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RENEWABLE ENERGY IN INDIA: DEVELOPMENT AND PROSPECTS

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Development of renewable energy is of great importance in India in the backdrop of ever increasing demand for energy excessive dependence on oil imports and mounting deficits in Balance of Payments, volatility in oil prices, depleting fossil fuel reserves, threatening energy security and climate change resulting from increasing emissions of Green House Gases (GHG). The growth rate of energy consumption has exceeded the growth rate of production of energy. Development of renewable energy can be a solution to these problems. Renewable energy was in use in India since the age old times although not commercially. Now efforts are being made to utilize it to the fullest extent. This paper deals with the nature and level of development of renewable energy in India. It examines the nature of India's energy problem, development of renewable energy, potentials, investment in renewable energy, and the factors responsible for slow diffusion of renewable energy across the country, measures taken by the government to promote renewable energy and the major challenges ahead.

INTRODUCTION

Energy is one of the important inputs of economic growth. The availability of energy and its quality determines the nature and speed of growth of an economy. Energy is the prime mover of economic growth, and is vital to sustaining a modern economy and society for any country across the world[1]. But India is facing huge bottlenecks in energy supply. Although the utilization of energy resources is becoming more efficient and new reserves are being explored the supply of energy lags behind the mounting requirements stemming from rising population, industrial development and improvement in standard of living. Exhaustible nature of fossil fuels is threatening energy security and sustainable development. Optimal utilization of fossil fuels and development of renewable energy are the only options to achieve inter generational equity in energy use and sustained growth of the economy. Efforts are being made at the global level in order to promote renewable energy technologies. India, being rich in natural resources has a huge potential of renewable energy and is playing a significant role in development of renewable energy. India's efforts to achieve strides in diffusion of renewable energy assumes much importance since it is one of the largest emerging economies in the world and its efforts and achievements can influence the activities of the developing as well as developed countries and may also help in reducing the growth rate of global GHG emissions. This paper deals with the nature and level of development of renewable energy in India. It examines the nature of India's energy problem, development scenario of renewable energy, potentials, the factors responsible for slow diffusion of renewable energy across the country and the major challenges ahead.

The paper is based on secondary data taken from various national and international reports, CDM pipeline database and the website of the Ministry of New and Renewable Energy. It is divided into 4 sections. Section 1 deals with India's Energy problem and projections. Section 2 deals with the development of renewable energy in India. Here focus is made on the current status and potentialities. Section 3 examines the investment prospects and the steps taken by the government

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in renewable energy sector. Section 4 points out the major challenges in the path of development of renewable energy in India.

INDIA'S ENERGY PROBLEM AND PROJECTIONS

India has been in the grip of energy crisis since 1973 when the oil exporting countries suddenly increased the oil prices manifold. There were frequent oil shocks. Importing oil for India's ever increasing needs is eating away its foreign exchange resources. Planning Commission noted that primary commercial energy demand has grown at the rate of six per cent between 1981 and 2001[2]. Commercial primary energy consumption in India has grown by about 700% in the last four decades. As per the Report of the Expert Committee on Integrated Energy Policy appointed by the Planning Commission of India published in 2006, India needs to sustain an 8-10% economic growth rate, over the next 25 years in order to eradicate poverty and meet its human development goals. It will need to increase its primary energy supply by 3 to 4 times, and electricity generation capacity by 5 to 6 times (2003-04 levels) if it is to meet the energy needs of all its citizens by 2032 and maintain an 8 percent GDP growth rate. The commercial energy supply needs to grow at 5.2- 6.1 percent per annum and total primary energy supply at 4.3-5.1 percent per annum over the next few years. This implies a four-fold increase in India's energy requirement over the next 25 years. Despite a continuous increase in total installed capacity the gap between supply and demand has continued to rise because of growing population, urbanization, industrialization and high incomes. Table 1 shows the projected primary energy and electricity requirements.

