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Strategic planning and challenges to the deployment of renewable energy technologies in the world scenario: its impact on global sustainable development

Ashiwani Yadav[1] · Nitai Pal[1] · Jagannath Patra[1] · Monika Yadav[1]

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Abstract
To achieve the solutions to environmental problems that the world is facing in the current scenario, possible enduring actions projected to attain global sustainable developments are needed. Today, the world needs clean energy revolution to decline necessity towards fossil fuels; such a vital clean energy revolution may enhance the implementation of renewable energy technologies (RETs). The RETs have the unique capabilities to accomplish the requirements for energy and its associated services to ensure human societal and economic improvement; however, to make it successful, it must be sustainable globally. The present article describes the possible contribution associated with the RET to the three segments of sustainability. It enhances sustainability indicators like energy access and energy security; these impacts encourage the permanent societal and economic development. Irrespective of such opportunities, there are certain obstacles hindering sustainability of RERs towards sustainable development. These obstacles comprise market failures, lack of awareness, environmental, as well as institutional challenges. The proposed analysis and policy recommendations together will help to accomplish the goal of sustainability and mitigation of climate change. Also, it may decrease greenhouse gas emissions and provide healthy environment with clean energy for the present, as well as future, generations.

Keywords Environment · Greenhouse gas emission · Sustainable development · Renewable energy · Renewable energy technology

Abbreviations

RE	Renewable energy
RET	Renewable energy technology
RERs	Renewable energy resources
GHG	Greenhouse gas emission
SDGs	Sustainable development goals
SD	Sustainable development

✉ Nitai Pal
nitai@iitism.ac.in

[1] Department of Electrical Engineering, Indian Institute of Technology (Indian School of Mines), Dhanbad, Jharkhand 826004, India

CO_2 Carbon dioxide
MW Megawatt

1 Introduction

The advancement in global energy organization is touching close to a significant transformation. This year's 2018 edition of the International Energy Agency (IEA)'s comprehensive publication on clean energy technology highlights on the opportunity and challenges to promote the deployment of renewable energy technology (IEA 2018). Most of the elementary human needs, for example, cooking, lighting up, communication, and adaptability, require energy and its related services for operation (Chakraborty et al. 2016). Around 1.4 billion people of the world population lack the consumption of electricity, and mostly, approximately 85% of them live in rural areas. Hence, the number of community depending on biomass for their energy needs is abruptly increasing; it will become 2.8 billion by 2030 (Kaygusuz 2012). Nowadays, sustainable development (SD) has become the vital topic of the research; therefore for its attainment, many countries are improving their policies to explore the expansion of renewable energy technology (GSEII 2018). A set of globally sustainable development goals (SDGs) has been defined in United Nationals' General Assembly (UNGA) by the open working group in New York. These SDGs include 169 targets and 17 goals. According to Robert Brown, the idea of sustainable advancement holds its foundations in the possibility of a sustainable society and the administration of renewable and non-sustainable assets. Therefore, the world is, nevertheless, to promote the renewable electricity generation to fulfil the enormous requirement of energy.

In the present scenario of the world, RE access has become the most crucial factor for the attainment of sustainability oriented to social, environmental, and economic advancement of the society (SREEN 2017; Jaramillo-Nieves and Del Río 2010). For instance, the significant population of the world's energy access is provided by renewable energy resources (RERs), which makes a clean society, free from pollution, like GHG emission, and reduced local, as well as global pollutants, resulting in socio-economic development (Rao and Kishorev 2010).

The RET is growing fast, mainly in the field of the power sector governed by several factors, such as the cost-effectiveness of non-conventional technologies, committed policy, security of energy, and environmental contribution. Consequently, colossal enhancement takes place in field of renewable energy potential around the world. According to renewable energy (RE) target setting (IRENA 2017), it has been found that with the addition of new RE capacity, which is about 147 GW in 2016, thus, the increment in new investment in RE is approximately 18% from 2004 to 2016. Therefore, consumption towards the application of RE is increasing. Furthermore, the crucial section of the world, like developing countries, consumes 19% of the total electricity consumption, which is provided by RERs.

The report on the global trends in RE shows the increase in global RE capacity, which is about 785 GW by the end of 2016 with highest capacity of 199 GW in China as shown in Fig. 1 (Global Trends in Renewable Energy-KPMG 2017).

