing policy, and its dependence on political factors, including lobbying by influential groups. We should add that the state's fiasco may also be due to the imperfection of institutional and financial mechanisms for implementing GIP and the selfish behavior of officials.

Industrial policy is usually divided into 2 types: vertical, aimed at targeted support of industries and companies, and horizontal, which includes non-selective measures that promote the development of industries by creating comfortable conditions for doing business. This division applies to the GIP as well. Vertical policy tools that are widely used in various countries are: (a) direct financial support for enterprises, including soft loans, credit guarantees, grants for R&D and capital expenditures, tax incentives, provision of land and other assets at below-market prices, subsidizing prices and tariffs for environmentally friendly products, e.g., feed-in tariffs for renewable energy; (b) measures to stimulate demand for green products (public procurement, consumer subsidies, and export credits to foreign buyers). The horizontal policy includes measures aimed at improving the operating environment for companies by streamlining regulation, as well as facilitating access to industrial and logistics infrastructure, innovative technologies, and professional workforce. Horizontal policies are often viewed as preferable to selective support measures because they tend to be less costly and less likely to fail government (Harrison & Rodriguez-Clare, 2010).

A number of publications are devoted to the analysis of GIP in different countries of the world. In particular, the object of research was the green industrial policy in China (Adhikari & Ganguly, 2018; Liu et al., 2020), in Germany (Pegels, 2017), in India (Ganesan et al., 2020), in Brazil (Veiga & Rios, 2017). One of the main findings is that the implementation of GIP is extremely difficult matter, and its results, as the experience of the United States, India, and other countries shows, do not always meet expectations (Harrison et al., 2017; Rodrik, 2014).

Analysis of the theoretical foundations of GIP allows us to assess the prospects for its application in the context of Industry 4.0. In our opinion, despite the noted difficulties of the GIP it can be quite successfully used by the state to better realize the opportunities that Industry 4.0 opens in terms of transition to a cost-effective green economy, while minimizing negative consequences for the environment. The ultimate goal of GIP could be to increase the productivity, competitiveness, and environmental friendliness of national industrial production through the widespread adoption of environmentally sound digital technologies. In particular, the following steps by the state would help to achieve this goal:

a. promotion of technological modernization of traditional industries (mining, metallurgy, chemical industry, mechanical engineering, construction materials production, etc.) based on digital technologies, including industrial Internet of things, artificial intelligence, and additive manufacturing, which reduce the energy and resource intensity of production, the formation of industrial waste and CO_2 emissions and ensure the transition to closed production cycles in the future;
b. support for innovative environmentally friendly enterprises and industries that produce competitive green products using additive and other digital technologies;
c. participation in the creation of digital platforms and other information infrastructure facilities that contribute to building closed supply chains in industry and the transition to a circular economy;
d. support for R&D aimed at creating advanced digital technologies that can increase the productivity and environmental friendliness of manufacturing, as well as reduce the energy consumption of data centers and other computer equipment (green computing or green ICT).

It should be noted that these tasks are gradually being integrated into strategies, policies, action plans, and other program documents adopted by states and supranational bodies for the purpose of long-term planning of socio-economic development, including the transition to Industry 4.0 and to a green economy. As an example, we can cite 2 documents of the European Commission: “The European Green Deal” and “A New Industrial Strategy for Europe”, containing a common action plan for achieving two interrelated goals by European industry: climate neutrality and digital leadership. The documents note the importance of supporting the implementation of digital technologies for decarbonising traditional energy-intensive industries and building a circular economy (European Commission, 2019, 2020). Similar theses are contained in many national strategies for the development of Industry 4.0 adopted in the EU countries, in particular in Germany (Plattform Industrie 4.0), France (Alliance pour l'Industrie du Futur), Italy (Intelligent Factory Cluster).

Obviously, the content of the GIP in an Industry 4.0 environment can vary markedly from country to country. In developing countries, it is likely to focus on stimulating the modernization and decarbonizing of traditional industries using imported digital technologies. In developed countries, the main emphasis can be placed on promoting the development of environmentally sound digital industrial technologies, information systems and products that can consolidate their technological leadership and become an export item. Another priority area of efforts may be to support small- and medium-sized businesses that develop and produce a variety of green products and services using digital technologies.

We can assume that along with the adjustment of tasks in the conditions of digitalization of the economy GIP will have some other features.

Firstly, the priority of GIP will be the management of technological changes, primarily the creation and implementation of green digital technologies that allow achieving the desired economic and environmental effects. In this regard, GIP will be closely linked to the state scientific and technical policy. This circumstance will essentially complicate the implementation of GIP.

Secondly, the increased level of investment risks, environmental and information externalities that arise for private businesses when financing green digital technologies will require the government to more actively use measures of targeted financial support for investors in the form of soft loans, guarantees, grants, co-investment in capital and tax incentives. Thus, we can expect that the importance of horizontal GIP will increase, which will lead to higher GIP costs.

Thirdly, it is very likely that the costs of implementing a vertical green policy aimed at creating favorable conditions for digitalization and greening of production will accrue. In particular, significant budgetary investments may be required in fundamental and applied R&D, development of digital infrastructure, creation of information systems for monitoring and controlling the movement of resources necessary for the formation of a circular economy, as well as training of professional personnel capable of working with digital technologies.

Fourth, the projected raising in the complexity and cost of GIP will lead to increased requirements for the quality of public policy management. It will require highly professional management personnel able to competently understand the technological aspects of GIP, as well as effective transparent mechanisms for its implementation, which reduce the likelihood of errors in the selection of objects of state support, and will also allow responding promptly in case of problems with the use of state funds.

Fifth, given the complexity of GIP tasks, its outcome will largely depend on the ability of the authorities to establish constructive cooperation with the private sector, allowing the parties to better understand each other's needs and capabilities and on this basis optimally design and implement the GIP (Rodrik, 2014). The state itself cannot know everything; therefore, a productive dialogue with business in the format of joint forums and councils becomes particularly important.

Thus, it can be assumed that the implementation of GIP in the context of digitalization of the economy will require from governments a high level of competence and a willingness to bear significant costs for implementing policy measures. It is clear that not all countries have sufficient financial and administrative capacity to effectively conduct the GIP. At the same time, those states that can successfully manage the processes of digitalization and greening of production with the help of GIP will receive undoubted strategic advantages.

Russia is currently in dire need of a systematic and consistent green industrial policy that would help to solve the accumulated problems in the field of industrial development and environmental protection. Their scale and complexity is evidenced by a lot of data, we note only 2 indicators that clearly demonstrate the economic and environmental inefficiency of production in Russia. The energy intensity of Russia's GDP exceeds the average level of developed countries by almost 2 times.[1] In terms of the specific resource intensity of industry, showing the amount of resources used for the production of the final product unit, Russia exceeds them by 2–5 times (Gladkevich, 2016). The main reasons for this are the predominance in the structure of industrial production of resource- and energy-intensive industries associated with the extraction and primary processing of raw materials, while the share of high-tech and science-intensive industries in GDP in the 2010 s was only 19–21%, as well as obsolescence and high depreciation of fixed assets in many industries as a result of chronic investment shortages. In addition, the resource efficiency of production is negatively affected by the lack of sufficient incentives to implement rational, environmentally safe use of natural resources in the conditions of rent capitalism that has developed in Russia.

Currently, Russia has Federal law No. 488-FZ of 31 December 2014 "On industrial policy in the Russian Federation", the state program "Development of industry and increasing its competitiveness" (approved by The government of the Russian Federation on 15 April 2014), as well as a number of strategies, programs, and other strategic planning documents that determine the prospects for the development of certain industries and sectors of the economy. These documents state different measures aimed at improving the productivity and environmental safety of industrial production in Russia. The inclusion of these measures in the programs shows that the state quite objectively assesses the current negative situation. At the same time, the actual dynamics of the

[1] World Bank Open Data, available at: https://data.worldbank.org/indicator/EG.GDP.PUSE.KO.PP.KD?view=chart (accessed 25 August 2020).

indicators of the development of industries supported by the state indicates the low efficiency of the current measures, which do not have a noticeable effect on investment activity and the technological competitiveness of the industrial sector (Bulatov [Ed.], 2020).

Ambitious socio-economic goals have been set in Russia's national projects 2019–2024, which are currently the focus of the government's efforts. Measures for the development and digitalization of industry are presented in the projects "Labor Productivity and employment support", "International cooperation and export" and "Digital economy", and on environmental protection—in the project "Ecology". However, the passports of these projects do not address issues of improving the environmental friendliness of industrial activities.

An analysis of national projects, as well as existing programs and strategies for the development of manufacturing allows us to conclude that at present the state, in practical terms, does not set the task of pursuing a comprehensive GIP that takes into account the factor of transition to Industry 4.0. The documents mention measures to support the introduction of modern digital technologies to reduce the energy and resource intensity of production, but, in our opinion, they do not line up into a consistent system of actions. This conclusion is actually confirmed by the Minister of industry and trade of Russia D. Manturov. He notes that "in industrial policy, consideration of environmental restrictions is still quite fragmentary. Requirements related to environmental conservation are considered at the level of individual projects, but not strategic planning documents as a whole". The author points out the need to harmonize the approaches of industrial and environmental policy, and in fact the formation of Russia's environmental industrial policy at the strategic level (Manturov, 2018: p. 135).

An attempt to outline such a policy was made by the Russian Union of Industrialists and entrepreneurs (RSPP), which prepared a draft "Environmental industrial policy of the Russian Federation" in 2013. It focuses on possible steps to improve regulation in the field of industrial environmental relations, i.e., horizontal GIP measures. Unfortunately, this document, which contained many useful suggestions, turned out to be unclaimed. At the same time, the actual dynamics of indicators of development of industries that are the object of state support indicates the low effectiveness of existing measures that do not have a noticeable impact on investment activity and technological competitiveness of the industrial sector (Bulatov [Ed.], 2020).

In Russian economic science, interest in the problems of green, or, as it is often called, environmental industrial policy is also generally low, as evidenced by the small number of publications on this topic. We should mention among them the works (Porfiryev, 2018; Silvestrov & Zinchenko, 2017; Skobelev, 2019), which note the importance of taking into account the green factor in industrial policy, and also identify possible tasks and directions of GIP in Russia. For example (Skobelev, 2019: p. 78) identifies 2 main areas: industrial modernization, which improves resource efficiency and reduces the negative impact on the environment, and (2) return of production waste to economic circulation.

In our opinion, GIP in Russia should be systematic and cover a wide range of tasks related to improving the environmental friendliness, productivity, and competitiveness of industrial production, including: (a) supporting the modernization of traditional industries based on digital technologies that reduce the energy and resource intensity of products; (b) stimulating the development of small- and medium-sized innovative enterprises that produce green products, including from secondary raw materials, using digital technologies; (C) support R&D aimed at creating environmentally friendly and cost-effective digital technologies for industrial production and recycling.

To stimulate the processes of modernization of the mining industry, metallurgy and other traditional industries in which large Russian corporations play a leading role, horizontal policy measures aimed at creating a system of regulatory and tax incentives for more rational use of natural resources are of priority importance. As for the other two tasks, their solution will require from the state measures of targeted financial support, including the provision of significant tax incentives to investors.

The effectiveness of the GIP in Russia will critically depend on strengthening the administrative capacity of the state, which is understood as its ability to successfully pursue its policies through an effective bureaucracy that complies with established norms and rules (Knutsen, 2013). The aforementioned low efficiency of measures of traditional industrial policy in Russia is explained mainly by the weakness of such potential. As a result, Russia today is essentially an exemplary case for studying the failures of the state in the implementation of industrial policy. Insufficient competence of officials, corruption, lobbyism, inability to establish an equal productive dialogue with business—these are just some of the factors hindering the implementation of policy. Elimination or at least mitigation of their negative impact is a necessary condition for an effective GIP, as well as any other economic policy in Russia.

Conclusions

The digital revolution creates both new opportunities for improving the environment and additional environmental risks. An effective means of regulating the environmental and, at the same time, economic consequences of Industry 4.0 could be the GIP, aimed at increasing the productivity, competitiveness, and environmental friendliness of manufacturing by supporting the introduction of resource and energy-saving digital technologies. With the help of GIP tools, governments could encourage digital modernization of traditional industries, the creation of new industries that produce green products using additive technologies, and the necessary R&D.

It can be assumed that in the context of digital revolution the GIP will have a number of features. Primarily it will be focused on the management of technological change, and not on the development of individual industries, like traditional industrial policy. The high level of investment risks, environmental and information externalities arising from the financing of green technologies will require the state to apply—more actively—the measures of financial support to private investors. Along with this, the costs of implementing a horizontal green policy aimed at creating favorable conditions for digitalization and greening of production may increase. In particular, significant budgetary investments in R&D, development of information infrastructure, and training of professionals capable of working with digital technologies may be required. The projected boosting in the complexity and cost of GIP will lead to increased requirements for the quality of public policy management. The result of the GIP will largely depend on the ability of the authorities to establish cooperation with business, allowing the parties to better understand each other's needs and capabilities and on this basis to optimally design the GIP program.

Russia needs a systemic green industrial policy that would contribute to solving the accumulated problems in the field of industrial development, natural resource management, and environmental protection. In particular, state support for the introduction of modern digital technologies would reduce the resource intensity of industrial production, at the level of which Russia is far behind today. However, effective implementation of the GIP in Russia is possible only if the administrative capacity of the state is significantly strengthened.

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CHAPTER 26

Preparation of Non-financial Reporting in Modern Conditions: Formalization and Automation

Vladimir Y. Skobarev, Elena Y. Pertseva, and Timur V. Ruzmetov

Introduction

Nowadays, public non-financial reporting (reporting in the field of sustainable development) is an integral part of the best corporate practices and becoming more widespread every year. According to the Corporate Register (www.corporateregister.com), more than 10,000 reports are published annually worldwide. The number of reporting standards is also growing. In addition to the most widespread GRI Standards, the International Integrated Reporting Framework, SASB standards (United States), and the Guidance on core indicators for entity reporting on contribution toward implementation of the sustainable development goals (UNCTAD) have appeared and are gaining traction in the last decade. The Russian Federation has published a draft Government Resolution "On Approving the List of Key (Basic) Indicators of Public Non-Financial Reporting". There is increasing emphasis on climate reporting in accordance with the recommendations of CDP, CDSB, TCFD, etc.

V. Y. Skobarev (✉) · E. Y. Pertseva · T. V. Ruzmetov
Corporate Governance and Sustainability Department, FBK Grant Thornton, Moscow, Russia
e-mail: SkobarevV@fbk.ru

E. Y. Pertseva
e-mail: PertsevaE@fbk.ru

T. V. Ruzmetov
e-mail: Timur.Ruzmetov@fbk.ru

E. B. Zavyalova and E. G. Popkova, *Industry 4.0*,
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Preparing high-quality non-financial reporting is a very time-consuming process. The main problems are related to the fact that such reporting includes a large amount of heterogeneous information from many areas related to the social, environmental, and economic impact of the company. For example, information on work-related injuries, employee turnover, carbon dioxide emissions, waste generation, energy conservation, community support, industrial innovation, etc. In many of these areas, the degree of formalization of accounting processes for collecting, analyzing, consolidating data, and performing the necessary calculations is insufficient. The degree of automation of the non-financial reporting process is usually much lower than in the case of financial or tax reporting. Quality control systems for non-financial data are also less developed. Non-financial information is not often subject to internal and external audits yet. There is a lack of qualified specialists in the field of non-financial reporting. All these factors are holding back the spread of the practice of preparing non-financial reporting.

Nevertheless, pressure from various stakeholders encourages companies to prepare such reports, improve their quality, and reduce the time for their publication in relation to the end of the reporting period. Many years of experience in the development of the practice of preparing financial statements has shown that these tasks can be successfully solved by increasing the degree of automation of the relevant business processes.

We are aware of isolated attempts by Russian companies to expand the degree of automation of the process of preparing non-financial reporting beyond the use of MS Office tools. At the same time, dozens of developers around the world announced their specialized software products and positive experience of their use. What are these software products? What are their main characteristics? What factors inhibit their spread? What are the conditions for successful automation? We will try to answer these questions based on a study conducted by FBK Grant Thornton in 2020.

Methodology

Formalization as a Prerequisite for Automation

Based on many years of experience in providing assurance and consulting services in relation to non-financial reporting to the largest Russian companies, we can formulate the typical difficulties associated with the process of its preparation:

- The contour of non-financial reporting includes **many geographically distributed organizations** of various sizes and industry profiles
- **A large amount of data** on various aspects of activity is subject to consolidation
- In many aspects, **the collection and consolidation of information is done manually** (e.g., using Excel spreadsheets)

- **There is no formalization of the business process of preparing reports**, including control procedures for the preparation, collection, and data consolidation
- **There are no clear regulations regarding the content and format** of data presentation.

Automation is definitely a means of solving problems associated with the first three of the above positions. However, the lack of formalization and regulation of the business process for preparing non-financial reporting is a significant obstacle to its automation. Therefore, before deciding to start an automation project, it is advisable to objectively assess the state of affairs on these issues. If it is found unsatisfactory, then it is advisable to start by solving these problems. Below we will try to present our approach to solving them. We will call this the formalization of the business process of preparing non-financial reporting.

The main tasks of formalization are:

- Determining the timing of reports' preparation, determination of those responsible for providing information on various aspects of activities, implementation of control
- Reducing the risks of misinterpretation of information requests and providing incorrect data by developing detailed requirements for the preparation of information.

First of all, formalization should determine the forms for collecting quantitative and textual data and instructions for filling them out, taking into account the requirements of the applicable standards for the preparation of non-financial reporting (e.g., GRI standards):

- Forms for collecting quantitative data for departments of the head office and instructions for filling them out (to collect data on issues managed at the head office level, such as financial and economic data)
- Forms for collecting quantitative data for branches and subsidiaries and instructions for filling them out (for collecting data "on the ground", for example, data on environmental topics)
- Templates of forms for disclosure of quantitative data to be included in the report, and algorithms for consolidation and calculation of indicators
- Proformas for disclosure of descriptive (text) information (including requirements for disclosure of management approaches, disclosure of qualitative information on indicators).

Requirements for completing them must be defined for all forms, including:

- Responsible units
- Deadlines for preparing the form
- Conditions for preparing the form (including the need to prepare the form by a specific branch/subsidiary).

An important aspect of formalization is the definition of the roles of internal (project manager, members of the project working group, employees of the head office, branches and subsidiaries) and external (consultants, auditors) participants in the business process.

The following are the possible functions of internal participants in a business process:

<u>Project coordinator/manager:</u>

- Compilation of the report
- Interaction with external project participants.

<u>Head office department employees</u> (within the framework of functional responsibility):

- Filling out data collection forms for the level of the head office (including defining the boundaries of information disclosure by topic)
- Distribution of data collection forms to branches and subsidiaries, control of their completion and consolidation
- Preparation of quantitative and textual forms to be included in the Report
- Correction of data in the Report on the remarks of auditors.

<u>Employees of Branches and Subsidiaries:</u>

- Filling out data collection forms
- Correction of data according to comments of employees of the executive body responsible for the form and the auditor.

High-quality formalization allows you "to kill a few birds with one stone": to increase the efficiency of the existing business process for the period before its automation, to obtain its formalized description "as is" and to facilitate the process of forming technical requirements for an automated system. In fact, it is a prerequisite for automation.

The Main Characteristics of the Used Approaches to Automation:

A typical system for collecting and consolidating information for a non-financial report of a large company that already has experience in preparing is presented at Fig. 26.1.

Our vision of a target automation system for the preparation of non-financial reporting is presented at Fig. 26.2.

When choosing a software product, we suggest focusing on this scheme. When choosing such a product as the core of an automation system, many factors must be considered. For the purposes of our study of the world market of specialized software products for the preparation of non-financial reporting, we have identified a number of characteristics of software products (see below) that, based on our experience, should be taken into account by Russian companies. It should be borne in mind that the requirements for the hardware and software infrastructure of the user, which are imposed by these products (computing power, operating systems, etc.), remained outside the scope of our study.

1. **Automation capabilities of the business process of reporting:**
   - a multiuser mode
   - highlighting the individual stages of the report preparation process (opening a project, editing, approving, rejecting, completing …)
   - assignment of user roles during the preparation of the report (administrator, editor, manager …)

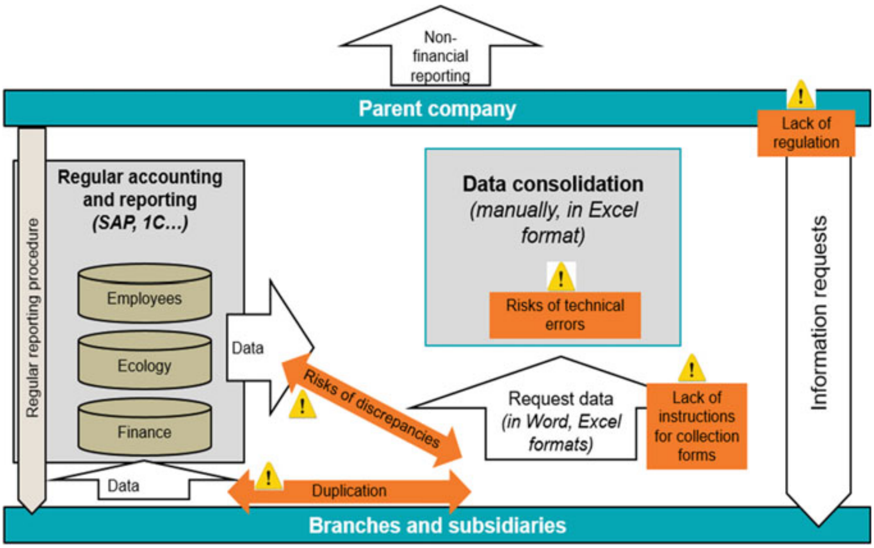

Fig. 26.1 A typical system for collecting and consolidating information for a non-financial report (*Source* Compiled by the authors)

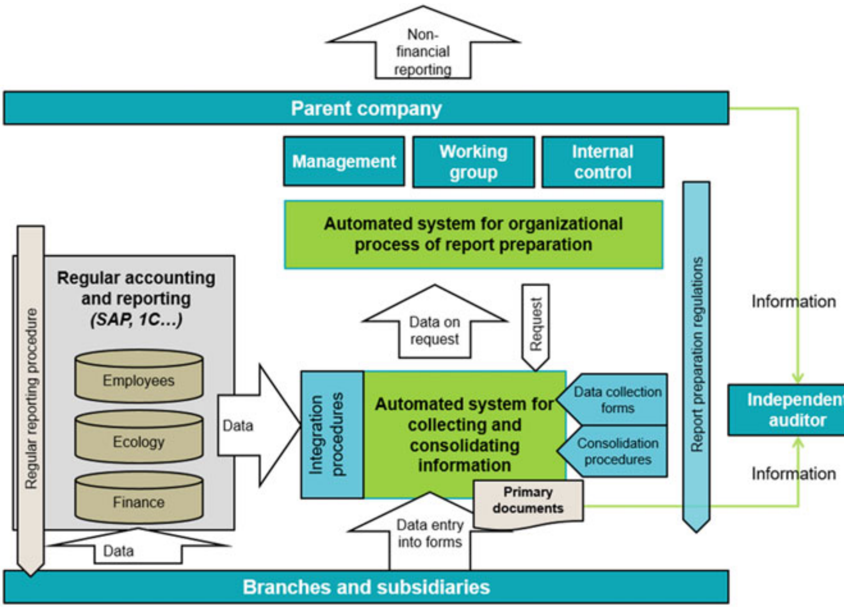

Fig. 26.2 Our vision of a target automation system for the preparation of non-financial reporting (*Source* Compiled by the authors)

- setting permissions for various types of user actions during the preparation of the report (data import, editing, approval, system settings …)
- setting access rights to information (period, report, chapter, section …)
- saving the version history of the report.

  These are the features common to software products for automating financial reporting.

2. **The allowable depth of the hierarchy of data input sources**

- one level/two levels/more than two levels in the source hierarchy.

  Sources of information are usually the division of the head office that prepares the report, the divisions of the head office that provides data on their functional areas, subsidiaries. Therefore, for large companies with an extensive structure, it is important to be able to directly enter data at all these levels.

3. **Input data**

- multidimensional (ERP, SAP BW…)
- relational (SQL Server, SAP HANA, OLE DB, ODBC…)
- flat files (MS Excel, MS Word, XML…)
- manual data entry via WEB-based interface.

  Since large companies often use a range of different products for accounting, tax and management accounting purposes, it is important to understand the capabilities of the products we analyze in terms of importing data already available in accounting systems. The possibility to enter missing data directly through the WEB interface is also useful.

4. **The possibility to import not only numeric, but also text data blocks to synchronize the presentation of homogeneous information in various types of reports (GRI, CDP...)**

   An important feature of non-financial reports is a high proportion of textual (descriptive) information, which it is desirable to unify if included in various types of non-financial reports.

5. **The availability of internal automatic controls for data entry (correct data formats, automatic verification of the equality of the sum to the sum of its components, etc.)**

- in case of flat files/in case of manual data entry

   The presence of customizable control functions allows you to reduce the number of input errors and thereby improve the quality and shorten the time for preparing reports.

6. **Automation of data consolidation processes from various sources and calculation functions**

- is provided directly in this software product without the need for improvement
- can be implemented by pairing with another software product (e.g., SAP DM-SAP BW)
- is a manual process (including via Excel).

   The weak points of the "manual" process of preparing non-financial reports are the consolidation of data from various sources in the structure of the company and the performance of specialized calculations to present information in accordance with the used reporting standards. Therefore, it is important to understand the capabilities of the software product on these issues.

7. **Format for reporting the result**

- in free text format
- standard settings (GRI, CDP, DJSI, SASB, UN GC...)
- creation/adjustment of settings (including the creating a report according to user standards)
- XBRL
- WEB

   An important factor for making a decision on the use of software products is their ability to present a report in various formats. These formats can be provided in the basic versions, or customized by the supplier or customer.

8. **Availability of visualization tools**

   A number of products offer convenient visualization tools for reporting information.

9. **Audit trail:**

- throughout the hierarchy of data collection/only at consolidation level/ no audit trail

The ability to trace the entire chain from the primary document to the reporting form and vice versa helps to improve the quality of reporting information.

10. **Availability of means to support the process of identifying material topics for disclosure**

    The material topics identification process is key in the reporting process for a number of standards (e.g., GRI Standards). However, in practice, this process is often not sufficiently substantiated and formalized. Therefore, the availability of tools to support this process in the software product will be useful (especially for companies starting their practice of preparing non-financial reporting).
11. **Estimated implementation period:**

    From a practical point of view, this is one of the most important issues. It should be borne in mind that, depending on the delivery set, the implementation time may vary significantly for the same product.
12. **The possibility of sales to Russia:**

    This point is undoubtedly important for Russian companies.
13. **The cost of the software product**
14. **The cost of the implementation services.**

Results

Analysis of Existing Products Based on Criteria

The object of the study was software products for automating the preparation of non-financial reporting, which the authors of the study have experience with (SAP DM (Germany), GRI Digital Reporting Tool (Netherlands)), as well as those whose developers completed the questionnaire formed on the basis of the above characteristics. This questionnaire was sent to 29 companies from around the world, including the 12 most significant ones according to the Valente and Murphy (2020) research. Completed questionnaires were obtained from nine (official sites of companies are listed below in References):

- ProcessMAP Corporation (United States)/ProcessMAP EHS&S Suite (ProcessMAP, 2020)
- IsoMetrix (United States)/IsoMetrix (IsoMetrix, 2020)
- Sphera Solutions (United States)/Corporate Sustainability Reporting (thinkstep (Sphera Solutions), 2020)
- Nasdaq (United States) / OneReport (OneReport (Nasdaq), 2020)
- WeSustain GmbH (Germany)/Enterprise Sustainability Management (ESM) Software & ESG Management Software (WeSustain GmbH, 2020)
- Worldfavor AB (Sweden)/Worldfavor Sustainability Management (Worldfavor AB, 2020)
- Accuvio (UK)/Accuvio Author (Accuvio, 2020)

- Gensuite, LLC (United States)/Gensuite, LLC (Gensuite, 2020)
- UL (United States)/UL 360 (UL, 2020).

