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A STUDY OF RENEWABLE ENERGY'S POTENTIAL CONTRIBUTION

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ABSTRACT

Renewable energy's contribution to the global heat, power and transport sectors has increased steadily. While growth in renewal's share of total energy use has been moderated by increases in both population and world energy demand—most notably in developing and emerging economies renewable energy markets and technology developments have accelerated quickly, even when compared to other rapidly developing technologies such as mobile phones. Although the last decade has seen tremendous advances in the electricity sector, the renewable heating and cooling sector has lagged behind. This is despite the marked growth since 2004 in the use of geothermal, solar thermal, and biomass heating technologies for water and space heating, process heat, and cooling. Given that the share of heating and cooling in final energy demand is much larger than that of electricity, fostering growth of renewable energy in this sector is crucial. In the transport sector, the use of renewable energy in the form of bio fuels grew at a rapid pace for much of the past decade. Biodiesel production increased twelve-fold, ethanol production, already at a higher starting point, grew three-fold. Over the same period, a small but growing use of gaseous biofuels in transport emerged, as well as initiatives to link renewable energy with electric transport. The evolution of renewable energy over the past decade has surpassed all expectations. Global installed capacity and production from all renewable technologies have increased substantially, and supporting policies have continued to spread to more countries in all regions of the world.

KEYWORDS: *Renewable energy's, contribution, heat, power, growth, development, technology, electricity sector.*

INTRODUCTION: Energy is a critical input for economic growth and sustaining development processes. Over one-third of the world's population, largely consisting of the poor in rural areas of developing countries does not have access to electricity. It is estimated that a new power plant would need to be added every two days to meet the

increasing global energy demand. This, however, is clearly an unsustainable proposition, and only emphasizes the urgent necessity for developing energy technologies that are environmentally sound, socially acceptable, and economically viable. Lack of access to affordable energy is an important factor contributing to the relatively poor quality of life in rural areas of developing countries. The potential markets of the rural poor are characterized by a high demand for energy for purposes such as lighting, cooking, space heating in the domestic sector; water lifting and transportation in agriculture; and small and medium enterprises. Biomass energy is the local energy available for meeting the minimum rural needs of cooking. Though the contribution of biomass sources in the overall energy scenario is gradually decreasing, it still contributes over 40% of the energy supply in the country. Sixty-five per cent of the biomass energy in the rural areas is apportioned to fuelwood, 20% to agricultural waste and 15% to cow dung. With the increasing use of commercial sources of energy there has recently been a substantial shift towards commercial sources.

As such, the future projections for energy in India do not show a proportionate increase in the fuelwood consumption with the rising population. It is difficult at this stage to predict the shift in the fuel-mix but it is clear that shift is taking place. Also, in view of global energy policy considerations, the final form of energy is more important than the primary form. Therefore, there has been a major thrust on how fuelwood and other sources of energy can be converted into desirable form, thereby making the primary sources of energy of secondary importance. This change is gradual but quite perceptible. The Government of India has focused attention on governance at the rural level through Panchayats, the body of elected members of the public. The Panchayats have also been assigned certain development tasks as laid down in the Eleventh Schedule of the Constitution of India. Social forestry and farm forestry, along with land improvement, implementation of land reforms, land consolidation and soil conservation, fuel and fodder, and non-conventional energy sources are the responsibility of the Panchayats. It is necessary to have a look at the energy policy and rural energy planning efforts made in India, as well as the ongoing programs, to consider how the biomass production can be better managed and regularized through local governance systems.

REVIEW OF LITERATURE: Today most of the world's energy is derived from conventional sources-fossil fuels as coal, oil, and natural gases. Electricity generated from fossil fuels such as coal and crude oil has led to high concentration of harmful gases as carbon-di-oxide, carbon-mono-oxide, sulphur-di-oxide etc in the atmosphere. Also the sources of fossil fuel in the earth are finite and will be depleted in few years. Most recent method to generate electric power is an auto mic reactor. All these conventional sources of energy has caused more environmental damage than any other human activity.

