Alarm for Renewable Energy Requirement in India

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***Abstract*— Alarming situation for the requirement of alternative energy sources has already been arrived. 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.**

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.

As the chart shows, oil remains the top energy source, providing 33.1% of global energy production - though as can be seen, its share has really flat lined in recent years.

Conversely, despite the environmental concern, coal's share has continued to grow, reaching about 30% of total consumption, nipping at oil's heals, up from 29.6% in 2011. Most of that growth came from China, but interestingly, while coal consumption dropped sharply in the US in 2012, it rose in Europe for the third straight year, as natural gas prices rose sharply there.

Renewable sources are growing rapidly, but were just 1.9% of total consumption in 2012. Still, that is up quite a bit in percentage terms from its 1.6% share in 2011.

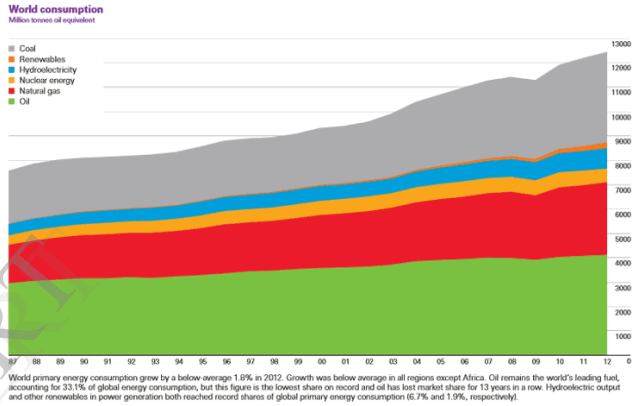

Fig1. World Total energy consumption

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.

II. 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 implement energy 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.

The country has an estimated renewable energy potential of around 200,000MW from commercially exploitable sources, i.e., wind, 49,000 MW; small hydro, 20,000MW and biomass/bio-energy, 26,000 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 18192 MW; India occupies the fifth position globally.

The role of new and renewable energy has been assuming increasing significance in recent times with the growing concern for the country's energy security. The renewable energy industry has approximately USD 500 million as turnover, the investment being about USD 3 billion. Of the estimated potential of 200,000MW from RE only about 25000MW has been installed to-date. The Indian Government has been at work, making a comprehensive policy for compulsory use of renewable energy resources through biomass, hydropower, wind, solar and municipal waste in the country, particularly for commercial establishments, as well as Government establishments.