Despite growing advancement, deployments of RETs face numerous challenges to maintain the expansion of the global RE market; the critical difficulties need to be discovered and dealt with adequately. It is essential to establish some practical policies, like regulatory policy support mechanisms, more and more investments, national and international cooperation, and political motivation to promote the advancement of sustainable energy

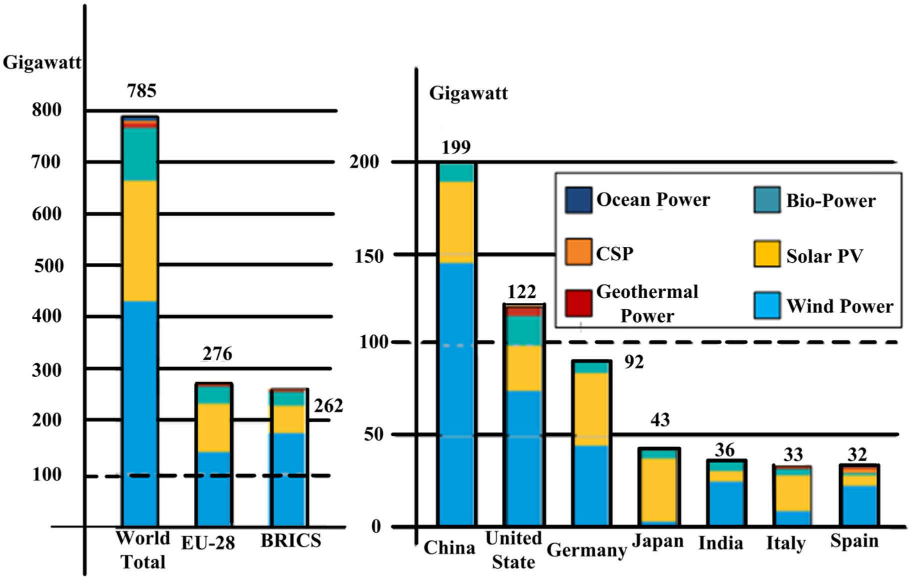

Fig. 1 Renewable power potential in the world, EU 28, BRICS, and top 7 countries, end of 2016 (Global Trends in Renewable Energy-KPMG 2017)

technologies (Energy Use by Economic 2017). The principal focus of this article is to give an idea regarding the impacts of RE on the three segments of sustainability with a descriptive analysis of practical cases, along with illustrative examples. Moreover, it also elaborates the possible contribution of RET projects to the three sections of sustainability and suggests a best possible solution to diminish the challenges.

2 Sustainable development and elements of sustainability

SD directs the connection regarding interactions between human society and environment. Usually, SD model has been organized in the triangular pattern (UNTR 2017). All are thought to be interconnected and relevant for sustainable development. The concepts of SD may contribute useful outlines to examine the relations between SD and RE. The interaction between SD and RE implementation is considered as a sustainable goal that is essential to accomplish (WEHAB Working Group 2002). Therefore, sustainability comes into action to achieve the goals of sustainable development.

2.1 The concept of sustainable development

Sustainable development (SD) can be stated as the advancement that fulfils the requirements of the current generation without negotiating the potential of future generations to satisfy their needs (Jaramillo-Nieves and Del Río 2010).

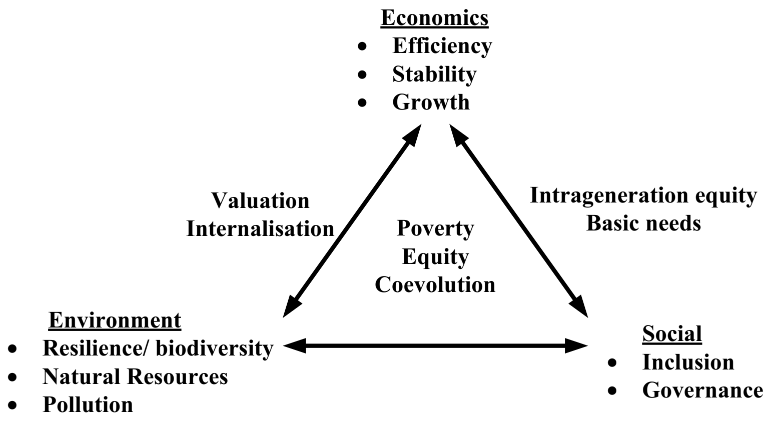

Fig. 2 Structure of sustainability

2.2 Elements of sustainability

The conceptual structure of the sustainability model has three segments of sustainability, such as social sustainability, economic sustainability, and environmental sustainability as shown in Fig. 2 (WCED 1987).

2.2.1 Environmental sustainability

Environmental sustainability is the capability that keeps up the rates of renewable asset harvesting, ensuing decline in the local population, and stability of the environment (Uddin et al. 2010). It identifies the reduction of pollution, globally, like ozone depletion, radiation of carbon dioxide (CO_2) level, and greenhouse gases. It also determines the level of exploitation of natural resources associated with specific territory, the preservation of adaptability, and coherence.

