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Status and Potential of Renewable Energy Resources in India

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Abstract: Global energy needs are rising rapidly, as are greenhouse gas emissions from the energy sector. Today, India is a large consumer of fossil fuel such as coal and crude oil. The rapid increase in use of non- renewable energies such as fossil fuel, oil, natural gas has created problems of demand and supply. Because of which, the future of non- renewable energies is becoming uncertain. Also India has had a negative energy balance for decades, which has resulted in the need to purchase energy from outside the country to fulfil the needs of the entire country. Even though, the Ministry of Power has set an agenda of providing power to all by 2012. This paper reviews the status of different renewable energy resources in India, the potential and identifies barriers and strategies for accelerated deployment. It gives an overview of the renewable energies in India while evaluating the current status and the deployment of each of these technologies to date in India. It also reviews the multi-criteria assessment of different renewable energy and draws out vital conclusions. It is based on the secondary information collected from various mass media including internet, various reports and other international institutions.
Keywords: Greenhouse Gas, Fossil Fuel, Energy Balance, Renewable Energy.

Introduction:

India is the fourth largest energy consumer in the world after the United States, China, and Russia. In recent years, India's energy consumption has been increasing at a relatively fast rate due to population growth and economic development. Rapid urbanization and improving standards of living for millions of Indian households, the demand is likely to grow significantly. In order to sustain the production, industries have opted for inefficient diesel-fuelled backup power. India's energy planning, which is based on the twin objectives of high economic growth and providing electricity to all, is failing to meet either.

The domestic power demand of India was 918 billion units in 2012. It is expected that at 9.8% annual growth, the demand will reach 1,640 billion units by 2020. At this pace, India will require 390 GW in the next eight years which is almost double its current installed capacity of 210 gigawatts (GW). There is growing energy inequity between rural and urban areas and also between the developed and developing states. There are millions who are yet to be benefit from electricity in rural India. The scarcity of electricity in rural areas in comparison to urban areas seems to be biased in delivery through the centralized system. While the urban-rural difference

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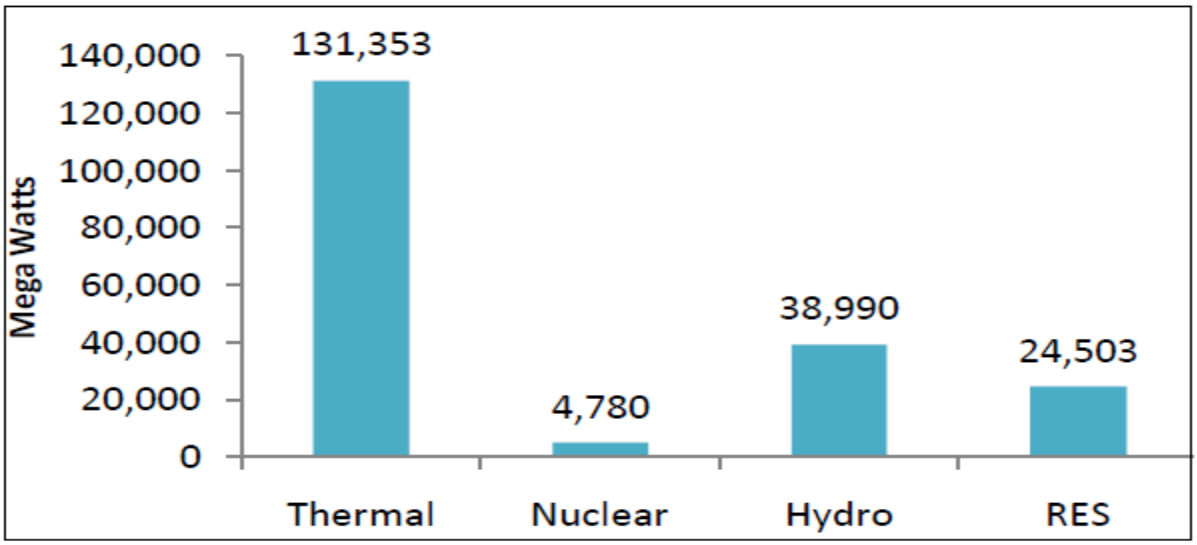
in energy supply could be reduced through renewable energy, it is more complex to overcome the widening gap between developed and not so developed states (Anonymous (2013).

