

Clean energy: sources, technology, economics and relevance

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Abstract

Background/Objectives : Owing to the popular myth that the non-conventional energy is economically unviable, the paper deliberates on the feasibility of these alternate sources of clean energy.

Methods/Statistical Analysis : The present article explores the various avenues in non-conventional energy such as solar energy, tidal, bio-gas, geo-thermal, ocean/marine etc and the efforts by the present day government in India.

Results : The necessity to shift to clean energy is compelling due to global pressure and stand taken by India as a leading developing nation of 1.2 billion people in the international forums. Moreover taking into account the huge demand for domestic/industrial power, India's interests also lies in replenishable energy in contrast to polluting fossil fuels which are limited in quantum.

Key words : bio-fuels, clean energy, photo-voltaics, renewable sources, solar power.

1. Introduction

Renewable energy is defined as the energy derived from sun, wind, rain, tides, waves & geothermal heat. Renewable energy if properly tapped can replace the conventional energy sources such as coal, fossil fuels which are limited in quantum and available at select places only. Whereas, renewable energy is abundant throughout the globe and moreover replenishable. Due to its availability at all locations, renewable or non-conventional energy can be decentralized, which is very advantageous in a vast country like Indian subcontinent. Further it is being considered as green, clean and sustainable energy due to the absence of any side effects viz., pollution in the case of coal, environmental degradation/ deforestation/ increase in seismic disturbance which is prevalent in large hydel projects, nuclear holocaust due to disasters in nuclear power plants. The debate for clean energy was in the news due to Three Mile Island accident in Pennsylvania, USA (1979) and Chernobyl disaster in Russia (1986), but the momentum picked up with the recent Fukushima catastrophe in Japan (2011).

2. Sources of clean energy

2.1. Biogas

India is predominantly an agricultural economy with around 60% of its people living in villages. Due to abundant availability of biomass resources such as cattle dung, kitchen waste, agricultural waste etc in the rural hinterlands, the decentralized bio-gas units offer greater viability & sustainability. Initiatives for setting up biogas plants are being taken by Ministry of New and Renewable Energy (MNRE) under an Integrated Technology-package in entrepreneurial mode which includes generation, purification/enrichment, bottling and piped distribution of biogas. Installation of such plants would revolutionise the rural electrification which is riddled with umpteen power cuts. Huge potential exists for medium size biogas-fertilizer plants in the hinterlands. Govt of India is providing financial assistance upto 50% of the cost (excluding cost of land) for a limited number of such projects for implementation following an entrepreneurial mode on Built, Own and Operate (BOO) and re-imbusement basis.

2.2. Solar energy

Harnessing of radiant light & heat from the sun and converting the same into productive energy using a range of ever-evolving technologies such as solar heating, solar photovoltaics, solar thermal electricity, solar architecture and artificial photosynthesis forms the core concept of solar energy. Solar technologies are broadly characterized as either passive solar or active solar depending on the way they capture, convert and distribute solar energy. Active solar techniques include the use of photovoltaic panels and solar thermal collectors to harness the energy. Passive

solar techniques include orienting a building to the Sun, selecting materials with favorable thermal mass or light dispersing properties, and designing spaces that naturally circulate air. The development of affordable, inexhaustible and clean solar energy technologies will have huge longer-term benefits and it will increase countries' energy security through reliance on an indigenous, inexhaustible and mostly import-independent resource, enhance sustainability, reduce pollution, lower the costs of mitigating climate change, and keep fossil fuel prices lower.

2.2.1. Relevance of solar energy in Indian context

India is advantageously placed in the globe with high potential for using the solar energy. Solar radiation is available for as much as 42 out of 52 weeks in a year and if successfully tapped, it can produce about 5,000 trillion kWh/yr or 600,000 GW[1]. India is densely populated and has high solar insolation, an ideal combination for using solar power in India. The amount of solar energy produced in India in 2007 was less than 1% of the total energy demand. At present, the installed grid connected solar power is 2,200 MW and is expected to add an additional 10,000 MW by 2017, and 20,000 MW projected by the year 2022. Govt of India is making it mandatory to use solar-powered equipment and applications in all government buildings, as well as hospitals and hotels under National Solar Mission (NSM). Coupled with the subsidies announced by Govt of India on adoption of solar technology, steep reduction in the cost of PV panels is responsible for the sudden demand in solar energy.