2.2.2 Economic sustainability

Economic sustainability stated as the ability to promote a certain level of financial support. In this regard, the primary indicator for economic sustainability is the advancement in the living standards of any local or regional population and progress in regional per capita income. It also determines the improvement in the lifestyle of the local communities, decreases in energy dependency, and growth in the modification of energy supply. Economic sustainability is attained if the system executes a cost-effective and reasonable amount in the present and future, taking into consideration the cost-efficient and cost improvement potential of supply.

2.2.3 Social sustainability

Social sustainability is defined as the capability of a social structure, like a country, to build up process and outline that could not only meet the needs of its present members but also support the capability of future generations to preserve a lively community. Some researchers point out that SD may not be achieved unless the sustainability of cultural and social systems is ensured, comprising the accomplishment of stability, social cohesion, and social peace (Palanisamy and Parthasarathy 2016). Some significant actions have been taken to attain social sustainability, such as a decrease in unemployment, enhancing the quality of jobs, reduce poverty, and increase regional interest towards RET investments.

2.3 The necessity to estimate sustainability into action

Sustainability and SD have turned out to be the governing principles of environmental policy and its development globally (Trzyna 1995). It is easy to understand the endured relationship between elements of sustainability as shown in Fig. 2 (Khan 1995). It is essential to create a sustainable framework for energy supply and its consumption to apply the concept of sustainability into action. The policy framework must deal with the three dimensions of sustainability to achieve the basic needs of human beings, like enhancing the living standards of the local population. A clean energy technology is a vital source of energy for the accomplishment of better education, reduced poverty, and hunger. Moreover, RETs enhance the advancement of health issues, boost economic development, supply power for dehydrating the crops and irrigation in rural village, and promote lighting facility in schools. Therefore, it becomes essential to estimate the sustainability into action.

3 Global renewable energy access and future potential

Seventy-five per cent of the total global energy utilization is covered by 22 countries that contributed to the department of clean energy ministry. At present, 30% of the worldwide electricity can be generated only from wind and solar PV because of its low cost and reaching to low carbon future (IEA 2017). According to the renewable global status report in 2017, global energy transition is well preceding with a record of new acquisition of established renewable energy capacity due to fast drop in costs and resolution of economic development (World Energy Outlook 2017). Worldwide RE expenditure in 2015 crashed fossil fuel expenditure with a global record of US $286,000 million spent, promoting the 12 years aggregate total to US $2300 billion. It has been found that solar, wind, biomass, small hydro, marine sources, and geothermal energy contributed 138,500 megawatts (MW) to the global power in 2016 (enlarged from 127,500 MW). Still, on the global scenario, it is essential for the global community to support its obligation to regulate the advancement for achieving the identified requirements, particularly in emerging countries (BIREC 2005). Worldwide organizations, like the United Nation Framework Convention on Climate Change (UNFCCC), the United Nation Division of Sustainable Development (UNDSD), and others, lead a significant role to the exchange of RET among different countries around the world. It also improves its financing and building capacity. India, the USA, and China are enhancing an essential role imminent to a global energy transition and distribution.

Table 1 Renewable energy generation capacity at the regional level. *Source*: IRENA (2017)

Region	Capacity (GW)	Global share (%)
North America	330	16
Europe	487	24
Eurasia	91	5
Central America Caribbean	13	1
Middle East	16	1
Asia	812	41
South America	193	10
Africa	26	2

Table 2 Current renewable energy projects status (Developing renewable energy project 2017)

Country	Project	Technology	Status	Size
Egypt	Kom Ombo PV	PV	Main contract bid	200 MW
	Gulf of Suez	Wind	Main contract bid	250 MW
	Zafarana	Wind	Complete	534 MW
Jordan	MEMR—Al Harir, Wadi Araba, and Maan	Wind	Execution	300–400 MW
Kuwait	MEW/KISR—Shagaya Renewable Energy Complex	Solar	Execution	70 MW
Saudi	SEC—Duba Integrated Solar, Combined Cycle (ISCC) Power Plant Phase I	CSP	Execution	600 MW (CSP 20–30 MW)

Germany plays, additionally, a crucial aspect concerning the worldwide advancement of RET with the current G-20 presidency for the promotion of climate protection strategies and progress (WEO 2017).

3.1 Current global renewable energy capacities

According to the International Renewable Energy Agency (IRENA 2017) reports at the end of 2016, the total global renewable potential amounted to 2006 GW. As depicted in Table 1, it shows that Asia leads to the share of 58% for the new invested capacity, that is, a total of 812 GW (41% of global capacity) in 2016. Therefore, Asia becomes the leading growing region, with an increase of +13.1% in renewable capacity (Table 2).

