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Renewable Energy: Opportunity and Prospect in Indian Energyscape

Joyjeet Sen[1], Souvik Sen[2] , Sourav Ganguly[1]

[1]Department of Geological Sciences, Jadavpur University, Jadavpur, Kolkata – 700023, India

[2]Department of Earth Sciences, Indian Institute of Technology Bombay, Powai, Mumbai, Maharashtra – 400076, India

Presenting author, E-mail: Joyjeetgeosc@gmail.com

Abstract

The shortage of energy resources is experienced globally, due to exponential increase in energy consumption. Provision of adequate quantities and kind of energy is and will continue to be a challenge to us. Depleting oil reserves, high developmental cost of unconventional resources, greenhouse gas emission by burning fossil fuels and accumulation of nuclear waste from nuclear reactors will inevitably force people to replace most of our conventional energy sources with renewable energy in near future. 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 greenhouse gas emissions and exploitation of opportunities for fostering social cohesion, value addition and employment. This focuses the solution of the energy crisis on judicious utilization of abundant renewable energy resources, such as biomass, solar, wind, geothermal and ocean tidal energy. This paper reviews the renewable energy scenario in India's energyscape as well as extrapolates the future developments keeping in view the consumption, production and supply of power.

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. Today, India is the ninth largest economy in the world, driven by a real GDP growth of 8.7% in the last 5 years (7.5% over the last 10 years).India is now the eleventh largest economy in the world. In 2011-12, India was the fourth largest consumer in the world of Crude Oil and Natural Gas, after the United States, China, and Russia. India's energy demand continued to rise inspite of slowing global economy. India always had a negative energy balance and stands forth in purchasing energy from outside countries. Harnessing the renewable energy options can be a solution to this increasing struggle between demand and supply. It is clean, environmentally safe, produces lower or negligible levels of greenhouse gases and other pollutants when compared with the fossil energy sources they are replacing.

Renewable energy sources in India

Renewable energy is derived from the natural processes that are replenished constantly. The definition includes electricity and heat generated from solar, wind, ocean, hydropower, biomass, geothermal resources, bio fuels derived from renewable resources. In India, major renewable energy

resources generating power are –Wind, Small Hydro, Biomass waste and solar (Figure 1). Here we present the different forms of renewable energy options in Indian energy mix, their prospects, recent developments and issues/challenges related to those.

Wind Energy

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. 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 11087MW installed capacity and potential for on-shore capabilities of 65000 MW. High quality wind energy sites, at 80m hub-height with a minimum capacity factor of 25 percent, 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. Wind generation in the South and Western India appears to have a strong seasonal correlation to electricity demand in the North and can potentially play a significant role in meeting the increased demand during May through September. As for diurnal variations, wind generation appears to substantially coincide with the diurnal variation in electricity demand all over India, with wind speeds steadily ramping up from morning to evening.

Considering the large wind potential and reasonably good temporal correlation of wind generation with electricity demand, it is possible to imagine scenarios where wind energy can play a substantial role in India's energy mix and contribute significantly to reduction in power shortages in the short term and energy security as well as environmental sustainability in the long term.

Small Hydropower

Energy from small hydro is the oldest. It is most reliable of all renewable energy sources. The development of small scale hydropower in India started almost in the pace with the world's first hydroelectric installation in 1882 at Appleton USA. The 130 KW installations in Sidrapong (Darjeeling) in the year 1897 was the first installation in India. The other installations were Shivasamundram at Mysore (2000 kW), and Bhoorisingh in Chamba (40 kW) in 1902, Galogi at Mussoorie (3000 kW) in 1907, Jubbal (50 kW) in 1911 and Chhaba (1750 kW) at Shimla in 1913. These plants were used primarily for lighting in important towns and are still working. The country has an estimated SHP potential of about 15000 MW. So far 514 SHP projects with an aggregated installed capacity of 1693 MW have been installed.

The term 'small hydro' has a wide range in usage. It covers schemes having installed capacities from a few kW to 25 MW. In India small hydro schemes are further classified as; Micro hydro up to 100 kW plant capacities, Mini hydro from 101 kW to 2000 kW and Small hydro up to 25000 kW plant capacities.

Biomass and Biogas Energy

India is predominantly an agricultural economy, having huge quantity of biomass available in the form of husk, straw, jute, cotton, shells of coconuts wild bushes etc. Biomass is produced in nature through photosynthesis achieved by solar energy conversion. Biomass fuels used in India account for about one third of the total fuel used in the country, being the most important fuel used in over 90% of the rural households and about 15% of the urban households. Despite advancements in biomass energy technologies, most bioenergy consumption in India still remains confined to traditional domestic uses. The modern technologies offer possibilities to convert biomass into synthetic gaseous or liquid fuels (like ethanol and methanol) and electricity.