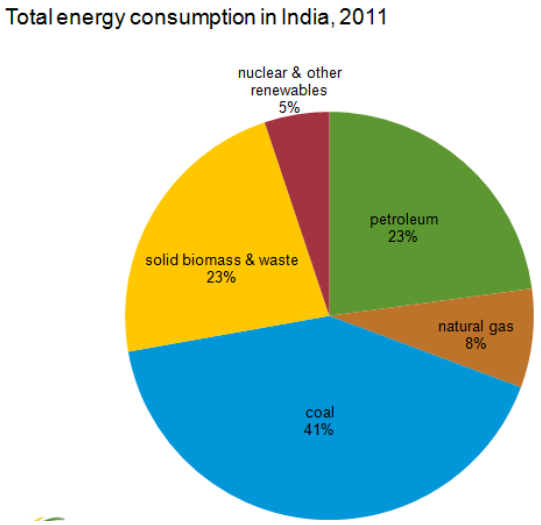

Fig2. Total energy consumption in India

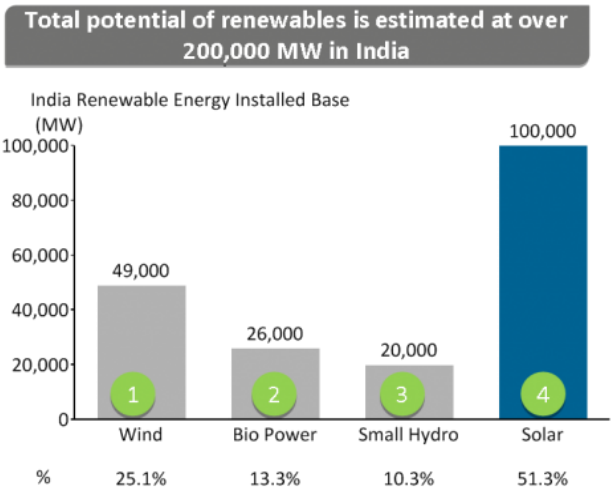

Fig3. Potential of renewable energy in India

A. *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 22,000 MW. Currently, India has 3,360 MW commissioned. The facts reinforce the idea of a commitment by India to develop these resources of power production.

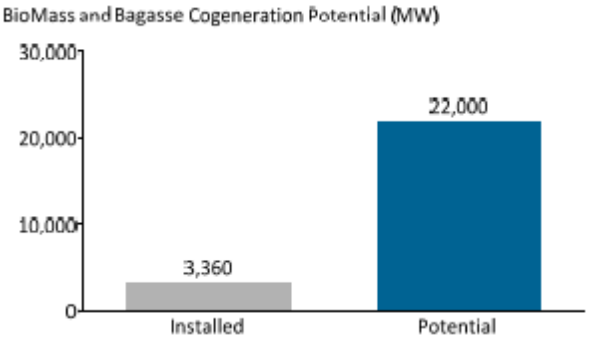

Fig4. Potential of Bio-Mass and Bagasse

B. 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.

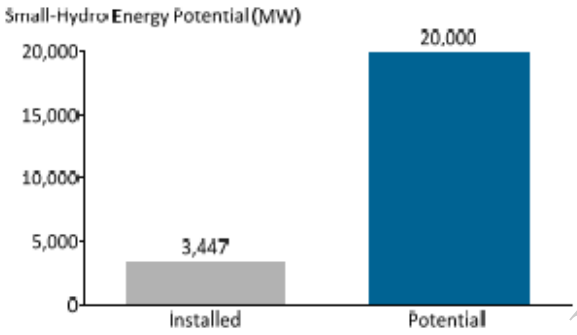

Fig5. Potential of Small-Hydro Energy

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 20,000MW
- Technology is mature and reliable
- Installed is 3,447MW to date Two types of technology are used

(i) High-head systems
(ii) Low-head systems

C. 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 49000 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 49,000 MW. A capacity of 18192MW has been installed.

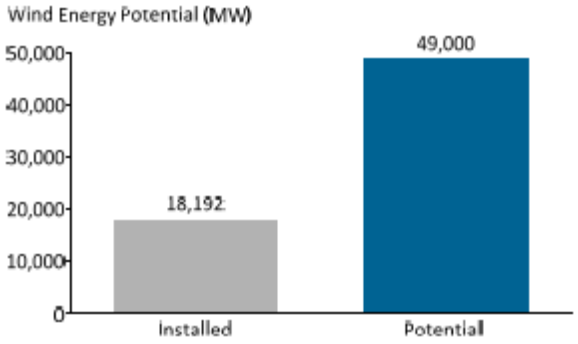

Fig6. Potential of Wind Energy

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.