3.2 Global capacity growth in renewable energy and its future potential

Through implementation of internationals cooperation enhanced investments, political will, and valiant policy actions, the future sustainable energy needs can be achieved. The present study shows the remarkable progress in global RE generation capacity by the annual growth report of IRENA (IRENA 2017). The study reveals that till 2016, the global non-conventional energy generation capacity was 20, 06,000 MW; among all RERs, hydropower with an installed capacity of 11, 22,000 MW is observed to be the leading contributor of the total worldwide aggregate RER capacity. The contribution of 467 GW and 296 GW potential is acquired by solar and wind energies, respectively, that shows covering most parts of the generation, solar and wind lead among all renewable capacity (Adamantiades and Kessides 2009). Wind and solar together will represent more than 80% of global renewable capacity growth in the next 5 years. The best part is attained by the marine energy with net output nearly 500 MW (i.e. tide wave and ocean); moreover, 13,000 MW output of geothermal energy and about 110 GW power output of bioenergy were produced in 2016 (WEO 2017). To achieve the climate goal from Paris Agreement, the agreement purposes long-term objective of keeping the rise in global average temperature below 2 °C and to ensure greenhouse gas emission to zero by 2050 (Paris Agreement 2016). If the present proportion of growth is maintained in the coming future, then the target of making it as 50% of total primary energy source may be achieved in next two decades by 2040 (Global Trends in Renewable Energy-KPMG 2017).

3.3 Current status of leading renewable energy projects

There are several examples of sustainable social projects around the world, and such type of projects occurs in all form of communities like in large, medium, and small cities; in towns; in counties; and in rural communities. Some examples of these projects installed in the USA are Arlington, VA New Heaven, CT; Atlanta, GA New York; SCP 2018. The Eversheds clean energy group is leading organization working towards green energy revolution; recently, it has presented a report on the growth and prediction of RE projects in Middle East regions. The report shows that Egypt topped the area with an installed capacity of 4.8 GW RES, while 880 MW is in the pipeline by setting a target of 20% till 2022. Some of the leading projects either established or planned are enlisted for the allusion (Fig. 3).

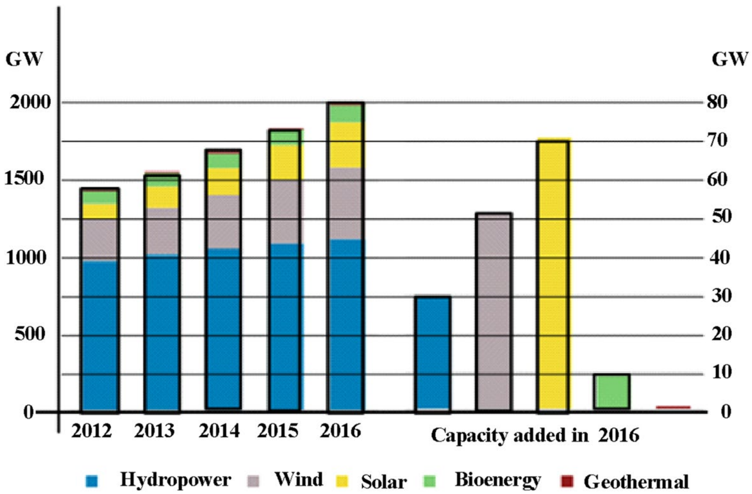

Fig. 3 Renewable energy generation capacity by different energies. (Renewable capacity highlights-IRENA 2017)

4 Impacts of renewable energy technologies for social, economic, and environmental sustainabilities

This article argues the prospective contributions of RET projection in achieving the three segments of sustainability, namely, social, economic, and environmental (Del Río and Burguillo 2008a, b; Al-Riffai et al. 2010). In this regard, it explores the effects of RETs on a well-defined set of opportunities, which are as follows:

(a) Human development and social cohesion,
(b) Energy impacts,
(c) Energy security,
(d) Impact on climate change and environment,
(e) Educational impacts,
(f) Effect of RETs on the creation of job opportunity.

The above set of opportunities may be achieved with the deployment of RETs that is the most significant contributions of RET application to accomplish SDG (Flamos 2010). The most likely contributions of RETs are for the energy protection, climate change, and mitigation of environmental effects. This section elaborates on current energy access programs and highlights various global impacts of RETs on sustainability indicators. The analysis is structured and shown in Table 3. The study indicates that accomplishment of RETs has significant implications on sustainable development in the form of poverty reduction, creation of job, and increasing accessibility of power (Del Río and Burguillo 2009). The impact of the different RETs on various sustainability indicators is shown in Table 3. A more detailed explanation for each of the above-mentioned opportunities is given below.

4.1 Social cohesion and economic development

The extensive literature regarding the impact of social cohesion on development implies the strengthening of the harmony between ethnic, spiritual, and other groups of personalities. Socio-economic development is the process of social and economic development in a society. Socio-economic development is measured with indicators, such as GDP, life expectancy, and level of employment (Kassels 2003). As RE projects increase, the people's engagement with the activities associated with the RE projects, thus enhancing the socio-economic aspect of the many populations. In this way, deployment of RET accelerates the quality of social relations; it also helps to reduce poverty in every form universally and enhance healthy lives, as well as promote welfare for all.