It should be noted that the authors did not have the opportunity to verify the quality of the answers to the questionnaire questions.

Thus, the characteristics of 11 software products were analyzed. Some respondents did not answer all the questions posed.

As can be seen from the Fig. 26.3, the vast majority of the reviewed software products have the required characteristics. The relatively weak points in this sample are the availability of internal automatic controls, automation of data consolidation processes and calculation functions, and availability of means to support the process of identifying material topics for disclosure. It should also be borne in mind that the basic versions of these products are usually not Russified. In terms of the implementation timeline, a number of respondents noted their dependence on the supplied functionality and indicated more than one possible interval. Suppliers offer different schemes for the use of their products (purchase and rent). The cost also varies depending on the functionality and can be quite significant even for a large user company.

Conclusions

Despite the fact that the process of preparing non-financial reporting, as noted earlier, is complex (affecting many functions) and not standardized (requiring adaptation for each specific organization), there are software solutions on the market that allow companies to automate the reporting process (or at least its separate components). Our analysis has shown that software products for supporting the process of preparing non-financial reporting on the market meet most of the requirements necessary, in our opinion, to improve the efficiency of this process and the quality of reporting. The availability of such software products allows companies not to invent automated systems from scratch, but to use existing proven solutions.

At the same time, in any case, the first step toward the efficient use of automated systems is the formalization of the preparation of non-financial reporting in order to build orderly and formalized processes in the organization. A well-conducted formalization is also a necessary basis if a decision is made to independently develop a system for automating the preparation of non-financial reporting based on universal accounting and reporting systems (e.g., 1C).

The software product profile	Matches
1. Automation capabilities of the business process of reporting	
A multiuser mode	10
Highlighting the individual stages of the report	9
Assignment of user roles during the preparation of the report	9
Setting permissions for various types of user actions during the preparation of the report	10
Setting access rights to information	9
Saving the version history of the report	9
2. The allowable depth of the hierarchy of data input sources (10 replies)	
One level	1
Two levels	2
More than two levels in the source hierarchy	7
3. Input data	
Multidimensional	8
Relational	7
Flat files	9
Manual data entry via WEB-based interface	10
4. The possibility to import not only numeric, but also text data blocks to synchronize the presentation of homogeneous information in various types of reports	9
5. The availability of internal automatic controls for data entry (10 replies)	
In case of flat files	6
In case of manual data entry	8
6. Automation of data consolidation processes from various sources and calculation functions (10 replies)	
Is provided directly in this software product without the need for	7

Fig. 26.3 Summary information in terms of characteristics (*Source* Compiled by the authors based on survey, as well as on GRI's digital reporting tool [2020] and SAP Disclosure Management [2020])

The software product profile	**Matches**
improvement	
Can be implemented by pairing with another software product	7
Is a manual process	8
7. Format for reporting the result	
In free text format	8
Standard settings	9
Creation/adjustment of settings	8
Supplier customization	2
Client customization	8
XBRL	2
WEB	7
8. Availability of visualization tools (10 replies)	8
9. Audit trail (10 replies)	
Throughout the hierarchy of data collection	9
Only at consolidation level	-
No audit trail	1
10. Availability of means to support the process of identifying material topics for disclosure	7
11. Estimated implementation period (10 replies)	
Up to 3 month	9
From 3 to 6 months	5
From 6 to 12 months	4
More than 12 months	-
12. The possibility of sales to Russia (10 replies)	10
13. The cost of the software product (thousand USD) **(7 replies)**	
For free	1
Minimum purchase cost:	
3,25	1

Fig. 26.3 (continued)

The software product profile	Matches
15	1
20	1
40	1
Minimum annual rental cost:	
15	2
100	1
Maximum purchase cost:	
40	1
200	1
>1000	1
Maximum annual rental cost:	
60	1
500	1
14. The cost of the implementation services (thousand USD) **(7 replies)**	
<=10	2
>10, but <=50	2
150	1
0	2

Fig. 26.3 (continued)

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CHAPTER 27

Economic and Institutional Aspects of Environmental Protection

Egor A. Vasyunin, Arthur A. Dmitriev, and Inna V. Lipatova

Introduction

Aspects of environmental pollution are mainly regulated by administrative means, which, in our opinion, are ineffective. In the context of the development of the modern economy, it is advisable to talk about an environmental tax. The concept of environmental tax is the formation of tax revenues in both the federal and regional and local budgets. An environmental tax will replace current payments for various types of environmental impacts.

The function of nature has always been to provide natural resources for economic activity and absorb industrial and consumer waste. But for a long time we used the concept of "unlimited resources", of which there are many, and therefore they have no price. On the other hand, nature was attributed the ability to accept an unlimited amount of waste, and therefore there were no economic problems in using soil, water, and air for waste disposal.

E. A. Vasyunin (✉) · A. A. Dmitriev · I. V. Lipatova
Financial University Under the Government of the Russian Federation, Moscow, Russia

I. V. Lipatova
e-mail: ILipatova@fa.ru

E. B. Zavyalova and E. G. Popkova, *Industry 4.0*,
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Methodology

After the report "The Limits to Growth" was presented for the Club of Rome, the world community realized that natural resources are limited, and if the level of consumption remains significant in most areas, all these resources will soon be exhausted. In 1992 this report was updated.

All over the world we see the destruction of nature. Every second we lose 3,000 km^2 of wood and 1,000 tons of natural soil (Laszlo, 1991). Half of the total cut down forest died in 1950–1990. In almost all parts of the world, wood consumption exceeds several times its amount equal to annual natural growth. Forests have a beneficial effect on the climate, retaining water and restraining the effect of the greenhouse, and deforestation is dangerous because it causes air pollution and acid rain. Figure 27.1 shows data on the number of deforestation in hectares.

From 1860 to 1985, energy consumption increased 60 times. Most of the energy is consumed by industrial countries. Europeans consume 10–30 times, North Americans consume 40 times more commercial energy than third world countries. Natural gas resources, which have a less harmful effect on the environment compared to other types of fossil fuels, will remain for 240 years if annual consumption remains at the same level as in 1990 (taking into account open gas fields). If consumption grows to 3.15% per year, as it was before, gas will last only until 2054. If coal and oil are replaced by gas faster than before, gas resources are expected to be exhausted within 50 years. All this can even happen if the exploration of new gas fields allows to increase the volume of known resources by 4 times (Third World Resurgence, 1997). Figure 27.2 shows data on world energy consumption by sector.

At present, radioactive and chemical agents are the most difficult to produce among industrial wastes along with substances of global exposure, such as gases, which cause a "greenhouse effect". There are very few natural organisms that can be processed into non-hazardous substances. Today, about 65,000 types of synthetic substances are sold, and only 1% of them are tested for toxicity. And only 20% of 3–5 newly created compounds are studied in terms

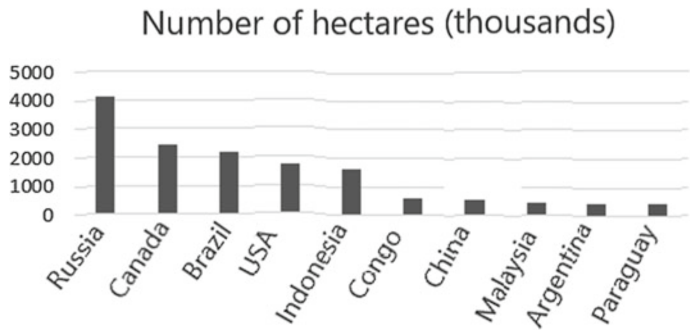

Fig. 27.1 Area of deforestation (*Source* compiled by the authors)

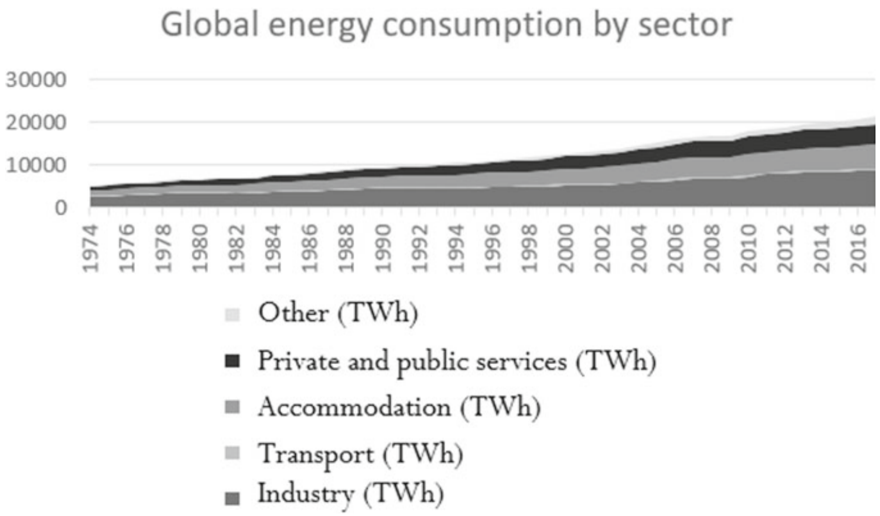

Fig. 27.2 World energy consumption by sector (*Source* International energy agency, official site https://www.iea.org/statistics/electricity/)

of their possible toxicity, while the community is aware of environmental issues. 90% of such industrial waste comes from industrialized countries that transfer environmentally hazardous production to third world countries where industrial waste is also transported (Meadows & Randers, 1992).

How can the economy counteract these trends? The answer lies in the current economic order. In a market economy based on numerous independent organizations and enterprises, the latter act on the basis of the need to obtain growing profits—as the difference between sales results and expenses.

However, air pollution resulting from industrial activities and forest destruction is not considered the expense of one enterprise. Countermeasures are considered the task of the whole society; the state, as a rule, is forced to bear the necessary expenses. In this regard, the theory speaks of an external negative impact, social costs, which are not taken into account in the calculation of this enterprise.

The first answer to this fundamental problem associated with costing was to postulate the so-called compiler principle. Where possible, the perpetrator of social costs should be identified and held accountable. This leads to the internalization of the external effect by imposing responsibility for bearing material costs on the initiator.

The boundary of the application of this principle lies where it is technically impossible to identify the undeniable author. In this case, the principle of social responsibility is applied, that is, the entire community assumes responsibility for all consequences. Air and water pollution is usually cumulative, and the "fault" of a particular organization cannot be established. The border, however, also lies in the economic zone, because if organizations are forced to finance environmental measures, they may be on the verge of economic inability.

Results

Environmental issues pose certain challenges to organizations with private property. On the one hand, state rules force entrepreneurs to take some measures or circumvent some steps aimed at protecting the environment. However, compliance with the rules as such is not the goal of organizations. We can talk about the environmental goals of organizations when they, on their own initiative, declare that environmental protection is their goal, recognizing their environmental responsibility. The goals can be realized in special measures, such as: checking the composition of the material in the purchased raw materials; the use of environmentally harmful substances and their replacement with environmentally friendly materials; control and modernization of production processes in terms of energy consumption, harmful substances, and industrial waste; the possibility of recycling products; refusal to use excessive packaging to reduce waste, etc.

Thus, the problem of environmental protection provides the basis for the introduction of environmental policy, the main criteria of which are formulated by the Swiss economist Bruno S. Frey (1985): efficiency, fair distribution, and consequences for public finances. Other criteria are the reliability of information about the causes and effects, the duration of the activity until the moment of exposure, moral aspects related to the willingness of the community to take environmental measures and, of course, the interests of all interested parties. Based on these criteria, the following environmental policy tools are recognized: (1) Convincing the need for voluntary action; (2) Public quantitative indicators; (3) Environmental taxes; (4) Grants; (5) Market relations in the implementation of environmental certificates.

Currently, the problem of environmental pollution is especially relevant in Russia. Therefore, the study of measures taken by leading industrialized countries to protect the air environment is of practical interest. Also significant is the problem of more effective application of the current legislation of the Russian Federation.

Today, this situation can be explained (but not justified) by the economic crisis. The priorities are such that very few funds are allocated for environmental programs, and they require huge investments. That is what limits the application of effective measures of foreign countries. Moreover, even existing laws are not respected. There is an urgent need to tighten control over compliance with existing standards for air and water.

Environmental standards exist in accordance with the law. This is a system of environmental standards. The main indicators used to control water and air quality are the maximum level of pollution (MCL), the concentration of a specific chemical that does not cause pathological changes or diseases in humans, and the degradation of natural ecosystems if exposure occurs every day for a long time. period of time. MCL in the Russian Federation is quite strict and can be compared with world ones. Although in many regions and waters they are not observed, which is an indicator of pollution and environmental degradation. At the same time, in 103 cities with a population of 50 billion people, MCL in the air exceeds more than 10 times.

Worldwide harmful emissions amount to 1 or 3 billion tons per year, most of which are in highly developed countries located in the central part of the northern hemisphere.

There are more than 24,000 enterprises in Russia that dispose of hazardous waste in air and water. 33% of emissions are from metallurgy enterprises, 29%—from energy enterprises, 7%—from the chemical industry, and 8%—from coal mining. More than half of all air emissions are from transport.

Specialists have long considered the demographic situation in Russia "catastrophic". The pollution of air and water by industrial enterprises is so deep and harmful to the environment that it is one of the most powerful negative factors affecting humans. Studies prove that in Russia only 10% of school graduates are healthy. Over the past decade, the number of healthy girls graduating from schools has decreased from 28.3 to 6.3%, that is, more than 3 times. Life expectancy in Russia is 69 years; it is 8–10 years less than in 44 capitalist countries.

Conclusion

All these data on the nature and state of human health eloquently confirm the undeniable links between the destruction of ecological systems and negative changes in the human gene pool. Under the influence of harmful substances from birth to old age, most people lose their health and shorten their lives. This leads to a decrease in labor productivity and an annual increase in medical services. That is why economic measures along with administrative actions can become an effective means of protecting the environment.

It is believed that the unfavorable environmental situation in Russia is due to the following reasons: (1) Property monopoly on natural resources and means of production, which deprived producers of incentives to protect the environment and brought state control over environmental protection to formalities; (2) The predominance of the military industry, which squeezed the octopus throughout the country and consumed all the funds allocated for environmental protection, modernization of technologies and restoration of production assets, which are on average 40–60% worn out; (3) The prevalence of consumer psychology and the belief that Russia's natural resources are endless and inexhaustible, poor environmental culture of the society, and lack of environmental education (Legislation & Economics, 1992).

But one cannot agree with such an explanation of environmental reasons. Even when the means of production were privately owned, acid rain destroyed everything in hundreds of Canadian lakes. When natural resources and means of production were state-owned, it was impossible to go unpunished for stopping or not fulfilling planned targets. At the same time, the state did not care about environmental protection.

The main reason for the destruction of the environment is the poor ecological culture of society, lack of awareness of the environmental consequences and neglect of the state toward nature, as well as legislative deficiencies. Although this was not enough, there were centralized capital investments in environmental measures. The draft State Ecological Program provides for the following measures to prevent environmental degradation and its improvement: reconstruction of worn-out facilities, introduction of the latest technologies and efficient designs of oil refineries, etc.

Aspects of environmental pollution are mainly regulated by administrative means, which, in our opinion, are ineffective. In the context of the development of the modern economy, it is advisable to talk about an environmental tax. The concept of environmental tax is the formation of tax revenues to the budgets of all levels of the budget classification. The environmental tax will replace current payments for various types of harmful environmental impacts, which will contribute to the implementation of the effectiveness of tax administration.

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CHAPTER 28

PPP as a Tool to Achieve Sustainable Development Goals and Implement the Concept of "Quality Infrastructure Investments"

Oleg V. Ivanov and Ellina A. Shamanina

Introduction

Infrastructure is an important component of economy. It makes a huge contribution to the production of goods and services, directly affects the quality of people's life, determines the level of development of society, and helps to ensure more sustainable, comprehensive growth.

The importance of infrastructure and its multiple impact on economic activity and people's lives are reflected in the 2015 United Nations Sustainable Development Goals adopted at the 2015 UN summit—the global agenda until 2030 aimed at solving global problems facing humanity. One of the goals explicitly provides for "creating sustainable infrastructure", in addition, many of the agenda goals are directly related to infrastructure development and investments, including ensuring and rational use of water resources and sanitation, ensuring access to modern energy sources, ensuring food security, healthy lifestyle, openness, safety and sustainability of cities and towns, etc. (United Nations, 2015; UN, 2015, 2016).

The Addis Ababa Action Agenda, adopted at the Third International Conference on Financing for Development (United Nations, 2020), notes that "both public and private investment play a key role in financing infrastructure, including through public-private partnership". The program emphasizes the need to "build capacity to enter into public-private partnerships, including with respect to planning, contracting, management, accounting and budgeting

O. V. Ivanov (✉) · E. A. Shamanina
Moscow State Institute of International Relations of the Ministry of Foreign Affairs of the Russian Federation, Moscow, Russia

E. B. Zavyalova and E. G. Popkova, *Industry 4.0*,
https://doi.org/10.1007/978-3-030-75405-1_28

for contingent liabilities", and the need to "share risks and rewards equitably, include clear accountability mechanisms, and comply with social and environmental standards" (United Nations, 2020; UN, 2015, 2016).

Russia is a country with a large territory, located between the centers of economic development in Western Europe and Southeast Asia. The construction and modernization of infrastructure, including the use of public-private partnership mechanisms, as a tool for ensuring connectivity and balanced economic growth of its regions, plays an important role in achieving sustainable development goals.

However, today the state of infrastructure in Russia, despite the positive shifts of recent times, leaves much to be desired. According to the Global Competitiveness Index, calculated by the World Economic Forum, Russia has made significant progress in terms of infrastructure quality and is ranked 50th in the world, although 4–5 years ago it was only 100th. Nevertheless, in many important components—quality of the road infrastructure, density of the railway infrastructure, efficiency of the air transport infrastructure, quality of electricity supply, etc., it is much inferior to the leading countries of the world (World Economic Forum, 2019). The general deficit of infrastructure in Russia and the high wear and tear of the existing one are a phenomenon of the domestic economy, generally recognized by economists and acutely felt by business and the population. Infrastructure provision in Russia is insufficient, being at the level of developing countries.

The purpose of the article is to study ways to improve the infrastructure complex through the prism of opportunities provided by the use of public-private partnership mechanisms.

World experience convincingly shows that public-private partnership can be an effective tool for infrastructure development and economic modernization. Institutional and legal conditions for development of PPPs have developed in Russia, and a certain experience has been accumulated in the implementation of PPP projects. At the same time, it seems that recently, due to a number of reasons, the use of PPPs is being "put on pause" by the government. In order for the PPP institute in the country to work in full force and become an effective leverage for modernizing infrastructure and achieving sustainable development goals, it is desirable to solve a set of tasks recommended by the authors. These tasks have both theoretical and practical dimensions: On the one hand, they are designed to facilitate the search for optimal forms of interaction between the state and business on the path to achieving sustainable development goals, on the other hand, to help improve the effectiveness of specific mechanisms for development of the infrastructure complex and ensure economic and social growth of the regions.

Methodology

In recent years, the concepts of "sustainable infrastructure" and "quality infrastructure investments" have become increasingly widespread in economic science and practice.

Sustainable infrastructure refers to "infrastructure projects that are planned, designed, built, operated and decommissioned in a way to ensure economic and financial, social, environmental (including climate resilience) and institutional sustainability throughout the project life cycle". Infrastructure resilience also includes such an important element as climate change, assessed in terms of greenhouse gas emission reduction, climate risks and disaster risk management. In addition, it is understood that infrastructure projects must comply with both national and international commitments, in particular, serve as a tool to achieve the SDGs and the goals of the Paris Agreement to limit global warming (Amin et al., 2019).

Numerous studies (Bhattacharya et al., 2019a; Donaldson, 2010; Dinkelman, 2011; Ncube, 2013; Straub, 2008; Nicolas et al., 2019; Dobbs et al., 2013; Inderst, 2016) confirm that increasing investment in infrastructure is important not only for the infrastructure itself, but also has a powerful multiplier effect—it contributes to jobs increase, improves quality of life, leads to increase in incomes and stimulates consumption, which is one of the main factors of economic growth. Investments in environmentally sensitive infrastructure help preserve natural environment by preventing negative impacts on biodiversity and ecosystems, reducing greenhouse gas emissions and pollution, increasing resilience to climate change and ensuring efficient use of resources.

The concept of "quality infrastructure investment", initiated by Japan in 2015, is increasingly being developed and promoted by G20. In 2016, based on the Principles for promoting investment in quality infrastructure (G7, 2016), adopted in the same year by G7, the Goals for improving the quality of infrastructure were agreed (G7, 2016). In 2018, the Roadmap for the development of infrastructure as a separate class of investment assets was adopted. In 2019, the Principles for investment in quality infrastructure were agreed, which included increasing the positive impact of infrastructure on achieving the goals of sustainable development and growth of the national economy, increasing the economic efficiency of infrastructure projects throughout the entire life cycle, integrating social and environmental aspects into infrastructure investments, resilience to natural disasters, emergencies and other risks, improving the quality of infrastructure management (G20, 2019).

Although the concepts of sustainable infrastructure and quality infrastructure investments differ significantly from each other, they are not contradictory, but rather complementary. Sustainable infrastructure is anchored in the Agenda-2030 and the Paris Agreement to limit global warming. The drive to build quality infrastructure is tied to the recognition of importance of high-quality investment and cost-effectiveness throughout the project lifecycle, as well as adherence to strict environmental and social standards. Both concepts build on traditional criteria for sustainable development—economic, environmental and social, both focus on issues of governance, sustainability and life cycle cost.

However, despite the general understanding of the importance of infrastructure development for ensuring economic development and improving the quality of life, as well as a significant increase in infrastructure spending, there is still a significant shortage of funds allocated for infrastructure development in the world, the so-called "infrastructure gaps" problem is acute. "Infrastructure gap", as defined by the UN Economic and Social Council, means "the excess of demand for infrastructure to support increased production and consumption over supply" (UN ESCAP, 2011). According to the estimates of Oxford Economics and Global Infrastructure Hub, the infrastructure gap for the period 2021–2040 is no less than $15 trillion. In 2020 alone, the global infrastructure investment shortfall will exceed $500 billion. Infrastructure gaps will continue to take place on all continents—in Asia, North and South America, Europe and Africa (Oxford Economics and Global Infrastructure Hub, 2020; ADB, 2017; ADB, 2018).

G20 expert researchers in their approaches to infrastructure problems believe that equal emphasis should be placed on the importance of eliminating infrastructure financing gaps and ensuring quality infrastructure investment (Runde, 2019; Sawada et al., 2019; Yoshino et al., 2019, Chua et al., 2014, etc.). Expert community is practically unanimous in the opinion that further infrastructure development and elimination of emerging or existing infrastructure gaps are impossible through state financing channels alone, and the involvement of the private sector is imperative to address the gap. Addis Ababa Action Agenda as well as G7 (2016), and G20 leading experts (Sawada et al., 2019) see an effective tool for helping to solve global infrastructure problems in expanding the use of public-private partnership mechanisms.

World theory and practice convincingly testify that public-private partnership can bring tangible benefits to all parties involved in it (Gerrard, 2011; Grimsey & Lewis, 2004; Ivanov, 2016, etc.). An objective analysis, however, requires admitting that the PPP phenomenon is ambiguous and so far the academic community has not developed a single point of view on this institution. PPP, possessing a significant number of different advantages, is not free from a number of systemic problems that are significant for objective understanding of this institute (Heinz, 2006; Linder, 1999; Tetřevová, 2006; Whitfield, 2010, etc.). Among the researchers, there are even those who see "the fundamental incompatibility of corporate interests with solving environmental problems and ensuring universal access to quality public services" (Hall, 2015). Nevertheless, in the global political and academic environment prevails the view about the possibility and feasibility of using PPP mechanisms to solve the problems of sustainable development, including through the implementation of the concept of "blended finance", which implies joining the efforts of the public and private sectors in financing infrastructure projects (OECD, 2018a, b; OECD and WEF, 2015; UN, 2014; OECD, the World

Bank and UN Environment, 2018, others). In this context, there is a wide range of recommendations, designed to increase the effects of attracting private potential into infrastructure to ensure sustainable development goals, to enhance the synergy of combining efforts of the state-business tandem. The main tracks of work are the following:

- Formation of a solid institutional framework to ensure sustainable infrastructure. The solution to this problem includes development of infrastructure policy, including PPP policy, formulation of spatial development strategies, development of investment plans specifying clear targets, prioritization of infrastructure projects (Bhattacharya et al., 2019b);
- expanding private financing of infrastructure. In recent decades, PPPs have experienced a renaissance in international political discourse, and many countries and organizations have become convinced of their potential to improve efficiency of public service delivery. In this context, PPPs can help fill the funding gap and become an innovative tool for infrastructure development. The success of this approach depends on how governments can provide a solid regulatory framework for PPPs, unify procurement and tendering procedures, streamline project selection, establish PPP units, ensure quality PPP project preparation, attract qualified private partners (Sawada et al., 2019);
- an important component of international efforts should be the development of a common methodological platform—reaching agreements on a common understanding of the concepts of sustainable infrastructure and quality infrastructure investments, public-private partnerships, further work on the development of international guidelines for PPP, gradual convergence, and—in the future—unification of approaches to infrastructure as a class of investment assets, including standardization of tools and mechanisms for assessing sustainability of infrastructure projects in world practice (Runde, 2019).

Results

Assessments of Russian infrastructure by Russian researchers correlate with evaluations of international experts: Russian infrastructure has been in dire need of investment for decades, and current investments do not cover the minimum needs. The unsatisfactory state of infrastructure in Russia covers all sectors and is typical for all regions (InfraONE, 2019). Direct consequence of this situation is the presence of serious infrastructure gaps. The total unmet need of Russia in infrastructure investments in 2019 was estimated at 1.6% of GDP, by industry—in transport—950 billion rubles, housing and communal services—300 billion rubles, social sphere—200 billion rubles (PPP National Development Center, 2018).

One of the main ways to address the problem of infrastructure gaps and promote sustainable development could be the use of PPP mechanisms. During the past decade, PPP market in Russia has transformed from a fragmented set of individual projects to a single integrated market with well-established rules of the game, wide industry coverage, and a large number of participants. The number of PPP projects has grown by more than 10 times and now totals more than 3.600, the volume of private investment obligations under PPP projects increased 2.5 times and reached 2.8 trillion rubles (ROSINFRA and PPP Development Center, 2019). The geography of partnership has expanded—PPP projects are currently being implemented in the vast majority of Russian constituent entities of the Federation. The sectoral spectrum of the use of PPP mechanisms is becoming more and more diverse: along with the traditional spheres—road infrastructure, utilities, energy, the practice of using PPP mechanisms has expanded to the industrial, agricultural, and IT infrastructure, has become entrenched in the sectors of public transport, railway transport, port infrastructure, social sphere (health care, education, social protection). The regulatory, organizational and institutional framework, PPP both at the federal and regional levels, has been significantly strengthened.

At the same time, one should not overestimate the place and role of PPP in the development of the country's infrastructure as well as its impact on the macroeconomics and contribution to sustainable development. Russia still lags significantly behind many "PPP-mature" countries in terms of PPP's share in GDP, in terms of capital expenditures of PPP projects per capita, etc. (PPP National Development Center, 2018; ROSINFRA and PPP Development Center, 2019).

Analysis of the PPP state policy and practical steps of the federal and regional authorities suggests that the approaches of the Russian authorities at different levels to the development of the infrastructure complex as a whole are in line with the recommendations of the international expert community on laying a systemic basis for it in order to ensure sustainable development.

Public governance began to include strategic goal setting and long-term planning of infrastructure development. Recently, a number of important state strategic planning documents have been adopted. In 2019, the government approved the "Strategy for the Spatial Development of the Russian Federation for the Period up to 2025"—a strategic planning document defining the priorities, goals and objectives of regional development of Russia. The Comprehensive Plan for the Modernization and Expansion of the Trunk Infrastructure until 2024, adopted by the government in 2018, is of great importance from the point of view of the formation of specific plans for the long-term development of the country's infrastructure. The total cost of the plan is estimated at 6.3 trillion rubles, 3 trillion of which will come from the federal budget, the rest will be financed from extra-budgetary sources.

