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Prospects and Challenges of Renewable Energy in India

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Abstract – India is one of the fastest growing economy of the world. But this growth is accompanied with the crisis in the field of energy supplies, environmental control, population increase, poverty and shortage of food and material. Resource limitation today demands their judicial use, which otherwise threatens to its end. Energy is the key indicator of sustainable development. Most of the power generation in India is carried out by conventional energy sources, coal and mineral oil-based power plants which contribute heavily to greenhouse gases emission. India is one of the countries which blessed with numerous renewable energy resources via. Solar power, hydro power, wind power and biomass energy. The demand for renewable energy resources is increasing as it fulfils both the objectives of improvement in environmental conditions and poverty alleviation. Solar energy when considered on human scale is renewable and is environmentally acceptable, but its use is still in primitive stage in many parts of the country mainly because of economic barriers. Likewise, biomass energy is being used in many forms all over the world, but the most needed eco-friendly forms are still in premature stage in most of the world. Research, development, production and demonstration have been carried out enthusiastically in India to find a feasible solution to the perennial problem of power shortage for the past three decades. India has obtained application of a variety of renewable energy technologies for use in different sectors too. This paper attempts to study the present status, challenges and future prospects of renewable energy in India.

Key words: Energy, Renewable energy, Resources, challenges, prospects and potentials.

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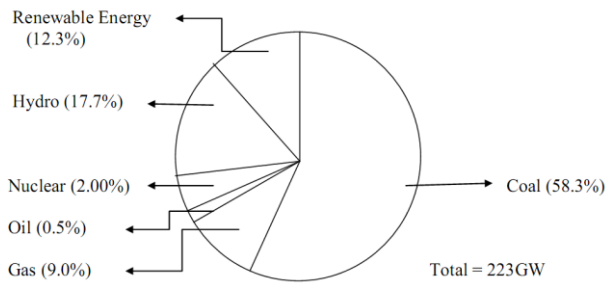
INTRODUCTION

India accounted for one fourth of world's population but is the fifth largest consumer of energy accounting for 4% (approx.) of global consumption. India's energy supply is dominated by coal and largely imported oil. But now days the energy planning of India has changed due to the climate change impact of present consumption pattern and the rising demand for energy.

Break up of installed power generation capacity



(Source: CEA,Ernst and young analysis as on 31st March 2013)

(Figure-1)

The Govt. of India has recognized that development of local, renewable resources is critical to ensure that India is able to meet social, economic and environmental objectives and has supported the development of renewable energy through several policy actions. India's first priority is to ensure a sufficient and stable supply of power by expanding fossil-fuel-based generation and installing new large hydro and nuclear power plants. The renewable energy sources will have two fold impacts, first eliminating the shortage of energy supply and the second to reduce the greenhouse gas (GHG) intensity .The National Action Plan on Climate Change (NAPCC) implemented by Indian Govt. has suggested that 15% of energy could come from renewable sources by 2020. Along with the above initiatives the demand for renewable energy will grow in India due to the following reasons:-

India is a leading country in renewable sources. India has abundant and untapped renewable energy resources including a large land mass that receives among the highest solar irradiation in the world, a long coastline and high wind velocities that provide ample opportunities for both land-based and offshore wind farms, significant annual production of biomass, and numerous rivers and waterways that have potential for hydropower.

Renewable energy provides a security measure for Conventional energy source. The renewable energy sources can be used as a security measure for scarce conventional sources of energy which can

be eliminated due to the huge demand. India's use of its indigenous renewable resources will reduce its dependence on imported expensive fossil fuels.

Reduce Inflation in fossil fuel prices. Increased competition for limited fossil resources is projected to push prices up, while increased deployment of renewable technologies pushes prices down in line with technology improvements and economies of scale. For example, oil prices in 2030 are projected to be 46% higher than in 2010 whereas the investment costs for photovoltaic (PV) systems under solar energy are expected to decrease to less than half of their 2007 levels over the same time period[1].

Solution to Rural Electrification. As a distributed and scalable resource, renewable energy technologies are well suited to meet the need for power in remote areas that lack grid and road infrastructure.

Renewable energy can be supplied to both urban and rural poor. Renewable energy technologies offer the possibility of providing electricity services to the energy poor while addressing India's greenhouse gas (GHG) concerns and goals.

Reduce the Greenhouse Gas Effect. Through its National Action Plan on Climate Change (NAPCC) and its recently announced carbon intensity goal, India has made a commitment to addressing its carbon emissions.

