International Research Journal of Engineering and Technology (IRJET) e-ISSN: 2395-0056
Volume: 08 Issue: 07 | July 2021 www.irjet.net p-ISSN: 2395-0072

Renewable Energy Resources and their Potential in India

Shourya Bansal[1], Vipul Chauhan[2], Dr. J.P. Kesari[3]

[1,2]Student, Dept. of Software Engineering, Delhi Technological University, New Delhi, India
[3]Associate Professor, Dept. of Mechanical Engineering, Delhi Technological University, New Delhi, India

---

Abstract - *The Reason Behind the Deployment of Renewable Resources in India is economic development, energy security, improved access to energy, and preventing climate change due to global warming. Strong government policies and an increasingly advancing economy has made India one of the world's most attractive markets for renewable resources. The government of India has designed many frameworks and policies that are going to incentivise foreign investment to ramp up the country in renewable resources. This paper seems to present the significant accomplishments and the future prospects and projections of renewable resources in India.*

Key Words: **India, Renewable Resources, Renewable Energy, Policies, Future Prospects**

1.INTRODUCTION

In recent years India's economic prowess has started to grow at an unparalleled pace. The reason behind this is that India has emerged as one of the top choices of the investors from developed nations. With the huge influx FDI has led to increase in employment, and growth in the quality of life. India is now the fifth largest economy in the world. India has made some significant strides in the economics sector in the last decade. India in the last decade invested heavily in the renewable energy sector. India provides an ideal and favourable environment for renewable energy due to its geographical location.

1.1 Renewable Energy

Renewable energy sources refer to biomass energy, solar energy, wind energy, ocean energy and geothermal energy. The renewable energy is the energy obtained from renewable resources. Renewable resources are the resources that can be used repeatedly because these resources get replenished within a certain period of time naturally.

The demand for renewable resources is increasing on an exponential scale due to the rise in population and economic development. One of the major reasons behind the increase in the demand of renewable resources is the depletion of non-renewable resources and the global warming caused by the excessive use of non-renewable resources.

Energy from nuclear resources puts less strain on the limited supply of non-renewable resources such as fossil fuels. It is believed that demand for renewable resources is going to increase manifolds in the coming decade. The Use of Renewable Resources on a large scale is costly, and more research is needed for their utilization to be cost-effective.

1.2 Types of Renewable Resources

So there are major seven basic types of Renewable energy. And there benefits are that every country in the world is able to utilize at least one or two types of renewable energy depending on its geographical location and climate. Six basic types are - Solar, Geothermal, Wind, Ocean, Hydropower, and Biomass.

2.1 Hydropower

Hydropower is also commonly known as water power, it is the use of fast running water to convert the potential energy of water into kinetic energy which is then used to run turbines that are used to produce hydroelectricity.

In 2018 total electricity generation was 26.7 PWh of which 16% was generated from hydropower plants. Hydropower is a form of renewable resource because the water cycle is an endless, constantly recharging system, hydropower is considered a renewable resource.

2.1.1 Technological Status

Hydroelectricity generation is often regarded as a developed or mature technology, which is unlikely to advance any further. But for Small-Scale hydropower, there is still a room for more development and with technological advancements, the choice of very favourable sites, the costs of the small-scale Hydropower plant can be substantially brought down.

2.1.2 Environmental and social challenges

Modern Hydropower plants receive a lot of criticism due to the negative impact it has on the environment. During the land acquisition process and construction of the dam a lot of people are displaced and there is a large loss of vegetation and biodiversity. This has a significant effect on the environment. Some of the most important impacts are the displacement of indegenious local communities, sedimentation, changes in the fish biodiversity and deterioration of water quality standards and human health standards. However it is important to note that Hydropower projects have almost zero greenhouse gas and air pollutants emissions.