In recent years, the legal framework for PPPs in Russia has been significantly strengthened. The Federal Law "On public-private partnership, municipal-private partnership in the Russian Federation" (224-FZ) came into force. The Federal Law on Concession Agreements (115-FZ) has undergone a significant adjustment. Numerous amendments to it convinced private investors of the expedience of concessions, as well as of the legal protection of their rights.

This was reflected in the explosive growth in the number of concessions in the country, especially in communal services.

The government takes efforts to ensure development of PPPs in Russian regions. In this regard, the state uses both administrative measures and economic incentives. The government approved the indicator "The level of PPP development in the constituent entity of the Russian Federation". The integrated indicator of PPP level in the regions is calculated based on three groups of indicators: institutional environment—creating conditions for successful launch and implementation of PPP projects (availability of qualified specialists, authorized bodies, institutions for PPP development, PPP information resource on the Internet, etc.); regulatory and legal framework—adopted regulatory legal acts regulating the interaction of government bodies in the launch and implementation of PPP projects, as well as regulating the use of PPP mechanisms; implementation of PPP projects—experience in the implementation of PPP projects.

The establishment of PPP units contributes to an increase in the efficiency of public governance of PPP. Along with the Ministry of Economic Development, special PPP units have also been created in the ministries of transport, health, construction and housing, and communal services.

A special role in promoting concept of PPP belongs to development institutions, primarily the National PPP Center and the state corporation Vnesheconombank (VEB.RF). In order to promote the development of PPP, federal authorities try to provide regions with a variety of support—financial, informational, educational.

Since 2018 the state corporation Vnesheconombank (VEB.RF) launched a new instrument of financial assistance for implementation of PPP projects—the "Project Financing Factory". The factory is a mechanism for project financing of investment projects in priority sectors of the Russian economy on the basis of syndicated loan agreements, implemented with the use of government support measures. The sphere of interests of the Factory includes infrastructure projects in transport, energy, and telecommunications sectors.

State information support is an important factor in successful application of PPPs in the regions. Within the framework of cooperation between the National PPP Center, VEB.RF and Ministry of Economic Development of the Russian Federation, ROSINFRA Infrastructure Projects Support Platform, designed to provide market participants with up-to-date information on infrastructure projects implemented on the basis of PPP in the constituent entities of the Russian Federation, was created. The key service of the platform is the assistance to find potential partners for implementation of infrastructure projects (ROSINFRA).

Educational support is also an important long-term tool for promoting PPPs in the regions. A significant contribution in this direction is made by PPP Institute, established by the National PPP Center. The Institute conducts a variety of professional development programs for employees of regional and municipal administrations. The programs are aimed both at developing students' basic competencies on PPP and at acquiring knowledge, skills and abilities necessary for solving practical problems facing public customers: preparing a feasibility study for a project, organizing and conducting a competitive procedure, support project at the stages of commercial and financial closure, etc. (Ivanov et al., 2018).

The sectoral spectrum of application of PPP mechanisms has significantly expanded during the past decade: Today, it covers today both traditional industries and sectors (housing and communal services, transport, energy) and the social sphere (health care, education, sports, culture, social security). In recent years, as a result of changes in legislation, new areas of PPP application have emerged—information technologies, new segments of traditional industries (airport infrastructure, seaports, weight, and dimensional control system, high-tech medicine, etc.).

The forms of implementing PPP projects are becoming more and more diverse. Along with the "classical" concessions and PPP agreements, new forms such as life cycle contracts, leases with investment obligations, long-term investment contracts, and "corporative PPP" are widely used. In 2018, the first offset contracts for the localization of high-tech production of medicines were launched in Moscow.

Conclusions

– The institute of PPP, on which expectations in the context of the Agenda-2030 implementation and the achievement of SDG are placed, is not unambiguous. With all its advantages and benefits, PPP mechanism is not a panacea that can cure a sick infrastructure from all diseases. The PPP institute is not free either from its inherent internal contradictions or from external factors that influence its implementation. As one of the leading PPP theoreticians, E. Yescomb noted, "all the pros and cons in the case of PPP are not indisputable …" (Yescomb, 2013).

The PPP institute has a certain ambivalence—the availability of the same qualities, which are both significant advantages and significant disadvantages. PPP results, its integral characteristics will always depend both on specific conditions of the contracts and on how consistently the institutional principles of PPP are observed. Damping the negative impact of internal contradictions of the PPP institute is possible only by careful work on the terms of future agreement, the fullest possible inclusion in it of requirements, assessments and calculations reflecting public interests, transparency and accountability of the process of developing agreements.

– For decades Russian infrastructure has been in dire need of investment, and current investments do not cover the minimum needs. General state of infrastructure in the country is poor. Not a single Russian region has reached the maximum development index (10)—neither integral nor by industry. The worst developed is transport infrastructure in Russia: The average index for it is only 3.24 (hereinafter—out of a possible 10). The best sector is communal utilities and telecommunications infrastructure with 6.89 and 6.48, respectively. The minimum additional need of Russia for infrastructure investments in 2019 was estimated at 2.6 trillion rubles (InfraONE, 2019).

- The government is aware of importance and urgency of infrastructure problems in the country. In recent years, important conceptual and doctrinal documents focused on the development of infrastructure have been adopted—the Strategy for the Spatial Development of the Russian Federation for the Period up to 2025, the Comprehensive Plan for the Modernization and Expansion of the Main Infrastructure for the Period until 2024, the National Project "Safe and High-Quality Highways". Transport Strategy of the Russian Federation for the period up to 2030 is among the most important strategic documents for development of the country's infrastructure.
- The introduction of planning in development of infrastructure in Russia is undoubtedly a positive phenomenon. At the same time, it is necessary to realize that this is only the first step in the right direction. The Russian comprehensive plan is still a rather raw and vague document. The content of the plan and the logic of its filling are still very opaque. Many positions in the plan are described in a framework, and there is still no publicly available data on the list of projects, as well as information on the process of evaluating, ranking and selecting a project for the plan. In most cases, it does not include specific projects, but directions for financing. Many projects included in the plan are not new, most of them are taken from long-standing strategic planning documents.
- The trend toward serious infrastructural changes in Russia has not yet become sustainable. This, in our opinion, reflects the sentiment of private players, who are in a "standby mode" as the authorities' plans for projects with the expected participation of extra-budgetary funds remain unclear. There is still an "arrhythmia" in the development of budget funds, funding from the federal budget is being mastered with a delay. A significant amount of budgetary funds allocated for infrastructure development is spent inefficiently. Private investors are in no hurry to invest. They are waiting for clarity from the state on the projects that it plans to launch (InfraONE, 2020).
- Additional uncertainty in the prospects for development of the infrastructure sector is brought by the pandemic: A strong blow has been struck on the upcoming and launched projects. According to the estimates of the National PPP Center, the PPP market has been thrown back to the ten-years-ago level. Among the industries, most affected are social and

household services, health care, culture, leisure, tourism, physical education and sports, urban transport and transport infrastructure in cities. Due to the pandemic and the decline in oil prices, the federal budget was cut by 10%, the government intends to cut by almost 600 billion rubles expenses for the coming two years for a number of national projects, including Comprehensive plan for the modernization and expansion of the core infrastructure.

Foreign experience however shows that many countries in crisis times focus on accelerated development of public infrastructure, using both budget and private investments. To obtain additional financial resources, national debt is often increased, reserves are unpacked, and business funds are attracted on the principles of public-private partnership (PPP). And this, as practice shows, not only does not worsen the state of the economy, but, on the contrary, helps to move faster from recession to growth.

- Recently, there have been signs of some decrease in government enthusiasm for PPP. This was manifested in the halfway abandonment of the Roadmap for the development of PPP mechanisms adopted by the government in 2018, the lack of any clarity about the place and role of PPP in implementation of the Comprehensive plan for modernization and expansion of the core infrastructure, etc. The emerging turn in the government's economic policy toward PPP did not go unnoticed by Russian business either. As the chairman of the board of one of the backbone Russian banks—VTB bank A. Kostin noted, "it would be a big mistake if we fail to resume and even activate PPP" (ROSINFRA, 09 September 2020).
- Under the current conditions, not only increasing the volume of investments in infrastructure, but primarily the quality of infrastructure created should come to the fore. One of the barriers that currently exist on the market is the absence of single methodology, assessment system, and conceptual apparatus. The first "bricks" in the common foundation were laid by G20, which approved the principles of quality infrastructure investments.

Along with the principles of quality infrastructure investments, more than 50 instruments have been developed in the world aimed at implementing sustainable development approaches and helping investors in assessing financial, economic, environmental, social, management, and other aspects of infrastructure projects. These tools exist in the form of assessment, certification, and rating systems for projects, as well as in the form of reporting standards and guidelines. Some countries include requirements for projects to undergo an appropriate assessment in procurement documents through competitive procedures.

Creation of a national system for assessing and certifying quality and sustainable infrastructure projects in the form of an integral ecosystem could be—by analogy with foreign experience—a possible solution. The system could include an assessment method focused on the Russian market, but at the same time taking into account the mandate and requirements of foreign investors and funding organizations; the opportunity to obtain a certificate of conformity either by independently preparing the documentation for the application, or by seeking help from an accredited third-party expert; programs of additional professional education and accreditation of specialists in working with the methodology; digital tools for online assessment; awarding reference projects and disseminating best practices. Possible effects for the Russian economy and the infrastructure market could be an improvement in the quality of projects and standards for their preparation and implementation; an increase in the inflow of foreign investment and an increase in interest in investments in infrastructure on the part of both Russian and foreign institutional investors and financing organizations; development of professional qualities and expertise of all market participants, including builders, designers, infrastructure operators, suppliers, and consultants.

- In recent years, Russia has intensified its efforts aimed at deepening cooperation with G20 countries, including infrastructure track and PPP. Contacts and relations with national PPP authorities have been established, and there is a fruitful exchange of information and experience. The National PPP Center and VEB.RF prepared an analytical review on PPP development in G-20 countries, which was highly appreciated by the member countries. Obviously, the course on expanding cooperation in this format should be continued, especially considering that G20 is likely to be the major "intellectual engine" in development and promotion of the concept of "quality infrastructure investments", which will allow Russia to take a direct part in development and coordination of international efforts in this area.
- The task of more active involvement in the work of supranational development institutions and international financial organizations for the launch and implementation of infrastructure projects, including using PPP mechanisms, remains extremely important for Russia. Despite the fact that the Russian Federation is one of the founders and leading donors of the New Development Bank (BRICS Bank) and the Asian Infrastructure Investment Bank (AIIB), the number of loans approved and allocated by them for Russian infrastructure projects remains negligible, which indicates either a poor elaboration of domestic infrastructure initiatives, or the lack of a clear-cut strategy for working with these financial institutions.

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CHAPTER 29

Impact of Digital Technologies on the Transition to a "Green Economy"

Maria A. Kozlova, Anna A. Gorbacheva, and Pavel V. Fedosov

Introduction

"Green economy" is a complex concept, and various approaches have been developed in its interpretation. This concept appears in different ways in the documents of the UNEP (United Nations Environment Program), the United Nations Conference on Trade and Development, the Commission on Sustainable Development, the Institute for Global Growth, and other sources.

The most common definition of a green economy is found in the synthesis report for government officials "Towards a Green Economy": "UNEP defines a green economy as an economy that enhances human well-being and ensures social justice, while significantly reducing risks for the environment and its impoverishment". It is a "low carbon, resource efficient and socially inclusive economy" (Navstrechu, 2011).

The concept of a green economy was politically embodied at the 1992 United Nations Conference on Environment and Development in Rio de Janeiro (also known as the Rio Summit or Earth Summit).

The most important event for the development of the "green economy" was the global financial crisis of 2008, when the governments of various states and international organizations were faced with the need to develop ways to

M. A. Kozlova (✉) · A. A. Gorbacheva
MGIMO University (Moscow State Institute of International Relations), Moscow, Russia

P. V. Fedosov
Lomonosov Moscow State University, Moscow, Russia
e-mail: pavel.fedosov@zyfra.com

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reset the economy. It was then that the need arose to rethink the possibilities of economic growth in accordance with the concept of sustainable development aimed at building an ecological civilization (Zelenoe, 2016).

In October 2008, UNEP launched the Green Economy Initiative to secure political support and investment in green sectors of the economy and to implement environmental restrictions and regulations in disadvantaged sectors. On the eve of the UN Climate Change Conference in Copenhagen, in June 2009, the UN issued an inter-ministerial statement supporting the concept of a green economy, as it aimed to overcome multiple crises, stabilize the global economy, overcome environmental degradation and solve a set of social problems.

In February 2010, ministers and heads of delegation from the UNEP Global Ministerial Environment Forum in Nusa Dua in their declaration recognized that the green economy concept "can largely address current challenges and provide economic development opportunities and multiple benefits for all countries" (Kosarikov, 2015).

In March 2010, the General Assembly agreed that a green economy in the context of sustainable development and poverty eradication would be one of two specific themes for Rio + 20 (resolution 64/236). One of the key points was the report on the green economy, released by UNEP in November 2011 under the Green Economy Initiative, which contained the definition of "green economy", which is now generally accepted.

Promoting a green economy was a key theme of the Rio + 20 conference, in which governments agreed to create a green economy as an important tool for sustainable development—one that is inclusive and can stimulate economic growth, employment, and poverty eradication while maintaining healthy functioning of the Earth's ecosystems.

Representatives of the OECD, the IMF, and other international financial organizations declared the need to move to a green growth model. In particular, to assist in overcoming the consequences of climate change, the IMF is developing proposals for the creation of a global "Green Fund", the funds from which will be directed to individual states (IMF Survey, 2010). The concept of "green growth" is being applied by more and more states: Ministers of 34 countries, including the countries of the European Union, the United States, New Zealand, and Turkey, signed the Green Growth Declaration of the same name in 2009 (Makieva, 2015).

Digital technologies play a significant role in the transition to a "green economy" (IISD, 2010). However, it is noted that digital technologies can have both positive and negative impact on the environment. For example, F. Berkhout and J. Hertin (2001) and S. Forge et al. (2009) divide the effects of ICT into several subgroups. In Forge's classification, the negative effect arises from the production and physical use of ICT (environmental pollution, toxic waste). The positive effect is associated with the use of ICT in the production process (saving electricity, reducing the amount of used resources), replacing physical goods with virtual ones (e-commerce instead of office maintenance, e-books instead of printed books), sensors that reduce resource consumption (turning off the light in the absence of people, stop irrigation after the soil is saturated with water). A.K. Chowdhury and V. Shanmugan (2015) added to the positive effects of the use of digital technologies resource savings, not only in the production process through the use of detectors and sensors, but also in the trade process—the closure of kiosks and the transition to electronic commerce.

K.N. Chokou notes that digital technology can drive green economies in three main ways (Chiocoiu, 2011):

– by reducing the direct impact on the environment of production, distribution, operation, and disposal of ICT themselves (reduction of the use of toxic materials, waste disposal)
– by increasing the efficiency of production, distribution, and consumption of goods and services in the economy and in society as a whole (reducing energy consumption and reducing the amount of resources, replacing resources with virtual ones);
– by supporting the transformation of human behavior toward a more economical and environmentally friendly use of resources.

In addition, J. Townsend and W. Coroama (2018) note that digital technologies can contribute to the transition to a "green economy" both by saving resources and energy (save impacts), and by encouraging the transition to the use of "clean" technologies and technologies with reusable products (push impacts).

Among the individual areas of the impact of digital technologies on the transition to a "green economy", one can single out the "Internet of Things" and the economy of sharing. In 2017, the International Declaration "Internet of Things for Sustainable Development" (EY, 2018) was adopted in Geneva, which also considered issues related to the "green" economy: the use of Internet of Things technologies to combat climate change, support for the implementation of the Internet of Things in urban and rural areas to create smarter and more sustainable cities and communities. Environmental sensors help measure temperature, humidity and air composition, and radiation levels. Technologies in agriculture reduce environmental risks and control the content of harmful microelements.

The "sharing economy" is based on the sharing of goods and services that conserves energy and reduces resource consumption. And the transition to it is possible precisely due to digital technologies that control the presence of underutilized capacities that unite sellers and buyers on special digital platforms (Analytical Center, 2018).

International organizations and many states have already appreciated the benefits of digital technologies for the transition to sustainable development and a "green" economy. This is stated in UN documents (United Nations, 2018), as well as OECD (2019), EU. In 2015, the EU created a program for the transition to a Green Knowledge Society, which notes that it is planned to stimulate the use of ICT for energy conservation in all industries, as well as to ensure the use of ICT for more sustainable models of behavior of citizens and businesses (Perelet, 2018) … In Russia, in 2017, the Russian Government adopted the "Digital Economy of the Russian Federation" program. In 2019, the "Smart Cities" section was prepared, which would be included in the "Digital Economy" state program. The "Smart Cities" program is just one of the most significant examples of the use of digital technologies for the transition to a "green" economy.

Methodology

The study analyzed the impact of digital technologies on the transition to a "green" economy at various levels: at the city and regional levels, using the example of individual industries and enterprises. The main industries were highlighted, and examples of the successful use of digital technologies which can solve environmental problems and contribute to the transition to a "green economy" were given.

Also, a survey of Russian and Chinese students was conducted to determine the significance of the transition to a "green economy" and to assess the impact of digital technologies on the transition to a "green economy". In China, the survey was conducted among 100 students of 1st to 4th years of Ludong University through a written multiple-choice questionnaire. In Russia, a survey was conducted of 100 students of MGIMO and the Higher School of Economics with a written choice of answers. After that, a comparative analysis of the answers given by Russian and Chinese students was carried out.

Results

Let's consider the main areas in which the use of digital technologies contributes to the transition to a "green economy".

Impact of Digital Technologies on the Green Economy Transition of the City

According to the international organization Smart City Council, a "smart" city is "a city that can improve the quality of life of its citizens by providing them with long-term opportunities for cultural, economic and social development in a healthy, safe, motivating and dynamic environment" (Casini, 2017) … Another definition of a "smart" city is given by A.A. Hamid: Smart cities are cities powered by electronic technology (Hameed, 2019).

In Table 29.1, we look at how digital technologies are driving the transition to a green economy.

Currently, a lot of development focuses on the creation of "smart" cities—either rebuilding and modifying existing cities, or rebuilding new

Table 29.1 The impact of digital technologies to the transition to a "green economy" by industry

Energy	Reduction of energy use in buildings and for street lighting due to detectors and sensors
Transport	Reduction of emissions from transport due to more economical use of fuel, transition to shared car consumption based on electronic technologies
Water resources	Reduction of water use in homes through installation of sensors, reduction of land irrigation through more rational use of water based on sensory indicators
Electronic transactions	Transition to electronic commerce, electronic tourism, provision of electronic services leads to a reduction in the use of rare resources
Waste and emissions	Digital technologies can reduce and dispose of waste more efficiently

settlements taking into account digital technologies. Over the past decade, smart city programs have been developed in London, Amsterdam, Vienna, Barcelona, Stockholm, New York, Los Angeles, Seattle, Seoul, Melbourne, Vancouver, and elsewhere (Casini, 2017). There are also numerous initiatives and programs promoted at European and international levels to stimulate the transition to a "smart, sustainable and inclusive urban model". In Europe, two initiatives launched by the European Commission are worth noting: the European Innovation Partnership Smart Cities and Communities and the Smart Cities Platform to Launch Innovative Urban Projects in Energy, Transport and Information and Communication Technologies. In addition, funding is provided for the Horizon 2020 (€ 6 billion), Connecting Europe Facility (€ 6 billion), and Cohesion Funds for 2014–2020 (€ 23 billion for renewables, energy efficiency, smart grids, and mobility) (Casini, 2017).

Among the cities that are immediately built on the basis of information technology, one should mention the eco-city of Masdar, which is being built in the Emirate of Abu Dhabi, Songdo in South Korean, Iskander in Malaysia, Neom in Saudi Arabia, the eco-city of Tianjin—a cooperation project between Singapore and China (Esaulov, 2017). In Songdo, it is planned to constantly monitor the ecological state of the city using the indicators of sensors; in Tianjin, there must be alternative energy saving, recycling water supply, and the creation of a transport environment without motorized transport.

Russia also pays great attention to the creation of "smart cities". The corresponding project was prepared by Rostelecom with the participation of the Ministry of Construction, and in 2018 the government subcommittee on the digital economy approved the inclusion of the Smart City section in the Digital Economy program. According to the project, the number of cities included in the TOP-10 rating of "Smart Cities of the EAEU" should reach 5 by 2020 and 6 by 2022, and the number of cities included in the international rating of TOP-50 in the direction of "Smart City" should reach 3 by 2020 and 6 by 2024. The project envisages that by 2021 the portion of the population with digital services for informing about the state of the environment will reach 10%, and by 2024—50% (CNews, 2019). The houses will be equipped with remote metering devices for measuring the consumption of heat, energy, and utility costs (the share of such consumers will grow from 50% in 2020 to 95% in 2024 (CNews, 2019). The "Skolkovo Innovation Center" and "Innopolis" in the Republic of Tatarstan should be named as cities that are being built immediately as type of "smart cities" (Esaulov, 2017). In 2019, the Analytical Center for the Government of the Russian Federation (Analytical Center, 2019) reviewed the current development of projects in the digital economy in the regions of Russia. A number of regions named the Smart City program as one of their priority area (Moscow, Belgorod, Stary Oskol, Kostroma, Kaliningrad, Leningrad region, Komi Republic, Volgograd region, Perm region, Chelyabinsk region, etc.). For the transition of a city or region to "smart city", government assistance and funding are required. However, for individual enterprises, the transition through digitalization to a "green" economy is possible both with the help of the state and through the activities of private companies.

Impact of Digital Technologies on the Transition to a "Green Economy" in the Electricity Sector

One of the industries in which the transition to a "green economy" is being actively pursued is the electric power industry. In the context of the deteriorating environmental situation in the world and a high amount of greenhouse gas emissions, more and more attention is being paid to the development of renewable energy sources which should replace traditional fuels.

Both developed and developing countries pay great attention to the development of RES. Among the main investors in renewable energy are the United States, European countries (Great Britain, Germany, Belgium, Ireland, Norway, Romania, Sweden, Great Britain, Denmark, and Finland), China, India, Japan. The Eurasian Economic Union, which includes Russia, Belarus, Kazakhstan, Armenia, and Kyrgyzstan, also pays attention to the development of renewable energy sources, although they are lagging behind the leading countries at present.

However, there are also problems that hinder the development of renewable energy sources. Among these problems, E. K. Grosheva and A. D. Chuprin (2020) listed the lack of competitiveness of renewable energy in Russia at the present time, problems with the purchase of equipment and technologies due to sanctions, a decrease in energy consumption due to the crisis and, the availability of cheap renewable energy sources (oil, gas, coal). To solve the problem of non-competitiveness, which is one of the main ones, it is possible to use digital technologies (Mozohin, 2020).

After a series of pilot projects in the field of digital solutions, global IT companies and industrial giants have come to a stage where they need to follow a platform strategy. When implementing IoT platforms, not only are the basic elements such as data collection, storage, processing, and modeling provided by the platform important, but also those business applications that are deployed as platform solutions to create value.

These solutions help enterprises not only save more and spend less, but also to do it at the lowest cost through a single platform, rather than through a disparate IT landscape. In addition to the need to allocate resources to maintain disparate systems, the lack of a single effective tool (a digital platform) and the absence of uniform reference books and master data, generates a large amount of manual input and adjustments. In the case of the large data flow that renewable energy sources generate, this is one of the key factors.

Today a number of platform solutions used in the field of energy are already being created in the world. At the end of 2019, Baker Hughes, Microsoft, and C3.ai announced an alliance to create the BHC3 AI Suite IoT platform for the energy industry. Another example is the EcoStruxure IoT platform, developed as an open ecosystem by Schneider Electric in collaboration with partners Microsoft and Intel. As these examples show, platforms are often created in partnership between an industrial enterprise and an IT company. This model is most effective because the platform developer who has implemented the architecture and tools helps to create digital assets and manage data flows with the industrial enterprise.

Significant success in this direction has been achieved by an international company engaged in the production and distribution of electricity and gas—the Italian "Enel". By using AWS (Amazon Web Services cloud platform) as a platform for IoT and energy management, as well as a number of applications based on artificial intelligence technology, Enel conducts a whole range of tasks, including voltage control, generation distribution, frequency control, operational response to changing demand, planning, operation, and modeling of the utility distribution system.

As a result, the company optimizes existing networks without additional investment. Energy savings are estimated at over 144 GWh per year and CO2 emissions have been reduced by 75,000 tonnes per year. The key effect of the implementation of a platform solution for the development of RES technology was the reduction in operating costs after its implementation. This called Enel to increase the share of generation in Italy to 40% from alternative energy sources, while reducing the amount of harmful emissions.

Impact of Digital Technologies on the Transition to a "Green Economy" in Other Industries

Digital technologies are also actively used in agriculture and industry. An example of the use of digital technologies in agriculture is the use of pinpoint farming equipment. Sensors, cameras, and global positioning devices allow farmers to use the exact amount of water and fertilizer and reduce the amount of resources used (Perelet, 2018). Such technologies are used in the United

States, Australia, Holland, New Zealand, and the EU. For example, in the United States, satellite data are combined with data collected in the field to monitor soil moisture and discourage overuse of water. In Australia, sensors allow monitoring of soil erosion processes in order to prevent this in time (OECD, 2019). The WeatherTRAK system digitally monitors the irrigation process (GeSI, 2015).

In order to facilitate the transition of industrial companies to more sustainable use of resources, there are a number of supporting mechanisms in different countries. These include the Sustainable Accelerator programs in London, Rockstart in Amsterdam, GreenStart in San Francisco (Townsend and Coroama, 2018). In Russia, digital technologies are already being used by enterprises. For example, since 2016, the Magnitogorsk Iron and Steel Works has been using artificial intelligence technologies at its plants. The Yandex Data Factory solution, created specifically at the request of the Magnitogorsk Iron and Steel Works, allows to reduce the consumption of ferroalloys by an average of 5% while maintaining steel quality indicators, as well as reduces the amount of additional materials in steel production (Magnitogorsk Iron and Steel Works, 2016).

In the transport sector, the use of digital technologies contributes to the development of a sharing economy that saves resources. In Russia, the BlaBlaCar car-sharing system began operating in 2014, and in 2013 in the Russian Federation, they began to use the service for quickly and efficiently finding Uber taxis.

A Survey of Russian and Chinese Students on the Transition to a "Green Economy" and the Effectiveness of Digital Technologies

To assess the significance of the transition to a "green economy" and the impact of digital technologies, a survey was conducted among Chinese and Russian students. The survey of Chinese students revealed the main environmental problems, while the survey of Russian students showed how digital technologies can solve these problems.

The Chinese survey was conducted among 100 first to fourth-year students at Ludong University through a written multiple-choice survey. 80% of students answered that they were worried about the deterioration of the environment in China as a whole, while 87% were worried about the deterioration in their "small homeland". The level of the ecological state was estimated at an average of 3.2 points out of 5.

Moreover, students highlighted the importance of certain environmental problems (while they could mark several answer options):

- Water pollution—71%;
- Air pollution—85%;
- Noise—41%;
- Soil contamination—22%;

- Household waste—18%;
- Deforestation, loss of green spaces—11%; and
- Climatic changes—7%.

There was also a survey of 100 Russian students studying at MGIMO and the High School of Economics. Below are the results of the student survey:

1. Do you know the key technologies of Industry 4.0?

   As part of the survey, 70% of students showed that this concept is unfamiliar to them. The authors believe that such a definition (Industry 4.0) is not known to students precisely in this interpretation. However, a further survey showed that a number of technologies implemented within this structure are known to the students, although they didn't associate them with the specific category. Among the familiar technologies, the following were named in particular: Blockchain, Bioengineering, Internet of Things, Virtual and Augmented Reality, 3D printing, Cloud Servers, Smart Home technology, Big Data, and Neural Networks.
2. Select from this list the options that you previously knew about:

   a. "Smart" city;
   b. Internet of Things;
   c. Renewable energy sources; and
   d. Car sharing.