Current centralized energy planning of India is dependent on coal and fossil fuel sources. The main concern arises on how to protect the fossil fuel for our coming generation with simultaneously utilizing the different resources of energy for high and sustained economic growth. Pressure to increase its energy supplies and the consequent negative environmental impact of fossil fuels has led India to a conscious policy toward renewable sources (Kaur, 2010). Current scenario of energy demand and supply demands the research and development activities in exploration of new reserves. There is huge amount of potential available in the renewable energy system which can be explored and harnessed to meet the energy demand.

Role of Renewable Energy in India

Renewable energy can make a substantial contribution in each areas. It is in this context that the role of renewable energy needs to be seen. It is no longer "alternate energy", but is increasingly becoming a vital part of the solution to the nation's energy needs. In terms of all renewable energy categories, India is currently ranked fifth in the world with 15,691.4 MW grid-connected and 367.9 MW off-grid renewable-energy based power capacity. India is among the top five destinations worldwide for solar energy development according to Ernst and Young's renewable energy attractiveness index (Fig. 1).



(Source: Ministry of Power, GOI, 2012)

Fig. 1. India's Installed Power Capacity

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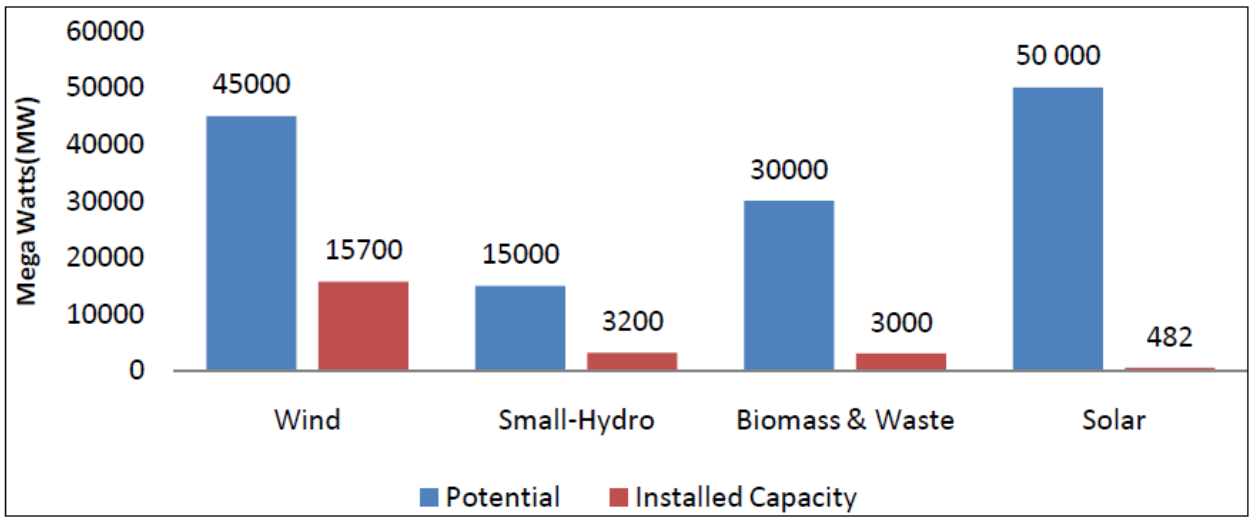
As on March 31, 2012, installed capacity of renewable energy based power generation was 24,503 MW, which is about 12 percent of the total installed capacity of 199,626 MW. The major renewable energy sources (RES) are wind energy, solar energy, biomass and waste energy, and small-hydro energy (Fig.2).



(Source: Ministry of Power, GOI, 2012)

Fig. 2. Potential and Installed Capacity of renewable energy sources

Solar Energy

Radiant light and heat from the sun, has been harnessed by humans since ancient times using a range of ever-evolving technologies. Solar radiation, along with secondary solar-powered resources such as wind and wave power, hydroelectricity and biomass, account for most of the available renewable energy on earth. Only a minuscule fraction of the available solar energy is used. India is both densely populated and has high solar insolation, providing an ideal combination for solar power in India. In solar energy sector, 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. India is endowed with rich solar energy resource. The average intensity of solar radiation received on India is 200 MW/km square (megawatt per kilometer square). With a geographical area of 3.287 million km square, this amounts to 657.4 million MW. However, 87.5% of the land is used for agriculture, forests and fallow lands 6.7% for housing, industry, etc., and 5.8% is either barren, snow bound, or generally inhabitable. Thus, only 12.5% of the land area amounting to 0.413 million km square can, in theory, be used for solar energy installations. Total energy consumption % in India is, by type combustible

