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ECONOMICS OF RENEWABLE ENERGY SOURCES IN INDIA

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Abstract:-Providing access to quality and sufficient energy to all households, individuals, sectors, and institutions at all times is the minimum condition for economic development. The climate change is gradually harming the environment, social and economic development of world economy. The major culprit fuelling the climate change is burning of fossil fuel. Hence, the power generation in India should not only aim at sufficient power generation, but also at generating clean, green and sustainable energy.

The major sources of renewable power in India are 1) Wind power 2) Small Hydro power 3) Biomass 4) Cogeneration biogases and 5) waste to energy. India is having 89,760 MW estimated potential of renewable energy. But less than 2% are harnessed in actual terms.

The important issue often spoken and debated in many studies is renewable energy projects are about the cost of producing the Renewable energy, despite huge subsidies. But I am surprised whether these studies take into consideration the aid and subsidies given to conventional sources of energy. The government of India also gave the coal to private and government thermal plants at a throw away prices. The CAG report revealed that 628.5 million tons of coal was given to government and private thermal power corporation almost for free, which is valued at Rs. 1.86 lakh crore! What if the costs of mitigating carbon emissions are added to cost of generating electricity from conventional sources, it would definitely be more costly than renewable sources.

Moreover, higher production cost alone should not refrain India from producing electricity from renewable sources, the Health of the individuals and economy are more important than higher cost of producing energy from renewable sources. It is also true, that energy from conventional energy cannot be completely done away. A proper energy mix with a major impetus to green and clean technology is the need of the hour.

Keywords:Renewable energy, Electricity, Biomass power, Solar, Wind, Sustainable Inclusive development, Primary Energy sources, GHGs, Climate change

INTRODUCTION :-

Providing access to quality and sufficient energy to all households, individuals, sectors, and institutions at all times is the minimum condition for economic development. Hence all economies strive for generating sufficient energy needed for its economy.

It may look surprising, shocking and strange, India despite more than six decades of planning; completed eleven five year plans, spent lakh of crores on providing the basic infrastructure; but still more than 1 lakh villages are not electrified in India. Only 65.6 percent of rural households are having electricity as primary lighting source accompanied by 93.8 percent households in urban India. In other words 35.54 percent of rural households still use kerosene as primary source of lighting compared with 4.9 percent of urban households; 75.9 percent of rural households still use firewood as primary cooking fuel in rural India. Only 12 percent of rural households accompanied with 64.6 percent in urban households use LPG as primary cooking fuel (TERI Energy data, 2013).

India's commitment to her citizens to provide 'electricity to all' failed miserably once again, as in the past, the latest being in 2012! India, the second largest growing economy in the world, is eleventh largest in the world in terms of GDP has also dubious distinction of fourth largest power buyer in the world. If India has to sustain its tag of popular investment destination and move ahead with inclusive growth; India has to increase its installed capacity to at least three times of the present at the

earliest.

The climate change is gradually harming the environment, social and economic development of world economy. The major culprit fuelling the climate change is burning of fossil fuel. The extraction and converting of Fossil fuels into energy degrades land, aids deforestation and defiling of rivers. It also emits Carbon, Sulphur and Nitrogen and aggravates the climate change. The International Energy Agency reveals that power sector is responsible for 37 percent of all manmade carbon dioxide (CO₂) emissions. Coal is the major source of energy that generates 40 percent of global electricity and it is also the major culprit. Energy sector generates about 23 billion tons of CO₂ emissions every year, which is in excess of whopping 700 tons a second.

India was generating 5106 GWH of electricity in 1950-51 which had increased to 959070 GWH by 2010-11 (Energy Statistics, 2012). The major share of electricity comes from the burning of fossil fuels. The following table gives the picture on fossil fuels contribution to aggregate climate change.