2.2 Biomass

Biomass is a fuel made of organic materials. It is a sustainable source of energy used to create electricity and many other forms of power. Biomass is mainly of fours basic types-

Table -1: Types of Biomass and Examples

Type of Biomass and Examples			
Woody Biomass	**Non Woody Biomass**	**Processed Waste**	**Processed Fuels**
Tees	Grass	Cereal husks	Biogas
Bushes such as coffee and tea	Cereal straw	Plant oil cake	Producer Gas
Shrubs and scrub	Swamp and Water plants	Sawmill waste	Methanol and ethanol
Palm, Bamboo	Energy crops such as sugarcane	Municipal Waste	Charcoal form water and residues

Biomass resources are easily available in most parts of the world. This has helped in increasing the contribution of biomass energy. If sophisticated technology is used, biomass can make a significant contribution to the world's energy needs. Although till date most of the biomass energy is used in traditional ways such as fuel for households and not necessarily in a sustainable manner and at an industrial scale. Although with the application of suitable technologies the application of biomass at modern industrial scale is becoming increasingly commercially viable.

2.2.1 Technological status

A variety of treatment processes make the use of biomass which is a complex system that offers a variety of options. Biomass energy conversion can produce a variety of forms of energy such as heat, electricity and fuels. Solid Biomass is used in domestic biomass based heating systems. In many developing countries biomass use has decreased since the introduction of improved stoves for cooking purposes. Solid Biomass is converted into fuel gas by gasification technologies, which are still in the developmental phase. The gas produced in this process can be used to generate electricity and produce hydrogen. Anaerobic digestion of biomass such as agricultural waste, manure, municipal waste and plant waste leads to breakdown of organic matter which produces biogas. In India there is widespread production of biogas from plants and animal wastes. The energy released by biogas can be used as fuel, it can be used for heating purposes such as cooking.

2.2.2 Environmental And Social Issue

Biomass is a carbon neutral source of energy, which makes it a very attractive option. But most of the best suited energy crops have a larger land cover and water requirement then the food crop. Furthermore the use of pesticides also affects the quality of water, which also has an impact on plants and animals. So the use of plantation biomass results in the removal of nutrients from the soil.

2.3 Solar Energy

Solar energy refers to the energy received from the solar radiation coming from the sun. Sun radiates more energy per day than the energy used by the world annually.Only a small part of the energy radiated by the sun reaches the earth but that amount of energy is sufficient enough to help us meet our energy needs. Every hour earth receives enough solar radiation to fulfill its daily energy needs. Due to this reason solar energy is considered a renewable resource.

2.3.1 Technological status

Solar energy is a very versatile form of energy, it provides us with multiple applications. It can be used to generate heat, electricity, light and hydrogen. There are several factors that determine the extent to which solar energy is utilized. These factors include the availability of low-cost and efficient technologies, effective storage and end-use technologies. Solar energy can be used in many forms such as solar electricity, solar thermal heat, and Photovoltaic Electricity.

2.3.2 Environmental and Social Issues

Solar energy technologies also have zero carbon emission during their operation but they do cause emission during the manufacturing process. The reason behind this is that thin films in solar technologies are manufactured using dangerous heavy metals. such as cadmium telluride. This material is also present in coal and oil, it is released on their combustion. At the point of generation of electricity solar energy requires large areas for energy collection. Due to this, the solar facilities often interfere with the current land use and often harm the wilderness of the area. The construction of solar facilities on large areas of land results in soil compaction and increased erosion. The central tower system requires water for cooling, which is of great concern in arid regions because an increase in water demand will put strain on the limited existing water resources. And as well as there is risk of chemical spills from facilities which can lead to the contamination of groundwater. Recycling of Solar panels is also an issue

since there are not many recyclers of solar panels around the world. Recycling of solar panels is particularly important because there are many precious metals used inside of the solar panels. Due to the unavailability of resources and facilities required to recycle solar panels, these precious recoverable metals are going to waste which can lead to scarcity of these metals in the future.

2.4 Wind Energy

Wind energy is used to describe the electricity which is produced by the wind. A region's mean wind speed and its frequency distribution are some of the parameters that are taken into account to calculate the electricity that can be produced by the use of wind turbines. Some technical advances are expected to open it to some new areas of development.

