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Resources of Renewable Energy in India

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ABSTRACT
Renewable energy resources sector growth in India has been significant, even for electricity generation from renewable sources. Renewable energy is energy generated from natural resources such as sunlight, wind, rain, tides, and geothermal heat, which are renewable (naturally replenished). Even for the decentralized systems, the growth for solar home lighting systems has been 300%, solar lanterns 99% and solar photovoltaic water pumps 196%. This is a phenomenal growth in the renewable energy sector mainly for applications that were considered to be supplied only through major electricity utilities. Some large projects have been proposed, and a 35,000 km2 area of the Thar Desert has been set aside for solar power projects, sufficient to generate 700 to 2,100 giga watts. Renewable energy systems are also being looked upon as a major application for electrification of 20,000 remote and unelectrified villages and hamlets by 2007 and all households in such villages and hamlets by 2018.
Keywords: Renewable Energy Program, solar, Photovoltaic, wind and Biomass.

I. INTRODUCTION

In recent years, India has emerged as one of the leading destinations for investors from developed countries. This attraction is partially due to the lower cost of manpower and good quality production. The expansion of investments has brought benefits of employment, development, and growth in the quality of life, but only to the major cities. This sector only represents a small portion of the total population. The remaining population still lives in very poor conditions. India is now the eleventh largest economy in the world, fourth in terms of purchasing power. It is poised to make tremendous economic strides over the next ten years, with significant development already in the planning stages. This report gives an overview of the renewable energies market in India. We look at the current status of renewable markets in India, the energy needs of the country, forecasts of consumption and production, and we assess whether India can power its growth and its society with renewable resources. According to Oil & Gas Journal (OGJ), India had 5.6 billion barrels of proven oil reserves as of January 2009, the second-largest amount in the Asia-Pacific region after China. India's crude oil reserves tend to be light and sweet, with specific gravity varying from 38° API in the offshore Mumbai High field to 32° API at other onshore basins. India produced roughly 880 thousand bbl/d of total oil in 2008, of which approximately 650 thousand bbl/d was crude oil, with the rest of production resulting from other liquids and refinery gain. India has over 3,600 operating oil wells, according to OGJ . Although oil production in India has slightly trended upwards in recent years, it has failed to keep pace with demand and is expected by the EIA to decline slightly in 2009. India's oil consumption has continued to be robust in recent years. In 2007, India consumed approximately 2.8 million bbl/d, making it the fifth largest consumer of oil in the world.

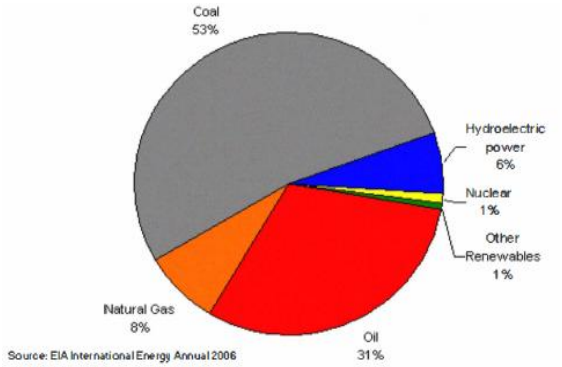
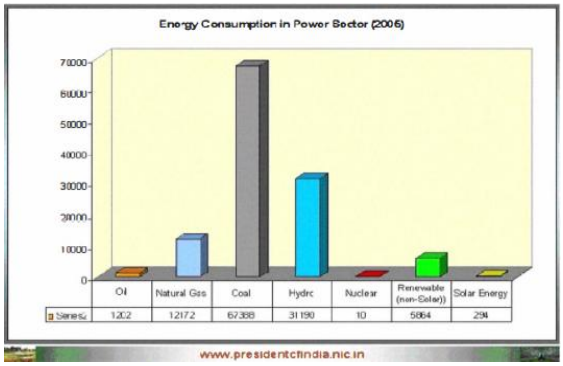


