Current Indian Perspective for Unconventional Energy Resources and its Exploration

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Abstract

India has one of the fastest and largest growing economies in the world, as well as an expensive populace of above 1.17 billion people. There is a very high demand for energy, which is currently satisfied mainly by coal, foreign oil, and petroleum, which apart from being a non – renewable, and therefore non – permanent solution to the energy crisis, it is also detrimental to the environment. The price of crude oil has risen sharply over the last few years, and there are no sign of a change in this trend. Thus,it is imperative that India obtains energy security without affecting the booming economy, which would mean that alternative energy source is found. This would mean that the country must switch from the non renewable energy – coal and crud oil – to 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 achieve its goal. Renewable energy in India, excluding large hydro projects already accounts for 9% of the total installed energy capacity, equivalent to 17173.9 MW of energy. In combination with large hydro, the capacity is more than 34%, i.e., 55204.44 MW, in a total installed capacity of 162,366 MW by June 2010. In the present paper an attempt has been made to describe the potential and utilization of renewable energy resources in India

Keywords*: Renewable Energy, Biomass, Geothermal, Hydropower, Electricity, Environment, Crude-Oil*

INTRODUCTION

Renewable energy is the energy derived from the resources that are regenerative, and do not deplete over the time. Renewable energy is also clean energy, which would mean its usage would not be damaging to the quality of the environment. Renewable energy refers to energy resources that occur naturally and repeatedly in environment and can be harnessed for human benefit. Fossils fuels too are theoretically renewable but on a very long time - scale and if continued to be exploited at present rates then these resources may deplete in the near future. Therefore, in reality, renewable energy is energy from a source that is replaced rapidly by a natural process and is not subjected to depletion in a human time – scale. Renewable energy sources are thus fundamentally different from fossils fuels.

Fortunately, India is blessed with a variety of renewable energy sources, the main ones being biomass, biogas, and the sun, and the wind, geothermal and small hydro power. (Large hydro power is also renewable energy in nature, but has been utilized all over the world for many decades, and is Generally not included in term 'new and renewable source of energy').

Municipal and industrial waste can also be useful source of energy, but are basically different forms of biomass.

Energy is the prime mover of economic growth and is vital to the sustenance of a modern economy. Future economic growth crucially depends on the long-term availability of energy from sources that are affordable, accessible and environmentally friendly. India ranks sixth in the world in total energy consumption and needs to accelerate the development of the sector to meet its growth aspirations. The share of fossil fuel in the current primary fuel-mix of the country is dominant as coal, oil and gas together account for around 65%. Share of renewable, including large hydro, is 34 percent.

India has a vast supply of renewable energy resources, and it has one of the largest programs in the world for deploying renewable energy products and systems. Indeed, it is the only country in the world to have an exclusive ministry for renewable energy development, the Ministry of Non-Conventional Energy Sources (MNES). Since its formation, the Ministry has launched one of the world's largest and most ambitious programs on renewable energy. Based on various promotional efforts put in place by MNES, significant progress is being made in power generation from renewable energy sources. In October 2006, MNES was renamed the Ministry of New and Renewable Energy (MNRE).

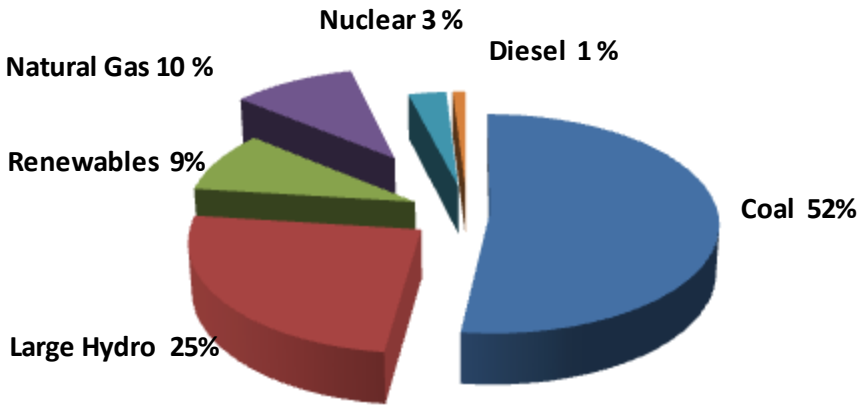

Fig. 1: India Installed Power Capacity (MW) (Source: Ministry of New and Renewable Energy GOI).

ENERGY SCENARIO IN INDIA

Today most of the energy is drawn from conventional non – renewable energy resource, such as coal and petroleum products. At present coal alone accounts for about 70% of India's electricity supply but it is not environment friendly. The main culprit behind conventional non – renewable energy resources is the uncontrolled emission of CO_2 which leads to global climate change. The developing world community is struggling with scarcity of power. Most of the power is derived from non – renewable conventional energy resources which are decreasing day by day. Therefore renewable energy resource utilization is the best solution to combat this problem.

