



Renewable energy scenario in India: Opportunities and challenges



Souvik Sen ^{a,*}, Sourav Ganguly ^b, Ayanangshu Das ^b, Joyjeet Sen ^b, Sourav Dey ^b

^a Geologix Limited, Dynasty Building, Andheri Kurla Road, Andheri East, Mumbai 400059, Maharashtra, India

^b Department of Geological Sciences, Jadavpur University, Kolkata 700032, West Bengal, India

ARTICLE INFO

Article history:

Received 2 March 2015

Received in revised form

29 May 2015

Accepted 2 June 2015

Available online 9 June 2015

Keywords:

Energy security

Renewable energy

Solar

Wind

ABSTRACT

Majority of the power generation in India is carried out by conventional energy sources, coal and fossil fuels being the primary ones, which contribute heavily to greenhouse gas emission and global warming. The Indian power sector is witnessing a revolution as excitement grips the nation about harnessing electricity from various renewable energy sources. Electricity generation from renewable sources is increasingly recognized to play an important role for the achievement of a variety of primary and secondary energy policy goals, such as improved diversity and security of energy supply, reduction of local pollutant and global greenhouse gas emissions, regional and rural development, and exploitation of opportunities for fostering social cohesion, value addition and employment generation at the local and regional level. This focuses the solution of the energy crisis on judicious utilization of abundant the renewable energy resources, such as biomass, solar, wind, geothermal and ocean tidal energy. This paper reviews the renewable energy scenario of India as well as extrapolates the future developments keeping in view the consumption, production and supply of power.

Research, development, production and demonstration have been carried out enthusiastically in India to find a feasible solution to the perennial problem of power shortage for the past three decades. India has obtained application of a variety of renewable energy technologies for use in different sectors too. There are ample opportunities with favorable geology and geography with huge customer base and widening gap between demand and supply. Technological advancement, suitable regulatory policies, tax rebates, efficiency improvement in consequence to R&D efforts are the few pathways to energy and environment conservation and it will ensure that these large, clean resource bases are exploited as quickly and cost effectively as possible. This paper gives an overview of the potential renewable energy resources in Indian context while evaluating the present status, the energy demand of the country and forecast consumption and production, with the objective to evaluate and assess whether India can sustain its growth and its society with renewable resources.

© 2015 Elsevier Ltd. All rights reserved.

1. Introduction

Energy has come to be known as a 'strategic commodity' and any uncertainty about its supply can threaten the functioning of the economy, particularly in developing economies. Achieving energy security in this strategic sense is of fundamental importance not only to India's economic growth but also for the human development objectives that aim at alleviation of poverty, unemployment and meeting the Millennium Development Goals (MDGs). The Indian economy has experienced unprecedented economic growth over the last decade. The economy of India is the seventh-largest in

the world by nominal GDP (behind United States, China, Japan, Germany, United Kingdom and France) and the third-largest by purchasing power parity (PPP) behind China and United States, as per International Monetary Fund [World Economic Outlook \(IMF-WEO\), April 2015](#). As per the real GDP growth (%change) India ranks at 9. According to IMF-WEO Indian economy has enjoyed a real GDP growth of to 7.5% in 2014–2015 as compared with 7.2% in the last.

Most of the commercial energy demand in India is met largely by imported fossil fuels. In 2013, India was the 4th biggest consumer and net importer of crude and petroleum products in the world ([Barpatragohain, 2015](#)). As the country is essentially dependent on energy import, any shortfall due to unforeseen geopolitical situation may cause acute energy scarcities which will consecutively impede the industrial growth and economic

* Corresponding author.

E-mail address: souvikseniitb@gmail.com (S. Sen).

progress.

In order to achieve energy independence, the dependency on imported oil has to be reduced by developing alternate energy sources. The average per capita consumption of energy in India is still much lower than that of developed countries. However, the same is expected to rise sharply due to high economic growth and scope for rapid industrialization. The sustainable renewable energy can be a vital link in industrialization and development of nation. In the near-term, total fossil energy demand will likely increase even faster because of steady industrial and economic growth. Apart from augmenting the energy supply, renewable resources will help India in mitigating the climate change. The competitiveness of alternate energy source is further enhanced due to rise in oil price and the added yields from carbon emission reduction credits under clean development management. The alternate energy technologies will create of sustainable energy sources for independence from politically sensitive fossil fuel imports and also reduce hazardous greenhouse gas emissions. The fluctuation of oil price due to increased geopolitical turmoil demands a transparent integrated energy policy for accelerated growth of domestic energy resources.

2. Current scenario: technology and economics

India has seen an annual growth rate of about 22% for renewable energy in the last decade. The production from non-conventional sources in India during 2013–2014 is about 53.22 billion units and the major contributors are wind and solar with 31.26 billion units and 3.35 billion units respectively (Barpatragohain, 2015). Alternate energy also payback to investment in the form of carbon credit for clean development mechanism. Wind and solar power do not produce waste and so no investment for waste management is needed during the lifecycle in such power facilities. Other potential resources are hydropower, tidal energy, geothermal energy and biomass/bio-waste.