Fig 1. The total energy consumed in India by type (2013)

Table 1. Total Energy Consumption In India During The Year 2013 And The Type Of Energy Consumed



II. RENEWABLE ENERGY SOURCES IN INDIA

A. Solar Energy

Solar power, a clean renewable resource with zero emission, has got tremendous potential of energy which can be harnessed using a variety of devices. With recent developments, solar energy systems are easily available for industrial and domestic use with the added advantage of minimum maintenance. Solar energy could be made financially viable with government tax incentives and rebates. An exclusive solar generation system of capacity of 250 to KW units per month would cost around Rs. 5 Lacs, with present pricing and taxes. Most of the developed countries are switching over to solar energy as one of the prime renewable energy source. The current architectural designs make provision for photo voltaic cells and necessary circuitry while making building plans. India's power sector has a total installed capacity of approximately 1,46,753 Megawatt (MW) of which 54% is coal-based, 25% hydro, 8% is renewables and the balance is the gas and nuclear-based. Power shortages are estimated at about 11 % of total energy and 15% of peak capacity requirements and are likely to increase in the coming years. In the next 10 years, another 10,000 MW of capacity and investment of about Rs. 24 lakh crore are required. Fortunately, India lies in sunny regions of the world. Most parts oflndia receive 4-7 kWh of Solar radiation per square metre per day with 250-300 sunny days in a year. India has abundant Solar resources, as it receives about 3000 hours of sunshine every year, equivalent to over 5,000 trillion kWh. India can easily utilize the Solar energy or Solar Power. Today the contribution of Solar power with an installed capacity of 9.84 MW, is a fraction « 0.1 percent) of the total renewable energy installed 13, 242.41(as on 31st October 2008 by MNRE). Solar power generation has lagged behind other sources like wind, small hydropower, biomass etc. But now realizing the potential of Solar energy, Prime Minister of India unveiled a National Climate Change Action Plan in June 2008. The plan will be implemented through eight missions with main focus on Solar energy in the total energy mix of the country.

B. Wind Energy.

Wind power is one of the most efficient alternative energy sources. There has been good deal of development in wind turbine technology over the last decade with many new companies joining the fray. Wind turbines have become larger, efficiencies and availabilities have improved and wind farm concept has become popular. It could be combined with solar, especially for a total self-sustainability project. The economics of wind energy is already strong, despite the relative immaturity of the industry. The downward trend in wind energy costs is predicted to continue. As the world market in wind turbines continues to boom, wind turbine prices will continue to fall. India now ranks as a "wind superpower" having a net potential of about 45000 MW only from 13 identified states.

C. Hydro Electric Power

India has a huge hydro power potential, out of which around 20 % has been realized so far. New hydro projects are facing serious resistance from environmentalists. Resettlement of the displaced people with their lands becomes major issue. In the 2005 National Electricity Policy the objectives have been set as follows: provision for access to electricity for all households; demand to be met by 2012 with no energy and peaking shortages and adequate reserves to be made available and reliable, and quality power supplies at reasonable rates. The Indian government considers hydropower as a renewable economic, non-polluting and environmentally benign source of energy. The exploitable hydro-electric potential in terms of installed capacity is estimated to be about 148,700 MW (See Table 1) out of which a capacity of 30,164 MW (20.3%) has been developed so far and 13,616 MW (9.2 %) of capacity is under construction. In addition, 6,782 MW in terms of installed capacity from small, mini and micro hydro schemes have been assessed. Also, 56 sites for pumped storage schemes with an aggregate installed capacity of 94,000 MW have been identified. The government expects to harness its full potential of hydropower by 2027 with a whopping investment of 5,000 billion Rupees.