Therefore, alternative sources of energy have become more important for the future

world. The alternative sources of energy are called Renewable Energy System. A Renewable Energy System converts the energy found in Sunlight, Wind, Falling-water, Sea-waves, geothermal heat, or Biomass into a form we can use such as heat or electricity. Most of the Renewable energy comes either directly or indirectly from Sun and Wind and can never be exhausted, therefore they called Renewable.

India receives 5000 trillion Kwh of Solar radiations per year. Most part of the country has 300 clear sunny days in a year. So in India alone it is possible to generate 20 MW Solar power per square kilometer area.

INDIAN RENEWABLE ENERGY SITUATION: In this section, Indian Renewable situation is examined with respect to its scope, potential, achievements and economics of renewable energy resources. Further this section deals with the rural energy policy issues with the help of numerical and theoretical experiences.

Renewable Energy Scope: A renewable energy source is environment friendly and reduces chemical, radioactive and thermal pollution. Renewable sources of energy such as solar energy are economically feasible in small scale applications in remote areas or villages (where there is no electricity) or in large scale applications in areas where the resources are abundant. The Renewable energy or the non-conventional energy sources are Sun, Wind, Falling- water, Sea-waves, Geothermal energy, method of co-generation etc. It is expected that 60% of all the energy will come from Renewable energy up to year 2070. The world Solar summit, world Solar Decade and the World Bank has recently allocated huge money to the projects dealing with Renewable Energy. World organizations as UNDP, UNISO, UNIDB etc US Department of energy (DOE) and National Renewable Energy Laboratory (NREL) .The European countries are doing lot of research work in Renewable Energy. The Ministry of Non-Conventional Energy sources (MNES) created in 1992, a Nodal agency of the Government of India, relating to Renewable Energy. The several Renewable Energy sources are Solar Energy, Solar Photovoltaic System, Bio-gas Energy, Biomass Ene rgy, Wind Energy, Small Hydro Power, Geo Thermal Energy, Ocean Tidal Energy, Co-generation Energy etc.

Today India has the World's largest programmes for Renewable Energy. Several Renewable Energy technologies have been developed and deployed in villages and cities of India. A Ministry of Non-Conventional Energy Sources (MNES) created in 1992 for all matters relating to Non-Conventional / Renewable Energy. It undertakes policy making, promotion, coordination of functions, R&D and technology development, intellectual property protection, human resources development and other matters relating to Renewable. Energy Government of India also created Renewable Energy Development Agency Limited (1REDA) to assist and provide financial assistance in the form of subsidy and low interest loan for Renewable Energy projects. India's achievement in the fields of Renewable Energy is very significant as shown in Table: 1.

Biogas Plants	28.50 lakhs.
Improved Chulhas	300 lakhs.
Solar Heating System	4,50,000 sq.m.
Solar Photovoltaic System	329 mw.
Biomass Power	200 mw.
Wind Power	1025 mw.
Small Hydro Power	183.45 mw.
Solar Photovoltaic Power	1590 kw.
Solar Cookers	4,75,000.
Solar PV Pumps	2868.
Battery Operated Vehicles	217.

Table 1- The installed capacity (As on 31 March 1999), can be summarized as below (in Units)

There are 153 Energy Parks in India to educate people about Renewable Energy. India also provided technical guidance and help to many developing countries for construction of Non-Conventional energy equipments. Several Renewable Energy equipments and products as Solar Photovoltaic Systems, Wind Turbine Equipments, Thermal Applications, and Solar Cookers etc. have been exported. India ranks third largest producer in the world of Solar cells and Photovoltaic (PV) modules. In India alone thirteen projects of 940 kW total capacities have so far been installed in different states. A number of R&D projects on Renewable Energy technologies have been implemented at several Research, Scientific and Educational Institutions, National Laboratories, Government and Industrial organizations in India.Ministry of Renewable Energy of India has taken major initiatives to encourage Private /Foreign Investments to tap energy from Renewable Energy sources. These initiatives include provision of Fiscal and Financial incentives, exemption from Excise duty, Sales tax and concessional customs duty in the imports of items used in Renewable Energy projects.