Table 1

Total Primary Energy Requirement (Mtoe) and Electricity Projections

Energy (Mtoe)				Electricity (GW)	
Year	Conventional	Non Conventional*	Total	Peak Demand	Installed Capacity Required
2011-12	496	169	665	158	220
2016-17	665	177	842	226	306
2021-22	907	182	1089	323	425
2026-27	1222	184	1406	437	575
2031-32	1651	185	1836	592	778

* Includes household requirements and consumption by small industries

Note: Data are projected at 8% GDP growth rate.

Source: Integrated Energy Policy Report, Government of India, 2006

As against this India had estimated coal reserves of 286 billion tones, lignite reserves of 41 billion tones, crude oil reserves of 757 million tones and natural gas reserves of 1241 billion cubic meters as on 31st March, 2011. The Compounded annual growth rates of fossil fuel based energy is given in table 2.

Table 2

Compounded Annual Growth Rates (CAGR) of Conventional Energy In India (1970-71 to 2010-11)

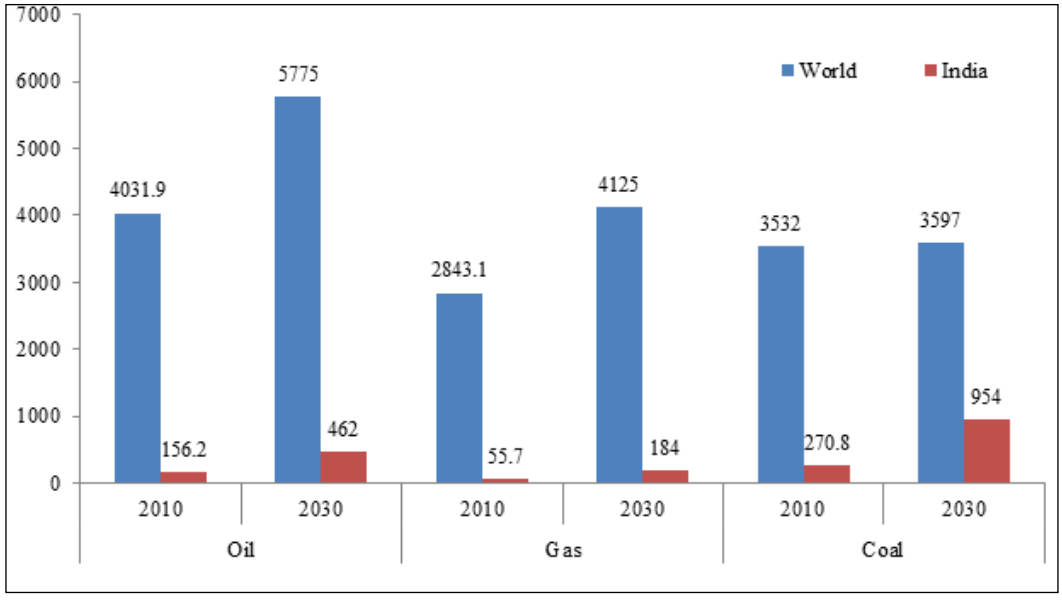
Source	Production (%)	Consumption (%)
Coal*	4.97	5.3
Lignite*	6.05	6.05
Crude Oil*	4.26	6.07
Natural Gas**	9.14	11.25

* million tones, ** Billion Cubic Meters

Source: Energy Statistics, 2012.

It is clear that growth rate of consumption has exceeded the growth rate of production of energy between 1970-71 and 2010-11. The share of India in global energy consumption is also expected to increase rapidly (Figure 1).

Figure 1. India's Share in Global Energy Consumption (Mtoe)



Note: Data for 2010 are actual, for 2030 are projected.

Source: BP Statistical Review of World Energy 2012

India's Per Capita Energy consumption has registered a CAGR of 3.44% during 1970-71. India's CO_2 emissions have increased about ten times during the period 1965-2011. During the same period fossil fuel consumption also increased about ten and half times. Data pertaining to fossil fuel consumption and CO2 emissions during 1965-2011 show a strong positive correlation of 0.99. Environmental problems associated with energy use have become severe in many urban areas. Concentration of pollutants is above safe limit in most of the cities. In this context development and

diffusion of renewable energy is highly relevant in India. Renewable energy sources offer viable option to address the energy security concerns of the country.