D. Biomass Energy

Biomass energy can play a major role in reducing India's reliance on fossil fuels by making use of thermo-chemical conversion technologies. In addition, the increased utilization of biomass-based fuels will be instrumental in safeguarding the environment, creating new job opportunities, sustainable development and health improvements in rural areas. Biomass energy could also aid in modernizing the agricultural economy. A large amount of energy is expended in the cultivation and processing of crops like sugarcane, food grains, vegetables and fruits which can be recovered by utilizing energy-rich residues for energy production. The integration of biomass-fuelled gasifies and coal-fired energy generation would be advantageous in terms of improved flexibility in response to fluctuations in biomass availability with lower investment costs. Waste-to-energy

plants offer two important benefits of environmentally sound waste management and disposal, as well as the generation of clean electric power. Waste-to-energy facilities produce clean, renewable energy through thermo chemical, biochemical and physicochemical methods. Moreover, waste-to-energy plants are highly efficient in harnessing the untapped sources of energy from a variety of wastes.

E. Bio-Fuels

India has more than 50 million Ha of wasteland, which could be utilized for cultivating plants. Jatropha is one of the options thought of by many minds for producing bio-fuels. It is a kind of plant which can come up on arid land, albeit with lower yield. There are issues such as low supply of quality seeds, technical advice, low knowledge of agencies which would buy seeds etc. But lately such agencies have come up and are offering technical advice as well as buying for further processing. Another option is coming up in bio-fuels which will beat Jatropha once the research on it is successful and scalable. Lot of it is being talked about around the world in the field of bio-fuels and is so attractive theoretically that anyone could go for it. When the output is compared in terms of oil in liter per acre, it is better than Jatropha by about 100 times. This option is Algae. The input is none other than carbon dioxide - the old foe of clean environment and light – which is aplenty. Just by using these two things algae grows, and could be used forextracting oil and then extracting bio-fuel from it. It will also act as a sink for carbon dioxide and seems to be the most attractive option.

F. Energy from wastes

Tons of wastes are generated daily in Mumbai alone. Such huge quantity of wastes generated all over Indiaare a huge opportunity to be tapped. Sorting is required to be done for organic and inorganic and there is a good quantity for energy needs. Some of these are converted into fuel briquettes and sold.

III. ELECTRICITY SHORTAGE

India suffers from a severe shortage of electric capacity. According to the World Bank, roughly 40 percent of residences in India are without electricity. In addition, blackouts are a common occurrence throughout the country's main cities. The World Bank also reports that one-third oflndian businesses believe that unreliable electricity is one of their primary impediments to doing business. Further compounding the situation is that total demand for electricity in the country continues to rise and is outpacing increases in capacity. Adequate additional capacity has failed to materialize in India in light of market regulations, insufficient investment in the sector, and difficulty in obtaining environmental approval and funding for hydropower projects. In addition, coal shortages are further straining power generation capabilities. In order to address this shortfall, the Indian government has set the goal of adding 90,000 MW of additional electric generation capacity by 2012. In light of these targets, the private sector is beginning to step up investment in the sector. The country also grapples with electricity efficiency issues. In order to improve efficiency standards, the Energy Conservation Act was passed in 2002, which established the Bureau of Energy Efficiency and has sought to promote efficient use of energy and labeling of energy-intensive products. It is also possible to import some electricity into India, as the country's power grid is interconnected with the grids in Nepal and Bhutan. This has allowed for the export of surplus electricity to India, however, this is not likely to prove sufficient to make up for India's lack of electric generation capacity.

