Renewable Energy Development in Indian Deregulated Power Market: Future Aspects

Yog Raj Sood, and Naveen Kumar Sharma

Abstract**—** India is on the path of rapid economic growth along with speedy overall development; simultaneously it has to face the global threat of climate change. So, India has unique renewable energy resources (RES) and development of country depends to a great extent on harnessing these sources. Renewable energy sources and technologies have potential to provide solutions to the longstanding energy problems being faced by the developing countries like India. Renewable energy is a sustainable and clean source of energy derived from nature. These technologies have long been recognized as an important part of the solution to address energy security concerns and ensure economic growth in an environment friendly manner. Deregulation has changed the traditional mission and mandates of power utilities in complex ways, and had large impacts on environmental, social, and political conditions for India. The renewable energy based power generating systems can play a major role towards the fulfilment of energy requirements of restructured electricity market. In this paper, efforts have been made to summarize the availability, current status, environmental effects, promotion policies and future potential & strategies of renewable energy options in India**.**

Keywords**---**Competitive power market, renewable energy sources, renewable policy.

I. INTRODUCTION

COMPETITIVE power market has changed the traditional mission and mandates of power utilities in complex ways, and had large impacts on environmental, social, and political conditions for any particular country. India has a vast supply of renewable energy resources, and it has one of the largest programs in the world for deploying renewable energy based products and systems. India is a developing and fast-growing large economy and faces a great challenge to meet its energy needs in a responsible and sustainable manner. Power industry is moving rapidly from regulated conventional setup to a deregulated environment. In the deregulation environment, generation, transmission, and distribution are independent activities. There is a competition among generators for managing different customers. Main benefits from the deregulation include cheaper electricity, efficient capacity expansion planning, cost minimization, more choice, and better service. During the nineties decade, many electric utilities throughout the world have forced to change their way of operation and business, from vertically integrated mechanism to open market system [1]. India is on the path of rapid economic growth along with speedy overall development; simultaneously it has to face the global threat of climate change. India has unique renewable energy resources (RES) and development of country depends to a great extent on harnessing these sources. India has unique RES and development of country depends to a great extent on harnessing these sources. Since conventional sources of energy pose significant threats to our current and future global security, environmental quality, health and society. So there is urgent need to promote renewable energy in present Indian restructured power sector in sustainable and eco-friendly manner [2]. Restructuring in Indian power sector started with the unbundling of Orissa state power utility, and soon followed by many other states throughout India [3].

India also has followed the global change in power sector by establishment of the Regulatory Commissions in 1998 under the Electricity Regulatory Commissions Act 1998 (Central Law) to promote competition, efficiency and economy in the activities of the electricity industry and applied restructuring to Orrisa state electricity board firstly and after that to many other states. Central Electricity Regulatory Commission (CERC) has a key role in rationalizing tariff of generating companies owned or controlled by the Central Government in consultation with State Electricity Regulatory Commission (SERC) [4].

In the recent past, India has been growing at an average rate of 8.5%. Growth of economy is reciprocally linked to energy usage, and consequently the energy requirements of the country have increased phenomenally in the last couple of years. Growth of economy is reciprocally linked to energy usage, and consequently the energy requirements of the country have increased phenomenally in the last couple of years [5]. Over the years, Indian power sector has experienced a approx six-time increased in its installed capacity - it jumps from 30 GW in 1981 to over 201 GW by 30 April 2012 [19], but still there is a huge gap between generation and demand in India. Hence it needs to be establishing more generation plants preferably to be come from renewable sources by governmental as well as various private sectors. Electricity generation from renewable is assuming increasing importance in the context of large negative environmental externalities caused by electricity generation from fossil fuels based energy. Towards managing the environmental and social impacts; RESs have been drawing considerable attention in policy-making, project development, and operations [6-7]. The 56 percent of coal based plants generates large amounts of ash with other environmental harmful emission of gases such as carbon dioxide (CO_2), sulphur dioxide (SO_2), and nitrogen oxides (NOx). Immediate CO_2 reductions driven by the early deployment of RE may cost more than other options

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today, but will reduce the costs of mitigating climate change in the future. The future economic development trajectory is likely to result in rapid and accelerated growth in energy demand and the growing energy consumption from conventional sources of energy is likely to leads increasing emissions of gases, compounding the pollution problems and increasing Green House Gas (GHG) emissions [2, 8]. Mainly, global warming caused by greenhouse gases and CO_2 produced during the burning of fossil fuels, have been causing significant changes in the ecosystems and leading to nearly 150,000 additional deaths every year. On average, every 1 GW of additional renewable energy capacity reduces CO_2 emissions by 3.3 million tons a year [5]. So there is a great need to promote the renewable energy source in Indian power sector to meet future energy demand and remove GHG emission for environment protection. This paper emphasized the availability, current status, Indian power structure, environmental effects, promotion policies and future potential & strategies of renewable energy options in India.