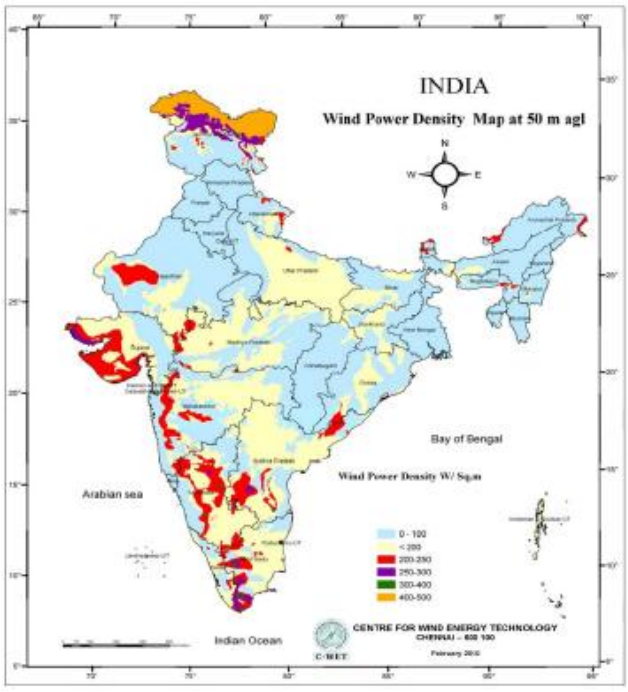

Fig 7. Wind power density map at 50 m level

D. 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 1045MW, while the total solar energy potential has been estimated at 100,000 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/sqmm/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

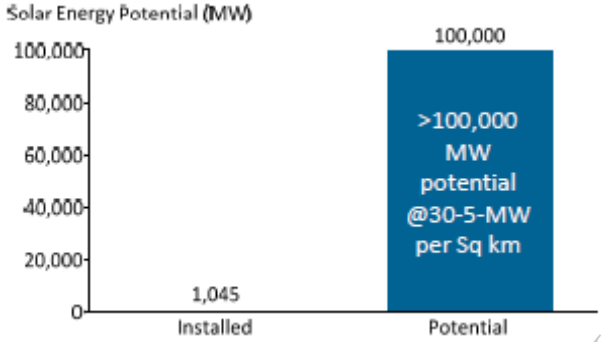

Fig8. Potential of Solar Energy

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.

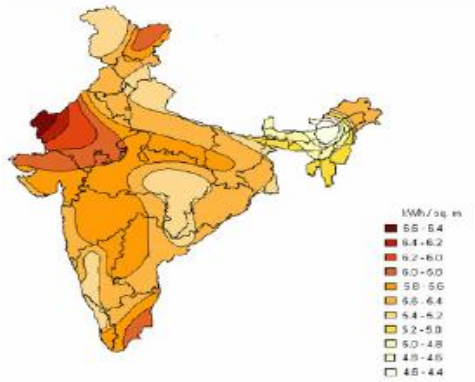

Fig9. High Solar Power Density in India

E. Geothermal Energy

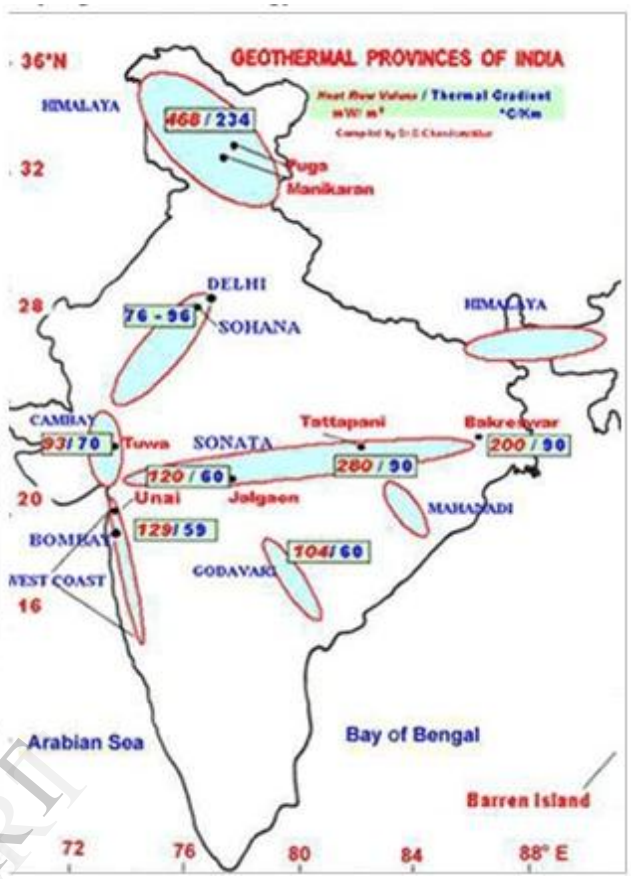

Fig10. Potential of Geothermal Energy in India

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.

