

Research Paper on Renewable Energy Systems

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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. 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 a more 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. In this paper, efforts have been made to summarize the availability, current status, major achievements and future potentials of renewable energy options in India. This paper also assesses specific policy interventions for overcoming the barriers and enhancing deployment of renewables for the future*

Keywords: Biomass, Hydropower, Wind energy, Solar energy

I. 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 [1]. India has an increasing energy demand to fulfill the economic development plans that are being implemented. The provision of increasing quantity of energy is a vital pre-requisite for the economic growth of a country [2]. The National Electricity Plan [NEP] [3] framed by the Ministry of Power (MoP) has developed a 10-year detailed action plan with the objective to provide electricity across the country, and has prepared a further plan to ensure that power is supplied to the citizens efficiently and at a reasonable cost. According to the World Resource Institute Report 2017 [4, 5], India is responsible for nearly 6.65% of total global carbon emissions, ranked fourth next to China (26.83%), the USA (14.36%), and the EU (9.66%). Climate change might also change the ecological balance in the world. Intended Nationally Determined Contributions (INDCs) have been submitted to the United Nations Framework Convention on Climate Change (UNFCCC) and the Paris Agreement. The latter has hoped to achieve the goal of limiting the rise in global temperature to well below 2 °C [6, 7]. According to a World Energy Council [8] prediction, global electricity demand will peak in 2030. India is one of the largest coal consumers in the world and imports costly fossil fuel [8]. Close to 74% of the energy demand is supplied by coal and oil. According to a report from the Center for monitoring Indian economy, the country imported 171 million tons of coal in 2013–2014, 215 million tons in 2014–2015, 207 million tons in 2015–2016, 195 million tons in 2016–2017, and 213 million tons in 2017–2018 [9]. Therefore, there is an urgent need to find alternate sources for generating electricity.

In this way, the country will have a rapid and global transition to renewable energy technologies to achieve sustainable growth and avoid catastrophic climate change. Renewable energy sources play a vital role in securing sustainable energy with lower emissions [10]. It is already accepted that renewable energy technologies might significantly cover the electricity demand and reduce emissions. In recent years, the country has developed a sustainable path for its energy supply. Awareness of saving energy has been promoted among citizens to increase the use of solar, wind, biomass, waste, and hydropower energies. It is evident that clean energy is less harmful and often cheaper. India is aiming to

attain 175 GW of renewable energy which would consist of 100 GW from solar energy, 10 GW from bio-power, 60 GW from wind power, and 5 GW from small hydropower plants by the year 2022 [11]. Investors have promised to achieve more than 270 GW, which is significantly above the ambitious targets. The promises are as follows: 58 GW by foreign companies, 191 GW by private companies, 18 GW by private sectors, and 5 GW by the Indian Railways [12]. Recent estimates show that in 2047, solar potential will be more than 750 GW and wind potential will be 410 GW [13, 14]. To reach the ambitious targets of generating 175 GW of renewable energy by 2022, it is essential that the government creates 330,000 new jobs and livelihood opportunities [15, 16].

A mixture of push policies and pull mechanisms, accompanied by particular strategies should promote the development of renewable energy technologies. Advancement in technology, proper regulatory policies [17], tax deduction, and attempts in efficiency enhancement due to research and development (R&D) [18] are some of the pathways to conservation of energy and environment that should guarantee that renewable resource bases are used in a cost-effective and quick manner. Hence, strategies to promote investment opportunities in the renewable energy sector along with jobs for the unskilled workers, technicians, and contractors are discussed. This article also manifests technological and financial initiatives [19], policy and regulatory framework, as well as training and educational initiatives [20, 21] launched by the government for the growth and development of renewable energy sources. The development of renewable technology has encountered explicit obstacles, and thus, there is a need to discuss these barriers. Additionally, it is also vital to discover possible solutions to overcome these barriers, and hence, proper recommendations have been suggested for the steady growth of renewable power [22,23,24]. Given the enormous potential of renewables in the country, coherent policy measures and an investor-friendly administration might be the key drivers for India to become a global leader in clean and green energy.

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 within 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

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 [10]. 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 [11–13]. 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 food

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 150,000 MW has been tapped so far. Countries like Norway, Canada, and Brazil have all been utilizing more than 30% of their hydropotential, while on the other hand India and China have lagged far behind. India ranks fifth in terms of exploitable hydropotential 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 is shown in Table 4 [14]

Table 4

Basin wise assessed hydropower potential [11].

Basin/Rivers	Probable installed capacity (MW)
Indus basin	33,832
Ganga basin	20,711
Central Indian river system	4152
Western flowing rivers of southern India	9430
Eastern flowing rivers of southern India	14,511
Brahmaputra basin	66,065
Total	148,701

Narmada Hydroelectric Development Corporation website.

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