India aims to be a global leader in renewable energy. India's intention to play a leadership role in the emergent global green economy is driving investment in renewable energy technologies. Recognizing the magnitude of the potential demand for renewable energy, India is attracting significant investment in renewable energy.

Reduce the Deficit of Balance of Payment: India is facing an unfavorable balance of payment which can be reduced by substituting the import of oil by developing the new renewable energy sources in the country.

Solution for Gap between Demand and Supply: Due to the industrialization and population increase the demand for energy is ever rising in India. This increased demand can only be served with combination of traditional and renewable sources.

Energy related land degradation and shortage of water: The renewable energy will also help in reducing the land degradation and water shortage problem which is the major drawback of traditional energy generation system.

RENEWABLE ENERGY SOURCES IN INDIA

Renewable energy is derived from natural processes that are replenished constantly. In its various forms, it derives directly from the sun, or from heat generated deep within the earth. Included in the definition is electricity and heat generated from solar, wind, ocean, hydropower, biomass, geothermal resources, bio fuels and hydrogen derived from renewable resources. The country has significant potential of generation from renewable energy sources. All efforts are being taken by Government of India to harness this potential. Following are the main sources of renewable energy in India:

BIOMASS AND BIOGAS ENERGY

The potential to generate power from biomass, as an alternative source of energy in India is to the extent of more than 50% of the total requirement. India is predominantly an agricultural economy, having huge quantity of biomass available in the form of husk, straw, biogases, jute, cotton, shells of coconuts wild bushes etc. Biomass is produced in nature through photosynthesis achieved by solar energy conversion. Biomass means organic matter. In simplest form, the process of photosynthesis is in the presence of solar radiation. An estimated production of 350 million tons of agricultural waste every year, biomass is capable of supplementing coal to the tune of about 200 million tones producing of power. The large quantities of cattle dung can be used in bio energy technologies viz., biogas, gasification, biomass combustion, cogeneration etc., to produce energy thermal or electrical energy.Biomass energy co-generation program is being implemented with the main objective of promoting technologies for optimum use of biomass resources of India. The biomass power generation potential in India is estimated at 30000 MW. Biomass can be used in three ways – gasification, methane gas production and combustion. The technologies being promoted include combustion either for power in captive or grid connected modes or for heat applications

WIND ENERGY

Energy of wind can be economically used to generat electrical energy Wind can also be used to provide mechanical power such as for water pumping. In India generally wind speeds obtainable are in the lower ranges. Therefore, attempts are on the development of low cost, low speed mills for irrigation of small and marginal farms for providing drinking water in rural area. The developments are

being mainly concentrated on water pumping wind mill suitable for operation in a wind speed range of 8 to 36 *kmph*. In India high wind speeds are obtainable in coastal areas of Saurashtra, western Rajasthan and some parts of central India.

SMALL HYDROPOWER

Energy from small hydro is the oldest. It is most reliable of all renewable energy sources. The development of small scale hydropower in India started almost in the pace with the world's first

hydroelectric installation in 1882 at Appleton USA. The 130 KW installations in Sidrapong (Darjeeling) in the year 1897 was the first installation in India. The other installations were Shivasamundram at Mysore (2000 kW), and Bhoorisingh in Chamba (40 kW) in 1902, Galogi at Mussoorie (3000 kW) in 1907, Jubbal (50 kW) in 1911 and Chhaba (1750 kW) at Shimla in 1913. These plants were used primarily for lighting in important towns and are still working. The country an estimated SHP potential of about 15000 MW. The term *'small hydro'* has a wide range in usage. It covers schemes having installed capacities from a few kW to 25 MW. In India small hydro schemes are further classified as; Micro hydro up to 100 kW plant capacity, Mini hydro from 101 kW to 2000 kW and Small hydro up to 25000 kW plant capacities.

SOLAR ENERGY

Solar energy has the greatest potential of all the sources of renewable energy. If only a small amount of this form of energy could be used, it will be one of the most important supplies of energy specially when other sources in the country have depleted energy comes to the earth from the sun. This energy keeps the temperature of the earth above than in colder space, causes current in the atmosphere and in ocean. It causes the water cycle and generates photosynthesis in plants. The Electrical energy can be produced from the solar energy by photovoltaic solar cells. SPV cell converts the solar energy directly to electrical energy. The most significant applications of SPV cells in India are the energization of pump sets for irrigation, drinking water supply and rural electrification covering street lights, community TV sets, medical refrigerators and other small power loads. Sunshine available in India is for nearly 300 days in a year.