F. Tidal Energy

India has a long coastline 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 11m and 8m with average tidal range of 6.77m and 5.23m. The Ganges Delta in the Sundarbans is approximately 5m with an average tidal range of 2.97m.The identified economic power potential is of the order of 8000 MW with about 7000 MW in the Gulf of Cambay, about 1200 MW in the Gulf of Kachchh in the State of Gujarat and about 100 MW in the Gangetic Delta in the Sunderbans region in the State of West Bengal.The Ministry sanctioned a project for setting up a 3.75 MW demonstration tidal power plant at Durgaduani Creek in Sunderbans, West Bengal.The State Government of Gujarat

formed a Special Purpose Vehicles (SPVs) with public private partnership and sponsored a study for large scale exploitation of tidal energy across the coastline of Gujarat. This study is based on one of the advanced technologies developed so for. In this technology kinetic energy of tidal currents has been proposed to be harnessed under the water and along the flow of water and without using the conventional methods like water wheel or other types of turbine.

G. Biogas

Biogas Technology will predominantly offer an excellent alternative energy source for rural India. It has the potentials to cater to the needs for cooking and basic fuel. Moreover, rural areas are in a better position to utilize local resources like organic and cattle waste for the generation of biogas.

Being a country where agriculture has always been one of the main sources of occupation for millions of people, biogas is not really the new technology in India. Way back in late1970s, National Biogas Program was introduced for finding adequate solutions to the fuel shortage crisis. There have been a lot of researches conducted for improving the biogas production by using alternative feedstock, and by trying out diverse microbial actions.

According to the Ministry Of Renewable Energy, India has the potentials of producing 10% of country's energy requirements by adopting the biogas technology, which is calculated to be around 17,000 MW.

Although India is moving at a good pace in the production of biogas, there are huge scopes for further growth in the sector. In the year 2012 alone, about 4.30 millions biogas units of household scale have been installed, although the potential estimation was expected to reach 12 million plants. That should tell you a lot about the volume of energy demand in the country.

National Biogas and Manure Management Program was introduced with the main aim of reducing the consumption of LPG gas in villages and rural areas.

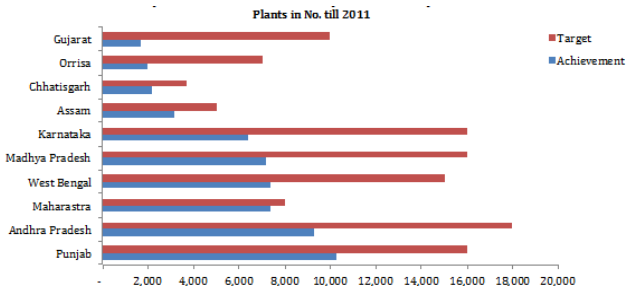

Fig11. Potential of Bio-Gas in India

The main advantages of biogas installations are:

- It is the viable method for generating cooking fuel or electricity
- It allows for systematic disposal of agricultural, cattle and even municipal waste
- It is derived from renewable resources, and hence it is environment friendly
- Many incentives and concessions are being offered by the government

Most of the states in India have adopted the program, in order to cope up with the shortage of power. Punjab, Andhra Pradesh, Maharashtra, West Bengal and Madhya Pradesh are among the top producers of biogas in India. In the year 2011, these states had more than 15,000 Biogas plant installations. At the same time, most of the other states in India are increasing their Biogas Energy capacities, with thousands of plants being installed every year.

Biogas Technology offers potential savings on conventional fuel and electricity.

III. 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

IV. 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.

V. CURRENT ENERGY POLICIES

A. *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.

B. *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.

C. *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.

VI. 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.

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