Potential of Renewable Energy in India

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***Abstract*–Renewable energy sources and technologies have potential to provide solutions to the long-standing energy problems being faced by the developing countries. The renewable energy sources like wind energy, solar energy, hydel energy, geothermal energy, tidal energy, biomass energy and fuel cell technology can be used to overcome energy shortage in India. Since India is a developing country, the energy requirement would increase to 3 -4 times the current requirement in future and the requirement can be fulfilled by renewable energy resources. India is increasingly adopting responsible renewable energy techniques and taking positive steps towards carbon emissions, cleaning the air and ensuring a more sustainable future. India hosts the world's largest small gasifier programme and second largest biogas programme. After many years of slow growth, demand for solar water heaters appears to be gaining momentum. Small hydro has been growing in India at a slow but steady pace. In this paper, efforts have been made to summarize the availability, current status, major achievements and future potentials of renewable energy options in India. This paper also assesses specific policy interventions and government efforts for overcoming the barriers and enhancing deployment of renewable for the future.**

Keywords: Renewal Energy, Sustainable Energy

I. INTRODUCTION

The World Energy Forum has predicted that fossil-based oil, coal and gas reserves will be exhausted in less than another 10decades. Fossil fuels account for over 79% of the primary energy consumed in the world, and 57.7% of that amount is used in the transport sector and are diminishing rapidly. The exhaustion of natural resources

and the accelerated demand of conventional energy have forced planners and policy makers to look for alternate sources. Renewable energy is energy derived from resources that are regenerative, and do not deplete over time. Renewable energy offers our planet a chance to reduce carbon emissions, clean the air, and put our civilization on a more sustainable footing. It also offers countries around the world the chance to improve their energy security and spur economic development.

Renewable energy supplies 16.7% of the world's final energy consumption (Fig. 1), counting traditional biomass, large hydropower, and ''new'' renewables (small hydro, modern biomass, wind, solar, geothermal, and biofuels). Traditional biomass, primarily for cooking and heating, represents about 11.44% and is growing slowly in some regions as biomass is used more efficiently or replaced by more modern energy forms. Large hydropower represents 3.34% and is growing modestly, primarily in developing countries. New renewables represents 2.4% and are growing very rapidly in developed countries and in some developing countries.

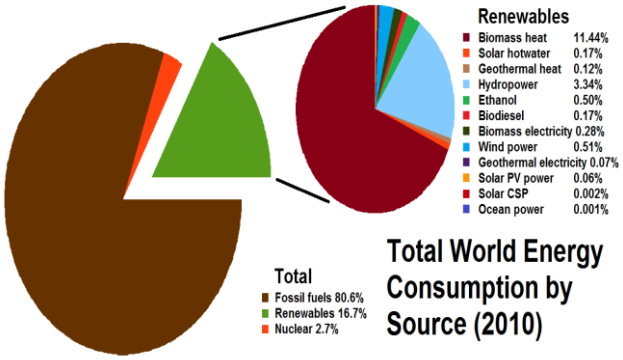

Fig.1. World Total energy consumption [2]

The usage of renewable energy resources is a promising prospect for the future as an alternative to conventional energy. Therefore, an attempt has been made through this paper to review the availability of renewable energy options in India, and provides information about the current status of renewable, future potentials of their uses, major achievements, and current government policies, delivery and outreach in Indian context. It paints a remarkable overall picture of renewable energy resources and position of India on global map in utilizing these resources.

2. RENEWABLE ENERGY IN INDIA

Energy is a basic requirement for economic development and in every sector of Indian economy. It is thus necessary that India quickly look towards new and emerging renewable energy and energy efficient technologies as well as implementenergy conservation laws. Against this background, the country urgently needs to develop a sustainable path of energy development.

Promotion of energy conservation and increased use of renewable energy sources are the twin planks of a sustainable energy supply. Fortunately, India is blessed with a variety of renewable energy sources, like biomass, the solar, wind, geothermal and small hydropower and implementing one of the world's largest programs in renewable energy. India is determined to becoming one of the world's leading clean energy producers. The Government of India has already made several provisions, and established many agencies that will help it to achieve its goal. Renewable energy, excluding large hydro projects already account for 9% of the total installed energy capacity, equivalent to 12,610MWof energy. In combination with large hydro, the capacity is more than 34%, i.e., 48,643 MW, in a total installed capacity of 144,980 MW. Fig. 2is showing installed power capacity (MW) in India.