2.2.2. Photovoltaic technology for harnessing solar energy

The direct conversion of light into electricity at the atomic level is the principle behind photovoltaics. Few materials are known to possess the photoelectric effect that causes them to absorb photons of light and release electrons. These free electrons when captured causes an electric current that can be used as electricity. Solar cells made from silicious materials are grouped in the solar panels to convert sunlight into electricity (Figure 1). Lot of technological improvements enhancing the efficiency of solar panels have been noticed in the recent past and research continues in this direction. 50% of solar energy is produced in Gujarat followed by Rajasthan at 39%. Gujarat has been a leader in solar power generation and contributes 2/3rd of the 900 MW of photovoltaics in the country. Prime Minister Shri Narendra Modi used to amplify the aspect of generation of solar power by putting solar panels on the Narmada canal branches in his election rallies, which was a win-win situation since apart from producing solar power, the installation of panels reduced the evaporation losses from the canals. Further, Prime Minister Narendra Modi has put great emphasis on solar projects and is inviting Foreign Direct Investment (FDI) in this sector.

Figure 1. Photograph of PV Solar Power Plant (on Left) & Solar Water Heating Plant (Right)



2.2.3. Application of solar energy in Indian context

Rural electrification is one of the most important applications of National Solar Mission initiated by Indian Government with 30% to 40% subsidy for the cost of lanterns, home lights and small systems up to 210 W. Other than the initial cost, nil recurring cost is the beauty of solar lamps. The greatest advantage lies in its decentralized nature obviating the need for centralized power generation coupled with heavy transmission lines incurring huge transit losses. Another major application exists in Solar PV water pumping systems used for irrigation and drinking water. The majority of the pumps are fitted with a 200–3,000 watt motor that are powered with 1,800 W PV array which can deliver about 140,000 litres (37,000 US gal) of water per day from a total head of 10 metres (33 ft). Solar driers are used to dry harvests before storage. Roof top solar water heaters are the norm in cosmopolitan cities and they can produce an energy equivalent upto 200 MW (Figure 1). These systems are now mandatory for all new structures. Pune has also recently made installation of solar water heaters in new buildings mandatory.

2.3. Wind energy

Wind power (Figure 2) has been employed in various parts of India on an experimental mode, but never on a massive scale. On the global level, India’s wind power generation contribution is barely 7% when compared with the Chinese at 30% and USA at 25%. India with a vast coast line has a huge potential for generating wind energy.

Figure 2. Photograph of typical wind mill (Left) & at East Renfrewshire, Scotland, UK (Right)



2.4. Bio-Fuels

Brazil is the pioneer in generating cellulosic-ethanol made from sugarcane termed as ‘bio-fuels’. According to the International Energy Agency, bio-fuels have the potential to meet more than a quarter of world demand for transportation fuels by 2050. Since 1970s, Brazil has had an ethanol fuel program which has allowed the country to become the world’s second largest producer of ethanol (after the United States) and the world’s largest exporter. Brazil’s ethanol fuel program uses modern equipment and cheap sugarcane as feedstock, and the residual cane-waste (bagasse) is used to produce heat and power. There are no longer light vehicles in Brazil running on pure gasoline. Realising the vast potential of bio-fuels in an agricultural dominant country like India, the Hon’ble Transport Minister Shri Nitin Gadkari has expressed interest in this sphere. Bio-Fuels not only liberate our country from excessive dependence on the huge crude oil import burden but also supports the cause of the farmers in extending reasonable Minimum Support Prices (MSP) and it is high time some serious action is deserved in this direction.

2.5. Geothermal energy

Geothermal power plants (Figure 3) are cost effective, reliable, sustainable, and environmentally friendly, but has historically been limited to areas near tectonic plate boundaries. The Himalayan belt such as Himachal Pradesh, Uttarakhand, Jammu & Kashmir and North Eastern part of India offers a great scope. One must have observed the presence of hot water springs in these nascent Himalayas which is in high seismic zone and it is nothing but the existence of geo-thermal energy. Recent technological advances have dramatically expanded the range and size of viable resources, especially for applications such as home heating, opening a potential for widespread exploitation. Geothermal wells release greenhouse gases trapped deep within the earth, but these emissions are much lower per energy unit than those of fossil fuels. No serious attempts have been made for tapping the geo-thermal energy in the Indian sub continent.