Under the New Policies Scenario of the World Energy Outlook (2011), total power capacity in India would reach 779 GW in 2035. To reach 779 GW in 2035, capacity must grow at a CAGR of 5.9 percent, or over 20 GW per year from 2009 through 2035. The largest addition per year up to now was nearly 18 GW during fiscal year 2011-2012; this scale of expansion could pose a challenge for the government (IEA, 2012) without a significant role for renewables[3].

RENEWABLE ENERGY IN INDIA-DEVELOPMENT AND POTENTIALS

The use of renewable energy is not a new concept for India. It was in use since the age old times although not commercially. People used it in a traditional way. Solar energy was used for drying clothes, grains etc, wind energy was used for grinding grain and sawing wood by windmills, and boats. The concepts of solar, wind, bioenergy and tidal energy used today are entirely modern and are capable of commercial application. India has high potential for generation of renewable energy from various sources- wind, solar, biomass, small hydro and cogeneration bagasse. But its utilization is still in its initial stages. Renewable energy sources contribute over 30% in India's primary energy supply. According to BP statistical review of world energy in 2010 share of renewable energy excluding hydro energy in total primary energy was only 0.02%. As per the annual report of the ministry of new and renewable energy renewable energy has started making visible impact in the Indian energy scenario. It contributes about 12% in the national electric installed capacity. The total potential for renewable power generation in India as on 31.03.11 is estimated at 89762 MW out of which wind power potential is 55%, small-hydro power potential is 17%, biomass power potential is 20% and power from bagasse-based cogeneration in sugar mills is about 6%. Across the states Gujarat has the highest share of about 14% (12,489 MW), followed by Karnataka with 12% share (11,071 MW) and Maharashtra with 11% share (9596 MW), mainly on account of wind power potential.

Installed generating capacity of electricity from new and renewable sources was 18.45GW i.e. about 11% of total Installed Generating Capacity of Electricity (Utilities). The total installed capacity of grid interactive renewable power has gone up to 19971 MW and thus witnessed a growth of 18.75% over 2010. Out of the total installed generation capacity of renewable power as on 31-03-2011, wind power accounted for about 71%, followed by small hydro power (15.2%) and Biomass power (13.3%). Among the states Tamil Nadu had the highest installed capacity of grid connected renewable power (6500 MW) followed by Maharashtra (3005 MW) and Karnataka (2882 MW). Out of total Biogas plants installed (41.98 lakh) maximum number of such plants were in Maharashtra (8 lakh) followed by Andhra Pradesh, Uttar Pradesh, Karnataka and Gujarat each with about 4 lakh biogas plants. Out of about 6.6 lakh Solar Cookers installed 1.7 lakh were in Gujarat and 1.4 lakh were in Madhya Pradesh. There were 1,352 water pumping Wind mills systems installed and 6,975 remote villages and 1,871 hamlets were electrified by March 2011.

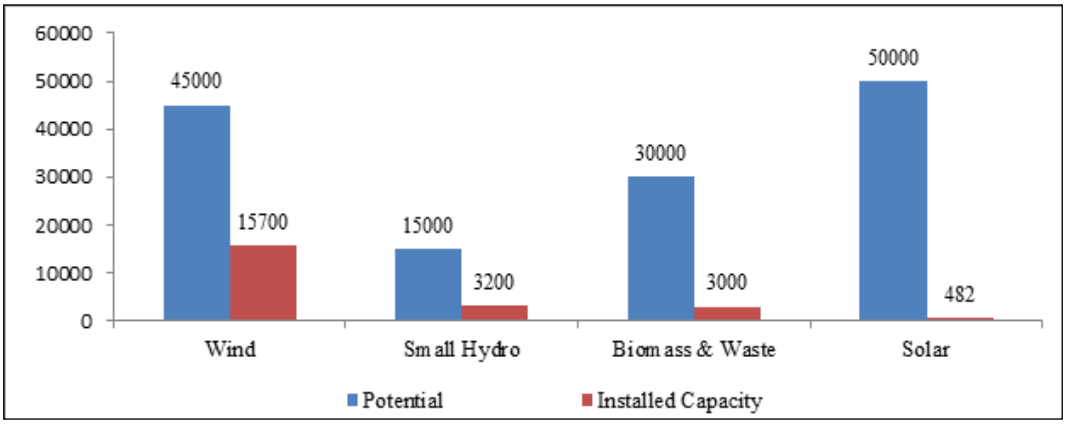
Wind power dominates India's renewable energy industry accounting for around 70 percent of the installed generation capacity from renewable sources. With an installed capacity of 18420 MW, India is the world's fifth largest producer of wind power after China, USA, Germany and Spain. It has an estimated potential of 45000 MW. During the fiscal year 2011-2012 wind energy alone delivered over 3GW to India's new installed capacity, accounting for over 16.5 percent of total new installed