With high economic growth rates and over 17% of the world's population, India is a significant consumer of energy resources (3.4% of global energy consumption). India, at 1.17 billion people, is the second most populated country in the world. India ranks fifth in the world in total energy consumption, and is projected to surpass Japan and Russia to become the world's third biggest energy consumer by 2030 (EAI). At the same time, the country is facing an acute energy scarcity which is hampering its industrial growth and economic progress. India is trying to tackling the energy crisis through a judicious utilization of renewable energy resources, such as biomass energy, solar energy, wind energy and geothermal energy. India consumes its maximum energy in residential, commercial, and agriculture purpose in comparison to China, Japan and Russia and US.

Coming to the power generation in the country, India has increased installed power capacity from 1362 MW to over 162,366 MW since independence to June 2010 and electrified more than 500000villages. This achievement is impressive but not sufficient. It is a matter of concern that 35.5% of households do not have access to electricity (Ministry of Power GOI) and as many as 80, 000 villages are yet to be electrified. The annual per capita consumption of 612 kWh is among the lowest in the world by June 2010.The ministry of power has drawn a road map to ensure 'power on demand' by 2012. The anticipated demand as per 16th Electric Power Survey requires an addition of 100,000 MW. In other words, the achievements of more than five decades need to be replicated in the next decade. This requires resources of Rs. 8, 00,000 crores. (Ministry of Power GOI). The task is daunting but not unachievable.

India has vast small hydro power potential of 15,000 MW out of which only 18.5% has been tapped so far. It is found that India has no geothermal power plant yet but according GSI (Geological Survey of India), geothermal resources in India are known to be able to contribute to the country's energy supply by more than 10,600 MW of sustainable power. According to Chandrasekharam (Head of Earth Science Department, IIT Bombay)

A marked disparity between the energy consumption pattern in urban and rural segments also forces a shift of energy scenario towards renewable energy systems. Villages and areas situated in remote and far flung areas can be depended on only self generating source like renewable. Renewable technologies are now matured and well understood technologies, thus it is now possible to connect them to grid and costly establishment and maintenance of transmission and distribution networks.

RENEWABLE ENERGY POTENTIAL IN INDIA

There is a large potential for renewable energy in India, an estimated aggregate of over 150,000 MW. As against the estimated 84776 MW renewable energy based grid connected power generation potential in the country, so far only about 17173.9 MW installed capacity has been achieved. The renewable energy excluding large hydro power based power generation capacity presently constitutes 9% of the total installed capacity in the country for power generation from all sources. The country is aiming to achieve up to 10% of additional installed capacity to be set up till 2012 to come from renewable energy sources.

Table 1: Grid Interactive Renewable Energy in India (Source: MNRE by 30 June 2010)

Sources	Potential (MW)	Installed Capacity (MW)	India's position in the

			world
Wind	46,092	12009.48	5th
Solar	200MW/km**2**	12.28	1st
Small hydro	15,000	2767.05	10th
Biomass	16881	901.1	4th
Cogeneration bagasse	5000	1411.53	-
Energy Recovery from Waste	2700	72.46	-
Geothermal	10,600	-	-
Ocean Energy	50,000	-	-
Wave Energy	-	-	-
Tidal Energy	-	-	-
Total		17173.9	

Wind Energy

The origin of wind energy is sun. When the sun rays fall on the earth, its surface gets heated up and as a consequence winds are formed. Kinetic energy in the wind can be used to run wind turbines but the output power depends upon the wind speed. Turbines generally require a wind in the range between 5.5 and 25 m/s.

The development of wind power in India began in the 1990s. Although a relatively newcomer to the wind industry compared with USA (35,159 MW), Germany (25,777 MW), China (25104 MW), and Spain (19149 MW), India) has the fifth largest installed wind power capacity in the world. The worldwide installed capacity of wind power reached 157899 MW by the end of 2009. According to the MNRE, the potential of wind power in India is approximately 46092 MW and installed capacity of wind power is 12009.48 MW by the end of June 210. Major states with higher capacity and wind power potential are Tamil Nadu, Andhra Pradesh, Karnataka, Kerala, Madhya Pradesh and Maharashtra.

Table 2: Estimated Wind Power Potential in India (Source: MNRE by June 2010)

S.No.	**State Potential**	**(MW)**
1	Andhra Pradesh	9063
2	Gujarat	7362
3	Karnataka	7161
4	Kerala	4 1026
5	Madhya Pradesh	4978
6	Maharashtra	4519
7	Orissa	1520
8	Rajasthan	6672
9	Tamil Nadu	4159
10	West Bengal	10 32
Total		46,092

It is estimated that 6,000 MW of additional wind power capacity will be installed in India by 2012. Wind power accounts for 6% of India's total installed power capacity, and it generates 1.6% of country's power. (Wind Power Wikipedia)

Samana wind farm is the largest wind farm in India and has a generating capacity of 100.8 MW. Suzlon, India's largest wind power company has risen to ranking 5th worldwide, with 7.7% of the global market share. Suzlon holds 52% of market share in India. Suzlon's success has made India thedeveloping country leader in advanced wind turbine technology.