2.4.1 Technological Status

While Large-scale Wind turbines have a mature technology, and they can be sited near or within the cities, where good mean wind speed and wind frequency distribution can be identified.But Small wind turbines are still emerging near the cities. One of the major reasons behind this is that small turbines are less cost-effective than large turbines and small turbines need further development, so that they can increase their efficiency and cost-effectiveness.

2.4.2 Environmental and social issues

Environmental and social aspects often come into picture in several different phases of wind turbine projects - building, manufacturing, normal operation, and decommissioning. Negative aspects of the use of wind turbines are discussed as acoustic noise emission, impact on bird behaviour, moving shadows caused by the rotors, visual impact it has on the landscape, and electromagnetic interference with television, radio, and radar signals. In practical terms, noise caused by wind turbines and visual impacts are one of the biggest causes of problems for development of wind farms.

2.5 Geothermal

Geothermal energy is referred to as the heat coming from the sun. It has a large potential in theoretical terms but practically a small amount of it can only be classified as reserves and resources. Geothermal energy is widely distributed. The technological capacity to use geothermal, not its amount, will determine its future contribution to the world's energy sector. Low temperature fields can be found in most countries but High-temperature fields that are used for conventional power production are mainly found in the areas with young seismic, volcanism, and magnetic activity.

2.5.1 Technological status

There are many areas in which geothermal energy might be developed in the future to provide more power. There is also a scope for the identification and exploitation of undersea geothermal resources. One of the main avenues in the immediate future is by the process of the development of hot dry rock , with better drilling methods. There are some underground reservoirs that have very high temperature and pressure brine with water having a temperature more than 375 degree celsius and pressure of 220 bars. In these conditions the water is in the supercritical state. If this supercritical steam could be extracted ,it could provide 10 times more energy than the traditional geothermal reservoirs. However, the technology required to extract and exploit such steam has not been developed till now. Geothermal use is commonly divided into two main categories. First one being electricity production. And the second one being the direct application of geothermal energy such as space heating and cooling, fish farming, industry and health spa. The cost-effectiveness, reliability, and environmental acceptability of direct use of geothermal energy has been proven around the world.

2.5.2 Environmental and social issues

Geothermal fluids have a variety of gases present in them, mainly nitrogen and carbon dioxide with some hydrogen sulphide and smaller proportions of mercure, ammonia, radon, and boron. The concentrations of the gases present are not harmful. The gas emissions from low-temperature geothermal facilities are normally a fraction of the gas emitted from high-temperature resources which are generally used for the generation of electricity..

2.6 Ocean energy

Ocean energy is made up of different types of energies such as tidal energy, wave energy and ocean thermal energy. The theoretical potential of all the types of ocean energies is quite large but the highest potential is of ocean thermal energy. However like other renewable energy resources ocean energy resources are diffuse, which make the usage of this energy difficult.

2.6.1 Technological status

The rise and fall of tides create an effect of a low-head hydropower system. Tidal energy has been exploited for centuries in the form of water mills. Wave energy remains at the experimental stage, with right now only a few prototypes giving the desired output. Electricity can be produced from marine currents if their velocity is high enough. The various turbines developed to use marine current energy often coincide with those developed for the wind turbines. Potentially the largest source of renewable

energy is exploiting the natural temperature difference in the sea using some technologies. The temperature difference should be as large as possible to deliver a technically feasible and reasonably cost-effective system on the basis of laws of thermodynamics. Ocean thermal energy conversion (OTEC) has a requirement of about 20 degree celsius, and so this limits the application of this technology to only some tropical regions with deep water.

2.6.2 Environmental and social issues

Marine technologies tend to have minimal offshore impact. Few facilities produce pollution while in operation. Tidal barrage is an exception, it produces some effect on marine biodiversity. In it the creation of a large artificial sea-water lake behind tends to affect fish breeding and marine biodiversity. Another such process is ocean thermal energy conversion, which may lead to release of carbon dioxide from seawater to the atmosphere. None of the technologies that we have so far discussed tend to cause any big measurable harm to the fish or marine biodiversity.