4.1.1 Economic development

The energy sector has been perceived as a key to economic development with a strong correlation between economic growth and expansion of energy consumption because the energy consumption per capita is directly related to the economic development (Del Río and Burguillo 2008a, b). In the last few decades, the substantial RET applications are being used in everyday life. Thus, it encourages clean energy production, leading to economic development. In today's scenario, RE promotes considerable cost savings in remote as well as rural areas, where grid access is unavailable; moreover, currently installed RET projects support sustained economic growth, give job security, and provide a clean environment for

Table 3 RE technologies: impact on selected SD indicators

Sustainable development indicators	RE technologies					
	Energy in biological sources (bioenergy)	Solar energy	Energy in geothermal	Hydel energy	Energy of ocean	Energy of wind
Reduction of poverty	Jobs and cooking (Kralova and Sjöblom 2010)	Decreases poverty	Low	Medium to high	Low	Medium to high
Security in energy	Secure source more subject to climate	Secure	Secure source	Secure source particularly to the conditions of climate	Early technology	Intermittent accessible
Accessibility of energy	Wide and easy accessibility especially for the economically backward people	Easy access especially for poor (Bhattacharyya 2012)	Confined	Limited to a certain extent		Limited to a certain extent
Emissions of GHG	Emissions of sustainable GHG, however, there is a chance of unsustainability in harvesting (Adamantiades and Kessides 2009)	During operations, minor emissions are there. Lifecycle emissions are the important one (Varun et al. 2009)	Life cycle emissions and site-specific emissions are there also to sulphur compounds (Mulholland et al. 2011)	From some reservoirs, an emission of methane takes place. Some of the reservoirs have a high range of emissions	During operations, no emissions are there. Emissions There is neutral lifecycle (O'Rourke, Boyle Reynolds)	During operations, no direct emissions are there. CO2 lifecycle emissions are there due to transport, installation, and manufacturing (Jacobson 2009)
Opportunities for employment	In rural areas, job opportunities increase. Employment ratio per MW due to biomass electricity is 4 and 0.14 for construction, O&M, installation, and so on (Moreno and Lopez 2008)	Jobs in urban as well in rural areas increase. Employment Ratio per MW due to solar PV is 34.6 and 7.69 for construction, O&M, installation, and so on. (Moreno and Lopez 2008)	It is high in local as compared with the natural gas It is because of drilling and plant construction that must be done at the site of a geothermal resource. Hence, local work force is benefitted regarding better employment.	Medium one Employment ratio per MW due to hydel energy is 18.6. And 1.4 for installation, O&M, construction, etc. (Moreno and Lopez 2008)	It is high in the local scale (Marine Energy Roadmap)	Employment in operations, installation, and manufacturing area. Estimated direct job at present is 500,000. (Global Wind Energy Council 2010)

all (Prakash and Bhat 2009). Various impacts of RET on sustainability with suitable examples are elaborated in Table 3.

4.2 Creation of employment opportunities

The United Nations Environment Programme (UNEP) has published a report entitled "Towards a green economy-pathways to poverty suppression and sustainable development, which reveals that around 2.3 million job opportunity all over the world are availing through the enhanced implementation of RET for energy production" (Kaygusuz 2012). Establishment of an alternate economy leads to the creation of job opportunities including promotion of self-employment options (Moreno and Lopez 2008). Several reports from other renowned organizations such as German Environmental Ministry indicate that RETs are providing large employment options worldwide, leading to social and economic development in remote areas (Kassel 2003). Development of RET delivers surplus energy and employment opportunities to local society by skill development (Goldemberg et al. 2000). The recent advancement of RE project creates the job opportunity in urban as well as rural area as depicted in Table 3. It has been observed that the wind and hydel energy reduces poverty in the range of medium and high, respectively. The most consistent increase in jobs has been created through solar PV and wind categories. Moreover, the job opportunities by PV and wind together almost become double since 2012. The employment in RE sector, excluding large hydropower, increased by 2.8% to reach 8.3 million in 2016. In the same year, implementation of good policy has created a record for the significant job creation in several countries around the world.