The country has an estimated renewable energy potential of around 85,000MW from commercially exploitable sources, i.e., wind, 45,000 MW; small hydro, 15,000MW and biomass/bioenergy, 30,000 MW. In addition, India has the potential to generate 35MW per square kilometer using solar photovoltaic and solar thermal energy. There has been phenomenal progress in wind power and, with an installed capacity of over 15700 MW; India occupies the fifth position globally.

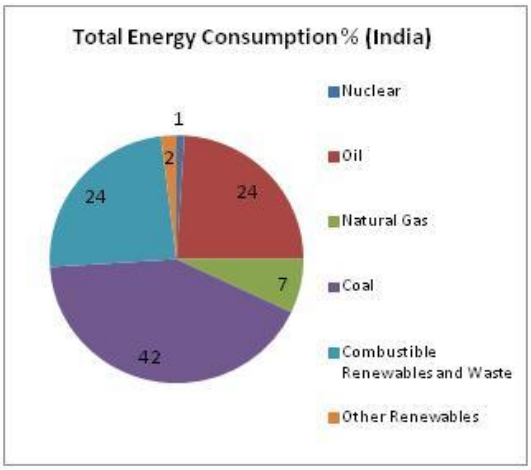

Fig2. Total energy consumption in India[2]

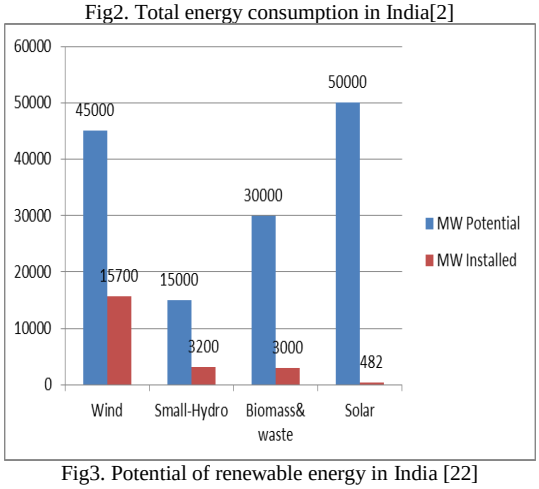

Fig3. Potential of renewable energy in India [22]

2.1 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 in 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.

It is argued that biomass can directly substitute fossil fuels, as more effective in decreasing atmospheric C02 than carbon sequestration in trees. The Kyoto Protocol encourages further use of biomass energy. Biomass may be used in a number of ways to produce energy. The most common methods are:

- Combustion
- Gasification
- Fermentation
- Anaerobic digestion

India is very rich in biomass. It has a potential of 19,500 MW (3,500 MW from biogas based 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)

2.2 Hydropower

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 2015 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 out of which a capacity of 30,164 MW has been developed so far and 13,616 MW of capacity is under construction. In addition, 15,000 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.

Some key figures concerning small hydro in India

- Less than 25MW is in the ‘‘small hydro’’ designation
- 4096 potential sites have been identified
- There is a potential of 15,000MW
- Technology is mature and reliable
- Installed is 1520MW to date Two types of technology are used
  (i) High-head systems
  (ii) Low-head systems

2.3 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. Wind resources can be exploited mainly in areas where wind power density is at least 400 W/m2 at 30 m above the ground. An annual mean wind power density greater than 200 W/m2 (watts per square meter) at 50-m height has been recorded at 211 wind monitoring stations, covering 13 states and union territories. India's wind power potential has been assessed at 45,000 MW. A capacity of 15700MW has been installed[1].

Advantages 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.