RENEWABLE ENERGY POTENTIAL: With a strong industrial base and successful commercialization of technologies in wind, SPV, solar, thermal, small hydel, biogas and improved biomass stoves, India is in a position today to offer "state-of-the-art" technology to other developing countries and play a leading role in the global movement towards sustainable energy development. India has a large potential for utilization of renewable energy. The scale over which potential can be economically exploited will depend largely on the

technologies, financing and the strategies of implementation of renewable energy projects. According to the Ministry of Non-Conventional Energy sources, there exists a potential exploitation of the order of 80,000 MW. Break of this potential is presented in the table 2.

The Middle East Conflict of 1973 resulted in sharp increase in the prices of the vital inputs of agriculture that is energy and fertilizer thereby adversely affecting the economy of developing and developed nations. The only apparent benefit from this unfortunate conflict has been the creation of awareness, in both developing and developed countries of the value of organic wastes as inexpensive sources of energy and plant nutrients. Sometimes a dark could have a silver lining. So the present man-made energy crisis created by the action of a few countries is a blessing in disguise. It should be considered as an amber light - a warning prior to the real danger (Vandana S; 2002)

Sl. No	Sources / Technologies	Units	Approx. Potential	Achieved so far
1	Wind Power	MW	45,000	1,267
2	Small Hydro (upto 50 MW)	MW	15,000	1,341
3	Biomass Power	MW	19,500	35
4	Biomass Gasifiers	MW		~
5	Biomass Cogeneration	MW		273
6	Urban and Industrial Waste	MW	1,700	15.20
7	Solar Photovoltaics	MW	Not Known	65
8	Solar Thermal Applications	MW/Sq.	35	0.55
9	Solar Water Heating Systems	Sqm.	Not Known	5,25,000
10	Solar Cookers	Numbers	Not Known	4,96,000

There are several barriers to the adoption of renewable energy technologies, but opportunities exist to overcome them. The financial limiting greater deployment of renewable technologies, the essential barrier lies in the perceived risk associated with investing in renewable energy technologies, which is generally higher, then competing conventional technologies, and the effects of this higher perceived rH-. On a technology's market:

- Capital markets generally perceive the deployment of emerging technologies as involving more risk than established technologies. The higher the perceived risk, the required rate of return demanded on capital.
- The perceived length and difficulty of the permitting process is an additional determinant of risk.
- The high front-end or financing requirements of many renewable energy technologies often present additional cost-recovery risks for which capital markets demand a premium.

The following are opportunities to address these financial constraints:

- Low interest loans or loan guarantees might serve to reduce perceived investor risk.

- Tax credits for renewable energy technology production through the early, high risk years a project may provide another mechanism.

- Regulatory cost-recovery mechanisms, which today often favor low-initial-cost, fuel based technologies, can be modified to recognize life-cycle cost as a more appropriate determinant of cost effectiveness.

- Effective redistribution of government spending in research and development that more directly reflects the potential of renewable energy technologies.

Effective valuation of external environmental costs associated with conventional fossil-fuel power generation. In a straight economic accounting based on dollars per kilowatt of generation, fossil fuel-fired facilities appear to be the option of least cost today. This method of accounting tends to neglect the environmental and social costs involved in producing electrical power by burning fossil fuels or using nuclear power. This form of economic analysis is in a relatively early form of development, yet has made great strides in recent years.

NEED FOR RURAL ENERGY POLICY IN INDIA: India is the second most populous nation in the world and has extreme ecological diversity. 70% of the population in India, close to 700 million, still lives in the rural areas. Meeting their energy requirements in a sustainable manner continues to be a major challenge for the country. All most 75% of the total rural energy consumption is in domestic sector. For meeting their cooking energy requirements, villagers depend predominantly on biomass fuels like wood, animal dung and agricultural residues, often burnt inefficient traditional cook stoves. The main fuel for lighting in the rural households is kerosene and electricity. Irrigation is mainly through electrical and diesel pump sets, while the rural industries and the transport sectors rely primarily on animal power and to some extent on commercial sources of energy like diesel and electricity.