4.3 Energy impacts

In today's scenario, global population has confined access to advanced clean energy services. The new policy scenario shows that prior access to clean cooking trails behind access to electricity (Goldemberg et al. 2000). For proper SD of society, it is an immense need to encourage the people towards the RE services for their energy requirement. Moreover, it is very crucial to provide energy access facility to the 1.2 billion people, i.e. 16% of world population who are living in the remote areas without access to electricity. Thus, to achieve the SDG, the basic necessity is to provide the clean electricity to the 2.8 billion people (SREEN 2017; Jaramillo-Nieves and Del Río 2010). The deployment of RET projects in any region consider intimate energy resources, which may reduce the energy crisis by providing the significant amount of energy to that region. In this aspect, Rewa Ultra Mega Solar (RUMS) park having the capacity of 750 MW has been proposed in the Rewa district of Madhya Pradesh, India, which fulfil the energy requirement to the Delhi Metro Rail Corporation (DMRC) and Power Management Company, Madhya Pradesh, India (SECI 2018).

4.4 Energy security

The energy security is referred as the uninterrupted accessibility of energy services at reasonable prices for the future utilization. Access to economical energy has become necessary to the operation of modern economies. The RERs are the best alternative assets for energy consumption because it can withstand energy stock beyond the extended period, ensuring that the RERs are utilized endurably. For long period prospective, energy security depends on streams rather than expendable stocks, while in case of short term it centralizes on the ability of the energy system to respond quickly against the sudden changes of demand–supply balance (Rourke et al. 2010). Energy security has severe constraint in the developing nations; this leads to the extensive utilization of already existing resources. The implementation of RETs and its practical application contribute energy security to the people of developing countries like Ghana, Egypt, Jordon. As the accessibility of solar energy is more comfortable especially for the poor people, the solar power may encourage the energy security to the rural communities in developing nation.

4.5 Climate change mitigation and reduction of environmental and health impacts

The RERs are the clean sources of energy, and implementation of these sources reduces GHG emission that in turn control the mitigation of climate changes. Today's climate change mitigation has turned out to be institutional in worldwide illicit relationships as the major challenge (Edenhofer et al. 2011). The best possible solution to climate change may be achieved through policy making and enhancing RET development in rural areas (SREEN 2017). The advancement of RETs depends on the specific technology, management, and site characteristics associated with each RE project (Mitigating Climate Change-Greenhouse Gas Emission 2017). The energy generation via RETs decreases air pollution and also improves health impacts by reducing the emissions of carbon, land degradation, water, and indoor pollution (Jacobson 2009).

The countries like China and India are using solar energy as a vital source of vitality to emerge as a global leader in energy production that in turn contributes to mitigation of climate change (Rajesh 2018). Biological energy provides a more secure source of electricity which also focuses to the mitigation of climate change. There are a lot of examples of biological sustainable projects across the USA like Arlington and VA New Heaven; these installed projects provide reliable energy access and also help to make environment clean and safe. Hence, the aforementioned environmental issues can be fixed by implementing the RET for the sustainable development (Davies et al. 2015).

4.5.1 Reduction in carbon dioxide (CO_2) emission

To encourage sustainable development along with mitigating climate change has turned out complete aspects of planning analysis and policy making of energy production. Approximately, two-third emission of the total worldwide greenhouse gases (GHGs) and 80% of CO_2 production are due to the burning of fossil fuels; hence, policy makers need to take necessary action to reduce carbon emission (Klugmann-Radziemska 2011). According to the *IRENA,* by 2050 the emission of the CO_2 must be reduced by 70% and vanished entirely by 2060 for the global energy production. The new policy scenario for the implementation of RETs in the power sector minimizes the level CO_2 emission by 60% (CPWE 2007). The *Paris Agreements-2016* has set a goal that aims to maintain the global average temperature less than 2 °C. To fulfil the target, emission intensity of CO_2 is required to drop by 85% in next 35 years, as the average reduction of the CO_2 emission is 2.6% or 0.6 gigatonnes (GT) every year in absolute terms.

5 Challenges and solution approaches for successful deployment of renewable energy technologies

Deployment of RE projects faces various challenges that prevents rapid adaptation of RET projects. Various factors may obstruct the selection and advancement of sustainable energy innovations. These obstacles focus on factors like institutional, informational, economic, social–cultural, and environmental issues (SREEN 2017; Sovacool 2009). The world energy markets need a constant implied operation to address the following challenges, for global SD (Goldman et al. 2005).

5.1 Socio-cultural

Socio-cultural challenges are related to the advancement of RET and its potential connection to the personal and societal values (Sovacoolet 2009). Therefore, particular norms, as well as values of individuals, groups, and societies, influence the consideration and acceptance of RETs (GNESD 2007). The assessment of socio-cultural SD draws attention to challenges that may arise due to the lack of government programs and attention to such socio-cultural concerns. If proper attention is not given to the remedy of RET, consequently it may reduce the advancement of RETs. In this regard, some of the following obstacles are as follows.