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renewable and waste 27.2 Hydro 1.8 Oil 23.7 Nuclear 0.8 Coal/Peat 40.8 Natural gas 5.6 other renewables 0.2 Even if 10% of this area can be used, the available solar energy would be 8 million MW, which is equivalent to 5,909 mtoe (million tons of oil equivalents) per year (Leone, 2011). 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. On November 18, 2009, it was reported that India was ready to launch its National Solar Mission under the National Action Plan on climate change, with plans to generate 1,000 MW of power by 2013. India has a vast potential for renewable energy sources, especially in areas such as solar power, biomass and wind power. The current installed capacity of renewable energy is around 92204 MW, constituting about 7.3 percent of India's total installed generation capacity. Technological breakthroughs for cost-effective photovoltaic technology could generate a quantum leap in the renewable energy sector since India is well endowed with solar insolation (average of 6 kwh/ sq.mt./day).India plans to announce increased subsidies for solar-power generation, as the country looks to scale up production of renewable energy and show it is committed to mitigating climate change. India just had 2.12 megawatts of grid-connected solar generation capacity. As part of the National Solar Mission, the ministry aims to bolster the annual photovoltaic production to at least 1,000 megawatts a year by 2017. With an installed capacity of 123 GW, the country currently faces energy shortage of 8 percent and a peak demand shortage of 11.6 percent. In order to sustain a growth rate of 8 percent, it is estimated that the power generation capacity in India would have to increase to 306 GW in the next ten years which is 2.5 times current levels. However, as of October 2009, India is currently ranked number one along with the United States in terms of installed Solar Power generation capacity (Lalwani and Singh, 2010).Table 1 shows the total energy consumption in India

Table 1: Total Energy Consumption in India

Number of solar street lighting systems	55,795
Number of home lighting systems	342,607
Solar lanterns	560,295
Solar photovoltaic power plants	1566 kW
Solar water heating systems	140 km^2 of collector area
Box-type solar cookers	575,000
Solar photovoltaic pumps	6,818

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Wind Energy

Wind energy is one of the most promising alternative energy technologies of the future. During recent years, the amount of energy produced by wind-driven turbines has increased rapidly due to considerable advancement in turbine technologies, making wind power economically compatible with conventional sources of energy. The use of wind power in India has been gaining importance with rapid installation in the last few years. Wind energy makes up the majority about 68 % of the total renewable energy capacity installed in India. Initial estimates from Centre for Wind Energy Technology (C-WET) suggest that wind energy potential at 80 metres height (with 2 % land availability) would be over 100 GW. Some studies have estimated even higher potential ranges up to 300 GW (GOI, 2014). By the end of October 2013, India had a total installed capacity of 19,933 megawatt (MW), with 1,699 MW installed in 2012-13 (Panwar and Kaur, 2014). The total wind power generation in 2011-12 was 23,399.5 gigawatt hour (GWh), or about three and a half times the output of a new 1,000-MW nuclear reactor. The 12th Five Year Plan aims to install 15,000 MW between 2012 and 2017, which will almost double the total capacity of wind power in India (CSE, 2013).

Hydropower

In India, hydro power projects with station capacity of up to 25 MW fall under the category of small hydro power (SHP). The total installed capacity of small hydro power projects as on March 31, 2012, was 3200 MW. However, the estimated potential for power generation from such plants is over 15,000 MW. Most of the latent potential is in the Himalayan states - as river-based projects - and in the other states as irrigation canal-based projects. The SHP programme is largely private investment driven. Since the projects are economically viable, the private sector is keen on investing in SHP projects. The viability of these projects improves with increase in the project capacity.