Gas	Atmospheric concentration (ppm)	Annual concentration Increase (ppm)	Relative Greenhouse Efficiency (CO ₂ -1)	Current Greenhouse contribution (%)	Principle of Gas Sources
Carbon dioxide	351	0.1	1	57	Fossil Fuels deforestation
CFCs	0.00225	5	15000	25	Foams aerosols refrigerants solvents
Methane	1.675	1	25	12	Wetlands, Rice cultivation, Fossil Fuels
Nitrous oxide	0.31	0.2	230	6	Fuels, Fertilizers, deforestation

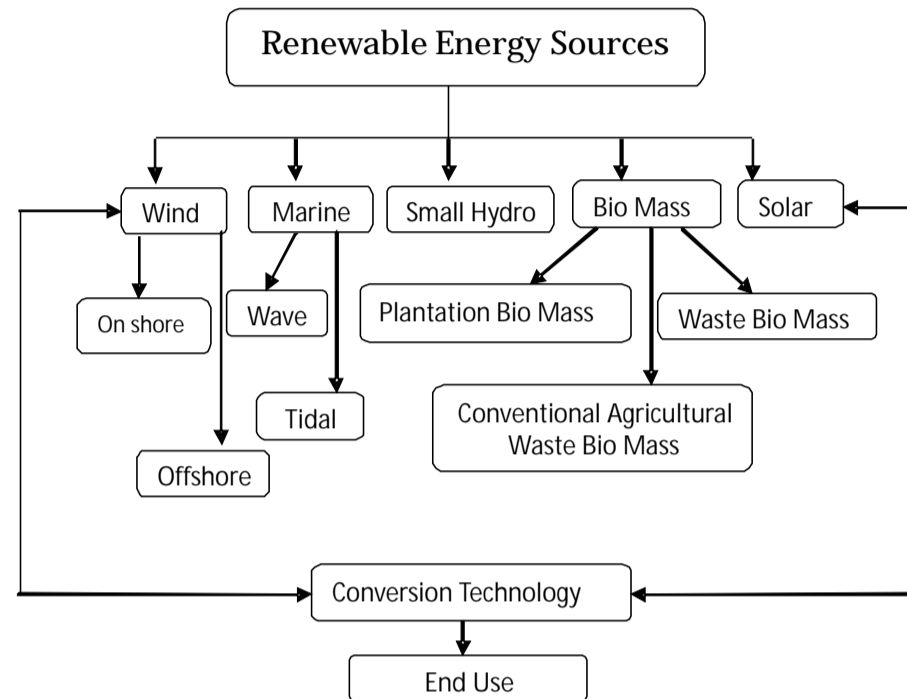
The burning of fossil fuels and deforestation is the principle source of emitting carbon dioxide that contributes most to the current Green house gases. Whereas foams, aerosols, refrigerants, solvents are responsible for emission of CFCs; wetlands, rice cultivation, fossil fuels are principle source of emission of methane while fuels, fertilizers and deforestation are principle source of emissions for Nitrous oxide.

Hence, the power generation in India should not only aim at sufficient power generation but also generating clean, green and sustainable energy. Fortunately 12.2 percent of total installed capacity comes from renewable energy sources as on March 2012 (India Wind Energy outlook, 2012). If a proper plan is done and implemented for green power generation, it will lead us to meaningful sustainable inclusive development.

There are two important issues that should be noticed from this 1) providing quality and adequate quantity power at all the times and 2) generating clean and green energy. Electricity shortages and power cuts have become regular and routine matter for Indians, more so of the rural Indians life. This is mainly due to lack of government will, foresightedness, vision and commitment on its part to provide 'clean and quality power to all at all the times'. In each and every five year plan the government failed to attain its own set target in terms of energy generation. Many a times the targets were revised so that their actual achievement does not look pale! For example in the ninth plan the actual achievement in relation to target fixed was just 47 percent, where as in tenth plan the actual achievement was 51 percent and in eleventh plan it was 76 percent, of course it was after prompt revision of the target!

The slippages in the capacity additions, unsatisfactory performances of the thermal stations and partly due to non completion of transmission lines' are responsible for today's precarious situation (Planning Commission, 1985). The other biggest challenge today in front of our government is not only to provide power to all, but providing them clean and green power.

The major sources of renewable power in India are 1) Wind power 2) Small Hydro power 3) Biomass 4) Cogeneration biogases and 5) waste to energy. The following chart gives the description of sources of the renewable energy.