1. From the SD point of view, challenges arise due to inadequate impacts on the biodiversity, ecosystem, and human heritage.
2. The behavioural difficulties occur due to the varying perceptions regarding cultural and social values.
3. Some people show unwillingness to adopt sustainable power only because of suspicious fear of insecurity.
4. The study assures that most of the application of RE is eco-friendly (Devine and Wright 2005). However, the interest of the public does not interpret RE into active at local level, whereas RE deployment often associated with explicitly of individual or society.
5. Site issue is an necessary concern for the implementation of the hydroprojects.
6. The perception of high risk associated with the application of RETs.
7. Establishment of new RETs projects requires the transfer of people from one place to another place that may create a massive public protest and riot.
8. Having wrong perception about cost of RET as large and visionary that affects the interest of people towards the RETs.
9. Some critical points such as influences on the environment, cost efficiency, and accomplishment of society wellness are essential and must be considered for development of RET (Gross 2007).

5.2 Administrative and political challenges

The administrative and political challenges state the regulatory perspectives that underline lack of attention given to the maintenance service by the administration, which may result more expenses to rectify the flaws in simple structure. Business owner and industrial clients are generally unaware of the RE potential. Therefore, they face the institutional obstacles to explore sustainable energy (SREEN 2017; Sen and Ganguly 2017). The policy makers of modern electricity generation have drawn more attention to discover minimal-cost solutions. Indeed, even local electricity organizations might be new to the advanced renewable projects. Most utilities have not examined how renewable assets could fit into their frameworks.

As a consequence of administrative obstacles to accomplish RE targets, the crucial issues in this perspective include.

1. Regulatory measures, like directives principle and designs, enhance the adoption of sustainable power source by limiting the administrative hazard which in turn creates interests towards SD.
2. The scarcity of adequate policy support creates obstacles to the development of the PV technology and its application (Zsigraiováet et al. 2009).
3. Develop transparency of worldwide markets using inspection followed by a collection of data associated with energy flow; moreover, assist global cooperation in energy technology to mitigate the environmental impact and protect the future energy supplies.

   Identifying solutions to common energy challenges through discussing with the delegates of non-member countries, global organizations, industry, and other stake holders.
4. The political action should prompt and energize more useful directions, in which the control is relevant in advancing towards the sustainable energy source.
5. Lack of coordination happens among various concerned authorities due to involvement of multiple administrations for authority procedures.
6. Precise planning, policy rules, guidelines, and measures are necessary to take into account for the interconnection of RE to the grid, that is challenging (Maxoulis and Kalogirou 2008).
7. Lack of dominant implementation strategy of RE policy.

5.3 Environmental challenges

Development of RETs dispenses certain ecological challenges that may be analysed on the national level including the global problems like climate change, ozone layer depletion, and CO2 emission. It is significant to know the environmental impact through the process of energy production from RES like wind power, solar, geothermal, biomass, and hydropower (Sovacool 2013). The exact type and intensity of environmental challenges may vary depending on the specific technology used like geographic location and types of sources. Some dominant hurdles in this regard are as follows.

1. The contribution of biomass and biofuels towards the reduction of CO_2 emission is very less as it produces a significant amount of air pollutant when they are burned.
2. Biomass and biofuels consume a significant amount of water, unlike other RERs.
3. The geological location and common conditions in a district region may create hindrance to RE advancement.
4. The wind turbines are dangerous up to some extent for avian population, but still, fossil-fuelled services are about 17 times more harmful to the avian community as per GWh basis than nuclear power stations and wind (Sovacool 2009).
5. Chemicals applied in PV cells fabrication like groundwater may be released into the atmosphere that is very harmful (Klugnann and Rabziska 2011). The toxic chemicals released into the atmosphere are observed a significant amount of acetone, ammonia,

methanol, and isopropyl alcohol leading to environmental issues (potential health and environmental impacts, 2003).
6. Environmental problems, usually, caused due to the creation of geothermal fields, including reduced quality of air and water, geological hazards, waste disposal, biological resources, and noise (Butlin 1989).
7. Concerning geothermal positioning, land issues occur (environmental regulations related to geothermal sources must include); additionally, ground water protection and soil protection issues are also need to be considered.
8. The hydropower creates no adverse effect on air quality. Still, manufacture and implementation of the hydropower dams may affect natural habitat of the sea such as fish and wildlife populations.

5.4 Market and economic challenges

RE has vast potential in the different region of the world, and this excellent potential of RE may be realized at an appropriate cost only. The most obvious and broadly advanced boundary to sustainable power source is realized particularly due to capital expenses, direct cost of construction, and establishing solar as well as wind farms. According to market research, it has been observed that most of the customers prefer to buy renewable power even if renewable power costs them slightly more than conventional power (Gross 2007). However, according to economic theory, chances of market failures may limit the advancement of RE potential unless significant policy measures are endorsed to motivate the development.