India adopted short-, medium- and long-term energy planning processes in the country. In the short term, the effort is to maximize returns from the assets already created in the energy sector, improving efficiency in production, transmission and end use; reducing energy intensity of different consuming sectors and initiating steps for meeting fully the basic energy needs of urban and rural households. In the medium term, progressive substitution of petroleum products by coal, natural gas and electricity, accelerated development of renewable and promotion of R&D efforts on decentralized energy technologies based on renewable resources have been suggested. In the long term, promotion of energy supply systems based largely on renewable and promotion of technologies of production, transportation and end use of energy, that are environmentally benign and cost effective, have been suggested though fuel wood, agro- residue.

Given the geographical and ecological diversity in the country, the consumption pattern varies quite considerably as well; for example, the per capita consumption of fuel wood, for instance, ranges from 0.14 kg per day in Haryana to 1.31 kg per day in forest-rich Himachal Pradesh. The fuel-mix also varies from region to region depending on the resource endowments. Fuel wood consumption is high in states (for instance, all the North- Eastern states) where there is considerable forester over, whereas dung cakes play an important role in states like Punjab and Haryana, which have little biomass cover. Crop residue is used in most areas as a backup fuel when other fuels are in shortage, such as West Bengal and Punjab.

Biomass fuels provide 85%-90% of the domestic energy (table 3) (Natarajan 1997). Cooking is the largest energy consuming end use. It accounts for nearly 90% of household energy; lighting and space heating consume the rest. Biomass (wood, animal dung, crop residue) in outdated, inefficient cook-stoves (10 per cent efficiency) is generally used for cooking, while inefficient devices fuelled by kerosene are used for rural lighting. The Planning Commission estimates the fuel wood requirement at 180 million tonnes in 2001, a substantial increase from the actual consumption of 162 million tonnes in 1996 (Ninth Five-Year Plan: 1997-2002). Kerosene is used mainly for lighting. Considering that only a third of households even in electrified villages have electricity connections, it is estimated that there are 70-80 million households in the country that are not served by grid electricity.

It has been observed that there will be a huge gap between demand and supply of electrical energy by the year 2045 and in the (BAU) scenario. The predicted gap increases from 7.4% in the year 2005 to 40% in the year 2045.Another problem that is faced by the Indian energy scenario is the emission of greenhouse gases (GHG) due to dominating fossil fuel based electricity production.Fig. 1 shows the contribution of various energy sources towards India's power needs.

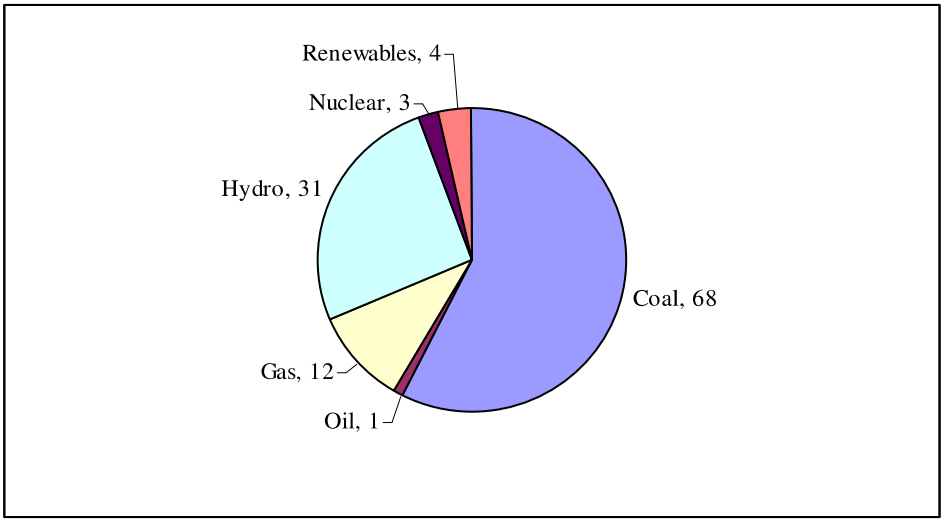

Fig.1: Resource wise installed electrical generation capacity (in GW) in India.