Figure 3. Geo-Thermal Plant at Geysers, California, USA (Left) & Nesjavellir, Iceland (Right)



2.6. Ocean/Marine energy

Marine energy (also sometimes referred to as ocean energy) refers to the energy carried by ocean waves, tides, salinity, and ocean temperature differences. The movement of water in the world's oceans creates a vast store of kinetic energy, or energy in motion. This energy can be harnessed to generate electricity in Tidal Power stations (Figure 4) to power homes, transport and industries. The oceans have a tremendous amount of energy and are close to many if not most concentrated populations. Ocean energy has the potential of providing a substantial amount of new renewable energy around the world.

Figure 4. Tidal Power Station (240 MW) at Rance, France



3. R & D on new technology

The Ministry of New and Renewable Energy (MNRE) of Government of India has taken up research on various New Technologies such as Hydrogen Energy, Chemical Sources of Energy from Fuel Cells etc. As part of these programmes, research, development and demonstration projects have been initiated at various research, scientific and educational institutes, universities, national laboratories, industry, etc. These projects are helpful in the development of indigenous research and industrial base, expertise, trained manpower and prototypes/devices/systems in the country.

4. Economics of renewable energy

Construction of large dams & thermal power plants is becoming increasingly difficult and at times impossible due to environmental activism and land acquisition related issues. Renewable energy offers an alternative particularly in developing countries. Further with their decentralized nature, the renewable energy eliminates the requirement of transmission and distribution lines which are expensive and also incur huge losses in transmission. Technology advances are opening up a huge new market for solar power. Solar power costs half as much as lighting with kerosene. For the entire electric power starved villages of India, renewable energy can offer an economic solution. Some of the renewable energy technologies that can be used in villages and rural areas as decentralized systems are:

- Family-Size Bio-Gas Plants.
- Solar Street Lighting Systems.
- Solar Lanterns & Solar Home Lighting Systems.
- Solar Water Heating Systems
- Solar Cookers.
- Stand-Alone Solar/ Biomass Based Power Generators.
- Akshay Urja / Aditya Solar Shops.
- Wind Pumps.
- Micro-Hydel Plants.

Small hydropower projects while sharing all benefits of hydro-electric generation, harnesses a renewable source of energy in an environmental benign manner. Therefore, loss to healthy atmosphere of society is almost nil. Being small, it does not involve any submergence or violation of the sanctity of the forest. Availability of reliable electric energy is expected to reduce over dependence on nature and this will reduce depletion of fuel like forest wood, kerosene, cow-dung etc presently being used as domestic fuel by people in the area. The magnitude of the

construction activity will not induce migration of labor to this area from other areas as local labor is available and thus local ecology will not be pressured[2].

5. Relevance of renewable energy

The necessity to adopt renewable energy has been compelled by global warming and other ecological concerns. The greatest advantage of renewable energy is that it allows us to tap the energy without disturbing the ecology. Fortunately, the awareness for renewable energy technologies is on the ascent. Global warming concerns coupled with high crude prices and increasing government support are motivating the governments of the day to drift towards the rapid use of renewable energy.

6. Conclusion

India has launched the ambitious 'Make in India' campaign with an intent to be developed as a favourite manufacturing hub showcasing its 3 Ds viz., Democracy, Demography & Demand as propounded by Prime Minister Shri Narendra Modi so as to attract foreign investors. All this would remain a mere dream if not supported by requisite infrastructure and availability of power remains a crucial factor for manufacturers to step in. A severe power shortage looms in all parts of the India and any mega power projects be it hydel or thermal or nuclear are fraught with serious environmental concerns. Renewable energy comes as a boon for a tropical country like India blessed with adequate sunshine throughout the year. Renewable energy is also economical owing to the fact that it is totally decentralised doing away with the distribution network. The technological advancements are offering cheaper solar PV panels thus enhancing the application of these technologies in the future. Renewable energy has a huge potential to replace the conventional captive power generating units using diesel, thus helps in reducing the import dependence in the long run. Huge scope lies for renewable energy in the Indian context due to its advantageous location in the tropics with abundant sunlight for tapping solar energy, agricultural produce for bio-gas & bio-fuels, vast coastline for venturing into wind & marine energy and lastly Himalayan belt for converting geo-thermal energy.

7. References

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