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Dr.K.Sasi Kumar

Editor-in-Chief

SUSTAINABLE ECONOMIC DEVELOPMENT - INDIAN PERSPECTIVE

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SUSTAINABLE ECONOMIC DEVELOPMENT - INDIAN PERSPECTIVE

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EDITORIAL MESSAGE

We take great pleasure in welcoming you to our Edited Book. The immediacy of e-based publication makes it possible for us all to be fully connected to each other and to developments in our field and to be directly involved in ongoing knowledge construction.

With several economies gearing towards the end of lockdowns, it's time for organizations to implement Post-COVID-19 business recovery strategies. Although it will let organizations restore balance to an extent, total recovery from the crisis is going to be a long and strategic battle. With these concepts in mind, we invited with scholarly discussions to facilitate new ideas for business sectors. This book also stands as a platform for Students and research scholars to express their innovative business models and solutions.

We are thankful to all academicians, research scholars and students who have contributed for this edited book. We also acknowledge the valuable suggestions and support offered by our colleagues and students. We are delighted that you are joining us as readers and hope you will also join us as contributors.



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SUSTAINABLE ECONOMIC GROWTH IN INDIAN PERSPECTIVE FOR SOLAR POWER

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Abstract

The primary objective for deploying renewable energy in India is to advance economic development, improve energy security, improve access to energy, and mitigate climate change. Sustainable development is possible by use of sustainable energy and by ensuring access to affordable, reliable, sustainable, and modern energy for citizens. Strong government support and the increasingly opportune economic situation have pushed India to be one of the top leaders in the world's most attractive renewable energy markets. The government has designed policies, programs, and a liberal environment to attract foreign investments to ramp up the country in the renewable energy market at a rapid rate. It is anticipated that the renewable energy sector can create a large number of domestic jobs over the following years. This paper aims to present significant achievements, prospects, projections, generation of electricity, as well as challenges and investment and employment opportunities due to the development of renewable energy in India. In this review, we have identified the various obstacles faced by the renewable sector. The recommendations based on the review outcomes will provide useful information for policymakers, innovators, project developers, investors, industries, associated stakeholders and departments, researchers, and scientists.

Keywords: National Electricity Plan, Ministry of Power, United Nations Framework Convention on Climate Change, Economic co-operation and development (OECD)

Introduction

The sources of electricity production such as coal, oil, and natural gas have contributed to one-third of global greenhouse gas emissions. It is essential to raise the standard of living by providing cleaner and more reliable electricity [1].



India has an increasing energy demand to fulfill the economic development plans that are being implemented. The provision of increasing quanta of energy is a vital pre-requisite for the economic growth of a country [2]. The National Electricity Plan [NEP] [3] framed by the Ministry of Power (MoP) has developed a 10-year detailed action plan with the objective to provide electricity across the country, and has prepared a further plan to ensure that power is supplied to the citizens efficiently and at a reasonable cost. According to the World Resource Institute Report 2017 [4, 5], India is responsible for nearly 6.65% of total global carbon emissions, ranked fourth next to China (26.83%), the USA (14.36%), and the EU (9.66%). Climate change might also change the ecological balance in the world. Intended Nationally Determined Contributions (INDCs) have been submitted to the United Nations Framework Convention on Climate Change (UNFCCC) and the Paris Agreement. The latter has hoped to achieve the goal of limiting the rise in global temperature to well below 2°C [6, 7]. According to a World Energy Council [8] prediction, global electricity demand will peak in 2030. India is one of the largest coal consumers in the world and imports costly fossil fuel [8]. Close to 74% of the energy demand is supplied by coal and oil. According to a report from the Center for monitoring Indian economy, the country imported 171 million tons of coal in 2013–2014, 215 million tons in 2014–2015, 207 million tons in 2015–2016, 195 million tons in 2016–2017, and 213 million tons in 2017–2018 [9]. Therefore, there is an urgent need to find alternate sources for generating electricity.

In this way, the country will have a rapid and global transition to renewable energy technologies to achieve sustainable growth and avoid catastrophic climate change.

Renewable energy sources play a vital role in securing sustainable energy with lower emissions [10]. It is already accepted that renewable energy technologies might significantly cover the electricity demand and reduce emissions. In recent years, the country has developed a sustainable path for its energy supply. Awareness of saving energy has been promoted among citizens to increase the use of solar, wind, biomass, waste, and hydropower energies. It is evident that clean energy is less harmful and often cheaper. India is aiming to attain 175 GW of renewable energy which would consist of 100 GW from solar energy, 10 GW from bio-power, 60 GW from wind power, and 5 GW from small hydropower plants by the year 2022 [11]. Investors have promised to achieve more than 270 GW, which is significantly above the ambitious targets. The promises are as follows: 58 GW by foreign companies, 191 GW by private companies, 18 GW by private sectors, and 5 GW by the Indian Railways [12]. Recent estimates show that in 2047, solar potential will be more than 750 GW and wind potential will be 410 GW [13, 14]. To reach the ambitious targets of generating 175 GW of renewable energy by 2022, it is essential that the government creates 330,000 new jobs and livelihood opportunities [15, 16].