capacity. More than 95 percent of the nation's wind energy development is concentrated in just five states in southern and western India – Tamil Nadu, Andhra Pradesh, Karnataka, Maharashtra and Gujarat. These five states accounted for over 85% of the total installed capacity at the end of the last plan period. Rajasthan is another emerging State with rising wind turbine installations.

Solar energy has the highest potential in India of about 50,000 MW of which most remain unutilized. Only 10% of biomass is exploited. The total installed capacity of small hydro power projects as on March 31, 2012, was 3200 MW. Figure 2 shows the potential and installed capacity of renewable energy sources.

Figure 2. Potential and Installed capacity of Renewable Energy Sources

(In the year 2011 in Mega Watts)



Source: www.mnre.gov.in

Prospects of Renewable Energy in India

Indian renewable energy programme is mainly private sector driven. New investment in renewables has now exceeded US $10 billion per year. Indian renewable energy market is the most developed in south Asia. Foreign Derect Investment upto 100% is allowed under the automatic route and can set up a wholly-owned subsidiary. Foreign investors are allowed to set up renewable-energy-based power projects on Build-Own-Operate (BOO) or a Build-Own-Transfer (BOT) basis. Investors are allowed to bring in funds directly, incorporate an Indian company, or allot shares to foreign investors.

India aims to increase the capacity to generate renewable energy by 40GW to 55GW by the end of the 13th Five-Year Plan (2022). The National Action Plan on Climate Change (NAPCC) has set the ambitious goal of a 1 percent annual increase in renewable energy generation. Meeting this goal may require 40–80GW of additional capacity in renewable energy capacity by 2017.

Solar Energy

Due to its geographical location India receives a high intensity of solar radiation. Most parts of India have 300 – 330 sunny days in a year, which is equivalent to over 5000 trillion kWh per

year. This is more than India's total energy consumption per year. The potential of the solar thermal sector in India also remains untapped. The Jawaharlal Nehru National Solar Mission launched in January, 2010 has set the ambitious target of deploying 20,000 MW of grid connected solar power by 2022. It aims to achieve grid tariff parity by 2022 through large scale utilization, rapid diffusion and deployment at a scale which leads to cost reduction, R&D, domestic production of critical raw materials, components and products, Pilot Projects and Technology Demonstration, local manufacturing and support infrastructure. Renewable energy is seen as the next big technology industry in India. The ministry of New and Renewable Energy has proposed an additional 500 MW generation during the Phase-I of the Jawaharlal Nehru National Solar Mission (JNNSM). Mission's road map is shown in table 3.

Table 3

Road Map of JNNSM

Application Segment	Phase I (2010-13)	Phase II (2013-17)	Phase III (2017-22)
Grid solar power	1100 MW	4000-10000 MW	20000 MW
Off-grid solar Applications	200 MW	1,000 MW	2,000 MW
Solar Thermal Collectors	7 million sq meters	15 million sq meters	20 million sq meters
Solar Lighting System	5 million	5 million	20 million