India is endowed with economically exploitable and viable hydro potential assessed to be about 84,000 MW at 60% load factor (1,48,701 MW installed capacity) (Singh, 2008). In addition, 6780 MW in terms of installed capacity from Small, Mini, and Micro Hydel schemes have been assessed. Also, 56 sites for pumped storage schemes with an aggregate installed capacity of 94,000 MW have been identified (Sinha and Dudhani, 2003). However, only 19.9% of the potential has been harnessed so far. Hydroelectricity is the term referring to electricity generated

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by hydropower; the production of electrical power through the use of the gravitational force of falling or flowing water. It is the most widely used form of renewable energy. India is blessed with immense amount of hydro-electric potential and ranks 5th in terms of exploitable hydro-potential on global scenario. India was one of the pioneering countries in establishing hydro-electric power plants. The power plant at Darjeeling and Shimsha (Shivanasamudra) was established in 1898 and 1902 respectively and is one of the first in Asia. The installed capacity as of 2008 was approximately 36,877. The public sector has a predominant share of 97% in this sector. In addition, 56 number of pumped storage projects have also been identified with probable installed capacity of 94,000 MW. In addition to this, hydro-potential from small, mini and micro schemes has been estimated as 6,782 MW from 1,512 sites (Lalwani and Singh, 2010). Table 2 describes the region wise power potential in India.

Table 2. Power Potential of India

S. No.	Region	Potential at 60% *L.F. (MW)	Potential already developed	Potential under development	Total Potential development	Potential yet to be developed
1.	Northern	30155	3955	2388	6263	23892
2.	Western	5679	1764	1585	3349	2330
3.	Southern	10763	5274	1098	6372	4391
4.	Eastern	5590	868	726	1594	3996
5.	North East	31857	314	305	619	31238
	India	84044	12175	6022	18197	65847

**L.F.- Load Factor*

(Source: Central Electricity Authority, Ministry of Power, 2006)

Geothermal

Geothermal energy is the earth's natural heat available inside the earth. This thermal energy contained in the rock and fluid that filled up fractures and pores in the earth's crust can profitably be used for various purposes. One energy source that has not been exploited at all, is the geothermal energy, which is an enormous, underused heat and power resource that is clean, reliable and home grown (Gera, el at., 2013).With growing dependence on coal and with increasing environmental problems, India will soon have to start exploiting this source of energy which has a potential of about 10000 MW. Chhattisgarh government has decided to establish the first Geothermal Power Plant of the country in Tattapani area of the Balrampur district with the help of NTPC.

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Biomass

Historically, traditional biomass has been a major source of household energy in India. Today, the total energy supply in India is composed of approximately 40% non-commercial energy sources such as wood and cow dung. Rural households in India predominantly use wood and cow dung as fuel for cooking and water heating due to lack of electricity. Modern biomass energy is derived from organic material and can be used in a variety of conversion processes to yield power, heat/steam, and fuel. In India, the use is focused on waste materials such as municipal, agricultural, or forest residues. Biomass is generally divided into three categories: biogas, solid biomass, and liquid biofuels. One third contributor of energy to India is biomass with a potential of 22,536 MW which comprises of solid biomass, which is an organic, non-fossil material of biological origins. Biogas which is principally methane and carbon dioxide is produced by anaerobic digestion of biomass and combusted to produce heat. Currently, India has 3697 MW (Anonymous, 2013) installed capacity. 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) (Meisen and Quéneudec, 2006).

Conclusion:

Looking at the present scenario, a sustainable energy system in country like India is essential, the need of the hour for sustainable development. Because of the inequality in energy distribution, renewable energy has the possibility of becoming the foundation for the country's future energy requirements. An analysis on the demand for new renewable technologies clearly shows a shift in preference towards these technologies as a source of energy- wind, biomass, geothermal, tidal, hydropower and solar. The popularity of renewable technologies can be noted by continuous rapid growth, despite economic breakdown and financial crisis. Introduction and use of renewable energy on a large scale will help in tackling issues like energy scarcity, variations in fuel prices and help India to be self-sustainable. India is already facing energy crisis as many parts still survive without electricity, hence renewable energy can act as panacea to its problems.

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Sustainable electricity supply is mainly necessary for lighting, cooking and comfort but also for watering agricultural fields. Growing demand due to the increase in population and more energy intensive lifestyles has diminished the availability of dominantly used fuels in rural areas, such as wood, coal, and kerosene, which further underscores the need to shift to more sustainable energy supplies. Government initiatives to utilize locally available energy resources need private sector support and collaboration between various stakeholders to achieve the goals of energy security and energy sufficiency in rural areas of India.

India's quest for energy security and sustainable development rests a great deal on the ability to tap energy from alternate sources or the renewable sources.

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