Solar Energy

Because of its location between the Tropic of Cancer and the equator, India has an average annual temperature ranges from 25oC–27.5oC. This means that India has huge solar potential. The sunniest parts are situated in the south/east coast, from Calcutta to Madras.

Radiant light and heat from the sun, has been harnessed by humans since ancient times using a range of ever-evolving technologies. Only a minuscule fraction of the available solar energy is used. In solar energy sector, some large projects have been proposed, and a 35,000 km² area of the Thar Desert hasbeen 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. 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, fallow lands, etc., 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. Even if 10% of this area can be used, the available solar energy would be 8 million MW.

The amount of solar energy produced in India is merely 0.4% compared to other energy resource. The grid–interactive solar power as of June 2010 was merely 12.28 MW. However, as of October 2009, India is currently ranked number one along with the United States in terms of installed Solar Power 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.

The Karnataka Power Corporation Limited (KPCL) has installed India's largest solar photovoltaic power plant at Yalesandra village in Kolar district of Karnataka.

Table 3: Total Solar Energy Consumption in India
(Source: http://en.wikipedia.org/wiki/Solar_power_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 km2 of collector area
Box-type solar cookers	575,000

Solar photovoltaic pumps	6,818

Biomass Energy

Biomass has been a key player in energy generation even in the past. Biomass, defined as all land and water based vegetation as well as organic wastes, fulfilled almost all of human kind's energy need prior to the industrial revolution. In present day scenario, once again its utilization for generation of energy has gained momentum because of limited availability of the conventional energy resources as well as environmental concern due to (Green House Gas) GHG emissions.

In the past decade there has been renewed interest in the biomass as renewable energy source worldwide. The major reasons for this are as follows. First of all technological developments relating to the conversion, crop production, etc. promise the application of biomass at lower cost and with higher conversion efficiency than was possible previously. In Western Europe and in the US, the second main stimulus is food surpluses producing agricultural sector. This situation has led to a policy in which land is set aside in order to reduce surpluses. Thirdly, the potential threat posed by climate change, due to high emission levels of greenhouse gases, the most important being CO2, has become a major stimulus for renewable energy sources in general. When produced by sustainable means, biomass emits roughly the same amount of carbon during conversion as is taken up during plant growth. The use of biomass therefore does not contribute to a build-up of CO2 in the atmosphere.

India is very rich in biomass energy and has a potential of 16,881MW (agro-residues and plantations), 5000MW (bagasse cogeneration) and 2700MW (energy recovery from waste), out of which only 2385 MW is installed in various form. Biomass power generation in India is an industry that attracts investments of over INR 600 crores every year, generating more than 5000 million units of electricity and yearly employment of more than 10 million man-days in the rural areas

Table 4: Estimated Biomass Energy Potential in India (Source: www.geni.org)

1	Andhra Pradesh	200
2	Bihar	200
3	Gujarat	200
4	Karnataka	300
5	Maharashtra	1000
6	Punjab	6 150
7	Tamil Nadu	350
8	Uttar Pradesh	1000

Hydropower

Hydropower is a renewable, non - polluting, and environment friendly source of energy. It is perhaps the oldest renewable energy technique to the mankind for mechanical energy conversion as well as electricity generation. Hydropower represents the use of water

resources towards inflation free energy due to absence of fuel cost characterised by highest prime moving efficiency and spectacular operation flexibility. Out of total power generation installed capacity of 162,366 MW in the country, the hydropower contributes 25% i.e. 40591.5 MW.

S.No	States	Identified Number of Sites	Potential (Mw)
1	Andhra Pradesh	489	552.29
2	Arunachal Pradesh	556	1333.04
3	Assam	60	213.84
4	Bihar	94	213.75
5	Chhattisgarh	164	706.62
6	Goa	9	9.10
7	Gujarat	292	196.97
8	Haryana	33	110.05
9	Himachal Pradesh	547	2268.41
10	Jammu And Kashmir	246	1411.72
11	Jharkhand	103	208.95
12	Karnataka	128	643.16
13	Kerala	247	708.10
14	Madhya Pradesh	99	400.58
15	Maharashtra	253	762.58
16	Manipur	113	109.10
17	Meghalaya	102 229.81	229.81
18	Mizoram	75	166.94
19	Nagaland	99	196.98
20	Orissa	222	295.47
21	Punjab	234	390.02
22	Rajasthan	67	63.17
23	Sikkim	91	265.54
24	Tamilnadu	176	499.31
25	Tripura	13	46.86
26	UttarPradesh	220	292.16
27	Uttrakhand	458	1609.25
28	West Bengal	203	393.79
29	A& N Island	12	7.91
	Total	5,415	14,305.47

