Renewable Energy Generation in India: Present Scenario and Future Prospects

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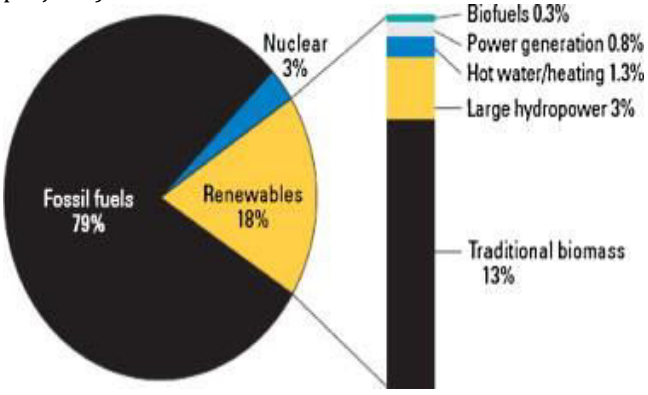
Abstract—Renewable energy sources and technologies have potential to provide solutions to the long-standing energy problems being faced by the developing countries. The renewable energy sources like wind energy, solar energy, geothermal energy, ocean energy, biomass energy and fuel cell technology can be used to overcome energy shortage in India.Strong government support and the increasingly opportune economic situation have pushed India to be one of the top leaders in the world's most attractive renewable energy markets.To meet the energy requirement for such a fast growing economy, India will require an assured supply of 3–4 times more energy than the total energy consumed today. The renewable energy is one of the options to meet this requirement. Today, renewable account for about 33% of India's primary energy consumptions. India is increasingly adopting responsible renewable energy techniques and taking positive steps towards carbon emissions, cleaning the air and ensuring amore sustainable future. In India, from the last two and half decades there has been a vigorous pursuit of activities relating to research, development, demonstration, production and application of a variety of renewable energy technologies for use in different sectors.

Index Terms—About four key words or phrases in alphabetical order, separated by commas.

• INTRODUCTION

The sources of electricity production such as coal, oil, and natural gas have contributed to one-third of global greenhouse gas emissions. It is essential to raise the standard of living by providing cleaner and more reliable electricity. The World Energy Forum has predicted that fossil-based oil, coal and gas reserves will be exhausted in less than another 10 decades. Fossil fuels account for over 79% of the primary energy consumed in the world, and 57.7% of that amount is used in the transport sector and are diminishing rapidly . The exhaustion of natural resources and the accelerated demand of conventional energy have forced planners and policy makers to look for alternate sources. Renewable energy is energy derived from resources that are regenerative, and do not deplete over time. Renewable energy offers our planet a chance to reduce carbon emissions, clean the air, and put our civilization on a more sustainable footing. It also offers countries around the world the chance to improve their energy security and spur economic development. Modern biomass encompasses a range of products derived from photosynthesis and is essentially chemical solar energy storage. Renewable energy supplies 18% of the world's final energy consumption , counting traditional biomass, large hydropower, and ''new'' renewables (small hydro, modern biomass, wind, solar, geothermal, and biofuels). Traditional biomass, primarily for cooking and heating, represents about 13% and is growing slowly in some regions as biomass is used more efficiently or replaced by more modern energy forms. Large hydropower represents 3% and is growing modestly, primarily in developing countries . New renewables represents 2.4% and are growing very rapidly in developed countries and in some developing countries. Global renewable energy capacity grew at rates of 15–30% annually for many technologies during the five-year period 2002–2006, including wind power, solar hot water, geothermal heating, and off-grid solar PV (Fig. 2). Renewable energy markets grew robustly in 2008. Among new renewables (excluding large hydropower), wind power was the largest addition to renewable energy capacity. An estimated $120 billion was invested in renewable energy worldwide in 2008, including new capacity (asset finance and projects) and biofuels refineries.