An estimated production of 350 million tons of agricultural waste every year, biomass is capable of supplementing coal to the tune of about 200 million tonnes producing of power. The large quantities of cattle dung can be used in bio energy technologies viz., biogas, gasifier, biomass combustion, cogeneration etc., to produce energy thermal or electrical energy. Biomass energy co-generation

program is being implemented with the main objective of promoting technologies for optimum use of biomass resources of India. The biomass power generation potential in India is estimated at 30000 MW. It results in a saving of about Rs.20,000 crores every year. Uttar Pradesh, Punjab, Karnataka, Bihar, Gujarat, Tamil Nadu, Andhra Pradesh are the states with very high biomass/bioenergy potential. Land supply, development of cheap and reliable combustion techniques, enhanced biomass productivity; economic operations of plantations and logistics infrastructure are critical areas which shall determine future of biomass in India.

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 – 27.5 °C. Therefore India has huge solar potential. 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 PWh/year or about 600,000 GW. The daily average solar energy incident over India varies 4-7 kWh/m^2 with about 1,500–2,000 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 manufacturers. India has been ranked 7th worldwide for solar photovoltaic cell production and secure 9th rank in solar thermal power generation. This capacity is growing rapidly due to the entry of various private players in manufacturing of solar energy equipment.

Solar energy can have difficulty competing with traditional forms of energy on the basis of price. The cost of production of solar energy is four times higher in comparison with conventional sources in India. Dedication of large land area for exclusive installation of solar arrays might have to compete with other necessities that require land due to issues regarding land availabilities. There is lack of reliable irradiation data, without which it’s difficult to calculate generated output and therefore the return on investment. Pricing of Renewable Energy Certificates (REC) is posing a challenge for the mechanism to be viable. Transmission infrastructure is still the area of development.

Tidal Energy

India has a great potential for uncapping this huge renewable and sustainable resource for power generation. India has a long coastline of about 7500 km and about 336 islands in Bay of Bengal and Arabian Sea with the estuaries and gulfs where tides are strong enough to move turbines for electrical power generation. The Gulf of Cambay and the Gulf of Kutch in Gujarat on the west coast have the maximum tidal range of 11 m and 8 m with average tidal range of 6.77 m and 5.23 m respectively. The Ganges Delta in the Sundarbans is approximately 5 m with an average tidal range of 2.97 m. The identified economic power potential is about of 8000 MW with nearly 7000 MW in the Gulf of Cambay, 1200 MW in the Gulf of Kutch in Gujarat and about 100 MW in the Gangetic delta in the Sunderbans region of West Bengal.

Tidal power has traditionally suffered from relatively high cost and limited availability of sites with sufficiently high tidal ranges or flow velocities, thus restricting its total availability. However, many recent technological developments and improvements, both in design (e.g. dynamic tidal power, tidal lagoons) and turbine technology (e.g. new axial turbines, triple-helix turbines cross flow turbines), indicate that the total availability of tidal power may be much higher than previously assumed and that economic and environmental costs may be brought down to competitive levels. There is significant room for innovation and more routine engineering development in energy harvesting and conversion devices as well as in the entire infrastructure required to support the construction, installation, maintenance and decommissioning of these systems.

Geothermal Energy

A number of geothermal power plants, which generate more than 10000 MW power are operational in 24 countries of the world. Besides, geothermal energy is being used directly for heating in at least 78 countries. The largest producer of this energy is USA generating about 3086 MW of electricity. India has huge potential to become a leading contributor in generating geothermal power. But, the power generation through geothermal resources is still in nascent stages in India. 340 geothermal hot springs have been identified in India. Most of them are in the low surface temperature range from 37° C-90° C which is suitable for direct heat applications. These springs are grouped into seven geothermal provinces - Himalayan (Puga, Chhumathang), Sahara Valley, Cambay Basin, Son-Narmada-Tapi lineament belt, West Coast, Godavari basin and Mahanadi basin. Some of the prominent geothermal resources include Puga Valley and Chhumathang in Jammu and Kashmir, Manikaran in Himachal Pradesh, Jalgaon in Maharashtra and Tapovan in Uttarakhand. A new location of geothermal power energy has also been found in Tattapani in Chhattisgarh.

But yet geothermal power projects has not been exploited at mass scale, owing to a variety of reasons, the chief being the availability of plentiful coal at cheap costs. If harnessed incorrectly, geothermal energy can sometime produce pollutants resulting in environmental hazards. Deep drilling is another issue. However, with technological development, better understanding of reservoir characteristics, increasing environmental problems and widening gap between energy demand and supply India will need to start depending on clean and eco-friendly energy sources in future; one of which could be geothermal.

Conclusions

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. There is an urgent need for transition from conventional petroleum based energy system to renenwable resource based systems. India has obtained application of a variety of renewable energy technologies for use in different sectors. There are ample opportunities with favourable 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.

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Figure 1: Contribution from various Renewable Energy Sources (Source: Ministry of Power, Government of India)