In order to fill present and future electrical energy demand and supply gap, it is necessary to look for various options for either reducing demand or to introduce alternate energy sources or both. Most economic option obviously is to introduce energy conservation measures. In an integrated energy policy report by Planning Commission [2] only new fossil fuel and renewable energy technologies have been considered for future supply options. In a national energy map for India technology vision 2030 prepared by TERI [3], supply scenarios have been developed for new and renewable energy sources. These two reports have not taken into account the energy saving potential in various sectors of economy. We feel that it is necessary to take a holistic approach to introduce energy saving potentials in various sectors of economy. Considering the vast potential of energy savings and benefits of energy efficiency, the Government of India enacted the Energy Conservation Act, 2001[4]. The Act provides for a legal framework, institutional arrangement and a regulatory mechanism at the Central and State level to embark upon energy efficiency drive in the country [5]. Energy Efficiency improvements not only reduce the energy consumed per unit products and services made available but also improve energy security of the country to ensure sustained availability of energy resources at affordable price. Estimated energy saving potential in various sectors is given in Table 3

Table 3: Maximum Electricity Saving Potential in different sectors in India

Sector	Electricity Saving Potential (%)
Industrial	25
Agricultural	30
Domestic	20
Commercial	20
Transport	20
Other	23

Though full exploitation of energy saving potential will reduce the demand and supply gap considerably, still there will be a need for more electricity production. Most of the environmental friendly options available so far are the renewable energy technologies. Harnessing renewable energy sources for electrical energy supply has the dual benefit of GHG mitigation as well as resulting in development of local capabilities and infrastructure. India has a major programme for renewable power. Installed renewable resource wise grid power is given in Table 4.

Table 4: Installed Grid-interactive renewable power by various sources

Grid-interactive renewable power	Installed capacity(in MW)
Wind Power	6070.2
Small Hydro Power(up to 25 MW)	1849.78
Cogeneration-bagasse	571.83
Bio Power	466.5
Waste to Energy	34.95
Solar Power	2.74
Total	**8996**

The aim of the present study is to establish a model that can project the electricity demand up to 2045 under the hypothesis of renewable electricity and energy savings. For this purpose the econometric model developed has been used to forecast the sectoral electricity demand exploiting full energy saving potential. The remaining demand-supply gap has been narrowed and finally calculated to be filled by renewable energy technologies mainly hydro, wind and bio power.

RENEWABLE POWER OPTIONS: Major renewable energy sources for power generation in India are hydro, wind and other renewable, which are briefly introduced here:

Hydro Power: The Indian government considers hydropower as a renewable economic, non-polluting and environmentally benign source of energy. The exploitable hydro-electric potential in terms of installed capacity is estimated to be about 148.7GW (see Table.5) out of which a capacity of 30.2 GW has been developed so far and 13.6 GW of capacity is under construction. Also, 56 sites for pumped storage schemes with an aggregate installed capacity of 94 GW have been identified. In fact installed capacity of hydro has increased at a compound growth rate of 4.35% per annum since 1991, higher than all other power sub-sectors.

Table 5: Hydropower potential in India

River Basin	Potential at 60% Load Factor(MW)	Probable Capacity(MW)
Indus Basin	19988	33832
Brahmaputra Basin	34920	66065
Ganga Basin	10715	20710
Central India Basin	2740	4152
System	6149	9430
East Flowing River System	9532	14511
Total	**84044**	**148700**

Wind Power: Power generation from wind has emerged as one of the most rapidly growing renewable energy technologies in recent years. India's wind power occupies fifth position in wind power installation after Germany, USA, Denmark and Spain [8]. The estimated power generation potential in India through wind is about 45 GW out of which 7.5 GW has been exploited [9].

Table 6: State wise Wind Energy Potential in India

S.No.	State	Gross Potential(MW)
1	Andhra Pradesh	8275
2	Gujarat	9675
3	Karnataka	6620
4	Kerala	875
5	Madhya Pradesh	5500
6	Maharashtra	3650
7	Orissa	1700
8	Rajasthan	5400
9	Tamil Nadu	3050
10	West Bengal	450
	Total	**45195**

The state wise potential for wind power generation is as shown in Table 6.The two states Gujarat and Andhra Pradesh are highest wind power producer because the coastal region of these states. The cost comparison with other renewable sources makes wind power as an economical power generation technology. The capital cost is comparable with conventional power plants.