• Renewable energy in India

India's population of more than 1028 million is growing at an annual rate of 1.58%. As fossil fuel energy becomes scarcer, India will face energy shortages significantly due to

increase in energy
prices and energy insecurity with in the next few decades. Increased use of fossil fuels also causes environmental problems both locally and globally. The economy of India, measured in USD exchange-rate terms, is the twelfth largest in the world, with a GDP of around $1 trillion (2008). GDP growth rate of 9.0% for the fiscal year 2007–2008 which makes it the second fastest big emerging economy, after China, in the world. There is a very high demand for

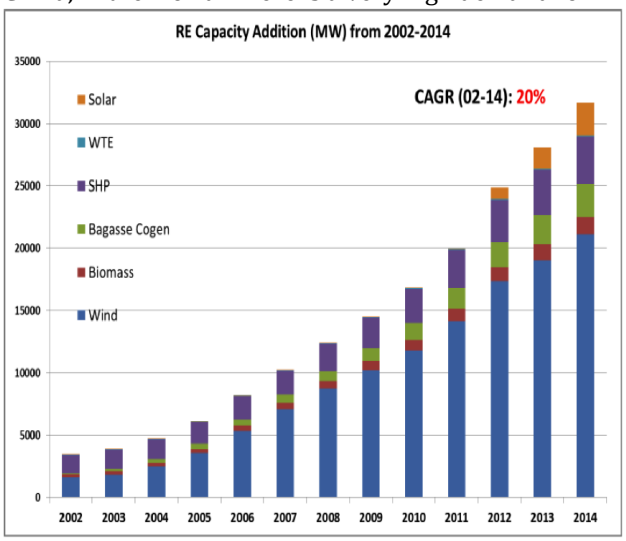


Table 2.1: Energy demand and its projection in India

S. No	Source	Unit	1991-92	2009-10	2020-21
1.	Electricity	TW-h	231	725	1300
2.	Coal	MT	229	690	1345
3.	Petroleum products	MT	57	165	335
4.	Natural gas	B Cu. m	18.6	65	130

energy, which is currently satisfied mainly by coal, foreign oil and petroleum, which apart from being a non-renewable, and therefore non-permanent solution to the energy crisis, it is also detrimental to the environment. Thus, it is imperative that India obtains energy security without affecting the booming economy, which would mean that the country must switch from the nonrenewable energy (crude oil and coal) to renewable energy. Government of India has created conducive environment for speedy development of RES and to attract private investors by providing subsidy, fiscal incentives, policies support, regulatory & legislative framework, finances, consultancy services, research design& development, up-gradation of existing technologies and planning & resource assessment The Government is mainly a catalyst and facilitator, however, the
Implementation is being carried out by the States or by the private sector. Many States have so far announced promotional policies for RES. The cumulative achievements of RES are elaborated.

- ## Biomass

In recent years, the interest in using biomass as an energy source has increased and it represents approximately 14% of world final energy consumption. Estimates have indicated that 15–50% of the world's primary energy use could come from biomass by the year 2050. Many countries have included the increased use of renewable sources on their political agenda. Biomass is one such
resource that could play a substantial role in a more diverse and sustainable energy mix. The energy obtained from biomass is a form of renewable energy and, in principle, utilizing this energy
does not add carbon dioxide, a major greenhouse gas, to the atmosphere, in contrast to fossil fuels. As per an estimate, globally photosynthesis produces 220 billion dry tonnes of biomass each
year with 1% conversion efficiency. Biomass resources suitable for energy production covers a wide range of materials, from firewood collected in farmlands and natural woods to agricultural and forestry crops grown specifically for energy production purposes. Energy production from food wastes or foodprocessing wastes, especially from waste edible oils, seems to be attractive based on bio-resource sustainability, environmental protection and economic consideration. India is very rich in biomass and has a potential of 16,881MW (agro-residues and plantations), 5000MW (bagasse cogeneration) and 2700MW (energy recovery from waste) . 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.