Table 2. The type of energy , installed capacity, estimated capacity factor, Estimated generation

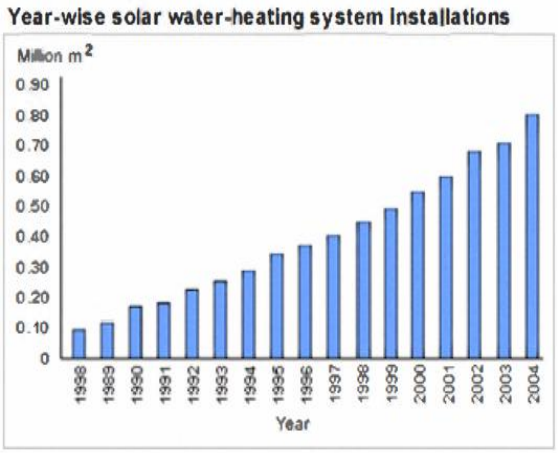
Type of energy	Installed Capacity	Estimated Capacity factor	Estimated Generation
Wind	2483 MW	14%	3045 GWh
Biomass Power	234 MW	70%	1435 GWh
Biomass Gasifier	69 MW	70%	423 GWh
Bagasse Cogeneration	379 MW	60%	1992 GWh
Small Hydro	1603 MW	50%	7021 GWh
Waste to Energy	41 MW	70%	251 GWh
Solar PV	2.5 MW	20%	4GWh

IV. SOLAR ENERGY PRODUCTION

India is both densely populated and has high solar isolation, providing an ideal combination for solar power in India. Much of the country does not have an electrical grid, so one of the first applications of solar power has been for water pumping, to begin replacing India's four to five million diesel powered water pumps, each consuming about 3.5 kilowatts, and off-grid lighting. Some large projects have been proposed, and a 35,000 km2 area of the Thar Desert has been set aside for solar power projects, sufficient to generate 700 to 2,100 gigawatts.In July 2009, India unveiled a $19 billion plan to produce 20 GW of solar power by 2020. Under the plan, solar-powered equipment and applications would be mandatory in all government buildings including hospitals and hotels. 18 November 2009, it was reported that India is ready to launch its Solar

Mission under the National Action Plan on Climate Change, with plans to generate 1,000 MW of power by 2013 Photovoltaic (PV) cells have a low efficiency factor, yet power generation systems using photovoltaic materials have the advantage of having no moving parts. PV cells find applications in individual home rooftop systems, community street lights, community water pumping, and areas where the terrain makes it difficult to access the power grid. The efficiency of solar photovoltaic cells with single crystal silicon is about 13 % - 17%. High efficiency cells with concentrators are being manufactured which can operate with low sunlight intensities.

Table 3. Year-Wise Solar Water-Heating System



V. WIND ENERGY PRODUCTION

The development of wind power in India began in the 1990s, and has significantly increased in the last few years. The "Indian Wind Turbine Manufacturers Association (IWTMA)" has played a leading role in promoting wind energy in India. Although a relative newcomer to the wind industry compared with Denmark or the US, a combination of domestic policy support for wind power and the rise of Suzlon (a leading global wind turbine manufacturer) have led India to become the country with the fifth largest installed wind power capacity in the world.

As of 31, October 2009 the installed capacity of wind power i India was 10,925 MW, mainly spread across Tamil Nadu (4301.6 MW), Maharashtra (1942.25 MW), Gujarat (1565.61 MW) Karnataka (1340.23 MW), Rajasthan (738.5 MW), Madhya Prades (212.8 MW), Andhra Pradesh (122.45 MW), Kerala (26.5 MW) West Bengal (1.1 MW) and other states (3.20 MW) . It is estimate that 6,000 MW of additional wind power capacity will be installed i India by 2012. Wind power accounts for 6% of India's total installed power capacity, and it generates 1.6% of the country's power.

Advantage of Wind Power

- It is one of the most environment friendly, clean and safe energy resources.
- It has the lowest gestation period as compared to conventional energy.
- Equipment erection and commissioning involve only a few months.
- There is no fuel consumption, hence low operating costs.
- Maintenance costs are low.
- The capital cost is comparable with conventional power plants. For a wind farm, the capital cost ranges between 4.5 crores to 5.5 crores, depending on the site and the wind electric generator (WEG) selected for installation.