II. Structure of Indian Power Sector

India is the fifth largest producer of electricity in the world. According to the planning commission, while the state governments account for 43% of the total generation capacity, the central sector and the private sector account for 30% and 27% of the generation capacity respectively, having aggregate capacity of 182 GWs out of which 65% is from thermal, 21% from hydro, 3% from nuclear and the rest about 11% is from renewable energy sources [19]. Although Over the years, Indian power sector has experienced a six-time increased in its installed capacity - a jump from 30,000MW in 1981 to over 201,637.03 MW by 30 April 2012 but still there is a huge gap in generation and demand in India hence need to be establish more generation plants preferably to be come from renewable sources by governmental as well as various private participation [19].

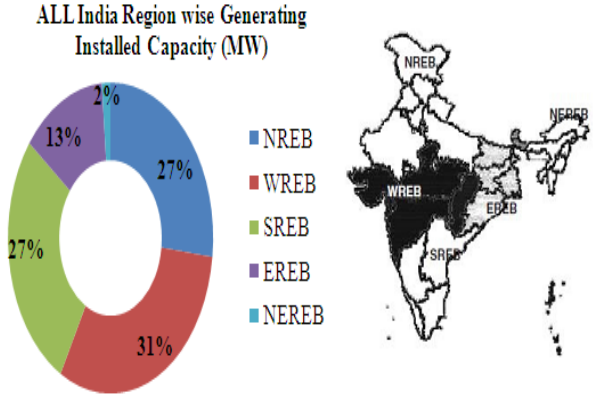

Fig. 1 Regional Electricity board of India and percentage of region wise installed capacity

The functions of centre electricity authority (CEA) are to advise the Ministry of Power (MoP) on national power policy, national power planning and regulatory matters on the national level where as State Electricity Regulatory Commissions (SERCs), does the same function at state level. Indian power sector is organized into five Regional Electricity Boards such as northern regional electricity board(NREB), southern regional electricity board (SREB), western regional electricity board (WREB), eastern regional electricity board (EREB) and north eastern regional electricity board (NEREB) as depicted in Figure 1 [2]. As shown in Figure 1, each regional electricity board covers many states electricity boards in India as on 31 April 2012. With the establishment of various inter-regional links, inter-regional power exchange has grown manifold. Growth of inter-regional power exchange has helped in meeting more demand in energy deficit regions besides achieving overall economy [20].

III. Current Status of RES in India

Renewable energy has been an important component of India's energy planning process. The importance of renewable energy sources in the transition to a sustainable energy base was recognized in the early 1970s.

A. Grid Connected

India, total grid-connected renewable power generation capacity of 26920.03 MW has been achieved till 31 January 2013, which is about 12% of the total installed power generating capacity in the country. It includes wind power of 18 GW, small hydropower of 3.5 GW, biomass power of around 3.4 GW, and around 1.2 GW Solar Power as shown in Table 1 [7].

Table 1
Estimated potential and cumulative achievements of RES connected Indian grid

Renewable energy program	Target for 2012-13	Total achievement during 2012-13	Cumulative achievement up to 31.01.2013
Wind Energy	2400	2500.00	18551.70
Small hydro Power	350	350.00	3506.24
Biomass Power	460	105.00	1248.60
Bagasse Cogeneration		350.00	2280.93
Waste to power (Urban & Industrial)	25	20.00	96.08
Solar Power	200	800.00	1236.48
Total	3435	3157.75	**26920.03**

A capacity addition of 15,000 MW is targeted during the 12th Plan period that would take the renewable power generating capacity to nearly 40,000 MW by 2017. This momentum is likely to be sustained and it is envisaged that the renewable power capacity in the country will cross 87,000 MW by 2022. The MNES (Ministry of New and Renewable Energy Sources), Government of India (GOI), has under taken measures to facilitate the growth of both grid and off-grid RE power through specific programs. Major programs in India for power generation from renewable include wind, biomass (cogeneration and gasifiers), small hydro, solar, and energy from wastes. The contribution of renewable to the total installed capacity of electricity generation has been rising after private participation into generation and distribution due implementation of restricting of power sector. The total potential of renewable in India for power generation is

estimated to be 84777 MW with the major contribution coming from wind energy [7].