	Pan-Amazon TREES Domain	Amazonia TREES Domain	Africa TREES Domain	Asia TREES Domain	Latin America Non-TREES Domain	Africa Non-TREES Domain
Carbon Model Parameters						
Maximum C biomass, tC ha^{-1}	155	223	171	181	56	43
Mean C biomass, tC ha^{-1}	129	186	143	151	47	36
Minimum C biomass, tC ha^{-1}	103	149	115	121	38	29
Soil Carbon loss, tC ha^{-1}	24	24	20	30	17	10
Maximum degradation C loss, tC ha^{-1}	39	56	43	45	14	11
Mean degradation C loss, tC ha^{-1}	26	37	29	30	9	7
Minimum degradation C loss, tC ha^{-1}	13	19	14	15	5	4
C regrowth rate, tC ha^{-1} yr^{-1}	2.8	5.5	3.4	3.8	0.5	0.5
Nb of years for full regrowth	46	35	42	40	94	72
Change Rates						
Deforestation rate, 10^6 ha yr^{-1}	1.08 ± 0.55	1.43 ± 0.88	0.85 ± 0.30	2.84 ± 0.90	1.9 ± 1.1	1.5 ± 0.6
Degradation rate, 10^6 ha yr^{-1}	0.61 ± 0.46	0.22 ± 0.21	0.39 ± 0.19	1.07 ± 0.44	n.s.	n.s.
Regrowth rate, 10^6 ha yr^{-1}	0.20 ± 0.11	0.08 ± 0.11	0.14 ± 0.11	0.53 ± 0.25	n.s.	0.07 ± 0.05
Net C Fluxes Over 10 Years						
Maximum net emissions, 10^6 tC	153 ± 88	260 ± 171	125 ± 52	456 ± 167	106 ± 51	60 ± 23
Mean net emissions, 10^6 tC	128 ± 74	220 ± 146	104 ± 44	385 ± 143	93 ± 45	53 ± 20
Minimum net emissions, 10^6 tC	103 ± 60	180 ± 121	83 ± 36	315 ± 119	81 ± 40	45 ± 17

[a]Here n.s. stands for not significant. The non-TREES domain of Southeast Asia (dry domain of India) is not considered as the forest area change estimates for this area are not significant.

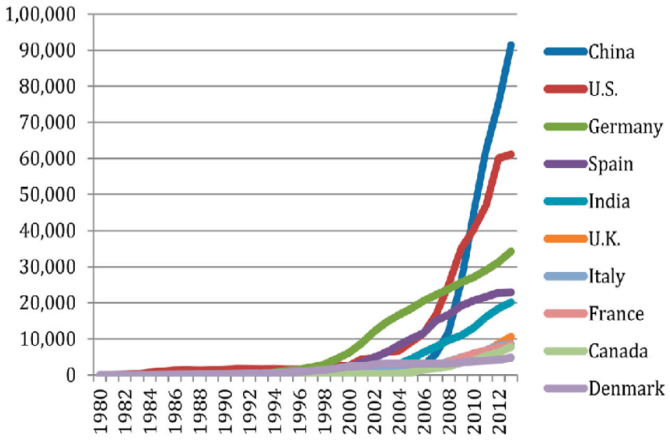
- ## Hydropower

Hydropower is another source of renewable energy that converts the potential energy or kinetic energy of water into mechanical energy in the form of watermills, textile machines, etc., or as electrical energy (i.e., hydroelectricity generation). It refers to the energy produced from water (rainfall flowing into rivers, etc.). Hydropower is the largest renewable energy resource being used for the generation of electricity. Only about 17% of the vast hydel potential of 150,000MW has been tapped so far. Countries like Norway, Canada, and Brazil have all been utilizing more than 30% of their hydro potential, while on the other hand India and China have lagged far behind. India ranks fifth in terms of exploitable hydro potential in the world. According to CEA (Central Electricity Authority), India is endowed with economically exploitable hydropower potential to the tune of 148,700 MW. The basin-wise assessed potential.

Maximum reservoir water content (hm^3)	644.60
Minimum reservoir water content (hm^3)	70.98
Maximum water elevation (masl)	329.50
Minimum water elevation (masl)	270.00
Tailwater elevation (masl)	198.00
Number of hydro units	3
Type of hydro units	Francis
Number of penstocks	3
Maximum flow (m^3/s)	279 (3 x 93)
Minimum flow (m^3/s)	40
Maximum power (MW)	319.7 (3 x 106.6)
Minimum power (MW)	21.9

• Wind energy

Winds are generated by complex mechanisms involving the rotation of the earth, heat energy from the sun, the cooling effects of the oceans and polar ice caps, temperature gradients between land and sea and the physical effects of mountains and other obstacles. Wind is a widely distributed energy resource. Total world wind capacity at the end of 2006 was around 72,000 MW. Wind energy is being developed in the industrialized world for environmental reasons and it has attractions in the developing world as it can be installed quickly in areas where electricity is urgently needed. In many instances it may be a cost-effective solution if fossil fuel sources are not readily available. In addition there are many applications for wind energy in remote regions, worldwide, either for supplementing diesel power (which tends to be expensive) or for supplying farms, homes and other installations on an individual basis.