Advantages and limitations of Renewable Energy

The advantages and limitation of the important renewable energy sources are discussed in the following section.

Wind power

The moving air in atmosphere is wind. Wind is used to generate electricity. Air flows to different areas due to pressure and temperature. Large fans are installed at the places where wind flow in high. When air flows into the blades of the fan, the blades of the fan moves and generates kinetic energy. Larger the blades and turbine, higher will be the power produced from wind. The kinetic energy is then converted into mechanical energy, which leads to production of electrical energy.

Advantages of Wind power	Limitations of Wind farm
1) Wind power is eco friendly, clean and safe energy source as it does not emit any carbon dioxide. 2) Equipment erection and commissioning can be done in less than six months and hence have the lowest gestation periods 3) The capital costs for a wind electric plant ranges between 5 to 6 crores which is lesser than any conventional energy's capital costs. 4) Operating and maintenance costs are also low; the energy cost per unit is also low.	1) Wind machines work depends on strong wind, winds strength and occurrence depends on nature. If air stops blowing for few hours, the power will be off for that number of hours. 2) Electricity from wind farms must have a back up supply from other source of energy which becomes redundant and idle if good wind is available. 3) Good wind sites are located in remote areas and transmission distribution from far of places adds up the cost

The important advantage of the wind energy is that there is no adverse impact on the global environment. The following table gives the comparison between fossil fuels and wind.

Comparison between Fossil Fuels and Wind

	Wind	Fossil Fuels
Availability	Usable as it exists	Have to be procured and made usable through laborious and environmentally damaging processes
Limitation on availability	Inexhaustible resource	Limited in reserves, expected to get completely exhausted in the coming 60 years
Transportation	Used where it is available	Have to be transported from the site for further processing exposing environment to danger
Use in production	Zero emission	Used in producing electricity releasing green house gasses
Geo-political Implications	Reduces our reliance on oil, safeguarding national security	Over-reliance on oil as a resource has undermined our energy security. E.g. OPEC crisis of 1973, Gulf War of 1991 and Iraq War of 2003
	There is no adverse effect on global environment. The whole system is pollution free and environment friendly.	Aggregates and fuels climate change

Source: www.cwet.tn.nic.in/html/information_gi.html?

Solar Energy

Solar energy is available for most part of the year in India. Solar energy is received in the form of cosmic radiations. It is utilized by converting into 1) Thermal conversion (direct heating) and 2) Photo conversion (indirect conversion). Solar energy is used in many applications. It is used to heat water (solar water heater), cook food (solar cooker), solar drying (solar cabinet drivers), solar furnace, and solar green house.

Advantage of Solar Energy	Limitation of Solar Energy
<ol style="list-style-type: none"> 1) It is eco-friendly as it does not emit any carbon nor creates any sort of pollution 2) Maintenance costs are negligible 	<ol style="list-style-type: none"> 1) Will not work during night and cloudy days. 2) The research and development in developing the appropriate technology to harness solar energy to its potential is in infancy 3) Harnessing solar energy is not available in concentrated form

Biomass Energy

Biomass is used to produce energy in various methods namely combustion, gasification, fermentation and anaerobic digestion. Biomass energy refers to burning of wood, agricultural waste, animal waste, and waste paper to convert as fuel. The burning of dung converts biomass into biogas and it is the mixture of CH₄, CO₂, H₂ and N₂.

Advantages of Biomass	Disadvantages of Biomass
<ol style="list-style-type: none"> 1) Eco-Friendly Clean Fuel 2) Economies to scale, lower cost per unit as it can be directly supplied to homes from plant 3) Aerobic digestion of sewage sludge and animal manure results in organic manure which is used as substitute for chemical fertilizers 	<ol style="list-style-type: none"> 1) Biomass energy emits methane gas 2) Lack of proper maintenance and servicing facilities in rural areas.