B. Off-Grid Renewable Power

It needs to be underlined that for two major reasons Indian renewable energy priorities are different from that of the developed countries. Firstly, and most importantly, it provides energy access to large rural populations including those in inaccessible areas and meeting unmet demand in many other areas. Perhaps the remoter areas can get electricity only through renewable sources [7]. Table 2 presents a summary of the achievements in off-grid/ distributed renewable power and decentralized renewable energy systems. While these achievements are evidently impressive, there is great need for potential and deployment of such off-grid/ distributed/ decentralized systems.

TABLE 2
OFF-GRID RENEWABLE POWER AND DECENTRALIZED ENERGY SYSTEMS (UP TO 31.01.2011)

S. No	Resources/ Systems	Cumulative Achievements (up to 31.01.2011)
Off-Grid/Distributed Renewable Power (including Captive/Cogeneration Plants)		
1.	Biomass Power / Cogen.(non-bagasse)	347.9 MW
2.	Biomass Gasifier	148.2 MWeq
3.	Waste-to- Energy	92.9 MWeq
4.	Solar PV Power Plants	81.0 MWp
5.	Aero-Generators/Hybrid Systems	1.5 MW
	Total	671.5 MWeq
Decentralized Energy Systems		
1.	Family Type Biogas Plants	4.475 million
2.	SPV Home Lighting System	6,69,805 nos.
3.	Solar Lantern	8,17,549 nos.
4.	SPV Street Lighting System	1,22,697 nos.
5.	SPV Pumps	7,495 nos.
6.	Solar Water Heating - Collector Area	4.98 million sq.m.
7.	Solar Cookers	6.39 lakh
8.	Remote Village Electrification	9009Villages and hamlets
9.	Energy Parks	514 nos.
10.	Aditya Solar Shops	302 nos.
11.	Battery operated Vehicles	305 nos.
MWeq. = Megawatt equivalent, MW = Megawatt, sq. m. = square meter		

IV. NEED OF RENEWABLE ENERGY SOURCES IN RESTRUCTURED POWER SECTOR

Energy sources include water, wind, solar, geothermal, and some combustible materials, such as landfill gas, municipal solid waste (MSW), and other forms of biomass. The use of renewable energy in its various forms is closely tied to the rise of civilization in the past also. The oil embargo of 1970's was a catalyst for the adoption and promotion of renewable energy and policies. The advent of competition in electricity markets necessitates a re-evaluation of renewable energy technology and policies. Concerns about the use of renewable energy sources in a competitive environment can be outlined in the form as, competition in the electric power industry will encourage utilities to become more efficient and reduce costs in order to lower electricity prices [1,5]. There will be a premium on short-term cost minimization in competitive electricity market. The development of renewable energy, which reduces dependence on fossil fuels, does not need to be imported, and generally produces fewer and less toxic pollutants than fossil fuels. Presently, in the Indian power sector major share in electricity generation is thermal generation and the main fuel used is coal. Fossil fuels are finite in nature moreover exploitation of these resources has adverse effects on the ecology due to mining, deforestation, particulate matter emissions, handling of waste, transportation dependency, etc.

Hence the growing concern over environmental degradation caused by fossil fuel based systems, opposition to large hydro projects on grounds of displacement of land and population, and the ever-rising shortage of power have highlighted the need for tapping renewable sources as an alternate energy sources for power generation in India [1, 21].

V. RENEWABLE ENERGY POLICY INITIATIVES IN INDIA

The recent significant growth of renewable energy is mostly a result of more favourable policies amid increasing concerns about climate change and energy security. The India now has the opportunity to build a sustainable energy future by engaging and stimulating the tremendous innovative and entrepreneurial capacity of the private sector [14]. Most countries like India that have undertaken recent electricity sector and market reforms now provide conditional access to the grid for independent power producers, including small-scale renewable energy producers. Different strategies are being used for promotion of renewable energy sources for power generation in India. A number of fiscal and financial incentives are being provided for promotion of renewables. Foremost amongst them is the Electricity Act (2003) which de-licensed stand-alone generation and distribution systems in rural areas. The National Rural Electrification Policy, 2005 and National Rural Electrification Policy, 2006 also stresses the need for urgent electrification. The New Tariff Policy (2006) stated that a minimum percentage of energy, as specified by the Regulatory Commission, is to be purchased from such sources [9-13]. A comprehensive RE Policy for all-round development of the sector, encompassing all the key aspects, has been formulated by MNRES. The policies targeting of 10% of additional grid power Generation capacity [22] to come from RE by 2012. Some of the policies and fiscal incentives in India for renewable energy developments are discussed in later sections.