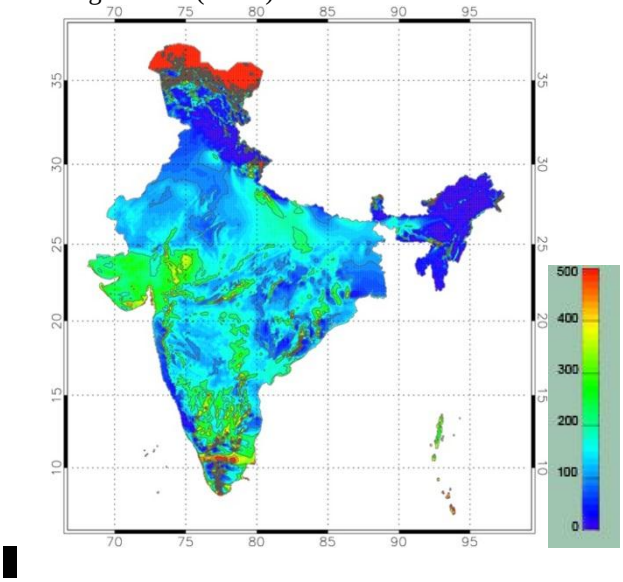

Fig 3. Wind power density map at 80 m level

2.4 Solar Energy

Solar power has so far played an almost non-existent role in the Indian energy mix. The grid-connected capacity in the country now stands at 481.48 MW, while the total solar energy potential has been estimated at 50,000 MW. Most parts of India have 300 – 330 sunny days in a year, which is equivalent to over 5000 trillion kWh per year. Average solar incidence stands at a robust 4 – 7 kWh/sqmtr/day. About 66 MW of aggregate capacity is installed for various applications comprising one million industrial PV systems – 80 percent of which is solar lanterns, home/ street lighting and solar water pumps, among others India is both densely populated and has high solar insolation, 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 [2].

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.

2.5 Geothermal Energy

Geothermal is energy generated from heat stored in the earth, or the collection of absorbed heat derived from underground. Geothermal energy is at present contributing about 10,000 MW over the world and India's small resources can augment the above percentage. Studies carried out by the geological survey of India have observed existence of about 340 hot springs in country. These are distributed in 7 geothermal provinces. The provinces, although found along the west coast in Gujarat and Rajasthan and along a west south west-east-northeast line runningfrom the west coast to the western border of Bangladesh (known as SONATA), are most prolific in a 1500 km stretch of the Himalayas.

3. ELECTRICITY SHORTAGES

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 of Indian 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

II. FUTURE OF RENEWABLE ENERGY IN INDIA

In India, renewable energy is at the take-off stage. India with large renewable energy resources (solar PV, wind, solar heating, small hydro and biomass) is to set to have large-scale development and deployment of renewable energy projects. India would also have to look for international cooperation in renewable energy through well-defined R&D projects.The Integrated Energy Policy report has recognized the need to maximally develop domestic supply options as well as the need to diversify energy sources.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. A modest assessment of investments in this sector will be about Rs. 300,000 crores over the next 25 years. MNRE has included in its mission: energy security; increase in the share of clean power; energy availability and access; energy affordability; and energy equity.A number of government and private organizations such as MNRE, Centre for Wind Energy Technology, Universities, IITs, NITs, Indian Oil Corporation Ltd. (IOCL) and The Energy Resource Institute (TERI) are involved in R&D of RES.

III. CURRENT ENERGY POLICIES

- *National Electricity Policy, 2005*

The National Electricity Policy aims at achieving the following objectives; access to electricity, availability of power demand (to be fully met by 2012), energy and peaking shortages to be overcome and spinning reserve to be available, supply of reliable and quality power of specified standards in an efficient manner and at reasonable rates, per capita availability of electricity to be increased to over 1000 units by 2012, financial turn around and commercial viability of electricity sector and protection of consumers' interests.

- *Tariff Policy, 2006*

The Tariff Policy announced in January 2006 has the following provisions:

1. Pursuant to provisions of section 86 (1) (e) of the Act, the Appropriate Commission shall fix a minimum percentage for purchase of energy from such sources taking into account availability of such resources in the region and its impact on retail tariffs.
2. It will take some time before non-conventional technologies can compete with conventional sources in terms of cost of electricity. Therefore, procurement by distribution companies shall be done at preferential tariffs determined by the Appropriate Commission.
3. Such procurement by Distribution Licensees for future requirements shall be done, as far as possible, through competitive bidding process under Section 63 of the Act within suppliers offering energy from same type of nonconventional sources.
4. The Central Commission should lay down guidelines within three months for pricing non-firm power, especially from nonconventional sources, to be followed in cases where such procurement is not through competitive bidding.

- *The Electricity Act 2003*

The Electricity Act contains the following provisions pertaining to non-conventional energy sources.