   Unlike the first question, it was apparent that the students were familiar with many modern technologies. 98% of respondents knew the benefits of renewable energy sources and car sharing, 67% were familiar with Smart Cities technologies. Lesser number (63%) knew about the concept of the "Internet of Things".
3. In which countries, in your opinion, is the "green economy" developing successfully?

   The largest number of respondents noted the Scandinavian countries (43%) as among the countries that are successfully developing a "green economy". The United States (35%), Western Europe (32%), NIS Asia (28%), Australia and New Zealand (12%), Japan (9%), Canada (4%) came next.
4. Students see the most pressing environmental problems as:

   a. Water pollution (76%);
   b. Air pollution (83%);
   c. Noise pollution (14%);
   d. Soil pollution (42%);
   e. Household waste (53%);
   f. Deforestation, loss of green spaces (76%); and
   g. Climatic changes (58%).

When comparing the results of surveys of Russian and Chinese students, it is noteworthy that the greatest concern in both countries is caused by air pollution and water pollution. However, while Chinese students are extremely concerned about the problem of noise, Russian students are concerned about the consequences of deforestation and climate change.

5. Students see the following problems as possible for improvement with the help of digital technologies:

    a. Water pollution (63%);
    b. Air pollution (55%);
    c. Noise pollution (60%);
    d. Soil pollution (48%);
    e. Household waste (63%);
    f. Deforestation, loss of green spaces (21%); and
    g. Climatic changes (28%).

    In general, it is obvious that students are aware of the high importance of the introduction of digital technologies in solving a number of the above environmental problems. While, the problem of climate change ranks fourth in importance as a response to the previous question, the possibilities of solving it with the help of digital technologies are placed only in sixth place.

6. Can you give an example of how digital technologies can improve the environmental situation?

The survey has shown that modern students are confident that digital technologies can solve many of the environmental problems. Really effective and currently used digitalization opportunities were named, such as the use of sensors to monitor the state of the environment, the introduction of electric transport, the transition to digital storage media, the creation of energy metering devices.

Thus, the survey showed that both Russian and Chinese students understand the importance of solving environmental problems, while Russian students also indicated how digital technologies can solve these problems.

Conclusion

The analysis carried out in the article has shown the importance of digital technologies for the transition to a “green economy”. Digital technologies are used both on the scale of cities (smart city technology) and at individual enterprises level. Digital technologies reduce the cost of using renewable energy sources, making them more competitive. As part of digitalization, sensors are installed on equipment that allow better control of energy consumption, reduce material consumption and the emission of harmful substances. By creating networks linking equipment into a single system, interruption is minimized, production efficiency is increased, which reduces the demand for energy and natural materials. In the sphere of consumption, the use of computer technologies allows for the reduction of emissions of harmful substances and permits saving rare resources so that they can then be passed on to the next generations. The importance of digital technologies in the field of transport is also great, since car sharing can reduce the amount of harmful emissions into the atmosphere.

The survey of Russian and Chinese students to assess the significance of the transition to a "green economy" and assess the impact of digital technologies, showed that the most students in both countries were worried about air pollution and water pollution. However, while the Chinese students were extremely concerned about the problem of noise, Russian students were concerned about the consequences of deforestation and climate change. Russian students noted that digital technologies could solve such problems as water pollution and the problem of household waste. At the same time, it should be noted that in the future it makes sense to interview a wider circle of participants to assess the impact of digital technologies, as well as to assess the scale of the impact of digitalization on solving environmental problems using the example of individual enterprises.

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CHAPTER 30

Geo-Economic Aspects of the "Green Economy" in Industry 4.0

Natalia Yu. Konina and Elena V. Sapir

Introduction

The modern world economy is characterized by an increasingly complex system of interrelated forces and factors that form a single geo-economic space (Revenko et al., 2019).

Geoeconomics emerged as a separate discipline at the end of the twentieth century. The scientific origins of geoeconomics must be sought at the junction of a number of social sciences, including world economy, political science, international political economy, macro- and microeconomics, geopolitics, international relations, history, economic history, economic geography, conflictology, theory of organization and management systems, international business and management.

N. S. Trubetskoy, P. N. Savitsky and N. N. Baransky, along with the European scientists like F. Rochrig and F. List (the concept of "autarchy of large spaces"), F. Braudel (the concept of "world-economy"), I. Wallerstein ("the world - systems approach"). S. Huntington, F. Fukuyama, M. Friedman, E. Giddens, etc. were among those whose ideas about geoeconomics were ahead of their time. They tried to describe the trends in the global development of human society in their models. The most famous geo-economic theory of the twentieth century is the world-system theory of I. Wallerstein, in which the

N. Yu. Konina (✉)
Moscow State Institute of International Relations (MGIMO University), Moscow, Russia

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

E. B. Zavyalova and E. G. Popkova, *Industry 4.0*,
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geopolitical interests of the leading countries are linked to the development and restructuring of the world economy.

It is worth mentioning the names of J. Attali, E. Luttvak, K. Jean, P. Savona, S. Fiore, and F. Bruni Roccia among the modern researchers of geoeconomics (Sapir, 2003).

Modern Russian geoeconomics took shape in the 1990s. The researchers noted that the balance of power in the world increasingly depends on the location of the main economic centers of the regions, natural resources, and productive forces.

The well-known Russian geoeconomist E. G. Kochetov defines geoeconomics as “a technique of national operation in the geoeconomic space in order to timely regroup forces to reach the most favorable conditions for the formation and redistribution of world income” (Kochetov et al., 2010). Geoeconomics examines the interaction between the reproductive system, politics, and space: the influence of spatial factors on the implementation of economic activity, taking into account geopolitical realities, the transformation of international economic relations and the change in economic interests and activities of states, the achievement of geopolitical results under the influence of global changes and the technological revolution.

The control over resources and space is no more a goal of modern geoeconomic as it was in the twentieth century. There has been a marked shift in emphasis of the geo-economic struggle between the main participants in control of the world reproduction mechanism for the redistribution of world income using geo-economic instruments, and also for providing the most profitable directions for the development of innovations and technologies for not just the leading geo-economic actors, but the entire world economy (Konina, 2018).

The subjects of today’s geoeconomics in the field of ecology are states and their organizations, as well as international financial and economic organizations, the large transnational corporations, and the largest megacities.

In modern conditions, it is necessary to assess the green trend of development of the world economy from the standpoint of geoeconomics. The limited reserves of natural resources (primarily raw materials and fossil fuels) and the aggravation of environmental and climatic challenges have caused the scientific community to pay close attention to this issue.

The teachings of V. I. Vernadsky about the noosphere and the work of the Russian academician N. N. Moiseev (1917–2000), about the problems of ecology and sustainable development, were developed in the research of N. F. Reimers on the interaction of the biosphere and humanity and the research of K. Ya. Kondratyev related to global ecology. The issues of ecology and sustainable development were studied by G. H. Brundtland. (Brundtland GH), Meadows D., Peccei A., Pierce D. (Reagse D.), Randers J., Tinbergen J., Forrester J.

Methodology

The methodology used in this article to study the geoeconomics aspects of the green economy is based on an integrated approach of analysis of the socio-economic system. The basic principle in this complex can be considered interdisciplinarity, taking into account the complex nature of geoeconomics and its manifestation in the world economy. The analysis was carried out using statistical methods, trend research methods, comparison, and systematization.

Conceptually, the reliance was made on the approaches to geo-economic analysis that have been formed in Russian and foreign science. Methodologically justified for generalizing the idea of the development of the object under study is the use of information and analytical information from international organizations, countries, and companies of the green sector of the economy. The author's methodology also involves the use of their own classifications and typologies of objects. The authors conducted a study of the scientific literature on the problem under study, significantly supplemented the prevailing views, and proposed the author's vision of this issue.

A systematic approach was applied, which made it possible to comprehensively consider a number of diverse elements previously studied separately. Thus, a study was carried out on the state and strategies of leading countries in relation to the green economy, the issues of the development of renewable energy sources (RES) were studied from the point of view of the geo-economic positions of different countries.

The most important theoretical and practical issue of the green economy from the point of view of geoeconomics is the emerging new contours of the international division of labor and the place of countries in the new world economy. The aim of the study is a comparative analysis of the geo-economic position of the leading countries, taking into account various aspects of the development of a green economy in the context of aggravating environmental and climatic problems.

Finally, by summarizing and synthesizing the data obtained, the main conclusions are drawn.

Results

The Main Part

The modern geo-economic landscape in terms of sustainable development and green economy is characterized by the following features:

First, the sustainable development and green economy agenda have taken its place in the struggle between different geo-economic actors, primarily leading states. As environmental and resource problems intensify, these issues will increasingly affect the geo-economic landscape. The issues that affect the interests of the main geo-economic actors in relation to the green economy are very diverse. These are the problems of combating global warming and decarbonization of economies, the transition to renewable energy sources and changes in the world energy, changes in international trade generated by decarbonization, and interaction and cooperation in solving global environmental problems (Khoshnava et al., 2019). It can be foreseen that in the coming years these issues will be supplemented by forced climatic and ecological migration, provision of freshwater, conservation of biodiversity, and others.

Second, the geo-economic issues of a green economy and sustainable development are increasingly shaped by technology, and increasingly influenced by the 4th industrial revolution.

Third, according to their approaches to the green economy and the geo-economic implications of environmental problems, the leading countries can be grouped into different groups.

Fourthly, green economy issues have become the focus of attention of a number of the largest international companies that are active participants in geo-economic events.

It is possible to identify the main actors that form the core of geo-economic activity in matters of sustainable development and green economy. The authors include the United States, EU, Germany (in the EU), China, Russia, India, and the UN, the international non-governmental organization Greenpeace and a number of leading TNCs as the main geo-economic players.

Sustainable development is increasingly intertwined with green economy and is today at the center of intellectual and political struggles between leading geo-economic actors. This ideological confrontation is being transformed into real politics and concrete actions that affect specific markets in different regions.

The new geo-economic landscape in the context of ecology is characterized by the increased interdependence of participants and the joint use of diminishing resources with different interests and at times tough confrontation between key geo-economic participants (players).

All leading geo-economic participants are facing a very acute problem of providing resources and the upcoming depreciation of fixed capital associated with the transition in the coming years to the production of a new technological order based on the active use of artificial intelligence, robots, and other technologies due to the 4th industrial revolution.

According to the latest report from the International Resources Panel, annual global production of materials tripled from 27 billion tons to 92 billion tons between 1970 and 2017.

The use of metal ores has increased by an average of 2.7% per year since 1970, while the use of non-metallic minerals, mainly sand, gravel and clay, has increased from nine billion tons in 1970 to 44 billion tons in 2017.

The same is true for fossil fuels: The use of coal, oil, and natural gas increased from six billion tons in 1970 to 15 billion tons in 2017; the growth of water intake increased from 2,500 km^3 per year to 3,900 km^3 per year from 1970 to 2010; and biomass (organic matter) had an increase in demand from 9 billion tons in 1970 to 24 billion tons in 2017.

According to the OECD's Global Material Resources Forecast 2060, the environmental burden will increase in the face of growing world population while maintaining the current rate of resource consumption, which will lead to an increase in the global use of materials to 167–170 billion tons in 2060.

But the point is not only that the world community has a limited supply of resources and is actively spending. The current pattern of resource use has a very negative impact on the environment and human health (Bina, 2013)

The green economy offers a solution to the range of problems caused by the modern Western post-industrial society with its unlimited consumption and dependence on accelerated technological progress, when, due to limited resources, the problem of employment, food, maintenance, living, and income of a huge part of the population can acquire a completely different dimension. The green economy is closely related to the concept of sustainable development and, on the basis of optimizing the relationship between man and nature, is designed to improve the efficiency of the economy and improve both the quality of life and the preservation of the environment (Bobylev, 2017).

Currently, there is no commonly accepted understanding and definition of a green economy. A green economy is broadly defined as any theory of economics that considers an economy to be a component of the ecosystem in which it is located.

The green economy includes the following main areas:

- Implementation and use of renewable energy sources;
- Green buildings;
- Eco-friendly transport;
- Rational management of water resources;
- Waste management;
- Organic farming in agriculture;
- Conservation and management of ecosystems.

For the purposes of this publication, a green economy refers to a low-carbon, resource-efficient economy that aims to reduce environmental risks and ecological scarcity and aims at sustainable development without environmental degradation.

In a green economy, employment and income growth is driven by public and private investment in economic activities, infrastructure, and assets that reduce carbon emissions and pollution, improve energy and resource efficiency, and prevent the loss of biodiversity and ecosystem (Piskulova, 2010).

The "green" economy raises the question of the degree of state intervention in the economy and its development is associated with institutional aspects, the state of all institutions, and involves the active participation of the state in resolving environmental issues. The market's inability to respond to environmental and climate protection needs is associated with high external costs and high research, development, and marketing costs for green energy and ecologically clean products.

The scale of the "green" sector of the world economy is already significant and growing all the time. Thus, the cost of manufactured goods and services in this sector in 2018 was estimated at $8 trillion, or 7% of world GDP, and employment of 25 million people. According to the German Ministry of the Environment, which presented the "Atlas of Green Technologies-2018", the volume of the global market for "green" technologies will grow between 2016 and 2025 from 3.2 trillion to 5.9 trillion euros, at an annual rate of 6.9%, which is almost twice the growth rate of the world economy.

In 2019, the market value of companies related to the green economy, in particular renewable energy, energy efficiency, water supply, waste management, and pollution control, is estimated to be about 6% of the global stock market, i.e., about $4 trillion.

1. In terms of geo-economic implications, active participation in the green economy and positions, the following groups of countries can be picked out:

   (A) Countries—United States, Germany, China as the geo-economic leaders of the green economy.

   - In the United States, despite the position of the US President Donald Trump's administration on global warming, the largest "green" economy has been formed, the volume of sales of which is estimated at about 1.3 trillion dollars and which employs about 9.5 million people. At the same time, the growth rate of the green economy segment in the last 3–5 years has exceeded 15–20% per year. The US green economy accounts for about 16.5% of the global green economy (Georgeson & Maslin, 2019).
   - Germany is the world leader in the export of environmentally friendly goods and services (in particular, more than 14% of the world trade in climate protection equipment). In 2025. 19% of German GDP will be generated by green technologies, up from 16% of GDP in 2016 (Germany Environmental Technologies, 2019).

The active participation of China and Chinese firms in global environmental issues and the green economy is of great geo-economic importance. With dynamic economic growth, industrial development, and urbanization, China in spite of major energy security and environmental challenges is playing increasingly important role in geoeconomics (Hsiung, 2009). According to research by Chinese scientists, long-term exposure to highly polluted air resulted in the premature death of about 30.8 million people between 2000 and 2016 (Liang et al., 2020).

More than 80% of China's environmental impact comes from three sectors: manufacturing (49.99%), electricity (22.63%), and other services (11.37%), these three sectors are key sectors for energy conservation, waste reduction, and environmental emissions.

China's tremendous economic success is based not only on a planned economy and skillful attraction of foreign investment, combined with a cheap and diligent labor force, but also on supply of cheap energy from coal mined in China. At the same time, China's geoeconomic approach to a green economy is notable for its healthy pragmatism. As a part of the climate agreement, China has pledged to halt rising carbon dioxide emissions by 2030. For the period from 2005 to 2019, the PRC government has invested enormous funds in green energy to improve the environmental situation. In 2019, China accounted for 33.8% (or 210.5 GW) of the installed capacity of wind farms worldwide. In 2018, the installed capacity of solar energy in China amounted to one-third of the total installed capacity in the world, 174.63 GW (9.2% of the total capacity of the PRC). However, not all investments in alternative energy sources in China have been recognized as effective due to their low contribution to economic growth. Therefore, along with the development of renewable energy sources, China in the near future is preparing to build new stations with 148 GW of coal generation capacity. The share of coal in the structure of primary energy in China fell to 58% in 2018 (in 2008—72%). By 2019, approximately 80% of China's coal capacity was using ultra-low emission technologies. By the end of 2020, China is expected to have the world's largest clean coal-fired power system with the highest efficiency. At the same time, according to the US Department of Energy, the PRC accounts for 30% of all carbon dioxide emissions in the world, compared to 15% of the US share and 5% of Russia. A major step forward was the decision of the PRC leadership to achieve carbon neutrality by 2060, announced in September 2020 on UNGA. For the geo-economic position of China, in terms of the green economy, intellectual property issues are of critical importance. Some of the competitive technologies in the field of renewable energy sources are not made in China.

(B) Countries that hold strong positions and generally benefit from the transition to a green economy: Japan, South Korea, Canada, EU countries, and the UK.

In Japan, the green economy engages about 3.4–4% of GDP and about 2.5 million people. Despite the preservation of a large share of coal-fired power plants in the country's energy sector, the country is leading in the development of innovative technologies in the field of environmental protection and has more than 23,000 patents in this area;

- In the EU countries as a whole—about 4% of total GDP is created in a green economy, about 5 million people work there, while in some countries the indicators are higher;
  - Great Britain is the world leader in terms of the share of the "green" sector in GDP exceeding 10%.

(C) Countries whose position in the context of geo-economic confrontation in the green economy is vulnerable: Russia, the EAEU countries, India, Brazil, and most developing countries.

2. The most important geo-economic aspect of a green economy is the transition to alternative energy sources and decarbonization. Of the total energy consumption in the world, 85% is accounted for by the consumption of fossil fuels—this is equivalent to about 11 billion tons of oil. The rest comes from hydropower, nuclear power, and renewable energy sources.

The dynamic growth of alternative energy is already leading to profound changes in the global energy markets. The dynamic development of renewable energy is due to a combination of institutional and investment factors. The United States, Germany, Japan, France, China, South Korea are actively investing in renewable energy sources. The lion's share of investments was directed to the development of wind and solar energy, primarily in projects for the construction of large wind power plants in Western Europe (offshore) and China. China has become a global leader, focusing nearly 40% of global investment in clean energy.

Global investments in renewable energy (excluding large hydropower plants) exceeded $250 billion annually between 2010 and 2019, and in 2019 amounted to $282.2 billion, which is 1% more than in 2018. It is expected that in 2017–2040 investments in new power generation capacities around the world will exceed $10 trillion, of which 72% will be directed to renewable energy sources (RES) (Bloomberg NEF, 2019).

Sustainable and significant growth of investments ensured the accelerated growth of capacities in the field of alternative energy. The share of solar and wind in the generation of global electricity exceeded 8% at the end of 2019. The output of wind power plants in 2019 amounted to 1404 TW * h, and solar power plants 699 TW * h. Thus, in 2019, wind and solar power plants in the world generated twice as much electricity as the entire energy system of the Russian Federation. China is the largest producer of solar and wind power, followed by the United States and Germany. The share of solar and wind energy in electricity generation in China was 8.6% at the end of 2019, 9.7% in the US, 8% in India, and 17.6% in the EU (IEA, 2019).

Low and constantly decreasing costs make renewable energy sources a competitive basis for decarbonizing the energy sector. Advances in technology have led to a significant reduction in the cost of electricity from solar and wind power plants. For example, wind farms located in the central states of the United States today produce the cheapest electricity in the entire country (prices for 20-year contracts for the supply of electricity can go down to 2 cents per kilowatt-hour or less). In efficiently organized markets, for example, in Brazil, Canada, Mexico, Germany, Morocco with good natural conditions, non-subsidized prices per kilowatt-hour (based on the results of tenders) in wind energy are consistently below 2–3 US cents per kilowatt. The situation is similar in solar energy. In conditions of an ideal climate and low cost of capital, the "one-part" price today is positively in the range of 1–2.5 US cents per kilowatt. By 2030, about ten countries will have installed solar and wind power (in total) in excess of 50 GW. These countries include China, the United States, India, Germany, Japan, South Korea, the UK, France, Spain, possibly Brazil, Australia, Italy, Canada, and Saudi Arabia.

Dynamic changes in the global energy sector are associated with large investments in high-tech technologies and equipment for wind and solar power plants, leading to changes in the energy balance of individual countries, in general leading to changes in companies, industries and countries focused on the extraction of fossil fuels, leading to changes in logistics and freight flows, creating chaos in the world markets of traditional energy carriers (hydrocarbons and coal) and posing great threats to the development of countries oriented to the export of hydrocarbons. Russia being heavily dependent on the export of oil, gas, or coal and using carbon-intensive infrastructure (refineries, petrochemical plants, coal-fired power plants) faces significant external economic, financial, fiscal, and macroeconomic risks due to the transition of the world economy from carbon-intensive fuels and value chains based on them.

3. The development of institutions and active investments have predetermined the dynamic development of various sectors of the green economy. Another area where the geo-economic interests of countries intersect is the growing market for so-called organic products (produced without the use of chemical additives), primarily food. The largest organic food market is the United States, where sales reached 5–6% of the total food market, as well as Denmark, Sweden, Austria, Switzerland. The global market for organic food and beverages is expected to reach $220 billion in 2023. In the United States alone, sales of organic products amounted to $49 billion in 2019 and are growing by 5.8% annually, which is three times the dynamics of the food sector as a whole.

The upward trend in the consumption of ecological goods is characteristic not only of food, but also of a wider range of consumer goods, for example, wood products including furniture certified as environmentally friendly. Most of the international trade in organic food is in the US and the EU, and as environmental problems escalate, this market segment will grow and gain in importance. All these trends draw attention to circular economy as the only possible solution of environmental problems (Geissdoerfer et al., 2017).

4. An important feature of the current geo-economic confrontation is a set of issues related to the actions of countries in connection with global warming.

The climate agreement developed in Paris in December 2015 and entered into force in November 2016, replaced the 1997 Kyoto Protocol that had been in force until then. The Paris Agreement, which was approved by 195 countries, points that the main threat to the Earth is global warming associated with the emission of greenhouse gases as a result of human activity. The main agreement is to keep the temperature rise on Earth within 2 °C in relation to the indicators of the pre-industrial era. If this figure is exceeded, the likely damage to the world economy could amount to about two percent of GDP by 2030–2035, i.e., up to $3 trillion per year.

It should be noted that the current Paris Agreement is the result of the geo-economic struggle of certain forces for their own interests, while the fact that anthropogenic influence is also a trigger of global warming is not fully established and proved. However, a significant number of scientists question the anthropogenic nature of the current warming, as there is not enough evidence yet.

Over the past decade, issues of global warming have been declared the main environmental problem. This direction has become most dominant in the green economy and the subject of most acute geo-economic struggle, which is associated with the reversal of the direction of the entire world economy at the cost of tens if not hundreds of trillions of dollars.

The most active measures to combat global warming are being implemented by the European Union, which in December 2019 presented its climate protection strategy until 2050. According to this document, greenhouse gas emissions in the EU countries should be reduced to zero in the next 30 years due to the abandonment of the use of oil, natural gas, coal and brown coal, the combustion of which emits carbon dioxide into the atmosphere. For a number of EU countries, in particular Poland and Estonia, new EU environmental solutions mean significant economic complications. At the same time, one of the most radical "green plans" was adopted in Germany. The implementation of the EU's green strategy and consequently, the rejection of natural gas and oil by European and other countries is a serious blow to the Russian economy and requires urgent measures.

The United States did not participate in the Kyoto Agreement from the very beginning, and on June 1, 2017, withdrew from the Paris Agreement.

The position of the US Republican Party, supported by representatives of traditional industries, regarding the fight against the greenhouse effect is that it is a very costly and harmful policy for the economy. Representatives of the Democratic Party, on the contrary, presented the Green New Deal project, according to which it is expected to achieve zero greenhouse gas emissions by 2030 and the goal of a complete transition to renewable energy sources is set. The potential cost of this initiative will range from several tens to 100 trillion dollars.

5. The difficult geo-economic position of Russia in the background of the implementation of the Paris Agreement and the transition to a "green" economy, should be noted.

Russia is faced with acute environmental problems, which lead to annual losses of about 15% of GDP. The situation with harmful emissions remains extremely unfavorable. Half of the urban population lives in conditions of high air pollution, to which public and private vehicles contribute from 50 to 90%. A significant part of surface water is assessed today as dirty and extremely dirty, and 7% of residents are not provided with quality drinking water.

The geo-economic features of the transition to a "green" economy in Russia are characterized by the following:

- A late transition to a green economy resulting in a significant lag behind the leading Western countries in this area;
- High resource intensity due to the "exportraw material" model of the economy, low innovation, and lower technological level of production of Russian companies, which entails an increased level of pollution, harmful emissions, etc.;
- A large share of environmentally unfavorable industries in the fuel and energy sector and metallurgy.

The only area where Russia continues to maintain its high technological effectiveness, with advanced scientific and technical development and equipment is- nuclear power, which, after the accidents at Chernobyl and Fukushima, causes great concern to all developed countries.

The transition of Russia's geo-economic competitors to a "green" economy based on science-intensive technologies both in the medium and long term, leads to a deterioration in the country's geo-economic situation, leading to serious losses, the scale of which only increases with time. The 30-year-old raw-material model of the development of the Russian economy, with focus on the production and export of hydrocarbons and other raw materials, carries very serious restrictions and problems. A decrease in energy exports, a favorable change in demand of LNG, an increased supply in the world oil and gas market (largely due to high-tech production of shale oil and gas) in combination with sanctions by the United States and other Western countries against Russia, amid a pandemic have already led to a drop in export revenues of leading Russian oil and gas companies and a significant weakening of the ruble. This has had a negative impact on the pace of economic development in Russia. Non-environmentally friendly products—oil, gas, coal, and ferrous metallurgy products account for more than 85% of Russian exports. In the next 30 years, due to the process of increased decarbonization throughout the world, the importance of fossil hydrocarbon energy sources will decline in favor of renewable energy sources (RES). Of all types of energy sources, natural gas, especially LNG, will remain the most attractive. However, the explored and proven oil reserves in Russia at the current production rate will last for 28 years. Therefore, against this backdrop of the emerging new hydrogen economy, the issue of the main export goods of Russia in the next 10–20 years remains very critical.

For Russia, the trends that are associated with the high intensity development of technology in "green" industries and lead to the strengthening of the positions of the "green" economy are very alarming. This is because of the extremely low level of innovativeness of the Russian economy, which not only aggravates the technological lag of industry and the economy in general, but also raises the question of the fate of Russian exports. The reason of Russia's lag in the green economy is a combination of factors, which can be attributed to the dominant line on the country's raw materials development, low innovation, insufficient investment, and dependent position in the international division of labor due to the formed technological lag.

An additional factor for why the first serious geo-economic problems appeared for Russia in the oil and gas markets amid falling demand and prices; was the EU's decision to introduce a carbon tax on all goods imported into the EU, especially in view of Western sanctions.

According to KPMG estimates, after the introduction of a new carbon tax in the European Union, Russian exporters supplying hydrocarbon fuels (oil and gas) and ferrous metallurgy products to Europe will have to pay between 33 and 50 billion euros in 2022–2030. In particular, for example, for the Russian TNK Severstal, which delivered 2.3 million tons of steel to Europe in 2019, the carbon tax will be about 143.5 million euros per year.

At the same time, it should be noted that the concentration on energy in the Russian economy remains high and the transition to renewable energy sources is extremely slow.

6. An increasingly important area of geo-economic confrontation, where the leading countries of the West are leading, is the development and implementation of 4IR technologies to solve environmental problems, in particular those related to air pollution and global warming.

These technologies of the fourth industrial revolution provide:

- Improved air quality monitoring using available low power wide area networks (LPWAN) to track air quality;
- More individual control of air pollution;
- Use of technologies to remove pollution and carbon from the air. New technologies include robotic trees, drones, air purification buses, and air separation plants;
- Clean transport through a shift to electric and autonomous vehicles, car sharing, smart public transport, and dynamic road pricing;
- Leveraging big data and blockchain solutions to encourage green decision making by consumers and companies;
- Decarbonization of the industry through the use of environmentally friendly commercial vehicles, cloud computing, virtual and augmented reality, and 3D printing.

In the coming years, the importance of innovations in environmental technologies will only increase, and countries with such technologies will receive additional competitive advantages (Yang et al., 2015).