OCEAN THERMAL ENERGY

This is also an indirect method of utilizing solar energy. A large amount of solar energy is collected and stored in tropical oceans. The surface of the water acts as the collector for solar heat, while the upper layer of the sea constitutes infinite heat storage reservoir. Thus the heat contained in the oceans, could be converted into electrical energy by utilizing the fact that the temperature difference between the warm surface waters of the tropical oceans and the colder waters in the depth is about 20 - 250K. Utilization of this energy, with its associated temperature difference and its conversion into work, forms the basis of Ocean Thermal Energy Conversion (OTEC) systems. The surface water, which is at higher temperature, could be used to heat some low boiling organic fluid and the vapors of which would run a heat engine. The exit vapor would be conducted by pumping cold water from the deeper regions. The amount of energy available for ocean is replenished continuously.

PROSPECTS OF RENEWABLE ENERGY

Energy requirement is vital component and directly related to the economic growth of a country. Access to energy has become essential to the functioning of modern economics. To alleviate poverty in the face of resource limitations and high population density, India requires an economic growth rate of more than seven percent. Renewable energy has become an important component of India's energy planning process since quite some time. The importance of renewable energy sources in the transition to a sustainable energy base was recognized in the early 1970s. At the Government level, political commitment to renewable energy manifested itself in the establishment of the first Department of Non-Conventional Energy Sources in 1982, which was then upgraded to a full-fledged Ministry of Non-Conventional Energy Sources (MNES) in 1992 subsequently renamed as Ministry of New and Renewable Energy (MNRE). This is the one of its kind Ministry in the world. MNRE is the nodal Ministry of the Government of India at the Federal level for all matters relating to new and renewable energy. The Ministry has been facilitating the implementation of broad spectrum programmes including harnessing renewable power, renewable energy to rural areas for lighting, cooking and motive power, use of renewable energy in urban, industrial and commercial applications and development of alternate fuels and applications. In addition, it supports research, design and development of new and renewable energy technologies, products and services. Ministry of New and Renewable Energy has ambitious programmes for deployment of off-grid/ distributed renewable power apart from the grid interactive renewable power and decentralized renewable energy systems for rural applications. Extension programmes of the Ministry are largely implemented through the State Renewable Energy Development Agencies. These agencies, in turn, mobilize participation of the State level machinery, local institutions, Non- Governmental Organizations (NGOs) and village level organizations for implementation of these programmes. However, the Ministry is trying to open out more channels to broaden the move in reach and help market mode through other partners. MNRE has set up a Solar Energy Centre near Delhi with the state-of-art facilities for testing of solar thermal and solar photovoltaic materials, devices and systems. This will soon become an apex Centre of Excellence. It also does applied research and training. A Centre for Wind Energy Technology has been set up in Chennai for providing technical support to the Ministry in the implementation of its wind energy programmes. Research and Development programmes are sponsored in research institutions, national laboratories and in industries, both public and private sectors. For market development and financing of renewable energy projects, a separate financing institution called the Indian Renewable Energy

Development Agency (IREDA) has been set up as a public sector undertaking. It is perhaps one of the only institutions of its kind in the world which provides institutional finance exclusively in the field of renewable and energy efficiency.

In view of the fast changing energy scenario both at domestic and international level and the important role expected to be played by new and renewable energy sources, it will be essential to introduce comprehensive, stable and long-term support policies, carefully designed programmes to ensure that they operate in harmony with existing state level mechanisms so as to avoid reducing their effectiveness. The following table gives a detail of various renewable energy sources in India.

Table-1

Potential and Installed Capacity of Renewable Energy in India

Resource	Estimated Potential (GW)	Installed Capacity (GW)
Wind	102.8	19.1
Small Hydro	19.7	3.6
Bio Power	22.5	3.6
Solar Power (Billion GWH)	6.0	1.7

(Source- MNRE, Installed Capacity at end March 2013)

Table-1 indicates the potential and installed capacity of various renewable sources in India. It states that India has a large potential of wind energy which is 102.8GW but the installed capacity of wind energy is very less only 19.1GW. Likewise the small hydro energy has the potential of 19.7GW but installed capacity of only 3.6GW. Bio power has potential of 22.5GW and installed capacity of only 3.6GW.India also has 6.0GW potential capacity and 1.7GW installed capacity of solar energy. It indicates that a very small part of these resources has been utilized and there India has vast renewable sources to explore.