A mixture of push policies and pull mechanisms, accompanied by particular strategies should promote the development of renewable energy technologies. Advancement in technology, proper regulatory policies [17], tax deduction, and attempts in efficiency enhancement due to research and development (R&D) [18] are some of the pathways to conservation of energy and environment that should guarantee that renewable resource bases are used in a cost-effective and quick manner. Hence, strategies to promote investment opportunities in the renewable energy sector along with jobs for the unskilled workers, technicians, and contractors are discussed. This article also manifests technological and financial initiatives [19], policy and regulatory framework, as well as training and educational initiatives [20, 21] launched by the government for the growth and development of renewable energy sources. The development of renewable technology has encountered explicit obstacles, and thus, there is a need to discuss these barriers. Additionally, it is also vital to discover possible solutions to overcome these barriers, and hence, proper recommendations have been suggested for the steady growth of renewable power [22,23,24]. Given the enormous potential of renewables in the country, coherent policy measures and an investor-friendly administration might be the key drivers for India to become a global leader in clean and green energy.

Projection of global primary energy consumption

An energy source is a necessary element of socio-economic development. The increasing economic growth of developing nations in the last decades has caused an accelerated increase in energy consumption. This trend is anticipated to grow [25]. A prediction of future power consumption is essential for the investigation of adequate environmental and economic policies [26]. Likewise, an outlook to future power consumption helps to determine future investments in renewable energy. Energy supply and security have not only increased the essential issues for the development of human society but also for their global political and economic patterns [27]. Hence, international comparisons are helpful to identify past, present, and future power consumption.

In 2016, India was the fourth largest energy consumer in the world after China, the USA, and the Organization for economic co-operation and development (OECD) in Europe [29]. Table 1 Projected primary energy consumption of the world between 1990 and 2040 [28] From: Renewable energy for sustainable development in India: current status, future prospects, challenges, employment, and investment opportunities

Region	Consumption (million tones oil equivalent)											Change (percentage per annum)	
	1990	1995	2000	2005	2010	2016	2020	2025	2030	2035	2040	1990–2016	2016–2040
United States	1966	2119	2310	2349	2284	2273	2334	2344	2341	2325	2299	0.6%	0.0%
Brazil	126	158	188	211	268	298	330	378	419	451	477	3.4%	2.0%
EU	1672	1661	1732	1819	1754	1642	1667	1623	1570	1513	1460	–0.1%	–0.5%
Russia	865	662	620	647	673	674	711	720	723	722	716	–1.0%	0.3%
Middle East	264	351	423	565	734	895	980	1085	1189	1287	1382	4.8%	1.8%
Africa	222	244	274	327	389	440	509	603	710	840	1002	2.7%	3.5%
China	683	889	1008	1800	2491	3053	3387	3753	4017	4207	4319	5.9%	1.5%
India	195	251	316	394	537	724	880	1118	1365	1624	1921	5.2%	4.2%

Current achievements in renewable energy 2017–2018

India cares for the planet and has taken a groundbreaking journey in renewable energy through the last 4 years [52, 53]. Dedicated ministries along with financial and technical institutions have helped India in the promotion of renewable energy and diversification of its energy mix. The country is engaged in expanding the use of clean energy sources and has already undertaken several large-scale sustainable energy projects to ensure a massive growth of green energy.

1. India doubled its renewable power capacity in the last 4 years. The cumulative renewable power capacity in 2013–2014 reached 35,500 MW and rose to 70,000 MW in 2017–2018.
2. India stands in the fourth and sixth position regarding the cumulative installed capacity in the wind and solar sector, respectively. Furthermore, its cumulative installed renewable capacity stands in fifth position globally as of the 31st of December 2018.
3. As said above, the cumulative renewable energy capacity target for 2022 is given as 175 GW. For 2017–2018, the cumulative installed capacity amounted to 70 GW, the capacity under implementation is 15 GW and the tendered capacity was 25 GW. The target, the installed capacity, the capacity under implementation, and the tendered capacity are shown in Fig. 4.
4. There is tremendous growth in solar power. The cumulative installed solar capacity increased by more than eight times in the last 4 years from 2.630 GW (2013–2014) to 22 GW (2017–2018). As of the 31st of December 2018, the installed capacity amounted to 25.2122 GW.
5. The renewable electricity generated in 2017–2018 was 101839 BUs.
6. The country published competitive bidding guidelines for the production of renewable power. It also discovered the lowest tariff and transparent bidding method and resulted in a notable decrease in per unit cost of renewable energy.
7. In 21 states, there are 41 solar parks with a cumulative capacity of more than 26,144 MW that have already been approved by the MNRE. The Kurnool solar park was set up with 1000 MW; and with 2000 MW the largest solar park of Pavagada (Karnataka) is currently under installation.
8. The target for solar power (ground mounted) for 2018–2019 is given as 10 GW, and solar power (Rooftop) as 1 GW.