Under Sections 3(1) and 3(2), it has been stated that the Central Government shall, from time to time, prepare and publish the National Electricity Policy and Tariff Policy, in consultation with the state governments and authority for development of the power system based on optimal utilization of resources such as coal, natural gas, nuclear substances or material, hydro and renewable sources of energy. Section 4 states that the Central Government shall, after consultation with the state governments, prepare and notify a national policy, permitting stand-alone systems for rural areas. Section 61, 61(h) and 61(i) state that the appropriate commission shall, subject to the provision of this Act, specify the terms and conditions for the determination of tariff, and in doing so, shall be guided by the following, namely, the promotion of cogeneration and generation of electricity from renewable sources of energy; and the National Electricity Policy and Tariff Policy. Section 86(1) and 86(1)(e) state that the state commissions shall discharge the following functions, namely, promote cogeneration and generation of electricity from renewable sources of energy by providing, suitable measures for connectivity with the grid and sale of electricity to any person, and also specify, for purchase of electricity from such sources, a percentage of the total consumption of electricity in the area of a distribution license.

- *National Rural Electrification Policies, 2006*

1. Goals include provision of access to electricity to all households by the year 2009, quality and reliable power supply at reasonable rates, and minimum lifeline consumption of 1 unit/household/day as a merit good by year 2012.

2. For villages/habitations 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.

3. State government should, within 6 months, prepare and notify a rural electrification plan, which should map and detail the electrification delivery mechanism.

4. The Gram Panchayat shall certify and confirm the electrified status of the village as on 31st March each year.

- *Integrated Energy Policy Report (Planning Commission) 2006*

Suggest a path to meet energy needs of the country in an integrated manner up to 2031–2032. It recommended special focus on renewable energy development.

IV.MAJOR ACHIEVEMENTS

- Over 4200MW grid power from wind, small hydro, biomass and solar energy.
- 3600 remote villages/hamlets, including those in Sunderbans, Bastar, Ladakh and the North East electrified through solar energy.
- Largest solar–steam cooking system for 15,000 persons/day set up at TirupatiTirumala Devasthanam.
- 7 lakh square meter collector area solar water heating systems installed.
- 3.5 million Biogas plants installed for cooking and lighting applications.
- 35 million improved wood stoves in rural homes.
- Integrated Rural Energy Program implemented in 860 blocks.
- 30MWcapacity Solar Photovoltaic products exported to various developed and developing countries.
- 280 Energy Parks set-up in educational institutions for demonstration of renewable energy systems and devices.
- Rs.25, 000 million direct subsidy given so far to beneficiaries/ users of renewable energy systems and devices, including subsidy for grid connected renewable power projects.
- Rs. 32,000 million loans provided so far by Indian Renewable Energy Development Agency Limited for 1600 renewable energy projects.
- CWET set up as a scientific and industrial research organization for wind resource assessment, equipment certification and R&D at Chennai in Tamil Nadu.
- Solar Energy Centre set up for development of solar energy systems and devices at Gurgaon in Haryana.

V. CONCLUSION

Energy security, economic growth and environment protection are the national energy policy drivers of any country of the world. The need to boost the efforts for further development and promotion of renewable energy sources has been felt world over in light of high prices of crude oil. A critical part of the solution will lie in promoting renewable energy technologies as a way to address concerns about energy security, economic growth in the face of rising energy prices, competitiveness, health costs and environmental degradation. Specific action points that have been mentioned include promoting deployment, innovation and basic research in renewable energy technologies, resolving the barriers to development and commercial deployment of biomass, hydropower, solar and wind technologies, promoting straight (direct) biomass combustion and biomass gasification technologies, promoting the development and manufacture of small wind electric generators, and enhancing the regulatory/tariff regime in order to main stream renewable energy sources in the national power system. Accordingly, increased focus is being laid on the deployment of renewable power that is likely to account for around 5% in the electricity-mix by 2032. Alternate fuels, essentially bio-fuels, are proposed to be progressively used for blending with diesel and petrol, mainly for transport applications.

Finally, renewable energy provides enormous benefits and can contribute significantly in the national energy mix at least economic, environmental and social costs and it is expected that the share of renewable energy in the total generation capacity will increase in future.

REFERENCES

[1] International Energy Agency IEA. Key world energy statistics. Available at: http://www.iea.org/Textbase/nppdf/free/2006/Key2006.pdf [Accessed: 07/06/2007].
[2] World Energy Outlook.International energy agency; 2010.http://www.worldenergyoutlook. org/2010.asp.