7. The largest international companies (TNC-transnational corporations), whose influence on the world economy has increased significantly are special participants in geoeconomics. The participation of the largest TNCs in the implementation of the principles of a green economy is ambiguous. The vast majority of industrial TNCs, especially from the extractive and traditional manufacturing industries, have a serious negative impact on the environment, especially at their subsidiaries and affiliates in developing countries, in violation of environmental laws and environmental regulations. A certain part of TNCs nevertheless makes a positive contribution to the preservation of the environment, using part of their financial, organizational, scientific and technical resources. Among TNCs that are conscientious in fulfilling environmental standards in their activities, creating "green" jobs and implementing significant environmental initiatives, one can mention Ford Motor Company, Disney, Johnson and Johnson, Hewlett-Packard, Fisher Investments, Starbucks, Nike, eBay, and Google.

A characteristic feature of modern geoeconomics is that along with countries, regions, megacities, international organizations have become participants in geo-economic processes. The activities of such non-governmental organizations as Greenpeace and the World Wild Fund (WWF) play a special role in promoting the ideas and principles of the "green" economy.

8. The geo-economic aspect of the implementation of a modern green economy by the leading Western countries is that to please certain stakeholders and companies, the emphasis is on anthropogenic global warming, while other real acute environmental problems do not receive due attention.

Among such pressing environmental problems, which are not given enough attention, it is worth highlighting the destruction of biodiversity and the pollution of the oceans with plastic. So, over the past 50 years, the population of wild animals on Earth has declined by more than two-thirds. The most important issue for all mankind is the fight against pollution of the earth and oceans with plastic, because if plastic is used in the same way, then according to experts' calculations, in 2050, there will be more plastic in the World Ocean than fish in volume and mass.

The most important task of the green economy is the transition to lean consumption and the increase in the life cycle of the materials used. According to Greenpeace, 90% of the raw materials are waste before the finished product leaves the factory. 80% of goods end up in a landfill in the first six months of their existence.

Leading actors in geoeconomics should focus on such complex global environmental issues as the preservation of large forests, rational water use, in particular, solving the problems of the Aral Sea, combating the destruction of the ozone layer and global environmental pollution due to the release of toxic chemicals into the atmosphere, land pollution and seas by radioactive and chemical waste, preservation of the ecology of Lake Baikal and other areas.

Conclusion

In the new emerging architecture of the world economy, environmental and green economy issues will play an increasingly important role. The sharp increase in use of irreplaceable resources together with the significant increase in the world's population has added to the problem of global warming.

Decarbonization and the transition to alternative renewable energy sources are the main areas of the green economy. Decisions in this regard significantly change the direction of development of the leading national economies, and in the long term, can affect the export specialization of countries and their competitive advantages.

The emerging geo-economic landscape is increasingly determined by the directions of the green economy, in particular, the resolution of the problem of global warming, decarbonization, and the development of renewable energy sources against the background of strategic changes in the direction of economic development based on the development of innovative technologies of the 4th industrial revolution.

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Part V

Financial Aspects of Climate Change Combating Based on Industry 4.0

CHAPTER 31

Green Bank Lending in the System of Green Financing

Yury I. Korobov, Sergey M. Bogomolov, Larisa V. Iliyna, and Marina V. Plotnikova

Introduction

Green financing has been actively developing all over the world. Thus, if the annual market of green bonds and credits did not exceed 50 billion USD in 2014–2015, then in 2017–2018 this figure exceeded 150 billion USD, and in 2019 it was above 250 billion USD (Climate Bonds Initiative, 2020), and total flows of green financing in public and private sectors (including the nonfinancial sector) showed a record-breaking increase as early as in 2017, amounting to 612 billion USD (Climate Policy Initiative, 2019). The main reason behind such rapid growth of the market of "green" finance consists in the generally recognized global environmental problems that can largely be solved through environmental protection projects that take into account resource-saving technologies and are implemented through money flows allocated to these goals. In addition, compliance with the principles of the green economy becomes an international brand, the availability of which may determine the ratings of a country and a particular enterprise, determining the lending terms at the international capital markets, the amount of additional fees in international trade, the level of investment attractiveness, etc.

Moreover, measures are being taken in Russia to line up the system of green financing, which has been implemented not only due to the need to follow global trends and standards, but also for internal reasons. Thus, environmental protection is one of directions of the Forecast of the long-term

Y. I. Korobov (✉) · S. M. Bogomolov · L. V. Iliyna · M. V. Plotnikova
Socio-Economic Institute, Yuri Gagarin State Technical University of Saratov, Saratov, Russia

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socio-economic development of the Russian Federation for the period until 2030, which implies, in particular, the provision of financing for “green” technologies. In addition, within the framework of implementation of the national project “Ecology”, provision has been made for the allocation of special-purpose budgetary resources for state support of green financing in Russia; in particular, it is planned that a certain part of them will be designated for the development of green lending (Yevishkin, 2020). The goals of the formation of the system of responsible financing, including green financing, are also defined in the policy paper of the Bank of Russia “Main directions for the development of the financial market of the Russian Federation for the period until 2019-2021”. In 2019, the concept of the management of the methodological system for the development of green financial instruments and responsible investment projects in Russia was published; it was drawn up by the members of the Working Group on Responsible Financing (ESG-finance), including green financing, of the Expert council on the long-range investment market under the Bank of Russia.

Furthermore, at this stage, both in terms of methodology and from the perspective of specific programs, a greater focus is on green bonds, while a lesser focus is on other instruments, including lending. For example, green loans account for only 10 billion USD out of the total volume of global green market of bonds and credits which was more than 257 billion USD in 2019, i.e., about 4% (Climate Bonds Initiative, 2020). Hence, green lending has not received adequate attention, despite its accessibility to a wider number of borrowers and its simpler management compared to the bond issuance mechanism. In this regard, the purpose of this paper is to explore the theoretical and practical aspects of green bank lending as one of major areas of green financing.

Background and Methodology

It will be logical to start the study of theoretic content of green lending with the identification of prerequisites to its emergence and development. Thus, United Nations Environment Programme (UNEP), which was developed in 1972 and marked the beginning of coordinated efforts for environmental protection and origin of the green economy at international scale, is generally considered to be the underlying conceptual framework of green financing. As a consequence of further activities and the adoption of official documents, a complex representation of the so-called sustainable development has been formed, which should ensure balance and unity of three essential components: environmental, economic, and social development component. This approach requires some realignment of milestones of the management of state and an individual enterprise in the implementation of the relevant principles. Accordingly, the changes being introduced are primarily relevant to the economy, which is certainly one of the bases for the implementation of sustainable development, for which cause the concept of “green economy” emerged. Thus, the most common interpretations of this term show that the green economy should be aimed at improving the economic growth while ensuring social equity and mitigating environmental risks, or even fully identified with the sustainable economy (e.g., according to the definition offered by the Green Economy Coalition) (Allen & Clouth, 2012).

Green financing, in turn, is an essential component of the green economy. In addition to the above, despite the fact that the concept of "green financing" is in most cases associated with money flows allocated to environmental goals, several approaches are used when formulating its specific content. These approaches primarily differ by the type of sectors on which the emphasis is made, and a specific list of aims and allocations of financing. Thus, a document published in China (Guidelines for Establishing the Green Financials System, 2016) primarily includes financial services with green finance, which is indicative of a primary focus on the financial sector, and the goals of green financing include environmental development, mitigation of global climate change, and more efficient use of resources. The representatives of the European Commission deem it necessary to consider green financing as one of the directions of sound finances and take into account currently available interpretations of green financing, including the concept of Deutsches Institut für Entwicklungspolitik, which includes both public and private financing of environmental projects with the components of green financing (Walter et al., 2017). This fact implies that the European Commission gravitates toward the broadside approach to the interpretation of green finance. Moreover, UNEP brings together various interpretations of green finance and uses it as a basis to establish a clear correlation between green financing and related definitions (UNEP Inquiry, 2016). Thus, if the relevant terms are distributed according to the extent of coverage of target allocations they designate from the narrowest to the widest, the following chain lines up: Low-carbon—Climate—Green—Socioenvironmental—Sustainable. Judging from the above, green financing is one of the types of financing for sustainable development, which covers money flows allocated to projects that are implemented taking into account the need for limitation of climate change or adaptation to it and to other environmental goals, which makes this concept similar to the term "ecologically responsible financing".

Russian regulatory framework, despite the use of definitions "green technologies", "green growth", "green financing", and other similar concepts with the adjective "green", has no clear official definitions thereof. However, the analysis of the context of some documents (in particular, the above-mentioned Forecast of the long-term socio-economic development of the Russian Federation for the period until 2030) testifies that green technologies, for example, are associated with technologies in the field of efficient use of resources, improving environmental efficiency and ensuring environmental security, implementing practical measures aimed at the clean-up of past environmental damage and mitigation of adverse impact of production and consumption waste. In addition, according to expert judgment (Ivanov, 2020), Russian terms in the field of the green economy may include to the so-called best available technologies, the concept of which is enshrined in Federal Law No. 7-FZ "On Environmental Protection" of 10 January 2002, as well as projects in the field of energy conservation and energy efficiency, the possibility of State support of which was claimed in Federal Law No. 261-FZ "Concerning energy conservation and improving energy efficiency and concerning the introduction of amendments to certain legislative acts of the Russian Federation" of 23 November 2009. Hence, the semantic content of financing of relevant projects and implemented with account of best available technologies also stays within international interpretations of green financing.

Of course, not all financial flows can be exclusively aimed at solving environmental problems or at least taking into account environmental risks, at least at present. Hence, green financing is developed as a special component of the financial system (Fig. 31.1). Green financing, in turn, includes green lending along with green bonds, green insurance, and other financial instruments related to environmental protection.

That said, several approaches are applied to the interpretation of the concept "green loan":

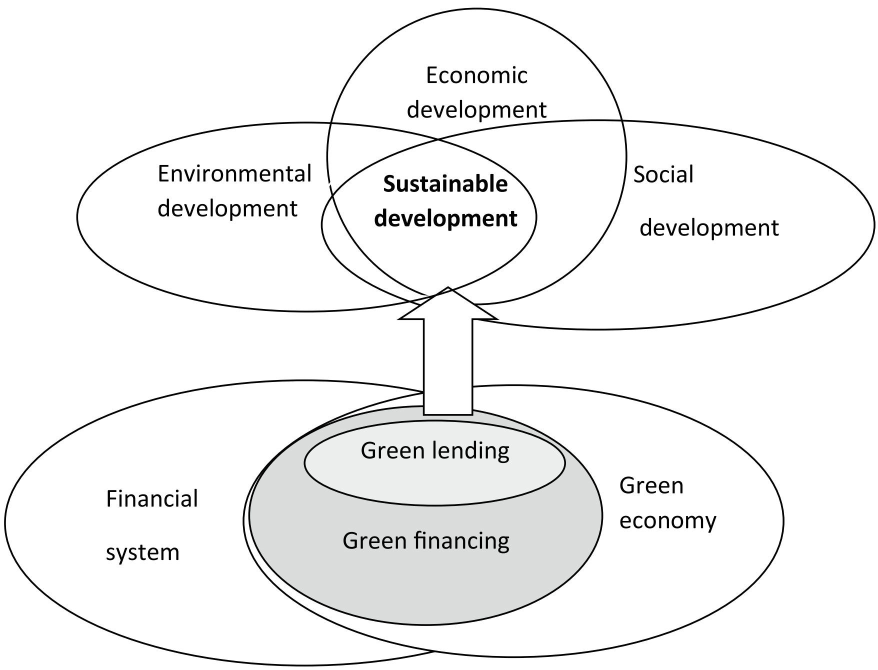

Fig. 31.1 Relationship between green financing/green lending and the concept of sustainable development (*Source* Developed and compiled by the authors)

- Consideration of green loan as any type of lending instrument which is one way or another related to the financing of the environmental (green) project, including within the scope of loan refinancing programs (Loan Market Association et al., 2020);
- Presentation of green lending as a strategy for supporting the formation of the green economy (Van Trang, 2016);
- Focus on preferential nature of such loans and the purpose of loan, related to technologies and methods to reduce carbon emissions (Australian English Dictionary, 2014);
- Identifying two categories within green loans: (a) lending for the production in the energy industry; (b) lending for projects and services in the field of environmental protection and energy conservation, subdivided into 12 subgroups (China Banking Regulatory Commission, 2013).

Hence, the term "green loan" is closely related to the concept "green project" ("environmental project"), which is interpreted as a project which is implemented within the framework of the green economy, that is, is aimed at ensuring environmental integrity, creating an infrastructure that would reduce the adverse impact of climate change, etc. (Expert Council on the Long-Range Investment Market Under the Bank of Russia, 2018). Relevant projects can be related, for example, to renewable energy, energy efficiency, sustainable waste utilization, sustainable land use, conservation of biological diversity, and green transport.

In addition to the above, similar to green bonds, the need has emerged to establish certain international generic approaches to green lending. Green Loan Principles, which were developed through joint efforts of three Associations (Loan Market Association et al., 2020), can be considered to be the best-known today.

Results

The study of theoretic and methodological aspects of green lending has made it possible to find out that it is conducted within the framework of general conceptual approaches to the formation of the green economy and green financing in particular. Hence, the management of green lending is based on conventional requirements to lending, but with due regard to the need to take into account the environmental component of the project.

It is expedient to primarily explore the relevant modernization of lending through the example of banks as the most important participants in the credit market. Thus, green bank loans have been quite extensively created and provided in international practice. That said, the environmental component is introduced not only into conventional loans for enterprises, but also into loan programs, which, at first view, are only tangentially related to environmental protection. For example, the "green" mortgage offered by foreign banks involves disbursement of loans for the purchase of energy-efficient houses, while "green" car loan involves disbursement of loans for the purchase of environmentally friendly vehicles at a reduced rate of interest (Bank of Russia, 2020).

In addition, loans adapted to environmental risk minimization goals have been emerging in the Russian banking market; two main groups can be singled out within them (Table 31.1):

– Individual programs related to environmental protection;

Table 31.1 Green loans in the Russian banking market

Bank	*Loan name*	*Loan specifics*
JSC ING BANK (YEVRAZIYA) (is included in international group ING)	Sustainability improvement loan	The credit agreement includes a term, according to which the credit interest rate can be increased or decreased as a result of the rating drift or a change in any other indicator of sustainable development of the borrowing company
PJSC CB Tsentr-Invest	Loans within the Program for the promotion of investments in energy conservation	The loans are granted for the introduction of energy-efficient technologies in industry, agriculture, services sector, public sector, housing and utilities sector, and private households. According to the results of the project implementation, reduced carbon dioxide emissions to atmosphere are calculated
PJSC Sberbank	Financing of projects that were received within the framework of the competition "Regions - sustainable development"	The project should be aimed at using high technologies and managerial decisions, including in the field of environmental problems. The project is financed on favorable lending terms
JSC Rosselkhozbank	Loans for the purchase of natural gas and natural gas fired machinery	The loans are granted on preferential terms within the scope of the national program of agricultural development

(continued)

Table 31.1 (continued)

Bank	*Loan name*	*Loan specifics*
PJSC Bank VTB	Loans for financing of renewable energy projects	These loans do not yet constitute an individual lending program of the bank, but are granted in a target-specific manner for projects that imply improvement of environmental specifications, reduce the consumption of natural resources and promote the use of renewable energy sources

Source Developed by the authors based on information provided by the banks operating in the Russian lending market

– Green loans which are provided within the framework of sustainable development credits.

Therefore, in order to provide quality loan facilities, the banks must develop appropriate green lending procedures, modernizing almost every stage of the credit process (Fig. 31.2).

Thus, at the preparatory phase, it is necessary to develop specific standards for green lending and criteria for the green project with account of international practices and regulatory requirements. That said, it is expedient to revise these standards at regular times with due regard to internal results of effected green lending and changes in regulatory framework, programs of competitors, and other external trends.

When the lending capacity of the borrower—a legal entity of an individual entrepreneur—is assessed, in addition to conventional requirements, one should pay attention to conformity of its activity to principles of the green economy. The objects of financing are also subject to a special analysis, that is, to what extent the loan-funded goals meet not only the general lending policy of the bank, but also the established criteria of "greenness". If an investment project is funded, the assessment should be even more detailed, since the level of impact on the environment, the potential beneficial effect for the environment from the project implementation, and other environmental characteristics need to be calculated, which requires special skills of the bank's employees. In this regard, an external credit assessment that can be conducted by specialized organizations is of considerable importance.

At the stage of development of lending terms and conclusion of a credit agreement, it is necessary to take into account the results of the previous analysis to determine whether special green lending terms (which are generally

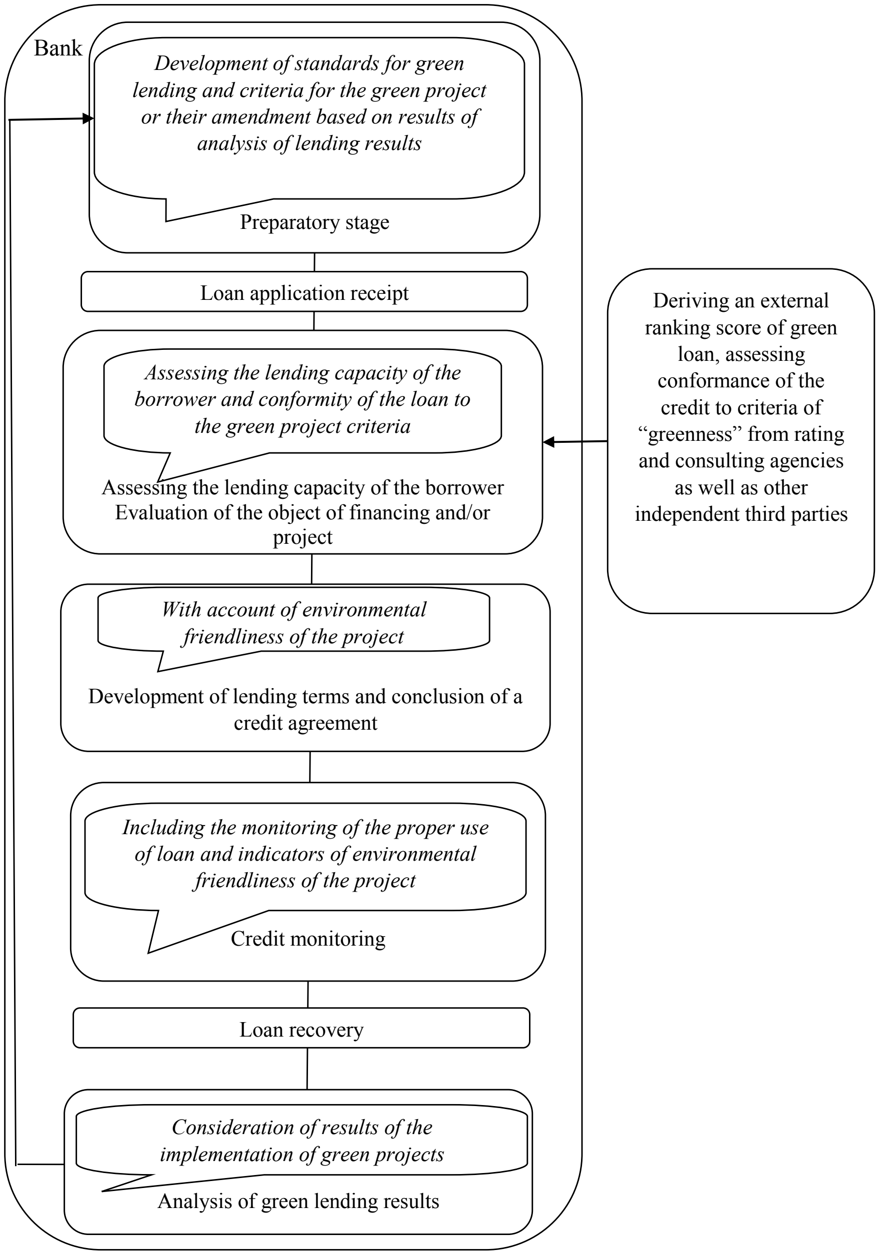

Fig. 31.2 Green lending process management in the banks (*Source* Developed and compiled by the authors)

preferential) can be applied to a particular transaction. This serves as a basis to establish particular lending parameters.

Credit monitoring is used to monitor the use of credit to environmental goals, as well as to measure the indicator values of the project which are indicative of the satisfaction of green project criteria (e.g., energy consumption, energy production, reduction of greenhouse gas emissions, etc.) (Loan Market Association et al. 2020; Miroshnichenko & Mostovaya, 2019).

Considering the fact that green lending can be considered to be a relatively young direction in the financial market, the final stage of analysis of lending results is of particular importance at present with due consideration of results of the implementation of green projects in order to clarify the following issues:

- To what extent the applied standards meet the actual needs of borrowers;
- Whether the risk management methods take into account the identified specifics of environmental risks;
- Whether the implemented lending programs provide the solution to environmental problems at the planned level, etc.

That said, such analysis can be performed not only at the intrabank level, but also within the framework of external centralized monitoring. Thus, in 2013, the China Banking Regulatory Commission (CBRC) established the Green Credit Statistics System (GCSS), which serves to collect and update information about outstanding amounts for "green" loans issued, about the quality of such loans, and about their environmental impact.

Conclusions and Recommendations

Thus, the research has found that green lending is one of the areas of green financing which includes various types of loans granted with account of the need for limitation of climate change or adaptation to it and other environmental goals. The management of green lending must be based on the best international methods and recommendations, including with due regard to the environmental risk assessment, the result of the implementation of loan-funded projects for environment, and other indicators in this field.

Efficient development of green lending is impossible without state support, appropriate regulatory environment, and infrastructure in general. Some of these areas are implemented in international practice and are discussed in economic literature (Babenko et al., 2020; Savinskiy, 2019; Yermakova, 2020; Yevishkin, 2020).

While systematizing and supplementing them, we believe it necessary to use a set of expansionary measures to support the development of green bank lending, including in Russia:

- Green loan refinancing by the Central Bank or an organization that has been specifically authorized for that purpose;
- State subsidization of interest rates on green loans;
- Setting lower interest rates, extended loan terms, and other favorable conditions for green loans;
- Lowering the bank reserve requirements for potential green credit losses;
- Reducing the risk-benefit ratios for green loans when calculating the shareholders' equity of the banks;
- Creating a special designated pool of funds from legal entities and individuals allocated for environmental project lending, for which lower rates of deductions to the mandatory reserve fund may be set;
- Tax concessions in the implementation of green projects;
- Developing an external rating system for green loans;
- Developing public-private partnership when financing green projects;
- Issue of government guarantees for green loans.

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CHAPTER 32

Investing in Greater Environmental Responsibility

Alexander P. Ilyin

Introduction

As a result of the LBO, the target corporation, as a rule, undergoes a delisting procedure (Renneboog & Vansteenkiste, 2017) and acquires the status of a private organization (a private company is a joint stock form of business without the circulation of shares on any stock exchange and, as a rule, with a relatively simple ownership structure without massive small investors). A private organization is armed with more ways to motivate management to act in accordance with the interests of shareholders. For example, new owners can directly enter management and having a controlling stake, transfer an arbitrary number of shares to management without facing restrictions on public companies, conclude an arbitrary contract by management without fear of a stock price reaction (Fenn et al., 1997). All these actions contribute to the redirection of some of the efforts of management from its own interests to the interests of the corporation, contributing to the growth of its value. On the other hand, a private organization is less dependent on the opinion of the mass investor, has fewer obligations to disclose information and, in general, can save on costs associated with publicity.

One of the hypotheses explaining the motivation of LBO is connected precisely with the possibility of saving on costs. The opinion that LBO and a going private transaction are almost synonymous is often found in Western financial literature and is based on facts: LBO is often not a merger/acquisition, but a buyout of a corporation by a group of individuals

A. P. Ilyin (✉)
Moscow State Institute of International Relations, Moscow, Russia

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(Fenn et al., 1997). The costs of maintaining a listing have been estimated by researchers at between \$100,000 and \$200,000 for US corporations (DeAngelo et al., 1984) and between £ 250,000 and a million pounds per year for UK corporations (Renneboog & Vansteenkiste, 2017). Listing is not the only form of activity that a non-public corporation can refuse; researchers also identify forms of activity, the exclusive meaning of which is to show signals about a stable financial position of the corporation to current and potential investors. For example, according to the theory of signals, a public corporation can pay dividends even if this is not the optimal option for using funds, but after the transition to the status of a private organization, withdrawals of corporate capital in favor of new owners are reduced (Bharath & Dittmar, 2010) … Empirical research confirms that savings on publicity costs are indeed a possible motive for LBOs, for example, a tendency has been found for relatively young public corporations to be delisted through an LBO transaction if a previous IPO did not achieve the planned results. In this case, the costs of publicity exceed the benefits, and organizations undergo LBO in order to reduce the costs of publicity, which confirms the hypothesis about the role of savings on various types of costs as one of the motives of LBO (Mehran & Peristiani, 2010).

The fundamental question is whether the costs of environmental projects are an example of the costs of publicity. The question is important because, in general, corporate spending on environmental projects is increasing (Gillan et al. 2010). There are three fundamentally different versions of motivating a corporation to implement costs in the framework of environmental projects:

(1) First, there is a direct link between environmental legislation, which is gradually tightening in Western countries, and the cost of environmental projects. Accordingly, there is a direct motive: corporations invest in environmental assets in order to comply with statutory requirements
(2) Secondly, regardless of legally established requirements, corporations can carry out environmental projects in order to attract additional attention of stakeholders: potential investors, consumers, and the public. This explanation is offered by the theory of signals, in which some of the actions of a corporation are carried out solely for the purpose of conveying certain information to stakeholders (Mahoney et al., 2013)
(3) The third hypothesis is that environmental projects pay off in the long term.

The idea of the study is based on the fact that if the second hypothesis is true, it may be beneficial for the organization to terminate environmental projects in the event of transition to the status of a private organization, since the capitalization of a private organization does not depend on the opinion of a mass investor, and its obligation to disclose information is small, including there is no obligation to publish so-called environmental responsibility reports. An organization that becomes private as a result of an LBO is an ideal subject to test this hypothesis, since we are talking about the same organization working on the same projects under the same legislation.

If such a corporation after the LBO stops environmental activity, this is evidence in favor of the second hypothesis. However, if projects continue, this is not evidence in favor of one of the hypotheses, since a private corporation can continue environmental projects in order to meet legal requirements, attract the attention of potential buyers, or make a profit if the projects pay off. The question is how exactly to estimate the share of environmentally active corporations that have terminated environmental projects after the transition to private status, in the total volume of environmentally active corporations that have passed the LBO.

Methodology

The problem with such a study is that there are no standard sources of information about environmental projects that are implemented by public corporations. Those corporations that are determined to draw attention to their environmental projects mention them separately in annual reports within the framework of Environmental reporting (Hossain et al., 2017), however, private corporations are not obliged to publish such a report and information about their environmental activities can only be obtained in two cases:

(1) If a private company voluntarily publishes information about its own environmental projects in public sources;
(2) If the environmental activities of the organization became the subject of proceedings or discussions, as a result of which some of the information became available.

Thus, the main task is to find information on the environmental activities of organizations that have become private as a result of LBOs and to identify those that have reduced the number of environmental projects or stopped them completely.

The research methodology is based on web search. It is assumed that the environmental responsibility of corporations and environmental projects is quite an important topic, including one of the topics that seeps into the news channels and is actively discussed on the Internet. In this case, if any of the corporations changed the principles of environmental policy after the LBO, this fact can be found on the network in thematic sources using text search technologies. The search is built on a special structure of text queries on the search engine.

The starting point for the study is the list of organizations that completed the LBO deal in the United States in 2018 or 2019. Since all organizations were public prior to the deal, their most recent (prior to LBO) annual reports are available. According to the annual reports, corporations were identified that paid attention to environmental projects. Indirect signs of ecological activity were also considered, like:

(1) The presence of a separate environmental report document or the corresponding section in the annual report;
(2) The presence of a section on environmental responsibility on the corporation website;
(3) Availability of separate statistics on environmental costs in the annual report.

Further, for each corporation whose environmental activity was confirmed during the publicity period, various text queries were built in the Google search engine, consisting of the name of the corporation and various combinations of terms that could be used in the text about the termination of environmental projects or the reduction of environmental costs. If such information is found, the corporation in question is identified as a corporation that saves on environmental costs in conditions when these costs do not need to be shown to the general public, which means that by its existence it confirms the signal hypothesis of environmental costs.