3. Wind energy

Wind energy is a clean alternative energy source as compared to conventional fuel and has the advantage of being harnessed in rural and remote areas. In order to tap the potential of wind energy sources, the scientific wind mapping has been done extensively. Presently, India has an installed power generation capacity of a little over 207.8 GW, of which renewable resources account for about 25 GW and wind makes up a majority of this installed capacity (Barpatragohain, 2015; MNRE, 2009). There is huge activity in wind power, pan-India with the installed capacity increasing to 10,000 MW. India today has the fifth largest installed capacity of wind power in the world with 11087 MW installed capacity and potential for on-shore capabilities of 65,000 MW. High quality wind energy sites, at 80 m hub-height with a minimum capacity factor of 25%, have a potential between 253 GW (no farmland included) and 306 GW (all farmland included). However the plant load factor (PLF) in wind power generation is very low, often in the single digits (Hossain, 2011).

Ministry of New and Renewable Resources (MNRE) has declared in its official website that under National Wind Resource Assessment programme, Ministry through National Institute of Wind Energy, Chennai (erstwhile Centre for Wind Energy Technology (C-WET)) and State Nodal Agencies had installed and monitored 794 dedicated Wind Monitoring Stations (WMS) of height ranging from 20 m to 120 m (20 m, 25 m, 50 m, 80 m, 100 m, and 120 m) throughout the country as on 31.12.2014 (MNRE Website – www.mnre.gov.in). Initially the wind monitoring was carried out only in known windy areas. Now it is extended to new/uncovered areas which are not explored in earlier projects to complete the Indian

Wind resource mapping. Further hundreds of private winds monitoring stations are also operational in the country. In its official website, MNRE has declared that based on the analysis on the data collected from these 700 plus wind monitoring stations, it has been found that 237 stations have economically preferable wind power potential greater than 200 W/sq m.

In India, winds are influenced by the strong south-west summer monsoon, which starts in May–June, the weaker north-east winter monsoon, which starts in October and during the period March to August, the winds get stronger over the whole Indian peninsula except the eastern coast (Hossain, 2011). Wind speeds during November to March are comparatively weak, though higher winds are available in the Tamil Nadu coastline (Hossain, 2011). Wind turbines are mounted on tower to capture the most energy with less turbulent wind. Wind turbine converts kinetic energy from the wind into electrical power. The combination of lift force (which pulls the blades toward it) and drag force (which acts against front side of blades) causes the rotor to spin like a propeller and spins the generator to make electricity. Wind turbines can be used as stand-alone applications, or connected to a utility power grid or even combined with a hybrid system. Wind farms, the arrays of large turbines are becoming significant source of renewable energy as part of a strategy to reduce dependency on fossil fuels.

The economics of wind energy is more encouraging than many other alternate energy sources. Unlike solar, the wind energy is available continuously and cost of power generation is cheaper at site. The wind power has emerged as a highly commercially viable and competitive energy source due to increased R&D activities and intrinsic strengths like non-polluting and sustainability. The generation cost of wind energy is mainly determined by the parameters like investment cost (production, transportation and erection cost), land-cost, operation and maintenance cost, average wind speed, and hub height and financial parameters like interest rate. (Lu et al., 2009). With new technology innovation and economies of scale production, the wind turbines (which influence the major investment cost) are becoming cheaper and more powerful. Thus, the cost of wind power generation per kW h shows a decreasing trend with time.

4. Solar energy

Theoretically, solar might seem an ideal energy source, as it is free and virtually limitless. The solar radiation reaching the earth's surface in one year provides more than 10,000 times the world's yearly energy needs. Furthermore, harnessing just one-quarter of the solar energy that falls on the world's paved areas could meet all current global energy needs comfortably. India is densely populated and has high solar insolation, an ideal combination for using solar power. Because of its location between the Tropic of Cancer and the Equator, India has an average annual temperature ranging from 25 °C to 27.5 °C. Therefore India has huge solar potential (Khanna et al., 2008). Driven by an increasing demand for electricity and widening gap between demand and supply, India has targeted 20 GW of Solar Power by 2022. With about 300 clear, sunny days in a year, India's theoretical solar power reception, on only its land area is about 5000 PW h/year or about 600,000 GW (Sharma, 2011). The daily average solar energy incident over India varies 4–7 kW h/m² with about 1500–2000 sunshine hours per year (depending upon location), which is far more than current total energy consumption. India has an expanding solar energy sector: 9 solar cell manufactures, 22 PV module manufactures, and 50 PV systems manufactures. India has been ranked 7th worldwide for solar photovoltaic cell production and secure 9th rank in solar thermal power generation (Parikh and Ghosh, 2009). This capacity is growing rapidly due to the entry of various private

Download English Version:

<https://daneshyari.com/en/article/4728198>

Download Persian Version:

<https://daneshyari.com/article/4728198>

[Daneshyari.com](https://daneshyari.com)