Table-2

Renewable Energy Actual Installations and Target

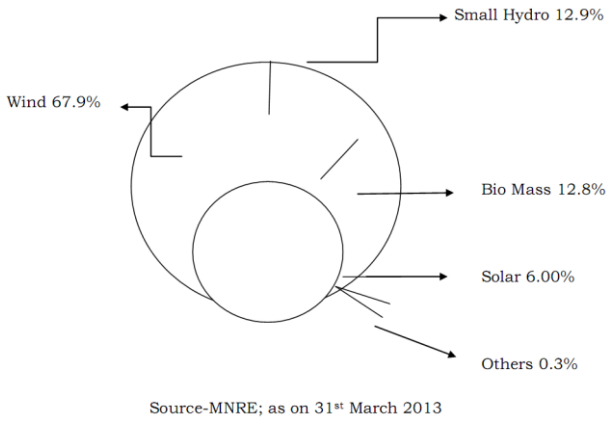
Renewable Energy	2010-11		2011-12		2012-13		2013-14	
	Target (MW)	Actual (MW)	Total (MW)	Actual (MW)	Total (MW)	Actual (MW)	Total (MW)	Actual(MW) As on 30.06.13
Wind Power	2000	2350	2400	3197	2500	1699	2500	512
Small Hydro	300	307	350	353	350	237	300	54
Bio-Power	472	474	475	488	475	472	425	_
Solar Power	200	27	200	905	800	754	1100	75
Total	2972	3157	3425	4943	4125	3162	4325	640

(Source:MNRE)

Table-2 depicts the target and actual installed capacity in 2010-11, 2011-12,2012-13 and 2013-14. It indicates that in 2010-11 the actual installed capacity is more than the projected targets for all the renewable energy sources except the solar power, in which actual installations are very much less then the target. In 2011-12 also the exceeding trend was shown by actual installed capacity much higher in solar power. But in 2012-13 the targets are not achieved, the installed capacity was lesser than the targets for all the sources.

It is clear from Table-1 and Table-2 that India has hardly exploited the renewable energy potential which exists in the country. Renewable energy potential is likely to be even greater considering that sources with significant generation capacity such as off-shore wind farms are yet to be mapped. In sectors such as wind and small hydropower, application of the latest developments in engineering design and equipment technology are also likely to increase potential, as are the discovery of new small hydro power sites. The potential for solar power will also increase significantly as technology improves.

Installed Capacity of Renewable Energy in India



Source-MNRE; as on 31st March 2013

(Figure-2)

India has great potential to accelerate the use of its endowed renewable resources to power its growing economy with a secure and affordable energy supply. The Government of India recognizes that development of local, renewable resources is critical to ensure that it is able to meet both its economic and environmental objectives, and it has promoted this development through policy action. The Indian economy has experienced tremendous growth over the past several years. Energy, in all its forms, underpins both past and future growth. For the Indian economy to continue this trajectory, India needs to address its energy challenges, which cross all sectors and impact all citizens. Electricity—both in terms of quality and access—is a key challenge.

CHALLENGES OF RENEWABLE ENERGY

More Ambitious Plans: The National Government's ambitious goals for solar energy coupled with the country's rapid progress in developing wind energy raise many questions regarding the sources and costs of the investment that will be needed to install and operate this infrastructure. The ambitious targets for 4,000-10,000 MW by 2017 and 20,000 MW by 2022[9] under the Jawaharlal Nehru National Solar Mission grid-connected solar PV may be hard to achieve under current policies and programs, and financing may be the biggest o Likewise, with 16 GW installed capacity of wind energy, India had already become the world's fifth largest market for wind by 2011, but ambitious plans for a further expansion to 31 GW by 2017 will face similarly daunting policy and financing problems.

Financial Problem: The high cost of debt — that is, high interest rates — is the most pressing problem currently facing the financing of renewable energy. Our financial modeling of actual renewable energy projects in India and elsewhere indicates that the higher cost and inferior terms of debt in India may raise the cost of renewable energy by 24-32% compared to similar projects financed in the U.S. or Europe[10]. General Indian financial market conditions are the main cause of high interest rates for renewable energy. Growth, high inflation, competing investment needs, and country risks all contribute. A shallow bond market and regulatory restrictions on foreign capital flows also adds to the problem, while the cost of currency swaps and country risk negate the advantages that could come from access to lower cost foreign debt. Continued high borrowing by the Government of India and related regulatory restrictions are likely to keep interest rates high.