If hypothesis 2 is true, then it may be profitable for an average organization to invest in environmental technologies before LBO, but it is not profitable afterward, since the more urgent problem of debt repayment requires high financial flows, while environmental technologies (within the framework of hypothesis 2) are not able to influence costs and revenues in the short term, and the private organization that has become public no longer needs public attention. Thus, if a statistically significant decrease in the attention of organizations to investing in environmental technologies is found, this fact will indirectly indicate that modern environmentally efficient technologies have not reached the payback level and investments in them are mainly due to the signaling effect.

Of course, the described methodology is not without its shortcomings, and, first of all, this concerns its inability to refute the hypothesis about the exclusively signal motivation of the environmental costs of corporations. In the event that a statistically significant number of corporations are found that have suspended environmental projects after becoming private organizations, the result will indicate that the hypothesis is confirmed. However, in the event that such corporations are not found, several explanations can be assumed, in particular:

(1) Signal theory, if signals are targeted not at investors, but at consumers;
(2) Other explanatory reasons for environmental costs;
(3) Imperfection of the methodology, in particular—the inability of search queries to find the necessary information behind the information uproar;
(4) The desire of organizations to hide the termination of environmental projects and other reasons.

In any case, a negative result does not negate the signaling hypothesis of environmental costs.

Results

In the process of implementing the research algorithm, more than a hundred organizations and more than a thousand different Internet sources were analyzed. In the first stage of the study, environmentally active corporations were found among the corporations that went through the LBO deal. Indirect signs of high environmental costs were taken to be the presence of separate sections on environmental responsibility on websites and in the annual reports of corporations. Also, based on this stage of the study, ecologically inactive corporations were identified, which, based on annual reports, either did not engage in environmental projects, or did not focus on these projects (which is indirect evidence against the signal hypothesis).

In the second stage of the study, text search methods did not find evidence that one of the environmentally active corporations has stopped implementing environmental projects, reduced environmental costs, or otherwise reduced its own environmental activity. Thus, it cannot be said unequivocally that one of the consequences of the LBO deal is the reduction of environmental costs by the corporation. On the other hand, numerous facts were discovered, like, the general information on the background of corporations was reduced to almost zero after the LBO; for some, the very fact of the successful completion of the LBO was the last news reflected on the network, which is indirect evidence of the lack of publicly available information about what kind of activities private corporations are engaged in. …

Moreover, in the thematic literature (Barton & Uhlhorn, 2010), mentions and empirical evidence based on the results of surveys were found to be of the opposite trend—the tendency of private corporations to implement environmental projects on the basis of their own initiative. Polls show that the motivation for implementing environmental projects in private organizations is most often the personal initiative of the management or the return on investment of environmental projects. Thus, it can be argued that, even if the signal theory is correct, signals are not the only and exhaustive motive for the implementation of environmental projects by commercial organizations.

Conclusion

The study is devoted to an important issue related to the motivation of corporate environmental projects. Why do organizations spend money on environmentally responsible activities? Are such projects profitable? Or is the only function of environmental projects to demonstrate to stakeholders the environmental responsibility of the corporation? The signal hypothesis test is based on the assumption that the corporation will reduce environmental costs in an environment where public attention is no longer important, but the importance of payback and savings after LBO is. In the process of searching on the Internet, it was not possible to find a single fact that would indicate that the environmental projects of the corporation, which initially demonstrated a relatively high level of environmental activity, are terminated after the corporation passes into private hands. Moreover, facts of voluntary (i.e., not related to environmental legislation) initiation of environmental projects by private corporations were discovered.

The result shows that private corporations generally have no lesser level of environmental responsibility than public ones, which means they do not pose an additional threat to the environment and do not need additional regulation. On the example of LBO transactions, this fact is reflected in the following way: there is no information on the termination of the organization's environmental activity after the LBO. However, there are alternative explanations for the results obtained: information may be hidden by the new owners of the organization or be absent from the network due to insufficient publicity of private corporations.

The hypothesis of signal motivation for environmental costs cannot be uniquely confirmed or refuted based on the results of the study. The results obtained can be explained both by the fact that environmental projects pay off and therefore private corporations continue to implement them and by the fact that the need to send a signal to environmentally responsible buyers does not disappear during delisting. The lack of data on the environmental activity of private organizations does not allow making a clear choice in favor of one of the hypotheses.

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CHAPTER 33

Financial Sector Growth, Consolidation, and New Technologies Make It a Powerful Actor in Tackling Global Environmental Challenges

Vasily N. Tkachev, Elizaveta V. Kiseleva, and Olga V. Fedyanina

Introduction

The role of the financial sector in the global economy has been growing steadily in the last decades, together with its size. A report by OECD demonstrates that credit by banks and other intermediaries has risen strongly in nearly all OECD countries since the 1960s, on average more than tripling relative to GDP (OECD, 2015). The stock market capitalization has also expanded considerably—from 20% of GDP in 1975 to more than 100% of GDP in 2000. It reached up to 120% of GDP shortly before the Great Financial Crisis (GFC) of 2007–2008, slightly decreasing afterward. Though the GFC and the Pandemic of 2020 led to deceleration of the financial sector expansion, the importance of finance for the global economy is likely to continue to rise in the coming years.

The tremendous growth of the global financial sector is accompanied by consolidation trends in the financial services industry and the increasing level of concentration of financial capital in major economies. More than half of all financial assets in the world are now concentrated in the United States, though China is quickly catching up with the United States, turning into global financial power (Petrov et al., 2019a, 2019b).

V. N. Tkachev (✉) · E. V. Kiseleva
Moscow State Institute of International Relations (MGIMO University), Moscow, Russia

O. V. Fedyanina
British Embassy Moscow, Moscow, Russia
e-mail: olga.fedyanina@fco.gov.uk

E. B. Zavyalova and E. G. Popkova, *Industry 4.0*,
https://doi.org/10.1007/978-3-030-75405-1_33

The scale and impact of financial sector on the global economy define its pivotal role in tackling global environmental challenges through mobilizing financial resources, providing insurance coverage, and helping to manage and hedge risks. This idea was expressed by the President of the ECB and the former head of the IMF Christine Lagarde: "High insurance coverage and deep capital markets help mitigate the macroeconomic impact of disasters. This matters at a microeconomic level, too, where a lack of effective access to insurance and finance can lead to a disproportionately greater impact of disasters on poorer households. In the absence of insurance, households will have to rely more on precautionary saving or government transfers. Substantial investment is likely to be required to underpin the energy transition, with some estimates running to hundreds of billions of euro each year in the European Union alone. Meeting that challenge requires contributions from both the public and private sector" (Lagarde, 2020).

Therefore, one of the key questions that modern policymakers and business community have to answer is how to urge the global financial sector to provide finance of the quantity and quality that will be sufficient to tackle global environmental challenges in the most efficient way. This research aims to evaluate the role of the Industry 4.0 digital technologies as possible drivers of sustainable finance and positive global environmental changes in the coming years.

Methodology

The research is based on the analysis of reports and data provided by specialized international organizations, academic literature, official statistical data, and information from official Web sites of companies involved in sustainable finance activities.

In order to achieve environmental and other sustainable development goals, financial flows should be channeled into activities that can be considered sustainable and away from unsustainable ones. To conduct the research, we apply the approach and definitions of the European Commission. According to it, sustainable (responsible) finance can be defined as the process of taking due account of environmental, social, and governance (ESG) considerations when making investment decisions in the financial sector (European Commission, 2020). Environmental considerations can include not only climate change mitigation, but also such issues as the preservation of biodiversity, pollution prevention, and circular economy. Social considerations include the issues of inequality, human rights, investment in human capital and communities, and labor relations. Governance considerations are related to management structures, employee relations, and executive remuneration and should ensure the inclusion of social and environmental considerations in the decision-making process.

We chose to evaluate the impact of the Industry 4.0 on the development of sustainable finance and environment by considering the application of artificial intelligence, since artificial intelligence is generally accepted as one of the most important features of the Industry 4.0.

Results

Financial instruments and mechanisms by themselves are sustainability-neutral. For investments to be directed primarily to responsible companies the latter should provide additional value to investors. The factors that create such additional value can be broadly divided into subjective (willingness to invest sustainably) and objective ones (such as impact of ESG factors on performance and risk of financial instruments).

Today the number of sustainability-aware investors is steadily growing. These fund-owners want not only to earn return on their assets, by also to make environmental and social difference, and are sometimes ready to tolerate slightly lower yields on ESG investments in comparison with other instruments that are present on the market. A survey of retail investors conducted by 2° Investing Initiative, demonstrated that two-thirds of French and German retail investors want to invest sustainably, with 64% of retail investors accepting a hypothetical −5% trade-off on their total returns(The 2° Investing Initiative, 2020).

However, with large institutional investors being the main actors on global financial markets, the rapid development of responsible finance should still be based on objective factors, such as performance and risks.

The risks posed by ESG factors can be broadly divided into two main categories: physical risks and transition risks (Network for Greening the Financial System, 2020b):

- Physical risks. Natural calamities and environmental incidents, as well as an array of social and governance risks can lead to substantial losses of assets incurred by nations and companies. In turn, financial institutions can be affected via their exposure to sovereign and corporate borrowers. The recent rapid growth of sustainable finance, in part, has been prompted by the growing awareness that ESG factors can have a significant impact on companies and industries, while traditional pricing models usually disregard these risks due to the difficulties in the assessment of their probability and financial impact. The notion that the failure to price in ESG-related risks leads to distortion of market prices in favor of unsustainable practices and the assumption that, all risks considered, the effective yields on sustainable instruments in the long run will be higher in comparison with unsustainable ones, represents one of the key assumptions lying at the basis of sustainable finance.
- Transition risks arise from human efforts to confront ESG challenges and include changes in public policies (such as introduction of carbon-trading systems, green certificates, specialized taxes, and subsidies), technology breakthroughs, shifts in investors' preferences, and disruptive business

model innovations. The growing anxiety about negative externalities produced by some businesses and the need to tackle global problems, such as climate change, force governments to introduce ESG-related regulations and punish unsustainable practices with fines and specially designed fees. Firms that fail to meet forthcoming regulatory requirements risk to find delayed compliance increasingly expensive.

Though physical risks may seem to influence performance of portfolios more directly, a survey of financial institutions conducted by the Network for Greening the Financial System, a group of central banks and supervisors, demonstrated that in most cases the key consideration of portfolio managers was not the risk differential between green and brown assets, but rather more diffuse perception of risks (Network for Greening the Financial System, 2020a). Most banks pursued sustainable practices as part of their corporate social responsibility strategies or in an attempt to mitigate reputational, business model, and legal risks, in other words, transition risks. Only five respondents claimed to have conducted backward-looking analysis on a potential risk differential between green and brown assets, but failed to achieve robust results, which can be explained by the absence of common classifications and limitations of backward-looking analysis (historical data do not reflect future climate-related risks). Many respondents underlined the lack of standardized client data as the main obstacle for defining the greenness of an asset. At the same time, respondents noted that companies with ESG projects are expected to have a better risk profile, as they are better informed of their environment and benefit from long-term rise in profitability in case they invest in energy-efficiency projects.

The Size of the ESG Market

Sustainable finance has already become a major trend on financial markets, though it can be difficult to calculate its share in the total sum of allocated funds due to the lack of established definitions. The estimated volume of ESG-principled investing varies from US$3 to US$31 trillion, which constitutes almost one-third of global assets under management (IMF, 2019). The ESG-dedicated funds account for US$850 billion of assets (or 2% of global assets under management) and are forecasted to grow rapidly in the coming years. Equity-based ESG funds controlled US$560 billion of assets in 2019. Global green bond issuance amounted to $168.4 billion in 2018.

The largest ESG markets are located in the European Union, the United States, and Japan. While in the US and Japan the strongest growth factor is environmental, in Europe the growth is driven mainly by governance factors.

ESG-Related Instruments and Practices

Financial markets have responded to the growing demand for sustainable financial instruments by offering a new array of investment opportunities—from green bonds to ESG-dedicated funds.

The rise of sustainable investing in equities came after the release of the UN Principles of Responsible Investment in 2006 and was prompted by acknowledgment of the substantial nature and long-term character of ESG-related risks.

A breakthrough in fixed-income sustainable investment followed in 2007, when some multilateral development organizations (International Bank for Reconstruction and Development, European Investment Bank) issued green label bonds. The Green Bond Principles and the Climate Bond Initiative were later developed to set up standards for green bonds issuance.

Institutional investors adopt ESG principles by subscribing to international ESG standards. The leading international organization in the field of developing such standards is the United Nations Environment Programme Finance Initiative (UNEP FI), a partnership between UNEP and the global financial sector that aims to mobilize private sector finance for sustainable development. UNEP FI has established or co-created Principles for Responsible Banking (PRB) (subscribed by more than 130 banks with the total sum of assets amounting to US$47 trillion, or one-third of the global banking sector), Principles for Sustainable Insurance (PSI) (applied by insurers that account for 25% of the world premium) and Principles for Responsible Investment (PRI) (applied by half the world's institutional investors with US$83 trillion in assets). It also supports Sustainable Stock Exchanges Initiative (SSEI) that today involves 90 stock exchanges representing almost all publicly listed capital markets (UNEP Finance Initiative, 2020).

The leading world banks have already subscribed to the Equator principles, undertaking to promote sustainable practices and to deny financing to unsustainable businesses.

Rating agencies develop specialized indices of sustainable businesses and assets (such as Dow Jones Sustainability Index, FTSE Global Climate Index Series, FTSE ESG Index Series, S&P Green Bond Select Index). In addition, they start to accompany their credit risk assessment reports with nonfinancial information arising from sustainability considerations.

The VanEck Vectors Green Bond ETF has become the first US-listed fixed income ETF for US and foreign green bonds, tracking the performance and yield characteristics of the S&P Green Bond Select Index.

Approaches to Incorporation of ESG Principles into Business Models

Financial institutions can choose different ways to incorporate ESG considerations into their investment decisions. Some of the most commonly used methods include:

- Negative screening, the most widely applied practice, which implies excluding from portfolios companies or entire sectors on ethical or religious grounds (such as tobacco, alcohol, and munitions) or based on environmental considerations (coal mining and coal-fired plants, sand oil, Arctic oil, and gas activities);
- Positive screening, developed later than negative screening, favors companies that comply with certain minimum ESG standards or norms (norm-based screening), or sectors and firms that are considered sustainable (sustainability-themed investments);
- ESG scoring uses a set of metrics to evaluate a company's performance across a number of ESG factors. The scores can further be used to compose sustainability rankings or be incorporated into broader credit scores;
- Limiting exposure to risk sectors as percentage of total financing and setting targets for exposure to positive impact activities are commonly used by financial institutions as part of their sustainability strategies.

Barriers to the Development of ESG Investing

Despite the growing demand from investors and clients, investment managers face significant impediments when trying to implement ESG principles into their investment decisions.

To start with, the unified global criteria for what can be considered ESG investment have not yet been developed. The same can be said about consistent methodologies and reporting standards.

The existing corporate ESG reporting is largely voluntary and inconsistent, as a result, only a small proportion of enterprises now publish ESG reports. Therefore, anyone trying to estimate ESG performance of a company has to deal with the lack of reliable and consistent information. In addition, some companies involve in so-called greenwashing (providing unrealistically positive reporting on implementation of ESG principles in their operations), attributing themselves responsible corporate behavior that they in fact do not pursue.

The G20 identifies such barriers to scaling and deploying sustainable finance as: information asymmetries; limited analytical capabilities (including difficulty in fully identifying, assessing, and pricing risks associated with unsustainable investments as well as upside opportunities of sustainable financing); maturity mismatches (lack of long-term funding required for sustainable projects); lack of internalizing environmental and social externalities (Sustainable Finance Study Group, 2018).

Performing ESG assessment in the absence of specialized disclosure implies processing vast amounts of unstructured and incompatible data from various sources. Hiring a team of analysts to conduct a specialized research would imply disproportionately high costs for an investor. On the other hand, companies, especially small businesses, can view ESG disclosure as an unnecessary expense.

Overall, high costs related to ESG disclosure may be considered a factor that drives both borrowers and lenders away from responsible financing. Therefore, digital solutions that would assess a company's ESG performance at a tolerable price could significantly accelerate the growth of responsible investing and, as a result, contribute to sustainable development.

The Promise of Data Science

Linking specific sustainable digital finance practices to the evidence of their impact demonstrates that digital finance that includes the use of such Industry 4.0 technologies as big data, artificial intelligence (AI), machine learning, blockchain and IoT in the financial sphere, contributes to achieving 13 out of 17 sustainable development goals (G20 Sustainable Finance Study Group, 2018). More specifically, digital finance accelerates the development of sustainable finance.

The potential of artificial intelligence, machine learning, and fintech in promoting responsible investment has been recognized on the highest level. In November 2019, the Monetary Authority of Singapore (MAS) announced the Green Finance Action Plan to promote a more sustainable financial system, which identifies harnessing technology to enable trusted and efficient sustainable finance flows as one of the four key thrusts. In June 2020, the Swiss Federal Council issued a report and guidelines on sustainability in the financial sector, stressing the key role of green fintechs as innovation drivers, and conducted the 2020 Green FinTech Survey to reveal obstacles and opportunities for fintechs to deliver positive environmental impact that transcends Switzerland's borders.

The processes that are expected to be facilitated by data science technologies include:

- Gathering and initial processing of standardized information. Algorithms, that would automatically collect accurate, consistent, and timely ESG relevant data, such as information represented in corporate ESG reports, are expected to accelerate and to lower the cost of ESG compliance assessment. This could be particularly useful when updating ESG indices. It has been estimated that applying algorithms to perform repetitive and high-frequency tasks can reduce operation costs of businesses by 50–70% (EY, 2016);
- Identifying patterns, references, and links across vast amounts of unstructured data. Development of such technologies can be considered a complex and difficult task, however, they could significantly enhance the effectiveness of decision making, risk pricing, and capital allocation;
- Detecting and eliminating inconsistencies to improve data quality;

- Measurement of ESG factors and their incorporation in pricing and decision making. The losses caused by ESG risks, such as climate change, are large, nonlinear, and hard to estimate. They can be incurred by particular companies or affect broader economic conditions, affecting volatility of financial markets and economic growth. Applying artificial intelligence to model these effects can help to better estimate their scale and identify the transmission channels, which can be used both by businesses (such as insurance firms to better assess risks and calculate premiums) and governments (to effectively internalize negative externalities by charging taxes and fines);
- Increasing transparency. Automatic processing of ESG data by artificial intelligence would ensure reliable and real-time disclosure, facilitate comparisons and eliminate greenwashing;
- Automatization of credit approvals;
- Facilitating regulatory compliance;
- Tailoring portfolios to investors' preferences;
- Other. Digital technologies can supply the financial industry with completely new tools. For example, a research conducted by Sony CSL for Japan's Government Pension Investment Fund found that AI can successfully define fund managers' styles and drifts by analyzing trading behavior data, and can therefore help to appoint managers, whose values and trading patterns are consistent with the goals and investment strategy of the fund (Sasaki et al., 2018).

The process of incorporating digital technologies into sustainable finance can be prompted by the fact that the already existing machine learning models and quantitative methods, used in other thematic and non-thematic portfolios, can be applied to EGS-financing as well, without the need to develop specific approaches.

The Examples of Companies Offering AI Solutions for Sustainable Finance

The first sustainable finance digital solutions have already found their way onto the market.

- One example of a company that applies AI to provide alternative ESG data insights to institutional investors is Truvalue Labs, which sells its services to the UK's £30 billion Brunel Pension Partnership and Government Pension Investment Fund. With the help of natural language processing and machine learning, it mines data from more than 100,000 non-company sources to help investors identify sustainable investments in accordance with their preferences;

- JP Morgan, an investment bank, applies AI-based Themebot to screen keywords in patent filings in order to find companies linked to new low-carbon technology;
- In 2014 Deep Knowledge Ventures, a venture capital firm, appointed an algorithm called VITAL (Validating Investment Tool for Advancing Life Sciences) to its boardroom. The algorithm proved useful when assessing future performance of biotech start-ups by detecting red flags that increased the probability of their failure;
- Sensefolio applies Machine Learning and NLP techniques to provide ratings on ESG performance of over 20,000 companies, claiming to derive data from more than 100,000 sources of information, including news, reports, social media posts, company reviews, etc. and mapping scores to 50 ESG subcategories;
- A similar service is provided by Sustainalytics, a Morningstar company, which compounds corporate ESG risk ratings. Sustainalytics also provides predictive analytics for smart climate investing and cheaper incorporation of ESG considerations into investment decision making;
- Ping An Group, a Chinese financial services conglomerate, aims to combine artificial intelligence with ESG to provide Ping An analysts with ESG-related investment suggestions, depending on their specific needs. AI is expected to automatically attribute about 500 ESG-related labels to investment projects based on their policy papers and principles; besides, the algorithm helps to reveal when and how investment decisions failed to comply with ESG principles, thus strengthening performance management of ESG;
- In Switzerland, a fintech platform yourSRI.com screens approximately €15 trillion of assets under management every day, enabling investors to create ESG ratings, receive key performance indicators and discretionary investment mandates for mutual funds and ETFs with one click. The platform combines traditional financial data (Thomsom Reuters/Lipper) with ESG data (MSCI ESG Research) and carbon data (ISS-Ethix) to automatically calculate environmental and social score of a fund as well as its carbon footprint;
- FTSE Russel in the UK created a new smart Global Climate Index that uses data from the FTSE Green Revenues data model to hedge climate-related risks and detect the upside opportunities from the transition to a low-carbon economy;
- Similarly, Deutsche Bank in cooperation with Solactive announced the launch of the Solactive Sustainability Index Europe, based on the S-Ray platform, a data-driven machine learning investment tool, to track the performance of environmentally and socially responsible European firms;
- Big data, machine learning, and AI have already transformed alternative lending platforms that started to offer loans to a broader base of customers and a new class of investment opportunities to savers. For example, Mercado Crédito in Argentina evaluates 400 variables when

providing loans to small enterprises in order to unlock innovation for social impact;

- A number of alternative finance platforms use artificial intelligence to find optimal investment opportunities for their customers. For example, CleanTek Market in Australia uses algorithms to match organizations active in the cleantech sector with each other, evaluate the quality of the deal and aggregate small projects into larger deals;
- A partnership between CréditAgricole Assurance and Airbus utilizes satellite imagery to enable precise calculation of losses incurred by grassland owners and farmers due to climate variations, which facilitates the development of innovative insurance products;

Risks

While giving a promise of tremendous benefits when it comes to evaluating and preventing ESG-related risks, artificial intelligence can itself become an ESG risk for societies and companies that aim to implement it into their operations.

- For one thing, the use of artificial intelligence could create a significant negative environmental impact, as the technology requires large amounts of computing power and can be considered highly energy-consuming. Mining of metals used to produce hardware can add to ecological degradation;
- Besides, like in any other sphere, artificial intelligence in finance aims to replace people when it comes to routine intellectual operations, such as gathering of information and its initial analysis. This, in turn, raises the question of possible layoffs and can add to social inequality and instability—the risks that AI is meant to help to mitigate. A 2018 report by OECD states that thought the worries about "massive technological unemployment" are exaggerated, automation in certain industries may lead to further polarization of the labor market;
- More detailed risk assessment in insurance increases the chances that some people or social groups become uninsurable. In sectors other than insurance, bias in algorithms can give rise to financial exclusion of disadvantaged groups;
- While the application of AI to make ESG-related investment decisions can improve the image of a company, the questions of ethics and privacy when collecting and processing information, including large amounts of highly personal data that especially financial institutions have access to, may act to the opposite;
- Another concern voiced by researches in the field of AI states that algorithms may replicate existing problems in society if the datasets that are used to teach the machine are themselves biased;

- The backward-looking character of data that algorithms analyze defines limits to what AI can do in finance;
- AI cannot be considered a reliable tool for predicting and estimating regulatory risks;
- Some other impacts of excessive use of artificial intelligence may be difficult to anticipate, such as its possible effects on democracy, the rule of law or on the human mind itself.

Taking the possible risks related to artificial intelligence into account, the United Nations suggested that AI algorithms should be subjected to special auditing to ensure that they benefit to the UN Sustainable Development Goals (Truby, 2020). The auditing should not, however, be so burdensome that it prevents innovation.

European Commission responded to the ethical and sustainability risks posed by artificial intelligence by developing Ethic guidelines for trustworthy AI. The report states that AI can be considered trustworthy if it displays three main characteristics: It should be lawful, ethical, and robust. The framework also outlines the seven key requirements that AI systems should meet in order to be deemed trustworthy: human oversight; technical robustness and safety; privacy and data governance; transparency; diversity, non-discrimination, and fairness; societal and environmental well-being for all human beings, including future generations; accountability.

General Data Protection Regulation, introduced by the EU in 2018, stipulates that any company can be required by the European Union to explain a decision made by one of its algorithms.

Policy Implications

Governments can and should play a leading role in encouraging wider use of digital technologies in sustainable finance by:

- Raising awareness about the potential, opportunities, and threats connected with utilization of digital technologies in sustainable finance;
- Providing risk assessment and disseminating knowledge about new sustainable digital finance solutions;
- Developing standards, methodologies, and legal frameworks in the field of sustainable finance;
- Hosting multistakeholder platforms to initiate discussion and serve as centers of gravity for action on sustainability;
- Introducing financial and other stimulus to promote sustainable investment;
- Improving digital and financial infrastructure;
- Integrating sustainability elements into the existing financial system.

Despite the bright prospects for the application of AI to evaluate corporate ESG performance, introduction of policymaker actions that would standardize and incentivize disclosure can significantly accelerate the growth of sustainable finance. Governments can not only improve reporting standards, but also guide companies in data analysis and risk analytics, developing methodologies that would efficiently price in externalities, evaluate and mitigate risks and turn long-term benefits from sustainability into today's performance. More and better data can reveal the spheres where market mechanisms fail to take negative externalities into account and therefore some policy action is needed. Finally, governments can introduce incentives to foster the development of sustainable finance markets.

Multilateral cooperation of countries in the field of ESG-related standards and supervision can help to overcome the lack of supervisory capacity and to avoid fragmentation of sustainable asset markets.

Artificial intelligence can be applied when developing the mentioned standards and regulations to define the most crucial ESG factors and to develop techniques of negative externalities internalization.

Conclusion

The research has identified two possible sources of growth for sustainable finance: the increasing willingness of ecologically and socially aware individuals to invest sustainably, even if at lower yields, and the assumption that, should ESG-related risks be properly reflected in the prices of financial instruments, sustainable investments would demonstrate better long-term performance-risk ratios in comparison with unsustainable ones. Though the second factor holds far greater potential, as it automatically increases the attractiveness of responsible investments for all market participants, until now financial institutions have struggled to develop methodology and instruments to effectively price in ESG-related risks. However, investors' demand for sustainable instruments, complemented by policy shifts toward sustainability in some countries, has turned out sufficient to instigate the development of a wide array of ESG-related instruments and has led to the emergence of noticeable and dynamic sustainability sector on the financial markets.

Still, it can be expected that further development of sustainable finance will be founded on pricing in risks and negative externalities associated with unsustainable business practices. Today financial intermediaries face numerous obstacles when trying to create ESG profile of a business. Some of the widely recognized impediments include the lack of standardized definitions of sustainable activities and instruments; the voluntary and inconsistent nature of corporate ESG disclosure; the complex and long-term character of ESG-related risks.

The further analysis has revealed that such Industry 4.0 technologies, as big data and artificial intelligence, can in a large part eliminate these barriers by speeding up and reducing the cost of collecting and processing vast amounts of unstructured ESG-related data and, consequently, accelerate the rise of responsible investment.

However, as the industry is still in the process of formation, active governmental supervision is required to ensure efficient and orderly development of sustainable finance. Financial authorities are expected to promote responsible investment by developing legal frameworks and guidance for financial institution as well as introducing regulations to internalize ESG-related externalities (such as quota trading systems, ESG-related fines, and fees). Besides, specialized supervision and regulations should be implemented in order to minimize the ESG-related and privacy risks accompanying the use of digital technologies in finance.