Hydro Electricity (Small)

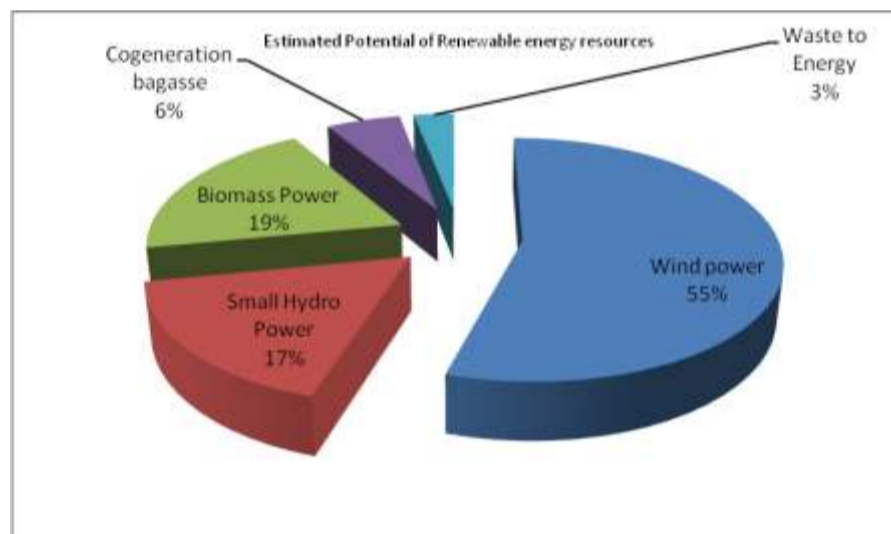
Hydro electric power refers to energy produced from water. If a hydro electric unit produces less than 25 MW, it is

regarded as small hydro plants. Two types of technology are used 1) high head systems and 2) low head system

Advantages	Disadvantages
1) Clean and eco-friendly, does not emit carbon to atmosphere 2) Reliable and advanced technology is available	1) Can be installed only in dominant rainfall areas. If rainfall is reduced, the power generation will suffer.

Potential of Renewable energy

When the demand for energy is higher, more so when issue of climate change is aggravated. The option is invariably the renewable sources which are eco-friendly. India has the huge potential of renewable power in India. The following chart refers to the estimated potential of renewable power in India.



Source: Derived from the data from Energy Statistics (2012), Central Statistics Office, National Statistical Organization, Ministry of Statistics and Programme implementation, Government of India.

There is no unanimity in estimating the potential of renewable energy in India. As per Government of India Energy Statistics, India is having the 89,760 MW estimated potential of renewable energy to be produced every year; wind power with the estimated 49130 MW of power is the largest renewable source potential in India. It is 54.73 percent of the total estimated renewable power. It is followed by Biomass power with 17538 MW (19.54%), small hydro power with 153.85 MW (17.14%), Cogeneration bagasse with 2707 MW (3.02) and solar energy. Whereas Gyan Research and Analytics (2012) estimates that India has 1,40,000 MW of potential in renewable energy sources. Out of them solar has largest potential with 50,000 MW followed by Wind 45,000 MW, Biomass and Waste 30,000 MW and Small Hydro with potential of 15,000 MW.

World Bank Report (2013) appreciates India's efforts in renewable energy. It assesses the Jawaharlal Nehru National Solar Mission phase I, which was launched in 2010 and opines that India will be a global leader in the development of solar power. It takes note that the installed capacity of solar power has increased from 30MW to more than 2000 MW during 2010 to 2013. Reports also highlights several challenges that are acting as barriers to India achieving solar targets namely lack of access to low cost financing, inadequate solar infrastructure, lack of raw materials for several PV manufactures and an underdeveloped supply chain leading to high inventory costs.

India is also now third largest annual wind power market in world. The Indian wind power has experienced record annual growth in 2011 with the addition of more than 3 GW of new installations (India Wind Energy outlook 2012). The approach paper to 12th plan period has fixed a target of 15,000 MW in new capacity additions and an aspirational target of 25,000 MW.