A. Electricity act 2003

The Electricity Act 2003 is having a significant impact on the renewable power because it recognized the role of renewable energy technologies in the National Electricity Policy and in stand-alone systems. Some of the important provisions for renewable in this act include various incentives to the producers of renewable energy. According to Section 3 (1) of the Electricity Act 2003, the central government shall, prepare the National Electricity Policy and tariff policy from time to time, in consultation with the State Governments [13]. The 'Electricity Act 2003' also has made the state electricity regulatory commissions (SERCs) crucial players in the context of state level policies for renewable energy. Under the Section 86(1) of the Act, it is mandatory for the SERCs to "promote co–generation and generation of electricity through

renewable sources of energy by providing suitable measures for connectivity with the grid. The E Act-2003 allow sale of electricity from renewable generation to any persons. It also specifies the purchase of electricity from renewable generation [9].

B. National electricity policy 2005

The National Electricity Policy 2005 stipulates that progressively the share of electricity from non-conventional sources would need to be increased; such purchase by distribution companies shall be through competitive bidding process; considering the fact that it will take some time before non-conventional technologies compete, in terms of cost, with conventional sources, the commission may determine an appropriate deferential in prices to promote these technologies [15].

C. The national tariff policy 2006

The National Tariff Policy mandates each State Electricity regulatory commissions (SERC) to specify a Renewable energy Purchase Obligation (RPO/RPS) by distribution licensees in a time-bound manner. The Central Commission should lay down guide lines within three months of its establishment for pricing nonfarm power, especially from non-conventional sources, to be followed in cases where such procurement is not through competitive bidding [10-11]. The main aim of this policy is reducing the cost of power through competitive process and capacity development.

D. National rural electrification policies (NREP), 2006

According to NREP to achieve the 10% Renewable energy target through Renewable Purchase Obligations RPO set by the various SERCs in there respective states, cognizant of its role in the promotion of RE, SERCs in many states have had been formulating encouraging policies to promote renewable energy. SERCs include preferential tariffs, RPO, reduction in contract load, banking and wheeling arrangements and guidelines for evacuation arrangement. Some SERCs have applied the RPO on the Open Access Consumers (OAC) and Captive Power Plant (CPP) consumers. Along with specifying a minimum RPO, certain SERCs have also set a ceiling for maximum power that can be purchased by the distributed companies (Disco's) from the RE sources in order to keep a check on increase in retail tariff due to higher power purchase costs. As per this policy for villages, where grid connectivity would not be feasible or not cost effective, off-grid solutions based on standalone systems may be taken up for supply of electricity based upon renewable so that every household gets access to electricity. Moreover where neither standalone systems nor grid connectivity is feasible then only alternative is to use isolated lighting technologies like solar photovoltaic may be adopted [16-18].

VI. RESEARCH & DEVELOPMENT (R&D) INITIATIVES

The "MNRE" also encourages the combination of the solar energy using systems and the buildings, in order to provide the necessary conditions for solar energy utilization during the design and construction. The Ministry of Non-Conventional Energy Sources has been supporting R&D for technology and manpower development in Renewable Energy. Present emphasis is on reduction in cost and increase in efficiency. For technology development, the R&D strategy would comprise five categories, viz [23].

- Basic research having a long term perspective for the development of innovative and new materials, processes and applications.
- Applied research aimed at improvement the existing processes, materials and the technology for enhanced performance, durability and cost competitiveness of the systems/ devices.
- Technology validation and demonstration projects aimed at field evaluation of different configurations, including hybrids with conventional power systems for obtaining feedback on performance, operability and costs.
- Development of R&D infrastructure in private public partnership (PPP) mode, and
- Support for incubation and start ups, a 3-tier R&D institutional framework, including high level research council, National Centre of Excellence and a network of centres of excellence

VII. ENVIRONMENTAL, SOCIAL AND ECONOMIC BENEFITS BY RES

Renewable energy is central to climate change mitigation efforts. Broad estimates indicate that mitigation from existing renewable energy portfolio is equivalent to around 4-5 % of total energy related emissions in the country. India is already providing competitive green investment loans, tariff subsidies and tax breaks for the renewable industry. These are some of its measures to encourage the economy to transform into a low-carbon economy [24]. A sustainable energy economy offers not just ecological benefits, but social and economic benefits too. Solar energy in India have the potential to offset a huge volume of GHG emissions as demonstrated and help realize a low carbon economy at a faster rate .India's climate modeling studies show that its per capita emissions will be around 2-2.5 tones of carbon-dioxide equivalent by 2020 and around 3-3.5 tones of carbon-dioxide equivalent by 2030, compared to around 1-1.2 tones presently [25].