Other Renewable Energies: In other renewable energies, small hydro power and bio power are promising to generate electricity to satisfy the demand up to some level. An estimated potential of about 15 GW [9] of small hydro power projects exists in India of which only 1.9 GW has been exploited. Since large potential of this technology exists in hilly areas, development of small hydro power for decentralized power generation can lead to rural electrification and local area development. There is a well-established manufacturing base for the full range and types of small hydro equipment in the country. Biomass-based power plants are ideal for decentralized application in rural areas, where either it is expensive to extend the grid or the power demand is low. The estimated potential of bio power is about 17GW [9] of which only 467 MW has been exploited. Power generation systems range from small scale (5-100kW), medium scale (1-10kW) to large scale (about 50MW) application [10]. Waste-to-energy and solar power contribution is 35 and 3 MW respectively. Since these are negligible as compared to above two renewable sources (i.e. small hydro power and bio power) they have not been considered for projection studies.

RURAL ENERGY DEVELOPMENT IN INDIA: Rural Development purse has never figured in the stated Energy Policy. Rural electrification is mainly perceived in the

context of energy requirements to meet the irrigation needs of agriculture as part of the overall food security policy. Therefore, Rural Electrification PRIORITY was to provide assistance for transmitting energy to agricultural pump sets to increase the productivity of land. Household electrification came as a secondary or incidental issue. The whole definition of rural energy in the past was to provide one connection to a village which was primarily used to electrify agricultural pump sets. The Government of India changed the definition of village electrification recently to state that a village is considered as electrified if it provides electricity/power to all the habitations in the village. They consider the village as electrified if al least 10 to 20% of the inhabitants in the villages are provided with energy for lighting.

Consequently, the emphasis is not on energy and its use for rural development, but availability of electricity for certain segment of households, in the villages and hamlets. The main issue is how do we bring rural development and bridge the gap between the power requirements for rural development and the energy policies of the government. The Rural Electric Supply Technology (REST) mission launched by the Government of India hopes to make power available for the rural households but even the stated policy objectives do not cover the strategies to provide energy to the poorest of poor households in the rural areas. If we need to achieve sustainability in rural development with emphasis on livelihoods and the means of enhancing the economic well-being of the poor households, it is necessary that affordable access to energy is provided to these households. The primary need is an integrated development strategy to use energy to improve health, education, nutrition and economic activities of the rural households. As such gender issues need to be addressed with adequate focus in the context of energy use. It is difficult to bring any meaningful integration between energy and rural development unless we take a integrated approach to development and energy end use.

CONCLUSION: In parallel with development in business sectors and speculations, 2015 saw proceeded with advances in renewable vitality advances, continuous vitality productivity enhancements, expanded utilization of savvy lattice innovations and huge advance in equipment and programming to bolster the combination of renewable vitality, and also advance in vitality stockpiling improvement and commercialization. The year additionally observed extended utilization of warmth pumps, which can be a vitality productive answer for warming and cooling. Work in the renewable vitality segment (excluding extensive scale hydropower) expanded in 2015 to an expected 8.1 million occupations (immediate and backhanded). Sunlight based PV and biofuels gave the biggest quantities of renewable vitality occupations. Extensive scale hydropower represented an extra a great many employments. Considering all renewable vitality advancements, the main managers in 2015 were China, Brazil, the United States and India. Private financial specialists ventured up their responsibilities to

renewable vitality essentially amid 2015. The year saw both an expansion in the quantity of extensive banks dynamic in the renewable division and an expansion in credit measure, with major new duties from global speculation firms to renewable and vitality productivity. New venture vehicles – including green securities, swarm financing and yields – extended amid the year. Standard financing and securitization structures likewise kept on moving into creating nation advertises as organizations (especially sun oriented PV) and speculators looked for higher yield, even to the detriment of higher hazard.

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