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CHAPTER 34

Financial Provision of Energy Security of Regional Economy in Transition to Industry 4.0

Vladimir S. Osipov, Murat A. Bulgarov, Oleg F. Krivtsov, and Sergei G. Vagin

Introduction

The energy aspect of the transition to Industry 4.0 is one of the most controversial in its management. With selective digitalization of the economy, Industry 4.0 is limited to individual high-tech markets, which is usually focused on industrial production. In this case, digitalization occurs according to the model of strengthening the specialization of economic systems in the real sector, which leads to an increase in energy consumption even while maintaining the current technological structure.

When moving to a higher technological layout, there is a sharp jump in energy consumption, as economic processes become more automated and, therefore, more energy-intensive. The energy sector cannot increase supply in the short term, causing an energy collapse. A striking example of the process described is Japan's energy crisis in mid-January 2021.

V. S. Osipov (✉)
Moscow State Institute of International Relations (University) of the Ministry of Foreign Affairs of the Russian Federation, Moscow, Russia

M. A. Bulgarov
Kuban State Agrarian University Named After I.T. Trubilin, Krasnodar, Russia

O. F. Krivtsov
Russian University of Transport, Moscow, Russia

S. G. Vagin
MIREA—Russian Technological University, Moscow, Russia

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The rapid increase in energy demand was mainly due to an increase in household consumption (due to changing weather conditions), but, regardless of the reason, there was an acute shortage of electricity, which naturally led to a multiple increase in its prices. In the described model, either increasing energy imports or financial support for increasing production capacity in the energy sector allows for energy security.

In the case of system digitalization covering the energy sector, an alternative model is implemented in which Industry 4.0 covers the entire economy. This makes it possible to evenly increase the demand for energy and its production in the economy based on Smart Grid. Thanks to resource-saving technologies, the digital development of the economy can reduce energy consumption. In order to improve energy efficiency, industry finance 4.0 is needed.

Therefore, the energy risks of moving to Industry 4.0 are high and need to be managed, in which financial security is important, requiring a flexible approach. To take into account the specifics of the digital economy of the economic system, energy security should be managed at the regional level within the country. This article hypothesizes that the second model is being implemented in the regions of Russia: the transition to Industry 4.0 contributes to improving the energy efficiency of the economy, and ensuring energy security requires financial support for Industry 4.0 as a whole.

The hypothesis put forward is opposite to the approach to financing Industry 4.0 in Russia when implementing many separate industry projects. The purpose of the article is to study the experience and prospects of financial support for the energy security of the regional economy in the transition to Industry 4.0 in modern Russia.

Literature Review

Energy security through the prism of energy efficiency is discussed in the publications of scientists such as Bogoviz et al. (2020), Inshakov et al. (2019), Lobova et al. (2019), Popkova and Sergi (2021), Popkova et al. (2019a, b), and Sisodia et al. (2020). The digital modernization of the energy sector of the economy and the transition to smart energy (Smart Grid) are disclosed in the works of researchers such as Ahuja and Khosla (2019), Gajula and Rajathy (2020), Isingoma-Wakaisuka et al. (2020), Mir and Ketti Ramachandran (2019), Nobre et al. (2019).

Therefore, the overall fundamental basis of the energy security issue in the transition to Industry 4.0 is formed, which provides a reliable theoretical basis for this study. At the same time, the regional and financial aspects of the problem remain poorly understood and are gaps for which this article examines the financial security of the energy security of the regional economy in the transition to industry 4.0.

Materials and Method

In order to test the hypothesis put forward, the article uses the methodology of economic statistics, using which regression relationships are established between the average annual change in electricity consumption (to Gross Regional Product - GRP) (y) as an indicator of energy efficiency and therefore energy security (according to Invest-Forsyth, 2021), the level of digitalization (d) and financial factors such as investment in fixed assets per capita (f_1), settled financial performance of enterprises (f_2) and regional budget balance (f_3). The values of factor variables are taken for 2021 (forecast data) from the dataset of the Institute of Scientific Communications (2021) on regional economics. The hypothesis is recognized as proven if:

$\beta < 0$ in a model $y = \alpha + \beta * d$.

A negative value of the coefficient β in the given regression model will mean that increasing the level of digitalization increases energy efficiency and, therefore, contributes to ensuring energy security (otherwise the hypothesis will be refuted). Regions of Russia with a different position in the Invest-Forsyth energy efficiency rating (2021), that is, with different energy security, were selected for the study, which ensured representativeness of the sample (the ability to extend the analysis results to the entire regional economy of Russia).

Depending on the results of the regression analysis and on their basis, the method of substitution in the regression equations will determine the optimal financial support and its direction in order to achieve the fullest possible energy security in the regions of Russia. In order to determine the prospects for the implementation of copyright recommendations, a variation analysis is carried out.

Results

In order to identify the digitalization model of the regional economy of Russia (fragmented digitalization or system transition to Industry 4.0) from the point of view of its consequences for energy security, a regression curve of the effect of the digitalization factor on energy efficiency is built on the basis of data from Table 34.1 (Fig. 34.1).

As it can be seen from Fig. 34.1, the coefficient β has a negative sign, which confirms the hypothesis put forward about the systemic digitalization of the regional economy of Russia. According to the regression equation, in 2021, an increase in the digitalization level of the regions of Russia by 1 point contributes to a decrease in energy consumption (in relation to GRP) by 0.2334% per year. This indicates the transition of the regions of Russia to smart energy (Smart Grid). Therefore, improving the energy security of the regions of Russia requires not isolated financing of the energy sector, but comprehensive financing of the digital modernization of the regional economy. Therefore,

Table 34.1 Energy security, the factor of transition to Industry 4.0, and factors of financial support in the regions of Russia in 2021

Position in rating	*Region*	*Average annual change in power consumption (to GRP), %* y	*Digitalization level, points 1–100* d	*Investments in fixed assets per capita, RUB* f_1	*Settled financial result of enterprises, million rubles* f_2	*Balance of the regional budget, million rubles.* f_3
Leaders	Arkhangelsk Oblast	−21.71	44.70	247,668.42	24,295.61	53,133.30
	Tyumen Oblast	−13.26	67.42	828,951.30	1,161,043.16	−285.67
	Volgograd Oblast	−12.00	51.61	88,602.38	0.73	22,494.44
	Republic of North Ossetia–Alania	−10.67	31.06	46,441.29	−0.59	−2,133.10
Rating Periphery	Ulyanovsk Oblast	−4.86	40.11	215,777.33	6,733.68	−9,452.30
	Novosibirsk Oblast	−4.86	54.07	82,228.76	773,861.22	6,835.29
	Republic of Kalmykia	−4.79	27.23	66,062.94	657.87	−870.80
	Republic of Karelia	−4.58	38.65	72,257.76	130,995.89	−1,218.59
Outsiders	Jewish Autonomous Oblast	3.71	26.85	59,119.19	0.00	−648.42
	Chukotka Autonomous Oblast	4.02	25.95	177,597.88	470.42	−17,399.48
	Kaluga Oblast	4.60	59.27	68,257.22	216,906.96	20,194.38
	Republic of Dagestan	5.18	27.57	62,816.22	−32,033.62	11,560.47

Source Compiled by the authors on the basis of the materials Invest-Forsyth (2021) and Institute of Scientific Communications (2021)

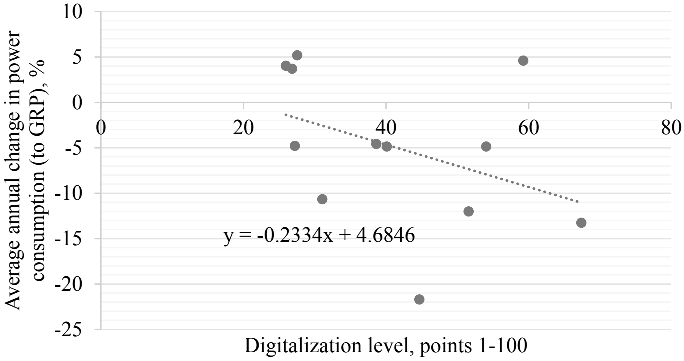

Fig. 34.1 Regression curve of the effect of digitalization factor on energy efficiency in the regions of Russia in 2021 (*Source* Calculated and compiled by the authors)

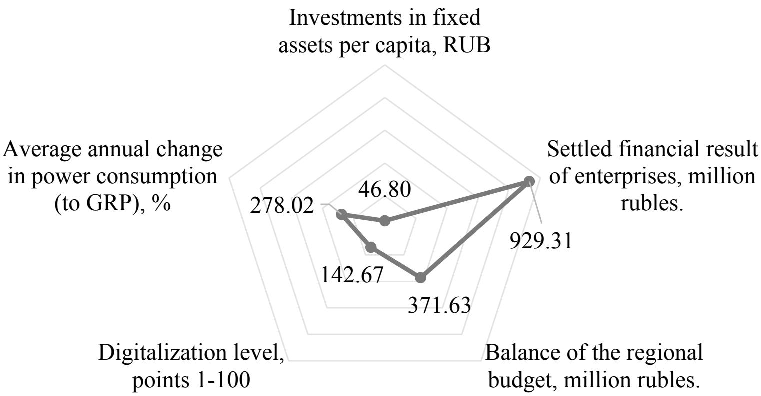

Fig. 34.2 Requirements for the financial provision of energy security of the regional economy of Russia in the conditions of transition to Industry 4.0 in 2021 (increase in indicators, %) (*Source* Calculated and compiled by the authors)

the regression dependence of digitalization on financial security factors was established and the equation was obtained:

$$d = 33.31467 + 0.000002 * f_1 + 0.000029 * f_2 + 0.000318 * f_3 \tag{34.1}$$

As it can be seen, all coefficients β in the constructed equation are positive. Consequently, all factors of financial support contribute to an increase in the level of digitalization of the economies of the regions of Russia in 2021. By the method of substitution in Eq. (34.1) and equation from Fig. 34.1, requirements for financial provision of energy security of the regional economy of Russia were obtained in the conditions of transition to Industry 4.0 in 2021 (Fig. 34.2).

The requirements obtained in Fig. 34.2 showed that with the highest level of digitalization (100 points, +142.67%) in the regions of Russia, the annual reduction in energy consumption can reach 18.66% (+278.02%), which will ensure complete energy safety. This requires:

- Increase of investments in fixed capital per capita up to 246601.40 RUB (+46.80%);
- Increase of the settled financial result of the enterprises to 1958197.73 million rubles (+929.31%);
- Increase of regional budget balance to 32310.70 million rubles (up to 371.63%).

In order to determine the achievability of the recommended requirements based on the data from Table 34.1, a variation in energy security, the transition factor to Industry 4.0, and the factors of financial support in the regions of Russia in 2021 are determined (Fig. 34.3).

As shown in Fig. 34.3, energy security in the regions of Russia is highly differentiated (variation -170.83%), as well as the values of financial factors. At the same time, the level of digitalization is relatively uniform (variation of 34.55%). This determines the moderately high probability of achieving the recommended requirements for financial security of the regional economy of Russia in the transition to Industry 4.0.

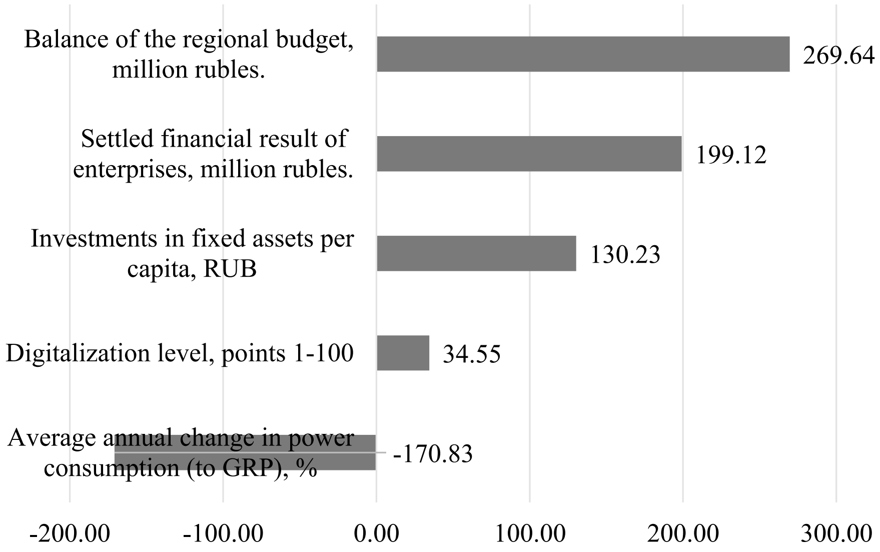

Fig. 34.3 Variation of energy security, transition factor to Industry 4.0, and factors of financial support in the regions of Russia in 2021, % (*Source* Calculated and compiled by the authors)

Conclusion

In such a way, on the example of the regions of Russia, a model of systemic digitalization covering the energy sector is demonstrated, in which the 4.0 industry is extended to the entire economy (the hypothesis is confirmed). For development of "smart" energy (Smart Grid) and ensuring energy security requirements for financial security of the Industry 4.0 in 2021, achievement probability in which practice is moderately high is recommended. By analogy with the regional economy of Russia, in future studies it is advisable to model the financial provision of energy security of the regions in the conditions of transition to Industry 4.0.

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CHAPTER 35

Financial Support for Circular Initiatives as a Basis for Ensuring the Environmental Safety and Sustainability of the Regional Economy in the Context of Industry 4.0

Veronika V. Yankovskaya, Margarita V. Vertiy, Natalia A. Rykhtikova, and Nikolai I. Berzon

Introduction

The implementation of circular initiatives in entrepreneurship contributes to increasing the sustainability of regional economic systems from the perspective of the noosphere approach as a fundamental scientific concept of sustainability. The noosphere is an area of economic activity in which the interaction and interaction of socio-economic activity with the environment is carried out.

At the theoretical level of economic science, it is assumed that circular initiatives allow from an environmental point of view to improve the state of the environment by reducing resource consumption (switching to reused resources). From a social point of view, it is to improve quality and increase life

V. V. Yankovskaya (✉)
Plekhanov Russian University of Economics, Moscow, Russia

State University of Management, Moscow, Russia

M. V. Vertiy
Kuban State Agrarian University named after I.T. Trubilin, Krasnodar, Russia

N. A. Rykhtikova
Krasnogorsk Branch of Russian Presidential Academy of National Economy and Public Administration, Krasnogorsk, Russia

N. I. Berzon
National Research University "Higher School of Economics", Moscow, Russia

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expectancy due to a more favorable environment. From an economic point of view (for business and the state), it is to increase the efficiency of entrepreneurship by saving on resources (reducing cost) and accelerate the rate of economic growth by overcoming the resource deficit.

In the 4.0 industry, circular initiatives are even more accessible thanks to the extensive automation of resource utilization, sorting, and recycling processes. Industry 4.0 is therefore called upon to contribute to the massive implementation of circular initiatives to ensure the environmental security and sustainability of the regional economy. However, as empirical evidence in the field of sustainable development shows, circular practices are not ubiquitous even in developed countries, but in developing countries such as Russia, they are the exception rather than the rule.

The divergence of theory and practice in the field of circular initiatives is an urgent scientific and practical problem that needs to be studied and solved. This article hypothesizes that the financial deficit is a deterrent to the promotion of circular initiatives, and increased financial support for circular initiatives will ensure the environmental security and sustainability of the regional economy in the context of Industry 4.0.

The purpose of the article is related to testing the hypothesis and developing recommendations for improving financial support for circular initiatives as a basis for ensuring the environmental safety and sustainability of the regional economy in the context of Industry 4.0 using the example of the regions of Russia.

Literature Review

The essence of the noosphere approach to the interpretation and management of the stability of the regional economy is disclosed in Grachev (2018a, 2018b), Turko (2019). Circular initiatives in entrepreneurship and their contribution to the environmental safety and sustainability of economic systems are outlined in the publications Bogoviz (2019a, 2019b), Hedlund et al. (2020), Khodaiji and Christopoulou (2020), Popkova and Parakhina (2019), Sergi et al. (2019a, 2019b, 2019c), Weigend Rodríguez et al. (2020), and Zhao (2020).

Based on the results of the literary review, it can be concluded that the issues of environmental safety and sustainability of the economy as a whole have been studied in sufficient detail and developed in the available scientific and economic literature, as well as the implementation of circular initiatives in entrepreneurship. At the same time, these issues are characterized by a gap related to the insufficiency of the financial aspect of supporting circular initiatives in entrepreneurship. The desire to fill the identified gap determined the purpose and organization of this research.

Materials and Method

The research is conducted in two steps. The first step: determining how much investment in fixed assets per capita (industry financing 4.0) is necessary to maximize the popularity of circular initiatives in entrepreneurship in the regions of Russia. To do this, the regression dependence of the share of organizations engaged in secondary processing on investments in fixed assets per capita is determined. The hypothesis is recognized as proven if the regression coefficient turns out to be positive, which will indicate a direct relationship of the indicators.

The second step is to identify the consequences of the widespread circular in entrepreneurship for the environmental security and sustainability of the regional economy of Russia. To this end, the regression dependence of environmental, social, and managerial sustainability on the share of organizations engaged in secondary processing is determined.

For the research, the top 10 regions of Russia on sustainable development (integral index) were selected in accordance with the ESG Rating Review (2021). The data required for the study for these regions are shown in Table 35.1.

Results

In the first step of this research, the regression dependence of the share of recycling organizations on investment in fixed assets per capita was determined (Fig. 35.1).

According to Fig. 35.1, with an increase in investment in fixed assets (in Industry 4.0) per capita by 1 thousand rubles, in the regions of Russia, the share of organizations implementing circular initiatives increases by 0.0085%. The relationship of the indicators is direct, which confirmed the hypothesis put forward.

The second step of this study identified the regression dependencies of environmental, social, and management sustainability on the proportion of recycling organizations, as shown in Figs. 35.2, 35.3, and 35.4, respectively.

In accordance with Fig. 35.2, with an increase in the share of organizations engaged in secondary processing, in the regions of Russia, environmental sustainability decreases by 1% instead of an increase (the position in the rating worsens) by 0.886 places, which is paradoxical.

According to Fig. 35.3, with an increase in the share of organizations engaged in secondary processing, in the regions of Russia by 1%, social stability increases (the position in the rating improves) by 0.2623 places.

According to Fig. 35.4, with an increase in the share of secondary processing organizations in the regions of Russia by 1%, management stability decreases instead of an increase (the position in the rating worsens) by 0.2183 places.

Table 35.1 Financial support, circular initiatives, and sustainability of the regional economy of Russia in the context of Industry 4.0 in 2021

Region	*Environmental (place by environmental factor)*	*Social (place by social factor)*	*Governance (place by management factor)*	*Share of organizations engaged in secondary processing (recycling) of production wastes, water or materials (%)*	*Investments in fixed assets per capita (in actual prices), thousand rubles*
Republic of Tatarstan	19	12	1	40.0	164.29
Moscow	42	5	3	50.0	225.90
Lipetsk Region	1	17	31	66.7	135.80
Khanty-Mansi Autonomous Okrug-Ugra	47	8	2	50.0	571.23
Kursk Region	3	20	16	25.0	131.08
Tyumen Region	27	13	4	50.0	567.17
Sverdlovsk Region	9	30	7	50.0	104.42
Leningrad Region	18	9	17	69.2	225.11
Saratov Region	5	44	26	33.3	69.06
Kaluga Region	7	29	28	62.5	107.61

Source Compiled by the authors based on RAEX Rating Review (2021), Federal State Statistics Service (2021)

Based on the regression equation obtained in Fig. 35.1, it was also established that in order to maximize the popularity of circular initiatives in entrepreneurship in the regions of Russia (100% of organizations implementing circular initiatives), it is necessary to increase the volume of investment in fixed assets per capita (industry financing 4.0) to 6,150.36 thousand rubles (by 2,572.15%), which is demonstrated in Fig. 35.5 together with the consequences for sustainability from the perspective of the noosphere approach.

As shown in Fig. 35.5, the achievement of targeted financial support for circular initiatives will produce conflicting consequences for the environmental security and sustainability of the regional economy in the context of Industry 4.0 in Russia:

- Environmental sustainability will decrease by 27.36% (to 22.67 places);
- Social sustainability will increase by 70.59% (to 5.50 places);

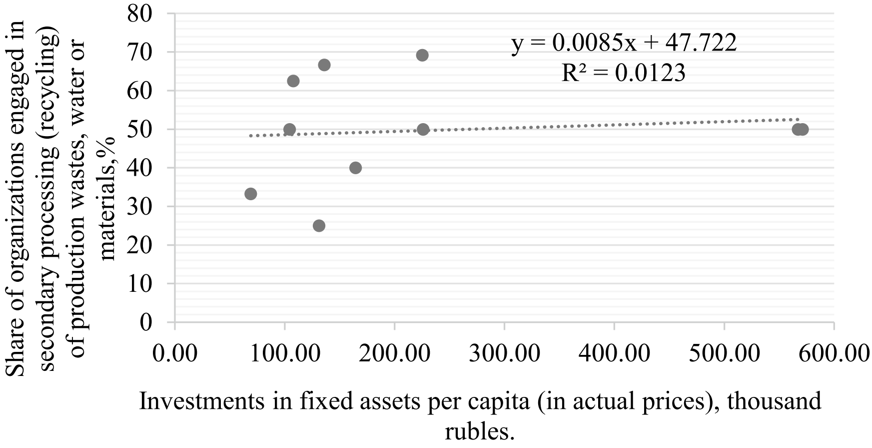

Fig. 35.1 Regression dependence of the share of recycling organizations on investment in fixed assets per capita (*Source* Calculated and built by the authors)

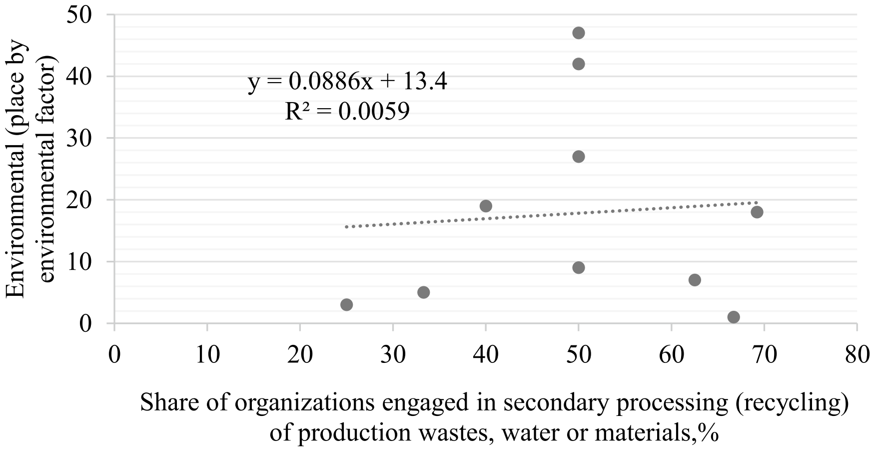

Fig. 35.2 Dependence of environmental sustainability on the share of organizations engaged in secondary processing in Russia (*Source* Calculated and built by the authors)

– Management stability will decrease by 81.37% (to 24.49 places).

Conclusion

Summarizing the above, financial support for circular initiatives is indeed needed, especially in the context of Industry 4.0. On the example of the regions of Russia, it has been proved that full-scale financial support allows you

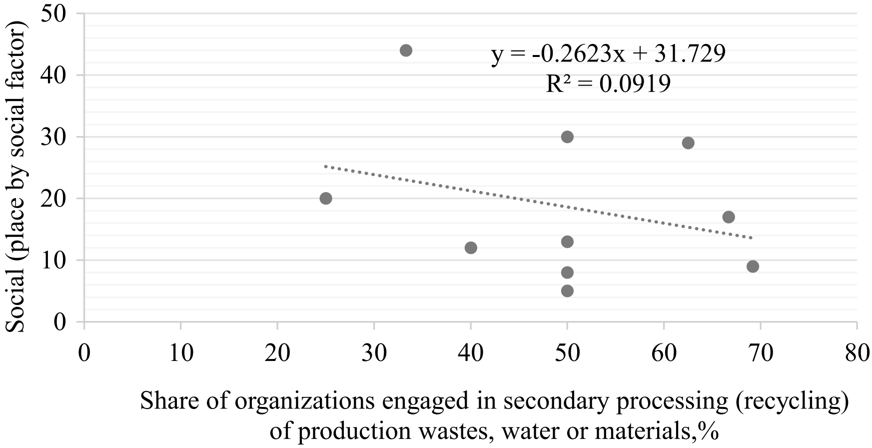

Fig. 35.3 Dependence of social stability on the share of organizations engaged in secondary processing in Russia (*Source* Calculated and built by the authors)

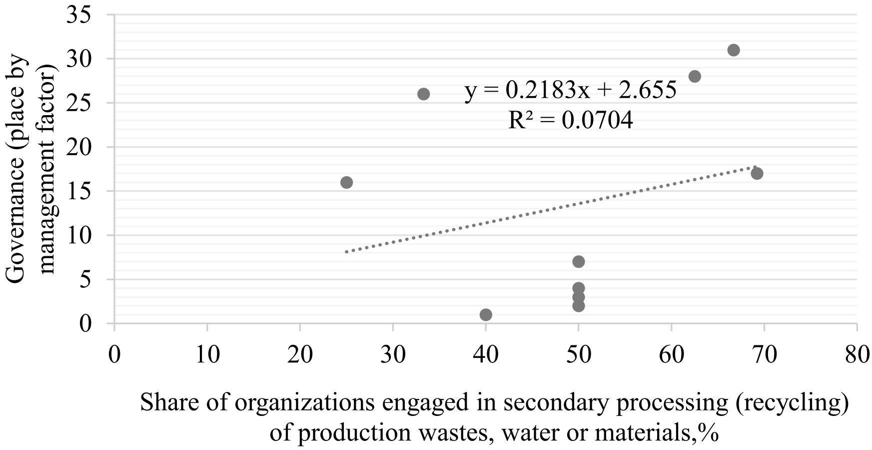

Fig. 35.4 The dependence of management stability on the share of organizations engaged in secondary processing in Russia (*Source* Calculated and built by the authors)

to achieve the complete circularity of entrepreneurship. However, the implications of this for the environmental security and sustainability of the regional economy are controversial and need to be studied in depth from the point of view of institutional economic theory—it is proposed to devote to it future scientific research.

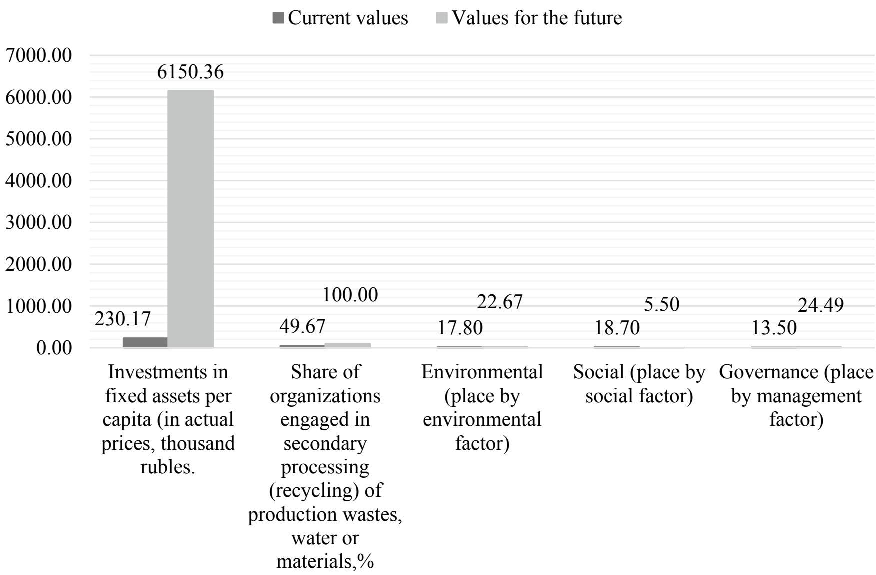

Fig. 35.5 Prospects for financial support for circular initiatives as a basis for ensuring the environmental safety and sustainability of the regional economy in the context of Industry 4.0 in Russia (*Source* Calculated and built by the authors)

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CHAPTER 36

Economic Growth vs. Ecological Safety: Financial Consequences of the Transition to Industry 4.0 for Russia's Regions

Galina N. Semenova, Mariana H. Barcho, Marina N. Rudenko, and Olga A. Ageeva

Introduction

Due to the influence of the COVID-19 pandemic and crisis in 2020—which is the most important factor of economic activities—the top-priority and strategically important—for the modern economy—initiative of the transition to Industry 4.0 has been moved to the background and even terminated. The plans for the digital reformation of economy around the world undergo serious transformations and are postponed. Instead of counting losses and evaluating the lost profit, it is expedient to use the pause in neo-industrialization, caused by the COVID-19 pandemic and crisis—to study the causal connections of digitalization—strengthen the substantiation of its necessity or reconsider its significance.