RES is in direct contravention to the huge social, economic and environmental externalities created by conventional power projects. The foremost benefit of deployment of RE technologies is employment generation. The renewable energy industry offers a variety of highly skilled and semi-skilled jobs and the sector is highly employment intensive. In India, if we sincerely implement the 15% RE target set by National Action Plan on Climate Change (NAPCC), we would have to add 90,000 MW of additional renewable power up to 2020. At an average of 20 jobs per MW (both direct and indirect) addition of 90,000 MW of renewable capacity can create 1.8 million jobs. Energy security and autonomy would be the major economic benefit due to freedom from fossil fuels. Import dependency exposes us to major price risks since fossil fuels are globally traded commodities [26].

VIII. Future perspectives for RES in India

The MNRE has set aggressive targets for renewable energy, with projections approaching 40,000 MW by 2017. The National Solar Mission, established under the NAPCC, has set a goal of generating at least 15% of India's power from solar energy. It envisages increasing the production of solar photovoltaic panels to 1,000 MW per year from the current 235 MW per year and generating 1,000 MW of grid-connected solar power, up from the current 481MW, by 2017 [7].

Table III
Development of grid-connected renewable power in India (in MW)

	In Process	Targets
Five-year Plan	By the End of the 11th Plan	By the End of the 13th Plan
Years	Through 2012	Through 2022
Wind	17,582	40,000
Small Hydro	3,358	6,500
Biomass	3,218	7,500
Solar	1,003	20,000
Total	25,161	74,000

India has set a very ambitious goal to increase the RE production. By 2017 15% of added electricity capacity should be renewable. Besides direct RE targets, India has also set targets concerning access to electricity. By "13th five year plan 2017-22"; planning commission (GOI) targeted the future development of total RES in India, which is shown in Table 3. The Committee has placed emphasis on higher use of renewables in all forms of services. It is expected that the contribution from renewables in power generation alone can be of the extent of 60,000MW in the year 2031-2032.

In the present Indian power sector with maturing technologies, promotion policies in renewable energy business, and suitability of various new renewable projects is likely to be improve, resulting in higher utilization of available government funds and faster market growth. India has experience with many technologies and their implementation. Worldwide India ranks fifth in installed wind energy installed capacity, fourth in annual PV production capacity and second with biogas plants [23].

Table IV
Deployment across the application segments

S. No.	Application Segment	Target for Phase 1 (2010-13)	Target for Phase 2 (2013-17)	Target for Phase 3 (2017-22)
1.	Solar collectors	7 million sq meters	15 million sq meters	20 million sq meters
2.	Off grid solar Applications, including rural solar lights	200 MW	1000 MW	2000 MW
3.	Utility grid power, including roof top	1,000-2000 MW	4000-10,000 MW	20000 MW

India possesses a very large solar energy resource which is seen as having the highest potential for the future. The first, recently announced, the very ambitious Jawaharlal Nehru National Solar Mission (JNNSM) with a target of 20,000 MW grid solar powers, 2000 MW of off-grid capacity including 20 million solar lighting systems and 20 million square meters. Solar thermal collector area by 2022 is under implementation. The main objectives of the mission are to help reach grid parity by 2022 and help set up indigenous manufacturing capacity. The deployment across the application segments is envisaged as follows in Table 4 [24]. By addition of RE capacity via creation of the National Clean Energy Fund; India is contributing more renewables power through grid. In India, many states recognizing by renewable energy as a grid-connected option and entry of major corporate groups into manufacturing of RE devices [25].

IX. Conclusions

Renewable energy is experiencing new enthusiasm and vibrancy all across, and the foundation of a new economy is being laid that is inclusive, sustainable and aspires for de-carbonization of energy in a definite time frame.Increased recognition of the contribution renewable energy makes to rural development, lower health costs (linked to air pollution), energy independence, and climate change mitigation is shifting renewable energy from the fringe to the mainstream of sustainable development. For renewable development in India, the renewable energy program has been in existence for more than three decades, but a market for renewable energy technologies still need to be exists. Renewable energy strategy needs to be integrated with liberalization of energy markets and withdrawal of direct government interventions in energy sector. Need to construct market-based energy policies that provide a competitive market framework, and may internalize externalities in terms of energy security, environmental protection and economic efficiency for effective promotion of renewable. India's rural areas and in reducing consumption of fossil fuels which is essential for future energy security of the country. It outlines the policies that have been followed to foster the growth of this sector and also indicates the targets and the future pathway.

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