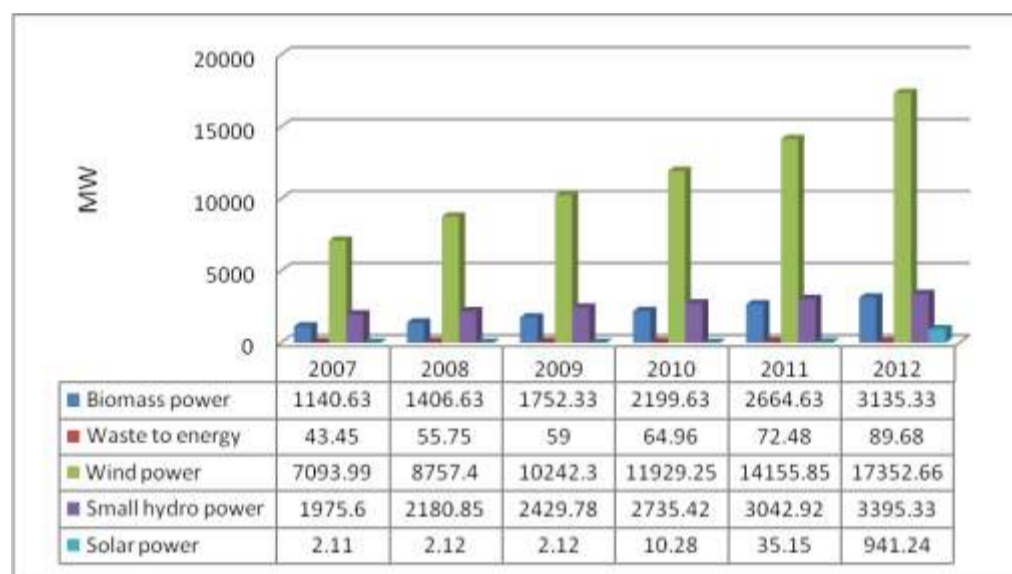
The small hydro energy projects are largely in PPP or in private sector. Gyan Research and Analytics (2012) estimates the potential of such plants to over 15,000 MW and believed that private sector is keen on investing in the small hydro projects. Biomass and Waste energy is utilized in rural areas in a very big way. Indian industries can also utilize the Biomass and Waste energy potential and can come out of energy woes.

The government of India has definitely made a major attempt by setting up the separate ministry for non conventional

energy sources. But still the potential realized in actual terms is very small. Gyan Research and Analytics (2012) finds that less than two percent of the renewable energy resource potential is realized.

Installed Capacity

Installed capacity of Renewable power in India (in MW)



Source: Compiled from various issues of Energy Statistics, Government of India

The installed capacity of renewable energy in India is 24932.24 MW. Wind and Solar power i.e. leading the renewable power installed capacity in India. In 2007, the Wind power installed capacity was 7093.99 MW which increased to 17352.66 MW by 2012 whereas the solar power installed capacity was a meager 2.11 MW in 2007 which has increased to 941.24 MW by 2012. In absolute terms the Wind leading power generator is followed by small hydro power (3395.33 MW), Biomass power (3135.33) Solar (941.24 MW) and Waste to energy (89.68 MW).

Cost of Conversion

Renewable energy has to be optimally utilized in India. But it is usually argued that though the renewable energy sources are freely available in nature, it is very costly to convert them to energy. It is argued that the capital costs to set up renewable energy plant and the backup plants of conventional sources drains out the advantages of free raw materials.

The IERDA estimates the capital cost of renewable energy in India would cost Rs. 3 to 4 crore per MW for wind, Rs. 3 to 6 crore for small hydro, Rs. 3 to 4 crore for Biomass and Rs. 25 to 30 crores for solar PV. Hence it is obvious that each kilowatt from renewable sources will be costing more than fossil fuel. In India, as per Central Electricity Regulatory Commission (CERC) notification No. 2/7/2008 the electricity from fossil fuels ranged between Rs. 4 to Rs. 12. But the CERC paper further clarifies that power production costs (Costs plus tariff) per KWH was Rs. 1.9 for domestic coal (pit head), Rs. 2.94 for domestic coal (load centre) and Rs. 3.50 for imported coal. But if the competitive bids are considered it is Rs. 1.19 per unit as Reliance won the L1 bidder competitive tariff bid for Susan UMPP (Shalini Singh, 2013). The CERC has also decided Rs. 15.39 for solar energy per unit in 2011-12 (CERC, Renewable Energy tariff 2011-12). The CERC has finalized the tariff of different renewable energy technologies for 2011-12 financial years. The following table gives the details of the same.

