Role of Renewable Energy Sources in India

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Abstract- The role of electric energy in our daily life is increasing exponentially. There is a rapid increase of productivity in industrial as well as agricultural sectors. It is of paramount importance to provide an economical as well as well-managed substitute of electric energy to the society. The renewable energy can be the only solution for energy crisis in this new millennium. This type of energy can boost the socio-economy of the nation and can be safely managed at individual level by the society. There is no rational argument as to why 100% of our power needs could not be met from renewable energy source.

Inclusion of Renewable Energy Technology's into utility operations can take many forms:

- **Dispersed small-scale generation, either utility-owned or customer-owned**
- **Farmers with Larger central groups of generators, e.g., wind power farms**
- **Stand-alone facilities**
- **Recovering existing facilities**
- **Co-firing in existing facilities**
- **Incorporating small-scale generation, e.g., photovoltaic, into buildings**
- **Specialized niche applications, e.g., remote loads.**

In this paper an attempt has been made to cover the present as well as future scenario of national renewable energy sources. In the end it can be recommended for our country as well as other Asian countries that pollution free, cost free, land free power generation gifted by nature must be explored to the best possible extent.

1. INTRODUCTION

India, being a developing county, has witnessed a rapidly growing energy need owing to the fast industrialization and increasing demographic profile. Modern society cannot normally exist without electric energy. Starting from the base of merely 1700 MW in 1950 the installed generating capacity has now risen to 80,000 MW approximately. Around 85% of villages are enjoying the benefit of electricity. Despite the progress achieved, the consumption is increasing at an annual growth rate of 4 to 5% and at the other side the conventional energy sources are exhausting. The Renewable energy source is only solution for future energy crises, which is cheap and clean as compare to non-renewable energy sources. The economy of the nation can be improved by utilizing such easily managed energy sources. The main sources are solar thermal, solar PV, wind, geothermal, ocean thermal, ocean wave, ocean tide, mini hydro, biomass, chemical, waste fuel etc. India has planned the following by new and Renewable Sources of Energy (NRSE) Schemes under ministry of Non-conventional Energy by ninth plan (1998-2003) given as:

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- Small hydro 320 MW
- Biomass 250 MW
- Agriculture waste 250 MW
- Solar & PV Thermal 100 MW
- Wind farms 2000 MW

The present status of renewable electric energy is shown in Table 1.

2. SOLAR ENERGY STATUS

India is the largest PV market in the world today. India receives solar energy equivalent to over 5000 trillion (10^{12}) kWh / year, which is far more than the total energy consumption of the country. India is one of the few countries with plenty of sunshine with an annual average insulation varying from 4-7 kWh per m²/day with 250-300 clear sunny days per year. Various types of solar thermal devices like solar water heaters, solar cookers, solar stills, solar dryers and so are available. According to the National Renewable Energy Laboratory, nearly 10 MW of PV modules are projected and installed during 1996. A recent drop in the interest rate (from 10.3 % to 2.5 %) from a U.S. $ 42 million grant from the World Bank in 1991 for PV market development. Recently, the World Bank agreed in principle to establish a $ 200 million second line of credit for the Indian Renewable Energy Development Agency (IREDA) achievements:

- The total capacity of about 4,60,000 mt^2 solar thermal collector area. [3]
- The total 4,80,000 nos. of solar cookers.

PV systems of about 47 MW aggregate capacity (about 600,000 systems) have been installed for various applications in the country. Under the PV program of MNES (ministry of non-conventional energy sources), about 3,80,000 systems aggregating to over 13 MW have been installed.

This includes 2,45,000 solar lanterns; 95,000 home lighting systems; 37,000 street lighting systems, 3,100 water pumping systems and of about 1 MW aggregate capacity of stand alone power plants / packs. Solar power systems are considered to have a significant potential in Telecommunication. An experimental system of small size has been installed at Tongpal rural telephone exchange. There are 825 kW of PV power units installed. There are also 954 PV community lights / TV and community facilities; 85,000 PV domestic lighting units / Lanterns; 32,872 PV street lights; and 1,373 PV water pumps.

- In Punjab PEDA (Punjab Energy Development agency) is providing around 500 solar water pumps at subsidies rates to the farmers for irrigation purpose. The actual cost is 4.5 lakh rupees where the farmers have to pay only Rs. 35000 only.[8]

3. BIO MASS ENERGY STATUS

The biogas plants have been developed in India during 1930s and 1940s. The design has been improved during 1950s. At present 150,00,000 biogas, plants are in operation in India. Whereas the figure of plants in 1991 was 15,00,000. India has vast land based, aquatic, forest, and rural, agricultural biomass resources of every type.it is fact that nearly 100 million tons of animal dung is available annually from 4160 million cattle population in india. It has been estimated that 1.5 lacs biogas plant can result in saving of 6 lacs tons of wood equivlant per year. It serves many purposes like: -

- Energy supply
- Rural development
- Waste disposal
- Environment balance

The range of this technology covers plants of few watts to a few hundred MW. For example a domestic Chulla, which burns wood or charcoal is rated less than 2 kW, a large urban waste incineration power plant is rated 150 MW. Biogas plants are available in sizes from 3 m^3/day to 2000 m^3/day of biomass feed. The potential for bio energy is estimated by IREDA at 17,000 MW. There is also an estimated additional 8,000 MW of cogeneration.[4]

3.1 PRESENT STATUS

- 16 MW of biomass-based cogeneration was operating, as well as
- 10 MW of biomass combustion-based power, and
- 20 MW of biomass gasifiers / sterling engines.