3. Accommodation of Renewable resources in India

Accomodation of renewable energy resources is important to combat the exponentially increasing pollution and also fulfill the ever increasing energy demands. Fortunately, India is a country rich in Renewable Energy Resources. India provides an ideal and favourable environment for renewable energy due to its geographical location. Now we explore and provide various implementations of renewable energy resources in India's context.

3.1 Solar Thermal Power

There are various possible Solar Thermal applications such as space heating, cooking, water heating, drying etc. Electricity generation is also possible in the Solar Thermal Electric power plants. These plants use the sun's energy at high temperatures using collectors and generate high-pressure steam. This steam, in turn , is used for conventional generators to generate electricity. Another possible usage is that of photovoltaic cells to directly convert the sun's energy to electric energy. In terms of solar electricity production per watt , India is ranked number one and this provides a good base for the further expansion of this renewable energy resource.

The photovoltaic cells can be placed on rooftops and it avoids land usage. As of 2015, the total installed capacity of grid connected Photovoltaic power systems is almost 4101.68 MW.

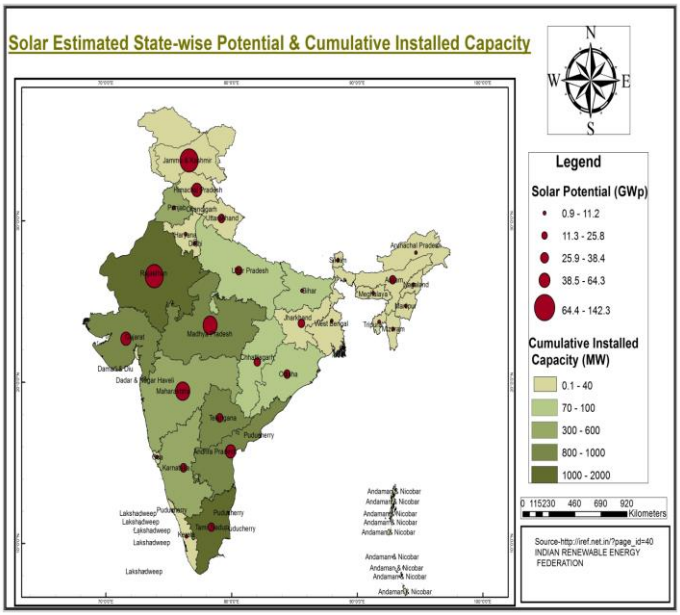

Fig -1: State-wise solar estimated potential

3.2 Hydroelectric Power

In terms of Hydroelectric Power production, Indian is ranked sixth in the world. This provides a stable base and a huge potential for growth of this renewable energy resource. In India itself, this is the largest renewable energy resource.

The installed capacity currently stands at approximately 40,661.41 MW, which accounts for 16.36% of the total electricity generation in India. India's Hydro Potential is huge, it is about 84,000 MW at 60% load factor and this can be economically exploited. Currently, around 49 large hydropower plants are under construction which can be completed as soon as 2022 with a total cumulative capacity of 15,006 MW. Additionally, potentially 6,740 MW of installed capacity from mini, small and micro hydel schemes are identified. Also, pumped storage schemes with an average installed capacity of 94,000 MW are assessed.

Pumped storage schemes can be helpful for meeting peak load demands, and also for storing the surplus electricity, which can be used to produce electricity at no aggregate cost when the rivers are flooding.

Table 1

Year/Period	Energy Supply Position (MU)				Peak Demand/Peak Met (MW)			
	Requirement	Availability	Deficit (-)	Deficit (-) (%)	Peak demand	Peak Met	Deficit (-)	Deficit (-) (%)
April - August, 2018	547611	544403	-3208	-0.6	172381	170765	-1616	-0.9
August, 2018	111970	111443	-527	-0.5	170976	170182	-794	-0.5