India is surpassed only by Germany as one of the world's fastest growing markets for wind energy. By the mid 1990s, the subcontinent was installing more wind generating capacity than North America, Denmark, Britain, and the Netherlands. The ten machines near Okha in the province of Gujarat were some of the first wind turbines installed in India. These 15-m Vestas wind turbines overlook the Arabian Sea. Now, in 2008, there is an installed capacity of 5310 MW; however, ten times that potential, or 45,000 MW, exists. Different types of Wind Power Generators used in India for Off grip Power generation, i.e., water-pumping windmills, aero-generators (a small wind electric generator having a capacity of up to 30 kW) and wind–solar hybrid systems.

• Solar energy

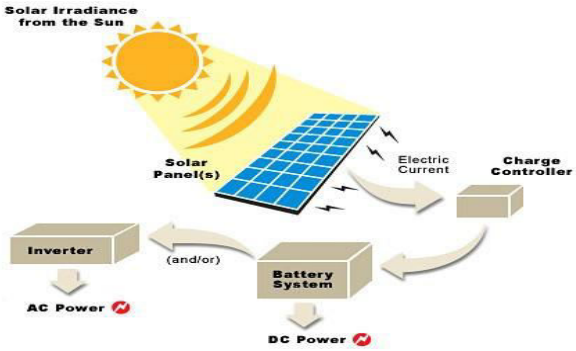
Solar energy is the most abundant permanent energy resource on earth and it is available for use in its direct (solar radiation) and indirect (wind, biomass, hydro, ocean, etc.) forms. Solar energy,

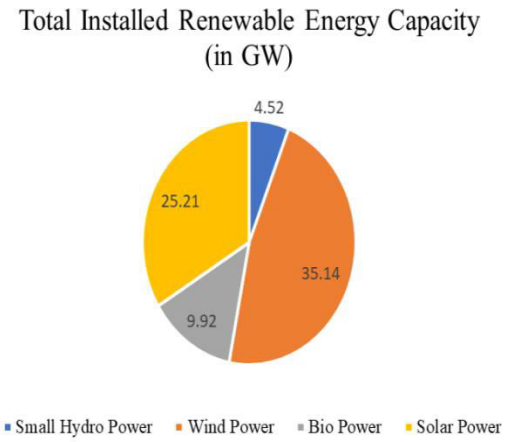
experienced by us as heat and light, can be used through two routes: the thermal route uses the heat for water heating, cooking, drying, water purification, power generation, and other applications; the photovoltaic route converts the light in solar energy into electricity, which can then be used for a number of purposes such as lighting, pumping, communications, and power supply in unelectrified areas.

The total annual solar radiation falling on the earth is more than 7500 times the world's total annual primary energy consumption of 450 EJ. The annual solar radiation reaching the earth's surface,

approximately 3,400,000 EJ, is an order of magnitude greater than all the estimated (discovered and undiscovered) non-renewable energy resources, including fossil fuels and nuclear. However, 80% of the present worldwide energy use is based on fossil fuels. Most parts of India receive 4–7 kWh of solar radiation per square meter per day with 250–300 sunny days in a year. The highest annual radiation energy is received in Western Rajasthan while the North- Eastern region of the country receives the lowest annual radiation. India has a good level of solar radiation, receiving the solar energy equivalent of more than 5000 trillion kWh/yr. Depending on the location,

the daily incidence ranges from 4 to 7 kWh/m2, with the hours of sunshine ranging from 2300 to 3200 per year.





• Conclusion-

it is clear that renewable energy sources are very useful in present day because now days energy is more required we need more sources but we know energy sources like natural gas , nuclear energy sources, coal are non renewable or will be reduced in a few years . So for overcome this problem more use of renewable energy sources is beneficial.

Renewable energy sources like solar, wind Never going to end because they are not limited

In present time as more consumption of energy is required we need more sources and also for future aspects renewable energy sources are best solution.

Keeping current and future usage got also gives investment cost for establishing the renewable energy sources.

Uses of renewable energy sources reduce the pollution issues also. It could also reduce emissions of CO2. So it is clear that there is strong need to establish more renewable energy sources.

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