Following economic issues are associated with the development of RETs

1. RETs advancement faces significant hurdles in case of market transactions.
2. Initial capital costs for sustainable power source constructions are typically very high.
3. Lack of market for sustainable power source; the high and fluctuating costs of sustainable power source in a few nations like China create hindrance to adoptability of RETs.
4. Most individuals are not able to manage the cost of sustainable renovation because their underlying establishment expenses and task costs are typically high that raises their market costs, eventually, constraining their attractiveness.
5. Due to constrained market for sustainable power sources, its advancement is restricted because when something is not attractive, individuals did not put a considerable amount in its improvement.
6. Initial capital, exchange costs, financial status, and accessibility of motivating forces are crucial factors that decide the people interest towards sustainable power source selection.
7. Initial capital cost of the sustainable power source is, generally, high as compared to conventional sources of energy.
8. The high expenses on investment are a huge obstacle to the accomplishment of feasible, sustainable power source proposals.
9. Many exchange costs are associated with the generation of RE sources that consequently raises the aggregate production costs.
10. Due to poor monetary conditions in the developing nations like sub-Saharan Africa and South Asia, an incredible distortion of the sustainable power source exchange has been experienced.

11. Inadequate or absence of credit offices to buy RET and to pay high-loan fees on credit services acts as hindrance in the accomplishment of RE implementation.
12. Due to a shortage of enough funding support in some developing as well as gulf countries like India, Sri Lanka, Kenya, Africa, and Nepal, the advancement of RE projects has been reduced.
13. Due to abrupt inversion of RET approaches and choices, relevant partners and speculators lose trust.
14. Due to the idea of sustainable power source structures, RE market needs clear strategies and legitimate techniques to expand the curiosity of investors.
15. Considering the grants, taxes, emission of GHG, and its effects on health as well as environment are the vital problem as it may lead to market failure (Rao and Kishorev 2010).
16. The economic possibility of RE project depends on the size of the grid and the type of technologies used in the implementation of RETs; as in rural areas people have more concern for low-cost energy supply such as small hydro, miniwind-generating plants.

5.5 Information and awareness challenges

The lack of information regarding availability and appropriate RETs options among the consumers affects popularity of RE. The lack of sources to promote the communication in isolated regions creates critical obstacles to the energy transition towards RE adaptation that, consequently, affects the capability of the various technologies in several countries. Thus, the market gap in consciousness is usually assumed to be the most crucial issue affecting the deployment of RE projects (Reddy and Painuly 2004).

Following are some dominant hurdles in this regard.

1. Incomplete public information about RE technologies.
2. Lack of information and attention to sustainable power source innovations and frameworks among provincial groups are another obstacle experienced in sustainable power accomplishment.
3. The lack of public awareness regarding advantages of RE in regular life.
4. Due to lack of awareness about new technologies, energy sectors are still reluctant because proper knowledge is the crucial point to accomplish the essential development in the field of the energy market.
5. Consciousness regarding RETs is the most critical point, but psychological concern towards this technology is the central point for the deployment of RETs (Sovacool 2009).
6. For the successful and efficient implementation of RE policies, there is an immense need to understand information regarding new relevant technologies (Jager 2006).

6 Conclusion

Energy is a prerequisite requirement in our everyday lives to enhance human advancement and promote social and economic development. To meet the twenty-first-century energy crises, RETs may be the best alternative because it has capabilities to achieve future energy needs of societies sustainably for new generations. The present article establishes relation between RES and sustainability. Moreover, it also presents descriptive analysis of transition from non-renewable energy to RES and how it helps to diminish climate change along with its other impacts.

A qualitative research has been done through reviewing the research articles in the field of this study. The study highlighted various impacts of RETs to the SD. Despite having sustainable features and numerous advantages, the accomplishment of RETs faces different kinds of technical, as well as non-technical, challenges, such as lack of information, market failures, environmental problems, administrative and political difficulties, and accessibility to raw materials for future RES deployment. In this aspect, a global approach towards policy making is required to resolve these challenges occurring in the implementation of RE projects, using a coordinated and systematic approach. Through this, deployment of clean energy technologies and its practical applications can be accomplished.

Presently, around 160 countries across the world have adapted RET applications and also promoting their policies effectively for its better advancement, but many technology areas still suffer from a lack of financial and policy support. Encouraging sustainable development has turned complete aspects of planning, analysis along with policy making of energy. In the *Paris Agreement*-2016, all countries come together to undertake ambitious endeavours in encountering environmental problems, like climate change and GHG emission. To achieve the climate goal from the Paris Agreement, to maintain temperature below a 2 °C warming, there is a need to reduce GHG emission to zero by 2050,

Finally, it concludes that the goal of sustainability may not be accomplished without expanding the application of RETs in the current energy scenario.

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