Source: www.mnre.gov.in

Wind Energy

Historically, wind energy has met and often exceeded the targets set for it under both the 10th Plan (2002-2007) and 11th Plan (2007-2012) periods[4]. India is implementing the world's largest wind resource assessment programme (WRA), an ongoing activity, which is being implemented by the Centre for Wind Energy Technology (C-WET), Chennai in association with State Nodal Agencies. WRA has so far covered 31 States and Union Territories involving establishment of about 696 automated wind monitoring stations. 92 wind monitoring stations were under operation as on 31.12.2012. 35 new wind monitoring stations have been commissioned in various States under Ministry's Wind resource Assessment programme during the year 2012-13. Wind energy is the fastest growing renewable energy technology for generating grid connected power amongst various renewable energy sources. Wind power is a mature and scalable clean energy technology where India holds a domestic advantage. India has an annual manufacturing capacity for over 9.5 GW of wind turbines today. Government's wind power programme covers survey and assessment of wind resources, facilitation of implementation of demonstration and private sector projects through various fiscal and promotional policies. A package of incentives which includes fiscal concessions such as 80% accelerated depreciation, concessional customs duty for specific critical components, excise duty exemption, income tax exemption on profits for power generation are available for wind power projects.

Biomass

India is in the fourth position in generating power through biomass. With a huge potential, India is poised to become a world leader in the utilization of biomass. Biomass resource potential is assessed at 500 MT/year and about 30% of the same or about 150 MT/annum is estimated surplus

biomass availability creating a potential of about 18,000 MW electricity generation. Biogas is mainly used in rural India based on cattle manure, vegetable wastes and agricultural residues. Biomass power generation in India is an industry that attracts investments of over Rs. 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. Biomass gasifier programme promotes electricity generation using locally available biomass resource in rural areas where surplus biomass such as wood chips, rice husk, arhar stalks, cotton stalks and other agro residues are available. National Biogas and Manure Management Programme was launched to set up family type biogas plants for meeting cooking energy needs in rural areas and to make available enriched biofertiliser. Government has also started a scheme 'Biogas based Distributed/Grid Power Generation Programme' from 2005-06 to promote biogas power generation, especially in the small capacity range based on the availability of large quantity of animal waste and wastes from forestry/rural based industries (agro/food processing), kitchen wastes etc. Biomass Gasifiers are now being exported not only to developing countries of Asia and Latin America, but also to Europe and USA. During 2012-13, Punjab, Maharashtra, Uttara Pradesh and Gujarat took a lead in biomass energy generation.

Small Hydro Power

Hydro power projects of less than 25 MW capacity are considered as small hydro projects in India. The estimated potential for power generation from these projects is 19749 MW out of which about 50% lies in the states of Himachal Pradesh, Uttarkhand, Jammu and Kashmir and Arunachal Pradesh.

Apart from these, India has reasonably good potential for geothermal. The potential geothermal provinces can produce 10,600 MW of power. A programme on tidal energy has been implemented to harness about 8,000 to 9,000 MW of estimated tidal energy potential for power generation.

Investment And Technological Transfer

There is vast scope for investment and technology transfer in renewable energy sector. Asian Development Bank, Multilateral and bilateral agencies like the World Bank group, Global Environment Facility (GEF), national institutions, NGOs, and private companies are the major investors in RETs. Renewable energy investment in India jumped from $1.3 billion to $3.0 billion and witnessed a CAGR of 19% during 2004-10. In attracting investments India is next only to China among BRIC countries. In 2010, investment in wind energy stood at $2.6 billion, solar energy at $0.5 billion and biomass $0.6 billion (UNEP 2011) India is the 4th largest country with regard to installed power generation capacity in the field of renewable energy sources. India ranks 4th in Ernst & Young Renewable Energy Country Attractiveness Indices (2011). Investment and technology transfer is also taking place through Clean Development Mechanism (CDM) envisaged by the Kyoto Protocol. India has about 29.7% CDM projects in Asia. Most of the projects are in sectors like energy efficiency, fuel switching, industrial processes, municipal solid waste and renewable energy. India has the second highest number of wind power projects registered under the CDM. According to CDM pipeline database 810 wind CDM projects with 13861 MW capacity and 130 solar CDM projects with 1491 MW capacity are in the pipeline in India**.**

For promotion and popularization of Renewable Energy and Energy Conservation in the states of India, state nodal agencies have been set up in different states to promote renewable energy and energy efficiency. These are working under the Ministry of New and Renewable Energy.