9. MNRE doubled the target for solar parks (projects of 500 MW or more) from 20 to 40 GW.
10. The cumulative installed capacity of wind power increased by 1.6 times in the last 4 years. In 2013–2014, it amounted to 21 GW, from 2017 to 2018 it amounted to 34 GW, and as of 31st of December 2018, it reached 35.138 GW. This shows that achievements were completed in wind power use.
11. An offshore wind policy was announced. Thirty-four companies (most significant global and domestic wind power players) competed in the “expression of interest” (EoI) floated on the plan to set up India’s first mega offshore wind farm with a capacity of 1 GW.
12. 682 MW small hydropower projects were installed during the last 4 years along with 600 watermills (mechanical applications) and 132 projects still under development.
13. MNRE is implementing green energy corridors to expand the transmission system. 9400 km of green energy corridors are completed or under implementation. The cost spent on it was INR 10141 crore (101,410 Million INR = 1425.01 USD). Furthermore, the total capacity of 19,000 MVA substations is now planned to be complete by March 2020.
14. MNRE is setting up solar pumps (off-grid application), where 90% of pumps have been set up as of today and between 2014–2015 and 2017–2018. Solar street lights were more than doubled. Solar home lighting systems have been improved by around 1.5 times. More than 2,575,000 solar lamps have been distributed to students. The details are illustrated in Fig. 5.
15. From 2014–2015 to 2017–2018, more than 2.5 lakh (0.25 million) biogas plants were set up for cooking in rural homes to enable families by providing them access to clean fuel.
16. New policy initiatives revised the tariff policy mandating purchase and generation obligations (RPO and RGO). Four wind and solar inter-state transmission were waived; charges were planned, the RPO trajectory for 2022 and renewable energy policy was finalized.
17. Expressions of interest (EoI) were invited for installing solar photovoltaic manufacturing capacities associated with the guaranteed off-take of 20 GW. EoI indicated 10 GW floating solar energy plants.
18. Policy for the solar-wind hybrid was announced. Tender for setting up 2 GW solar-wind hybrid systems in existing projects was invited.

19. To facilitate R&D in renewable power technology, a National lab policy on testing, standardization, and certification was announced by the MNRE.
20. The Surya Mitra program was conducted to train college graduates in the installation, commissioning, operations, and management of solar panels. The International Solar Alliance (ISA) headquarters in India (Gurgaon) will be a new commencement for solar energy improvement in India.
21. The renewable sector has become considerably more attractive for foreign and domestic investors, and the country expects to attract up to USD 80 billion in the next 4 years from 2018–2019 to 2021–2022.
22. The solar power capacity expanded by more than eight times from 2.63 GW in 2013–2014 to 22 GW in 2017–2018.
23. A bidding for 115 GW renewable energy projects up to March 2020 was announced.
24. The Bureau of Indian Standards (BIS) acting for system/components of solar PV was established.
25. To recognize and encourage innovative ideas in renewable energy sectors, the Government provides prizes and awards. Creative ideas/concepts should lead to prototype development. The Name of the award is “AbhinavSoch-NayiSambhawanaye,” which means Innovative ideas—New possibilities.

Conclusion

The renewable sector suffers notable obstacles. Some of them are inherent in every renewable technology; others are the outcome of a skewed regulative structure and marketplace. The absence of comprehensive policies and regulation frameworks prevent the adoption of renewable technologies. The renewable energy market requires explicit policies and legal procedures to enhance the attention of investors. There is a delay in the authorization of private sector projects because of a lack of clear policies. The country should take measures to attract private investors. Inadequate technology and the absence of infrastructure required to establish renewable technologies should be overcome by R&D. The government should allow more funds to support research and innovation activities in this sector. There are insufficiently competent personnel to train, demonstrate, maintain, and operate renewable energy structures and therefore, the institutions should be proactive in preparing the workforce. Imported equipment is costly compared to that of locally manufactured; therefore, generation of renewable energy becomes expensive and even unaffordable. Hence, to decrease the cost of renewable products, the country should become involved in the manufacturing of renewable products. Another significant infrastructural

obstacle to the development of renewable energy technologies is unreliable connectivity to the grid. As a consequence, many investors lose their faith in renewable energy technologies and are not ready to invest in them for fear of failing. India should work on transmission and evacuation plans. Inadequate servicing and maintenance of facilities and low reliability in technology decreases customer trust in some renewable energy technologies and hence prevent their selection. Adequate skills to repair/service the spare parts/equipment are required to avoid equipment failures that halt the supply of energy. Awareness of renewable energy among communities should be fostered, and a significant focus on their socio-cultural practices should be considered. Governments should support investments in the expansion of renewable energy to speed up the commercialization of such technologies.

The Indian government should declare a well-established fiscal assistance plan, such as the provision of credit, deduction on loans, and tariffs. The government should improve regulations making obligations under power purchase agreements (PPAs) statutorily binding to guarantee that all power DISCOMs have PPAs to cover a hundred percent of their RPO obligation. To accomplish a reliable system, it is strongly suggested that renewables must be used in a hybrid configuration of two or more resources along with conventional source and storage devices. Regulatory authorities should formulate the necessary standards and regulations for hybrid systems. Making investments economically possible with effective policies and tax incentives will result in social benefits above and beyond the economic advantages.

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