There are 148 alcohol-operated vehicles. By 2003 AD 18 million biogas plants may be in operation including 2.12 million family-size biogas plants, nearly 1,400 community night soil plants, and 19.9 million improved cook stoves will be in operation in India.

- First in its own type biomass (based on animal dung) plant is coming out in Ludhiana (Punjab) of 1 MW Capacity initially at the cost of 12 crore of rupees in next year in which 235 ton of dung will be collected daily from which 70 ton pure urea will also be extracted.[8]

4. GEO THERMAL ENERGY STATUS

Geothermal energy is a proven resource for direct heat and power generation. In over 30 countries geothermal resources provide directly used heat capacity of 12,000 MW and electric power generation capacity of over 8,000 MW. It meets a significant portion of the electrical power demand in several developing countries. For example, in the Philippines geothermal provides 27% of that country's total electrical generation, from power plant complexes as large as 700 MW. Individual geothermal power plants can be as small as 100 kW or as large as 100 MW depending on the energy resource and power demand. The technology is suitable for rural electrification and mini-grid applications in addition to national grid applications.

India has about 150 known geothermal sites having geothermal fluid of moderate and low temperature (<160^{0}C). The geothermal fields in India are in the form of hot water springs (40 to 98^{0}C) and shallow water receivers temperatures are less than 160 ^{0}C .The important hydro-geothermal resources locations are: -[3]

- Puga hydro-geothermal field, Jammu and Kashmir
- West coast hydro-geothermal field, Maharashtra and Gujarat
- Tattpani hydro-geothermal field, Madhya Pradesh

Over 36,000 GWh of energy (equivalent to about 4.1 million tones of oil per year) is currently harnessed world over for direct heat application. India has about 340 Hot spring localities spread over. Each of these have capability of being developing into center of value-added activities through the use of geothermal heat.Some of the projects are under progress in India:

1. Joint venture construction plans for proposed $1,000,000,000 integrated aluminum complex and captive 240 MW power plant, PECHINEY [France] & NATIONAL ALUMINIUM CO. (NALCO) [India]
2. $9.500,000,000 investment aimed at increasing domestic oil production including partner search, OIL & NATURAL GAS CORP. (ONGC) [India]
3. Construction plans for proposed 220,000 metric ton per year polyethylene terephthalate (PET) plant, RELIANCE INDUSTRIES LTD. (RIL) [India]
4. Plans for proposed $450,000,000 oil and natural gas field development project, OIL & NATURAL GAS CORPORATION LTD. (ONGC) [India]

5. OCEAN ENERGY STATUS

5.1 OCEAN THERMAL ENERGY

Ocean thermal power plant is envisaged in Kulasekharapatnam, Marakkanam, Pondicherry, Cuddalore, and Tamilnadu. There are total six plants of 100 MW each. The Indian Govt. has proved in principals the construction of 100 MW offshore power plants based on ocean-thermal energy conversion technology in 1991. The proposed plant, which would be built and financed by US Firm Sea Solar Power Inc. at a cost of US$ 250 m, is situated at Kulasekharapatnam in Tamilnadu. The India potential for the OTEC presently is approx. 2000 MW. It is India's first OTEC.

5.2 OCEAN TIDE ENERGY

The most tidal potential is in Gujrat and West-Bengal, which is about 10,000 MW, Kutch in Gujrat and Sunder Bun in West Bengal. Due to high capital cost and low continuous power output tidal power plant is not so popular in India presently. Surveys of other sites in Orissa, Tamilnadu, Kerala, Karnataka, Maharashtra and Andaman-Nicobar etc. are in progress though by the non-convention renewable energy department projects. The following sites are good prospects but require extremely high investment compare to conventional power plant of same rating. The estimated tidal power potential presently in India is about 15,000 MW.

5.3 OCEAN WAVE ENERGY

Ocean wave energy conversion has gained attention during recent years. Favorable sites have been identified in Tamilnadu, Kerala, and Gujrat etc. India's first Ocean Wave Energy pilot power plant (OWE) has been installed in Vizhingam Harbour near Thiruvanathapuram, Kerala has been commissioned in 1991. It is rated about 150 kW.