VI. BIOMASS ENERGY

Biomass includes solid biomass (organic, non-fossil material of biological origins), biogas (principally methane and carbon dioxide produced by anaerobic digestion of biomass and combusted to produce heat and/or power), liquid biofuels (bio-based liquid fuel from biomass transformation, mainly used in transportation applications), and municipal waste (wastes produced by the residential, commercial and public services sectors and incinerated specific installations to produce heat and/or power). The most successful forms of biomass are sugar cane bagasse in agriculture, pulp and paper residues in forestry and manure in livestock residues.

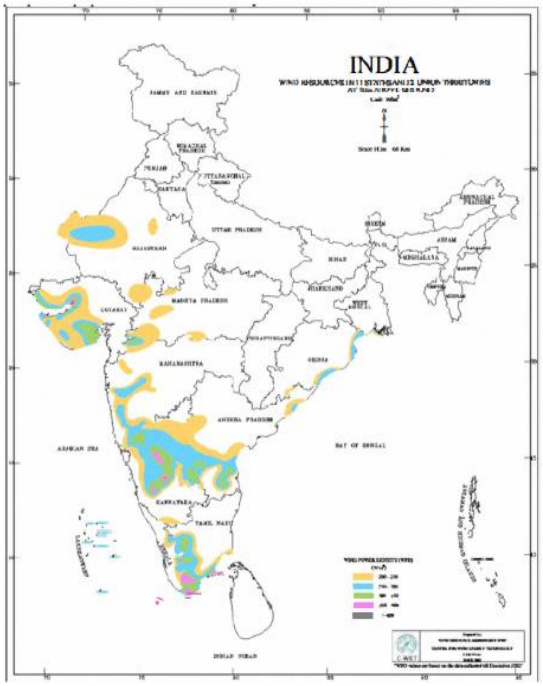


Fig. 2. Map shows the wind energy production in states and union territories of India.

India is very rich in biomass. It has a potential of 19,500 MW (3,500 MW from bagassebased cogeneration and 16,000 MW from surplus biomass). Currently, India has 537 MW commissioned and 536 MW under construction. The facts reinforce the idea of a commitment by India to develop these resources of power production. Following is a list of some States with most potential for biomass production:

- Andhra Pradesh (200 MW)
- Bihar (200 MW)
- Gujarat (200 MW)
- Karnataka (300 MW)
- Maharashtra (1,000 MW)
- Punjab (150 MW)
- Tamil Nadu (350 MW)
- Uttar Pradesh (1,000 MW)

VII. CONCLUSION

There is an urgent need for transition from petroleum-based energy systems to one based on renewable resources to decrease reliance on depleting reserves of fossil fuels and to mitigate climate change. In addition, renewable energy has the potential to create many employment opportunities at all levels, especially in rural areas. An emphasis on presenting the real picture of massive renewable energy potential, it would be possible to attract foreign investments to herald a Green Energy Revolution in India. It is modular in nature and consists of 106 automatic tracked parabolic concentrators arranged in series and parallel combination, each of 9.2 sq meter reflector area. The system is expected to save around 1,18,000 litres of diesel per year, valued at Rs. 2.3 million. In India, of late there has been a debate regarding whether hydro-power and solar power are green or renewable? Since solar power systems generate no air pollution during operation, the primary environmental, health, and safety issues involve how they are manufactured, installed, and ultimately disposed of. Also, an important question is how much fossil energy input is required for solar systems compared to the fossil energy consumed by comparable conventional energy systems. Another concern area is installing solar cells on the land area. This could be the primary demand driver for solar energy in India. Even though energy from renewable energy sources is growing rapidly, with markets such as solar cells, wind and biodiesel experiencing annual double digit growth, the overall share is only expected to increase marginally over the coming decades as the demand for energy also grows rapidly, particularly in many developing countries. In India, the scientific focus is deliberately moving towards transforming coal into clean energy as well as harnessing hydropower.

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