Indian Renewable Energy Development Agency Ltd. (IREDA) was established in 1987 as Non-Banking Financial Company under the administrative control of the Ministry of Non-Conventional Energy Sources (MNES) to provide term loans for renewable energy projects. Subsequently energy efficiency and energy conservation projects were added to its portfolio. The government has issued guidelines to all state governments for creation of an attractive environment for evacuation and purchase, wheeling and banking of electrical power from renewable energy sources. It provides financial incentives such as incentives and capital subsidies for renewable energy programmes. Concessions like capital subsidies, exemption from taxes and duties are being given to industrial units. Infrastructural facilities are being provided. A five year tax holiday is allowed for renewable energy power generation projects. Foreign investors can enter into a joint venture with an Indian partner for financial and/or technical collaboration and also for setting up of renewable energy based Power Generation Projects.

The Challenges

A study conducted by World Bank in 2010 points out some specific barriers for solar energy. They include policy and regulatory barriers relating to long term planning, clarity in policy guidelines, bankability of power purchase agreements etc, infrastructural barriers relating to the approval process and single window clearance to developers, land constraint, solar radiation and data related barriers, technology and financing barriers. The study also revealed the ways of addressing these barriers like making the power purchase agreements bankable, ascertaining the minimum and maximum capacity to be developed on the prior installation experience, removing the domestic content criterion, enabling single window clearances, greater involvement of state nodal agencies etc. It also suggested that a single government or semi-government financing agency to act as the focal point for all applications to be processed. Indian solar energy sector is also facing the problem of cheap imports from foreign solar manufacturers, primarily from China. Indian solar Industry is relatively modern and hence of relatively small scale and fragmented, leading to higher production costs. Renewable-energy resources are not evenly spread across the country and the high cost of renewable energy generation discourages local distribution companies from purchasing more than their obligatory amount of renewable generation. To address the imbalances and encourage renewable energy capacity addition in states with untapped renewable energy potential, the Central Electricity Regulatory Commission (CERC) promulgated a regulation creating renewable-energy certificates in January 2010 according to which renewable energy generators who register with CERC will have the option either to sell power at a preferential tariff set by their State Electricity Regulatory Commission or to sell the power and its associated environmental benefits in the form of renewable-energy certificates. The certificates can be sold in Central and State electricity regulatory commissions-approved exchanges to entities needing them to meet their Renewable Power Purchase Obligations, thus creating a national market for such generators to recover their costs. The trading started in January 2011.

According to Global Wind Energy Council inadequate grid infrastructure is one of the barriers for wind energy. Across most of the states with significant wind potential, the grid does not have sufficient spare capacity to be able to evacuate ever-increasing amounts of wind power. Hence the state distribution utilities are reluctant to accept more wind power generation. There is an urgent need to augment general grid capacity. Better forecasting of power demand and modernization of the grid is needed. In most of the states, availability of land for wind farms is a contentious issue. There are problems associated with conversion of land use status from agricultural to nonagricultural,

obtaining clearance for the land close to a protected area or forestlands. Another barrier to the growth of the wind sector is inordinately high borrowing costs.

Small hydro projects encounter the same problems of deforestation and resettlement as big projects.Some of the common barriers relate to the pricing rules, high capital costs, uncompetitive technologies, lack of capital, hidden subsidies to fossil fuels, insufficient infrastructure, lack of supporting institutional structure, lack of initiative and low level of awareness etc. Government should give tax rebates, tax relief and incentives, lower interest rates and provide easy access to credit, fix emission targets and encourage public private partnership, strengthen infrastructural facilities and encourage research and development in this field.

CONCLUSION

Renewable Energy Sector has a bright future and tremendous job creation potential in India. Targets have been fixed for the states for uptake of electricity from renewable energy sources. Appropriate policy framework is necessary to address various constraints and thereby create opportunities for business to fulfill the objectives of power generation from renewable sources. Policies should address promotion of innovative delivery models, structured training programmes to create skilled personnel, innovative designs and loan schemes, effective monitoring and evaluation frameworks, creating fiscal and policy incentives to enhance public and private sector participation, and their mainstreaming with the global markets, creating decentralized manufacturing and service. Focus should be given on mechanisms to attract private and international finance. Supporting domestic project developers and manufacturers through innovative finance options and international cooperation is beneficial.

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