Acceleration of the rate of economic growth is among the key advantages of the transition to Industry 4.0. However, the potential of using the digital

G. N. Semenova (✉)
Plekhanov Russian University of Economics, Moscow, Russia

Moscow Region State University, Mytishchi, Russia

M. H. Barcho
Kuban State Agrarian University named after I.T. Trubilin, Krasnodar, Russia

M. N. Rudenko
Perm State National Research University, Perm, Russian Federation

O. A. Ageeva
State University of Management, Moscow, Russia

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vector of growth of the modern economy has not been precisely measured, while it is obvious that it varies depending on countries and regions. The consequences for ecological safety are ambiguous and could be positive in case of implementing the eco-oriented digital technologies and negative in case of implementing the leading, but ecologically hostile, technological innovations. It is also necessary to take into account the existing context and, instead of isolated study of Industry 4.0, to consider its capabilities to stimulate the normalization of the financial manifestations of the COVID-19 economic crisis and to take into account the financial risks of transition to Industry 4.0—since new losses for companies might become critical.

Thus, this chapter aims at formation of a systemic vision of the transition to Industry 4.0 from the positions of its influence on economic growth, ecological safety, and corporate finances in the context of the COVID-19 crisis and pandemic in 2020 by the example of Russia's regions. The hypothesis of this research is as follows: transition to Industry 4.0 might become a systemic solution to all current problems of modern regions, including acceleration of economic growth rate, provision of ecological safety, and financial crisis management in entrepreneurship in the conditions of the COVID-19 pandemic and crisis and in the post-pandemic period.

Literature Review

The influence of digitalization and transition to Industry 4.0 on the studied aspects of economic activities is considered in the following works:

- On economic growth: Bogoviz (2020), Bogoviz et al. (2019), Matrizaev et al. (2019), and Shahiduzzaman et al. (2018);
- On ecological safety: Popkova et al. (2020) and Popkova and Sergi (2021);
- On entrepreneurship's finances: Brammertz and Mendelowitz (2018), Guseva et al. (2019), He and Li (2020), and Ozili (2020).

However, there are certain gaps: in particular, there is no systemic view of the consequences of transition to Industry 4.0 for economic growth, ecological safety, and entrepreneurship's finances; neither is the context of the COVID-19 pandemic and crisis considered. Here we try to fill these gaps.

Materials and Method

The choice of regional economy for this research is explained, firstly, by the high level of regions' differentiation by all studied indicators: level of digitalization, rate of economic growth, level of ecological safety, and profitability of entrepreneurship. The COVID-19 pandemic and crisis also had different influence on the economy of Russia's regions. Secondly, the Russian economy

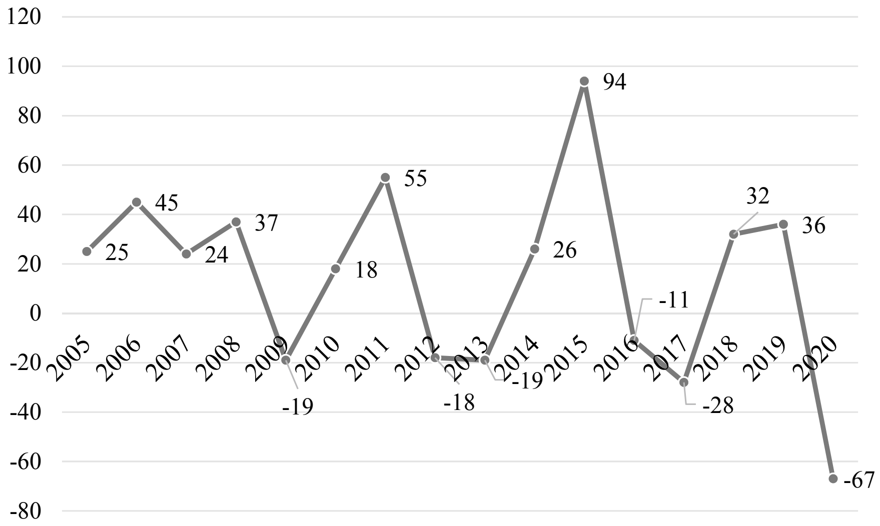

Fig. 36.1 Change of business's profit in March–May in 2005–2020, % (*Source* Built by the authors based on FinExpertiza Global [2021])

is a good (typical) example of the COVID-19 crisis in 2020, which is shown in Fig. 36.1.

As shown in Fig. 36.1, business's profit in 2020 reduced by 67%, which was caused by the COVID-19 pandemic and crisis. Reduction of entrepreneurship's profit is three times higher than the level of the 2008–2009 global financial crisis.

To check the offered hypothesis, we determine regression dependencies: the change of business's profit in March–May 2020, ecological safety index, and economic growth rate (growth of GRP) on digitalization level as the indicator of completion of the transition to Industry 4.0. The study is performed by the example of top 10 regions of Russia, where the reduction of entrepreneurship's profit in 2020 was the highest. The empirical data for the research are shown in Table 36.1.

Results

The results of regression analysis of the data from Table 36.1 are given in Figs. 36.2, 36.3, and 36.4.

As shown in Fig. 36.2, the transition to Industry 4.0 exerts moderate (correlation—16.78%) positive influence on ecological safety in Russia's top 10 regions by the level of the financial manifestations of the COVID-19 pandemic and crisis. Increase of the digitalization level by 1 point leads to growth of the level of ecological safety by 0.1577 points.

Table 36.1 Economic growth, ecological safety, financial consequences, and the transition to Industry 4.0 in top 10 regions of Russia by the level of financial manifestations of the COVID-19 pandemic and crisis in 2020

Region	*Change of business's profit in March–May 2020, %* *Pr*	*Ecological safety index, points 1–100* *Es*	*Digitalization level, points 1–100* *dt*	*Rate of economic growth (growth of GRP), %* *Eg*
Republic of Ingushetia	−3,262	63	28.59	1.8
Nenets Autonomous Okrug	−324	62	40.22	−7.8
Amur Oblast	−323	55	50.18	1.5
Republic of Crimea	−315	53	57.96	5.1
Jewish Autonomous Oblast	−168	50	26.58	0.4
Republic of Komi	−159	65	57.96	−1.5
Tomsk Oblast	−153	59	44.04	0.7
Republic of Tyva	−138	54	34.72	1.9
Yamalo-Nenets Autonomous Okrug	−120	59	67.36	14.8
Moscow	−107	68	66.93	3.0

Source Compiled by the authors based on FinExpertiza Global (2021), Green Patrol (2021), Institute of Scientific Communications (2021), and Rosstat (2021)

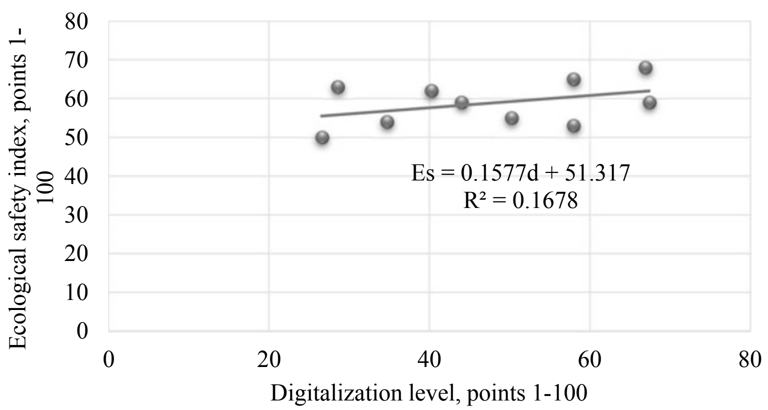

Fig. 36.2 Dependence of ecological safety on the digitalization level in top 10 regions of Russia by the level of financial manifestations of the COVID-19 pandemic and crisis in 2020 (*Source* Calculated and built by the authors)

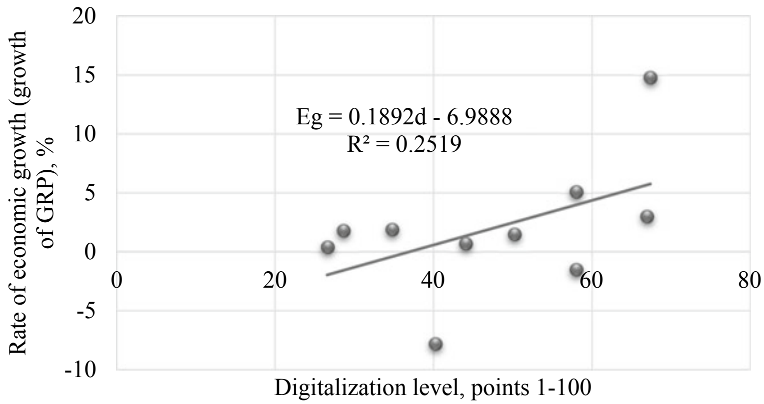

Fig. 36.3 Dependence of economic growth rate on the digitalization level in top 10 regions of Russia by the level of financial manifestations of the COVID-19 pandemic and crisis in 2020 (*Source* Calculated and built by the authors)

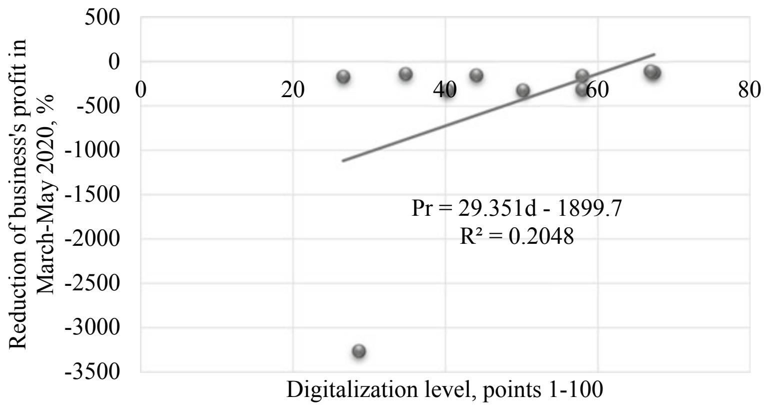

Fig. 36.4 Dependence of the change of business's profit on the digitalization level in top 10 regions of Russia by the level of financial manifestations of the COVID-19 pandemic and crisis in 2020 (*Source* Calculated and built by the authors)

As shown in Fig. 36.3, the transition to Industry 4.0 exerts moderate (correlation—25.19%) positive influence on economic growth in top 10 regions of Russia by the level of financial manifestations of the COVID-19 pandemic and crisis in 2020. Increase of the digitalization level by 1 point leads to acceleration of economic growth rate by 0.1892%.

As shown in Fig. 36.4, transition to Industry 4.0 exerts moderate (correlation—20.48%) positive influence on entrepreneurship's finances in top 10 regions of Russia by the level of financial manifestations of the COVID-19 pandemic and crisis in 2020. Increase of the digitalization level by 1 point leads to increase of business's profit by 19.351%.

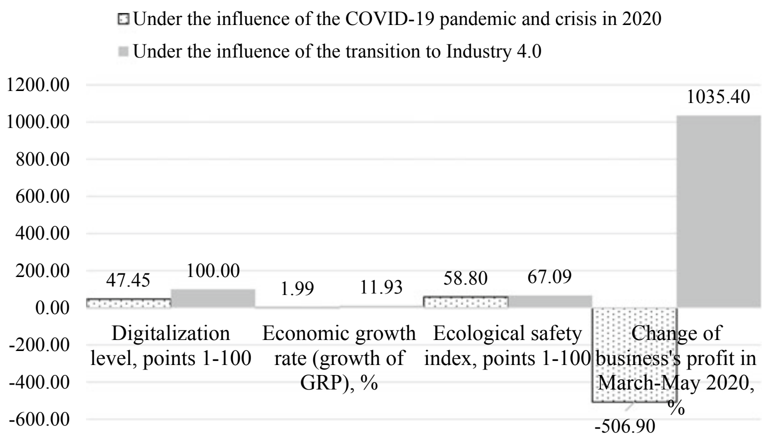

Fig. 36.5 Systemic view of the perspectives of transition to Industry 4.0 (*Source* Calculated and built by the authors)

Based on Figs. 36.2, 36.3, and 36.4, a systemic view of the perspectives of transition to Industry 4.0 could be formed (Fig. 36.5).

Figure 36.5 shows the consequences of achievement of the maximum possible level of digitalization—i.e., final transition to Industry 4.0 in top 10 regions of Russia by the level of financial manifestations of the COVID-19 pandemic and crisis in 2020. Increase of the digitalization level by 110.73% (up to 100 points) leads to the following:

- Economic growth rate grows by 5 times—up to 11.93%;
- Ecological safety index grows by 14.09%—up to 67.09 points;
- Business's profit reaches 1,035.40%, growing by 304.26%.

Conclusion

Results of the performed research have confirmed the offered hypothesis and have shown that Industry 4.0 does not imply any vivid risks (though there might be certain risks); instead, it creates advantages for economic growth, ecological safety, and entrepreneurship's finances.

It has been shown—by the example of top 10 regions of Russia by the level of financial manifestations of the COVID-19 pandemic and crisis in 2020—that transition to Industry 4.0 allows for full overcoming of all crisis phenomena in regional economy. That's why it is recommended—in the post-pandemic period—to concentrate efforts on stimulation of the rapid transition of Russia's regional economy to Industry 4.0.

At the same time, the hidden risks of the transition to Industry 4.0 need to be studied. The absence of vivid risks allows recommending the continuation of the processes of digitalization of Russia's regional economy, but they must be accompanied by the measures of risk management, which should be further developed.

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CHAPTER 37

Algorithm for Institutionalization and Financing of Responsible Production and Consumption in Russian Regions in Industry 4.0 in Order to Maintain Environmental Safety

Vladimir S. Osipov, Nelia A. Deberdeeva, Diana M. Nadyseva, and Nikolai I. Berzon

Introduction

The achievement and maintenance of environmental safety, although carried out under the guidance and often at the initiative of the state, must necessarily be based on social institutions—responsible production in business practice and responsible consumption in household practice. These institutions are created and implemented at the level of the regional economy. Developing countries, including modern Russia, experience increased complexity in ensuring the ecological security of regions due to the reduced (compared to developed countries) overall effectiveness of institutions in the economy.

Therefore, the problem of institutionalizing responsible production and consumption in the regions of developing countries is of high relevance, the

V. S. Osipov (✉)
Moscow State Institute of International Relations (University) of the Ministry of Foreign Affairs Russian Federation, Moscow, Russia

N. A. Deberdeeva
Plekhanov Russian University of Economics, Moscow, Russia
e-mail: Deberdeeva.NA@rea.ru

D. M. Nadyseva
Moscow Region State University, Mytishchi, Russia

N. I. Berzon
National Research University "Higher School of Economics", Moscow, Russia

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study and search for a solution of which is advisable on the example of the practical experience of Russia as a bright representative of developing countries (part of BRICS). In Industry 4.0, the problem is even more complicated, as economic and regulatory practices have to be implemented in two often opposite directions: digitalization and sustainable development.

This work hypothesizes that the solution to the problem can be achieved through financial management of the institutionalization of responsible production and consumption in the regions. The purpose of this work is to determine a promising algorithm for institutionalizing and financing responsible production and consumption in the regions of Russia in the 4.0 industry in order to maintain environmental safety. In order to achieve this goal, the following tasks are consistently achieved:

- Determining the current impact of industry financing 4.0 on the prevalence of responsible production and consumption practices in Russian regions;
- Proposal and justification of improved practices of financial support of practices of responsible production and consumption in Russian regions in Industry 4.0 in order to maintain environmental safety.

Literature Review

Environmental safety is identified as a strategic direction for the development of modern economic systems and a priority for sustainable development in the works of Bogoviz, Afonin et al. (2020), Bogoviz, Osipov et al. (2020), Bogoviz, Zakharov et al. (2020), Orlova et al. (2020), and Popkova et al. (2020). Practices of responsible production and consumption as progressive institutions of the green economy and sources of sustainable development of economic systems are studied in sufficient detail from a scientific and practical point of view in the works of Bapat (2020), Eggenschwiler (2020), He et al. (2020), Kumar and Anbanandam (2020), Popkova et al. (2021), and Tripathi and Kaur (2020).

Despite the high degree of elaboration of the specified individual components of the problem of this study, in general, the problem remains insufficiently studied and unresolved due to gaps related to the uncertainty of the nature of the process and the prospects for institutionalizing responsible production and consumption in the regions of developing countries (in particular, Russia), as well as the lack of elaboration of financing these practices through state regulation of the regional economy. The algorithm developed in this study to institutionalize and finance responsible production and consumption in the regions of Russia in the Industry 4.0 is designed to fill deterministic gaps in order to maintain environmental safety.

Table 37.1 Statistics of financing of Industry 4.0, responsible production and consumption in the regions of Russia in 2020

Federal District of the Russian Federation	*Percentage of households with Internet access, %*	*Percentage of business entities with Internet access, %*	*Industrial and Environmental Index,[a] points 1–100*	*Socio-ecological index,[a] points 1–100*
Central	88.9	93.1	66	83
Northwest	88.0	92.1	59	82
Southern	89.1	91.8	54	73
North Caucasus	86.9	77.7	30	75
Volga	86.1	92.8	51	81
Ural	86.8	91.7	59	75
Siberian	84.0	89.4	47	83
Far East	85.9	91.1	65	76

[a]Due to the lack of generalized statistics for federal districts, the data of the leading region for each federal district are indicated

Source Compiled by the authors on the basis of the materials Green Patrol (2021), Ministry of Digital Development, Communications and Mass Communications of the Russian Federation, Federal State Statistics Service, National Research University "Higher School of Economics" (2021), and Federal State Statistics Service (2021)

Materials and Method

In order to determine the current impact of industry financing 4.0 on the prevalence of responsible production and consumption practices in the regions of Russia, regression dependencies are determined, firstly, of the industrial and environmental index (as an indicator of responsible production) on the availability of the Internet for business structures (as an indicator of entrepreneurship involvement in the Industry 4.0) and, secondly, of the social and environmental index (as an indicator of responsible consumption from Internet accessibility for households (as an indicator of consumer involvement in the Industry 4.0).

Econometric modeling is carried out based on the data of Table 37.1 for 2020. The federal districts of the Russian Federation are the objects of study, which provides full coverage of the regional economy of Russia in this research.

Results

In order to determine the nature and features of the process of institutionalization of responsible production and consumption in the regions of Russia in the Industry 4.0, let us refer to the results of econometric modeling of the dependence of environmental safety results on financing factors in accordance with the statistics from Table 37.1 (Figs. 37.1 and 37.2).

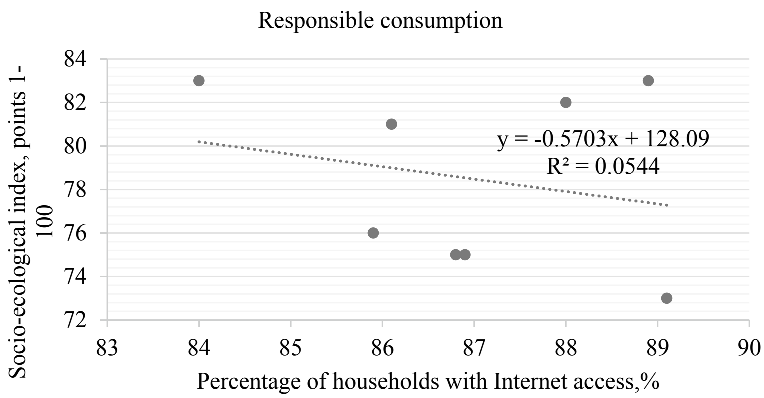

Fig. 37.1 Regression dependence of the industrial-ecological index on internet accessibility for business structures in the regions of Russia (*Source* Calculated and built by the authors)

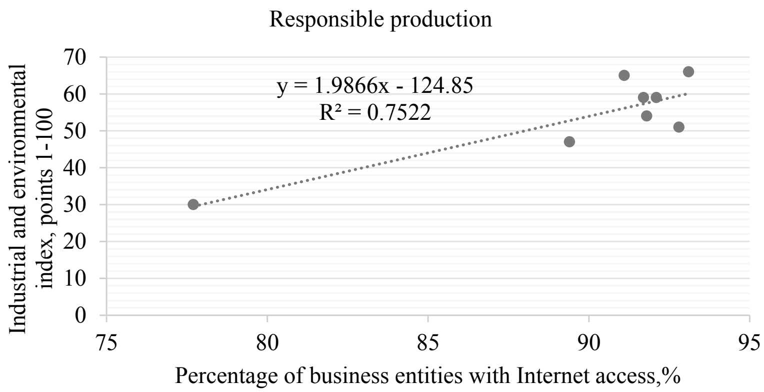

Fig. 37.2 Regression dependence of the social and environmental index on Internet accessibility for households in Russian regions (*Source* Calculated and built by the authors)

Taking into account the results of econometric modeling of the impact of social involvement in Industry 4.0 on the popularity of responsible consumption practices in the regions of Russia in 2020 (from Fig. 37.1), it can be concluded that the social and environmental index does not depend on the proportion of households connected to the Internet, as evidenced by the critically low value of the correlation coefficient (5.44%). Therefore, the process of institutionalization of responsible consumption in the regional economy of Russia in the conditions of Industry 4.0 is not launched and needs targeted regulation, which will allow to initiate this process.

The results of econometric modeling of the impact of business involvement in Industry 4.0 on the popularity of responsible production practices in the regions of Russia in 2020 (from Fig. 37.2) indicate that the industrial and environmental index largely (correlation 75.22%) depends on the share of business structures connected to the Internet (their increase by 1% leads to an increase in responsible production by 1.9866 points). Consequently, the process of institutionalization of responsible production in the regions of Russia in the conditions of Industry 4.0 has been launched and successfully implemented, although it needs the support of public administration bodies in the regions.

The results of econometric modeling suggest the following algorithm for institutionalization and financing of responsible production and consumption in the regions of Russia in the Industry 4.0 in order to maintain environmental safety (Fig. 37.3).

The algorithm presented in Fig. 37.3 shows a sequence of four logical stages of financial management of processes for institutionalizing responsible production and consumption in the regions of Russia in the 4.0 industry in order to maintain environmental safety.

At the first stage, the practice of using the capabilities of Industry 4.0 in a digital society in favor of responsible consumption is adjusted. It recommends financing household eco-practices aimed at improving the environmental efficiency of Internet use by households in the regions, financing green Internet platforms for responsible consumption in the regions, as well as financing regional programs for systemic digital literacy and environmental responsibility.

The second stage relates to the financial promotion of the environmental responsibility of digital entrepreneurship in the region. It proposes financing of eco-business practice aimed at financial support for neo-industrialization

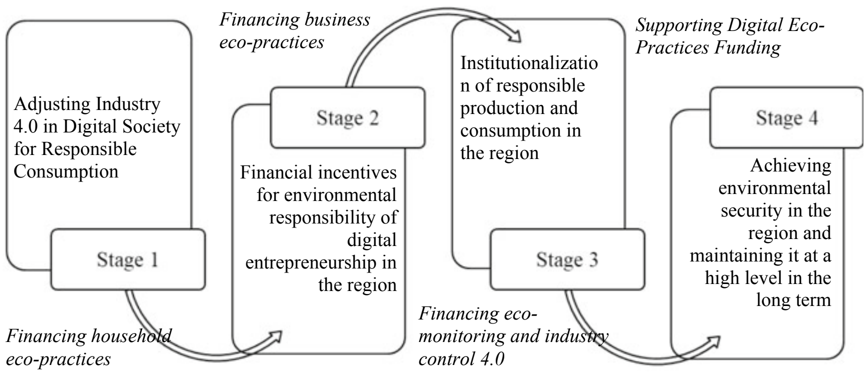

Fig. 37.3 Algorithm for institutionalization and financing of responsible production and consumption in Russian regions in Industry 4.0 in order to maintain environmental safety (*Source* Developed and compiled by the authors)

of environmentally responsible regional entrepreneurship and stimulation of corporate environmental responsibility of digital business in Industry 4.0 of the region.

The third stage is the institutionalization of responsible production and consumption in the region. It involves financing eco-monitoring and industry control 4.0 in the region. The fourth stage achieves environmental security in the region and is maintained at a high level in the long term. It recommends funding supporting digital eco-practices related to responsible production and consumption in Industry 4.0 of the region.

Conclusion

The results of the research revealed an imbalance in the contribution of society and business to the sustainable development of the regions of modern Russia. As it turned out, digitalization of business contributes to the popularization of practices of responsible consumption, but the internetization of society does not contribute to responsible consumption. This confirmed the hypothesis put forward about the insufficiently high effectiveness of institutional environmental security in the regions of Russia.

In order to solve the identified problem, an algorithm was developed to institutionalize and finance responsible production and consumption in the regions of Russia in Industry 4.0 in the interests of maintaining environmental safety. The proposed algorithm demonstrated the sequence of managing the processes of greening digital society and business in the regional economy, and also outlined promising areas of financial support for responsible production and consumption in the regions at each stage.

At the end of the research, the universality of the Russian experience and the possibility of its extension to the totality of developing countries should be emphasized. The developed algorithm for institutionalizing and financing responsible production and consumption in Industry 4.0 regions is recommended for use not only in Russia, but also in other developing countries to maintain the environmental safety of their regional economies.

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Unresolved Issues of Climate Change Combating as Challenges for Industry 4.0 (Conclusion)

The problem of global climate change has become more acute than ever in the context of the COVID-19 pandemic and crisis. This first volume of the book "Climate Change in Industry 4.0" has systematically reflected the impact of Industry 4.0 on climate change, which is unfortunately disappointing. High environmental risks and threats from climate change are holding back the economic activity and are powerful signals to redirect international investment flows to more environmentally friendly countries.

The problem of combating climate change is being addressed at the level of enterprises, territories, and the world community. But despite its high relevance, it receded into the background in the context of the COVID-19 pandemic and crisis. All resources are thrown to support health care, economic recovery, and social protection; in reality, the measures are taken only allow fighting the consequences but not the real causes of the pandemic. In the academic world, the ecological version of the COVID-19 pandemic is popular, which is very convincing, especially in the absence of an official version of an international investigation of the pandemic causes.

If the scientific version is correct, at least in part, without even being the main cause of the pandemic, if the already launched scenario of underfunding the fight against climate change continues, the world will find itself on the verge of new environmental disasters and pandemics, which are interdependent. As this first volume showed, Industry 4.0 is already influencing powerfully on global climate change, and in the future, as digitalization continues, this influence will increase.

The challenge for modern science is to redirect this influence and make it positive or at least neutral. Today, there are many unresolved issues in the sphere of combating climate change that pose the challenges for Industry 4.0. One of them is high, but not satisfied, need to ensure the environmental safety of the applied digital technologies. Another issue is related to the shortage of

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new—“green” digital technologies that must be created and implemented in Industry 4.0.

Other unresolved issues include infrastructure support for the environmental reorientation of Industry 4.0. In particular, questions remain about how to achieve full-scale funding for climate change combating projects in Industry 4.0, as well as how to prepare regulatory frameworks to stimulate “green” investment in Industry 4.0 and create a social environment that is receptive to responsible innovation in Industry 4.0 and ready to reimburse the environmental costs of Industry 4.0 enterprises. The answers to these questions are found in the second volume of this book.

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