6. WIND ENERGY STATUS

India ranks first in the developing world for installed wind capacity. With nearly 850 megawatts of wind capacity, it ranks fourth in the world after Germany, the United States, and Denmark. Most of this development occurred in 1995 and 1996, when capacity expanded by an average of several hundred megawatts per year. Among the States, Tamil Nadu has the most capacity-- approximately 75 percent of India's total in 1996-- while Gujarat and Andra Pradesh have most of the remainder. With electricity demand pressing, the government favored wind projects because they had a short gestation period and no air emissions. India has a wind power potential of 20,000 MW according to initial estimates which has been scaled up recently to 35,000 MW at 30 meters hub height and 45,000 MW at 50 meters hub height

- 557 MW of wind turbines have been installed.
- Nearly 3300 wind pumps have been installed in various parts of country.
- Several large wind farm projects, with a total capacity of 1,800 MW are under progress in the various states as:

  Gujarat (955 MW), Andhra Pradesh (347 MW), Karnataka (339 MW), Tamilnadu (100 MW), Kerala (50 MW), Madhya Pradesh (15 MW)

Several major developers, particularly from the U.S., such as Cannon, Zond, Sea-West, and Optimum Power are actively working on proposals, up to 100 MW capacities each. So far, 21 Indian firms have tied up with foreign collaborators for joint venture/licensed production of wind electric generators in India, and of them five are already actively engaged in their manufacture and installation. Tamilnadu, Punjab, Kerala, Madhya Pradesh and Andhra Pradesh state governments have agreed to purchase power generated in the private sector-run wind farms at the rate of 2.25 Rs./unit (6.4 cents/kWh). While the state of Uttar Pradesh has announced a buy-back rate of Rs.1.75 (5 cents/kWh). The Gujarat and Madhya Pradesh state governments have also introduced an innovative sales tax incentive. The data of wind velocity is already collected for 80 sites of India. The present project at Kukru, Betul envisages the setting up of a Wind based Power project at a cost of US$ 175 million. Based on wind surveys it is estimated that Kukru may have a wind power generation potential of 150 MW. The energy content of the wind at Kukru is 1206 kWh/m^2. This is comparable with windy sites in the Southern part of India. The mean wind power density is 157 W/m^2, which is reasonably good.

7. FINANCIAL STATUS FOR RENEWABLE ENERGY DEVELOPMENT[6]

7.1 World Bank Funding

The World Bank has mobilized a line of credit to the tune of US $ 195 million for the India: Renewable Energy Project The project envisages installation of a capacity of 187.5 MW in three renewable energy sectors:

- Small Hydro (100 MW), Wind farms (85 MW) and Solar Photovoltaic (2.5 MW).

7.2 Asian Development Bank Funding The Asian Development Bank (ADB) line of credit of US $ 150 Million is expected under the Renewable Energy Development Project in the following sectors of renewable Energy :- Wind Energy (60 Million US $), Co-Generation (65 Million US $), Biomethanation (20 Million US $), Solar Thermal Energy (5 Million US $)

7.3 Indian Government Funding

A favourable fiscal/policy environment exists in India for the development of renewable energy sources economically. From central government:

- Income tax holiday, Accelerated depreciation, Concessional custom duty, Capital/interest subsidy.

  The state government also formed some policies like:

- Energy buyback, Power wheeling and Banking facility etc.

7.4 Other International Funding Sources

The Government of Netherlands has sanctioned a grant-in-aid of 10 million Guilders for promoting NRSE technologies through IREDA, which has been trebled into 30 million Guilders in the second phase.

8. CONCLUSION

Many scientists believe that by the year 2030, when students in school today are grown and have their own families, they will be using new sources of energy. Instead of building new coal-burning power plants to generate electricity for your home, your house may have a roof with special shingles that convert sunshine into electricity. Or out in the countryside, there will be farms with something new. Among the grazing cattle and fields of crops will be huge towers with slow-turning propellers that convert wind energy into electricity. Your house could have large, south-facing windows that gather free light and heat from the sun. Renewable energy technologies have important advantages to utilities: they use a fuel source that is either free (such as sun or wind) or relatively inexpensive (such as wood waste or municipal solid waste); their project construction lead times can be significantly shorter than those of traditional power plants, thus reducing utility risks; their capacity can be increased incrementally to better match load growth; and they are environmentally cleaner than fossil fuels.

Particularly in India, the renewable energy sources can be developed in an economically efficient and environmentally safe way as under:

- Wind energy in the coastal belt or where there continuous flow of wind is available.
- Biomass energy in rural areas.
- Solar energy in states where there are more sunny days in whole year.
- Ocean energy in the coastal area of the country.
- Geothermal energy wherever it is available.

9. REFERENCES

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Table 1 [7]

Sector	**Potential**	**Achievement**
Biogas plants	12 millions	3.128 millions
Wind	45000 MW	1267 MW
Small Hydro	15000 MW	1341 MW
Biomass power/ co-generation	19500 MW	273 MW
Solar PV	20 MW/ sq. Km	47 MWp
Waste to Energy	1700Mwe	15.15 Mwe
Solar Water Heating	140 Million sq. m	0.55 Million sq. m
Biomass Gasifiers		35 MW