In India, hydropower projects with a station capacity of up to 25 MW each fall under the category of small hydropower (SHP). India has an estimated SHP potential of about 15000 MW, of which about 18.5% has been tapped so far i.e. 2767.05 MW. Ministry of New and Renewable Energy (MNRE) has created a database of potential sites of small hydro and 5,415 potential sites with an aggregate capacity of 14305.47 MW for projects up to 25 MW capacity have been identified.

Geothermal Energy

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. This energy is accessed by drilling water or steam wells in a process similar to drilling for oil.

Geothermal energy is an enormous, underused heat and power resource that is clean (emits little or no greenhouse gases), reliable (average system availability of 95%), and home-grown (making us less dependent on foreign oil).

India has reasonably good potential for geothermal; the potential geothermal provinces can produce 10,600 MW of power. Rocks covered on the surface of India ranging in age from more than 4500 million years to the present day and distributed in different geographical units. More than 300 hot spring locations have been identified by Geological survey of India. But yet geothermal power projects have not been exploited at all. However, with increasing environmental problems with coal based projects, India will need to start depending on clean and eco-friendly energy sources in future; one of which could be geothermal.

Thermal springs have been known to occur in India since centuries. At places, like Badrinath and Gangotri in Uttarakhand; Sohna in Haryana; Rajgir in Bihar; Bakreshwar in West Bengal and Ganeshpuri in West Coast, Maharashtra, temples have been built on thermal springs and thermal water was utilized by locals. Thermal springs have drawn attention, being the surface manifestation of the vast resources of geothermal energy at depth in the form of geothermal reservoirs.

India's first geothermal plant is expected to come up by 2012, with an initial capacity of 25 megawatt (MW) at an investment of US$ 64.66 million in the Khammam district of Andhra Pradesh (AP). It will be set up by Mumbai-based Geo Syndicate Power Private Ltd, a company incubated by the Indian Institute of Technology (IIT), Bombay, which has a special focus on exploration and production of geothermal energy.

Table 6: Geothermal Potential in India (Source: Geological Survey of India)

S.No.	Geothermal Province	Number of Thermal Springs	Heat Flow Rate (MW/m2)
1	Himalaya	100	100
2	Krishna - Godavari	13	180
3	West Coast	25	93 -1 29
4	Sonata	23	-
5	Combay	15	80

RENEWABLE ENERGY BARRIERS

There are many barriers to wider spread use of renewable energy resources; while they can be overcome and have been in many countries, doing so will require a large, concerted,

prioritized effort. The main constraints to the more widespread use of renewable resources are:

• Lack of information by the public, and even many governments, commercial and industrial energy officials, about the availability, costs and benefits of renewable energy technologies.

• Lack of knowledge by project initiators and managers of the social and energy related needs of rural communities, how to adapt projects to meet these needs, and involvement of the communities in the design of projects. Failure of public involvement may be the most significant barrier. If projects fail to meet the local needs for which they are intended, such failures can impede renewable energy applications for decades. Rural community residents can ill afford unsuccessful experiments.

• Failure to get the prices right, particularly distorting the energy market when heavily subsidized traditional energy is compared to renewable energy options -- and the failure to value all resources on a life-cycle cost basis taking into account externality costs to society.

• Preference for known fossil resources over newer renewable resources by government, commercial and industrial officials responsible for making energy decisions and by banking and other financing officials.

• Discrimination against intermittent energy sources such as solar and wind power by pool power dispatchers, utilities and government procurement agencies, even though these resources often are available at peak times of power needs.

• The small amount of R&D effort and funding being devoted to improving renewable technologies.

• Import duties on renewable equipment and other barriers to foreign investment generally and as related to renewable energy resources

• Lack of personnel trained in the installation, operation and maintenance of renewable energy equipment.

• Lack of knowledge and personnel trained in financing mechanisms available to support renewable energy projects.

CONCLUSION

The challenges of present energy scenario offers India a window of opportunity in the form of renewable energy sources to expand and diversify its energy supply towards greater sustainability, as well as environmental and social responsibility. India has witnessed substantial growth of renewable energy technologies in the country during the last two decades. This growth can be attributed to the participation of the private sector, as a consequence of favourable policy frameworks and investment options and opportunities available for such technologies. However, much more remains to be done in harnessing the true potential of renewable in the country. MNRE and other networking agencies are to achieve the targets by 2012 to reduce dependence on fossil fuels, which would result in a clean and green ‘Earth’

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