Sl.No	Technology Type	Total Levelised Tariff (Rs. /KwH)
1	Wind	3.55 to 5.33
2	Small Hydro	3.78 to 4.49
3	Biomass	3.59 to 4.94
4	Cogeneration	3.93 to 5.21
5	Solar Photovoltaic (PV)	17.91
6	Solar Thermal(CSP)	15.31

Source; Climate Parliament (2010)

The small hydro will be costing equalant or less than thermal energy, whereas the wind energy costs Rs 3.55 to 5.33/ kwh (climate parliament.net) but unfortunately the prices in the actual market was much higher than fixed by CERC due to shortage of energy, more so during peak hours.

Renewable energy is costly!

The other important issue often spoken and debated in many studies is that renewable energy projects are given huge subsidy and if these subsidies are removed, renewable energy will become further costly claims. The examples quoted are, renewable energy projects are given five year income tax holiday; eight crore rupees is given as capital subsidy in co-generation field with maximum capacity of 20 MW; Fifty percent of capital cost of a sewage electric power plant in given as a free grant (Sutanu Guru, 2002). But I am surprised, whether these studies take into consideration the aid and subsidies given to conventional energy sources. Moreover, the government of India is giving the coal to private and government thermal plants at a throw away prices.

The government of India, during 1993 to 2011 gave 206 coal blocks to government and private thermal power corporation almost for free. 165 coal blocks out of this 206 coal blocks were allocated between 2004 and 2011. The CAG report revealed that 628.5 million tons of coal was given to government and private thermal power corporation almost for free. If sold at market prices, it would have fetched Rs. 1.86 lakh crore to government treasury. This is regarded as Coalgate scandal. If this raw material (coal) was added to thermal electricity production cost, then even the thermal electricity would be relatively costly!

Comparative Costs

The other dimension is what would be the future cost, how much are they sensitive to fuel prices and how much do they cost without environment and other externalities. The following table reproduced from climate parliament, where in they have quoted it from World Energy Outlook 2011 is presented below;

(In 2008 \$ per Megawatt Hour)

Plant type	EIA's System Levelised cost of new generating technologies in 2016	Lazard's analysis of Levelised cost of Electricity in fuel 2008 in USA	
		Without environmental and other externalities, and fuel price or capital cost change	Sensitive to fuel prices
Coal	100.4	74-135	67-144
Gas (IGCC)	-	104-134	98-141
Nuclear	119.0	98-126	97-128
Wind	149.3	44-91	44-91
Solar PV	396.1	79-154	78-154
Solar Thermal	256.6	90-145	90-154
Biomass	111.0	50-94	50-94
Hydro	119.9	-	-
Geothermal	115.7	42-69	42.69

Source: Climate Parliament (2010)

If the costs of mitigating carbon emissions are added to cost of generating electricity from conventional sources it would definitely be more costly than renewable sources. Moreover higher electricity cost alone should not be considered, when economy is going for green and clean energy source. The cost of energy from renewable energy sources is also coming down with the invention of new advanced appropriate technology. It is also true, that energy from conventional energy cannot be completely done away. A proper energy mix with a major impetus to green and clean technology is the need of the hour.

CONCLUSION

Renewable energy becomes crucial to solve the nation's energy needs. It is not just the alternate energy, but crucial and required source of energy to mitigate climate change. "For India to reach its potential and to boost the necessary investment in renewable energy it will be essential to introduce comprehensive, stable and long-term support policies, carefully designed to ensure that they operate in harmony with existing state level mechanisms so as to avoid reducing their effectiveness" (India Wind Energy Outlook, 2012).

The Higher cost of producing electricity from renewable sources would come down with the innovation of new technologies in the field. Moreover, higher production cost alone should not refrain India from producing electricity from renewable sources, the Health of the individuals and economy are more important than higher cost of producing energy from renewable sources. Hence, sooner the better, Indian, economy should give major impetus to renewable energy sources.

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