Regulatory Problems: Regulation and the structure of the Indian power sector also raise significant issues. State-level policies – including the financial weakness of the state electricity boards that buy much of the output from renewable generators – increase project risk. Absence of conducive policy and regulatory framework in some states also posed some problems in implementation of plan regarding generation and distribution of renewable energy.

Low productivity and Low Capacity Utilization: In India the installed plants of renewable energy have very low productivity as compared to productivity of fossil fuel based plants. Moreover the total installed capacity of renewable energy is not fully utilized.

Technology related Problem: India do not have access to modern technology of power generation which creates obstacle in exploring the potential of renewable energy.

General difficulties in servicing and maintenance in remote areas where the renewable energy systems are installed as well as grid synchronization limitations on account of intermittent nature of supply. Inconvenience of use of certain renewable energy based applications vis-à- vis conventional means, quality and reliability of equipment–particularly for decentralized applications, lack of availability of adequately skilled, technical manpower, lack of adequate transmission infrastructure in states for evacuation of renewable power, lack of implementation infrastructure and general lack of awareness of end-users also imposed certain challenges to renewable energy.

CONCLUSION:

India has great potential to accelerate the use of its endowed renewable resources to power its growing economy with a secure and affordable energy supply. The Government of India recognizes that development of local, renewable resources is critical to ensure that it is able to meet both its economic and environmental objectives, and it has promoted this development through policy action. The Indian economy has experienced tremendous growth over the past several years. Energy, in all its forms, underpins both past and future growth. For the Indian economy to continue this trajectory, India needs to address its energy challenges, which cross all sectors and impact all citizens. Electricity—both in terms of quality and access—is a key challenge.

India already has experienced with sustainable energy projects and certain renewable energy project approaches. Though these initiatives are at initial stage of development and implementation, the potential of these initiatives is high. There are many possible ways in which these goals can be carried out in India: through combinations of different renewable technologies, grid based generation and micro-renewable and energy efficiency; develop, demonstrate and commercialize technologies for harnessing new and renewable energy sources in close concert with corporate, scientific and technical institutions, replace use of different fossil fuels wherever possible in even greater quantities, and increase access to electricity/ lighting in all remote and rural areas where it is needed, through Renewable Energy Systems, increase the contribution of renewable power in the total installed power generation capacity of the country from 16 per cent to about 18 per cent by 2022, with 7.3 per cent contribution to electricity mix. This would require an achievement of about 13% over the already ambitious targets proposed.

In India, diffusion of renewable energy technologies has gained momentum in recent years via evolution of relevant policies, institutional facilitation and learning-by-doing experience. Sustainable energy development agency (SEDA) will coordinate activities related to the development of renewable energy technologies and financing mechanisms in the

country. India has got ample solar insolation throughout the country. There is intense prospect of solar photovoltaic and solar thermal systems in the rural as well as urban areas of the country. Jawaharlal Nehru National Solar Mission (JNNSM) is expected to provide more valuable information regarding solar energy potential for larger projects in India. Grid connected renewable energy power would be dependent upon cost reduction and greater efficiency. Therefore, improvements in technologies and applications, particularly for solar power are very important. India consists of diverse potentials of biomass and biogas energy. Many wasteto- energy projects have proven budding applications of biomass and biogas which will not only provide electricity, but also reduce the unpleasant waste disposal problems of metropolitan cities of the country. There is limited potential of small hydro power plants in country. It is expected that country's peak demand will rise to 3,35,000 MW by 2017 and there is an urgent need to build up its energy infrastructure fast enough to keep pace with the economic and social changes and to ensure sustainable GDP growth and access to electricity for all. Further, there is an urgent need for transition from petroleum based energy systems to renewable energy resources to decrease reliance on depleting reserves of fossil fuels and to cope with climate changes. Mainstreaming of renewable is very essential. Energy security, economic growth and environment protection are the national policy drivers of any country of the world. The need to boost the efforts for further development and promotion of renewable energy sources have been felt in India because of high price of crude oil.

It is felt that the scenario in 2016-17, when 12th plan ends, will be quite different. There would have been further technological improvements and, hopefully, cost reduction in solar; oil prices prevailing at that time are unknown and could have increased substantially; environmental concerns and other factors may limit further thermal power generation expansion. Therefore, opportunities and needs for Renewable Energy could increase manifold and cost economics and imperatives change which would then require new strategies and policies.

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