Table 2

Region	Assessed (MW)	Status of Hydro Electric Power Potential as on 31.03.2012							
		Developed		Under Construction		Developed+ In Construction		Balance	
		MW	%	MW	%	MW	%	MW	%
Northern	52263	19023.3	36.40	5516.5	10.56	24539.8	46.95	27723.2	53.05
Western	8131	5552.0	68.28	400	4.92	5952.0	73.20	2179.0	26.80
Southern	15890	9658.9	60.79	1090	6.86	10748.9	67.65	5141.1	32.35
Eastern	10680	4922.5	46.09	1253	11.73	6175.5	57.82	4504.6	42.18
N-Eastern	58356	1427.0	2.45	2744	4.70	4171.0	7.15	54185.0	92.85
Total	145320	40583.7	27.93	11003.5	7.57	51587.2	35.50	93732.9	64.50

Table-2: Time-wise and Region-wise Hydo- electric power potential

3.3 Wind Energy

Theoretically, the extractable power from wind is in proportionality to the cube of its velocity and also the energy generation depends on rotor size of the turbine and the wind speed.

The estimated potential energy resources(wind based) are 102,788 MW assessed at 80m hub height. The installed capacity of wind derived power in India was 22,645 MW as of March 30th, 2015. By the year 2022, a target of 60,000 MW is set for wind generation capacity. The initial assessments for the possible wind energy resources alongside the 7,6000km long coastline has shown prospects of development of possible offshore wind power because the wind speeds there are higher and steadier.

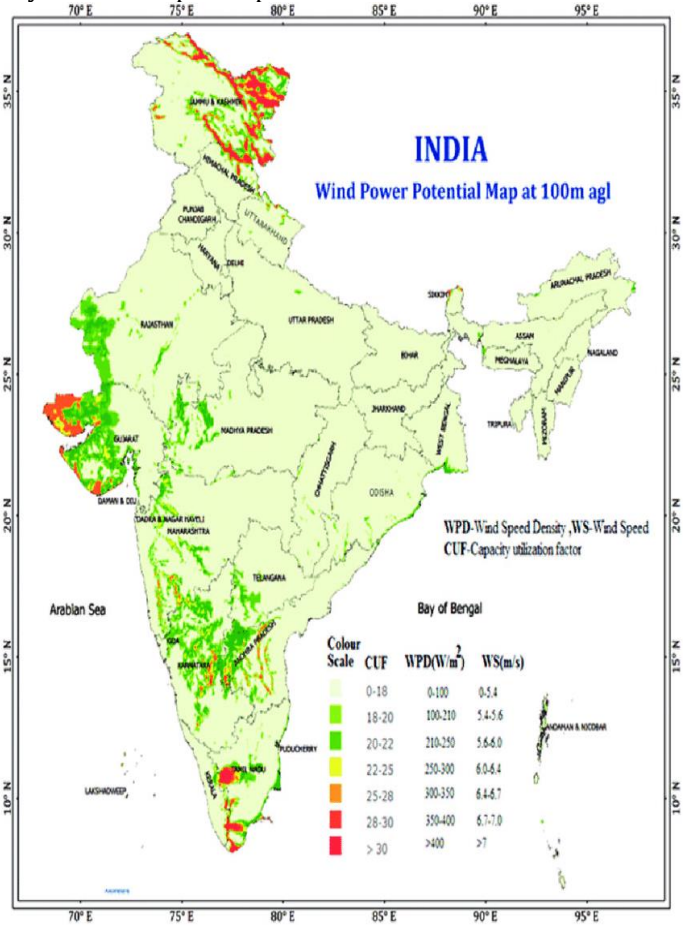

Fig -2: Wind Power Potential Map

3.4 Biomass Energy

A huge part of 70% of the country's population currently depends on biomass energy needs. It is widely available, renewable and also free of greenhouse and other polluting gases. Biomass majorly consists of forest and agricultural resources such as animal and plant manure. To produce energy, combustion of biomass is one viable option. Biomass can indirectly also be converted to various kinds of biofuels such as methanol and ethanol and can be further used in engines. Biogas, which is a form of gaseous fuel, can also be obtained from biomass by anaerobic fermentation. In total 288 biomass power plants and cogeneration plants with a total of 2,665 MW capacity have been installed in the country to feed power to the grid. Bagasse, which is the residue of crushing cane in mills, cogeneration projects approximately have the capacity of 1,666 MW. Till, 2022 a target of 10,000MW was set for the biomass energy resources.

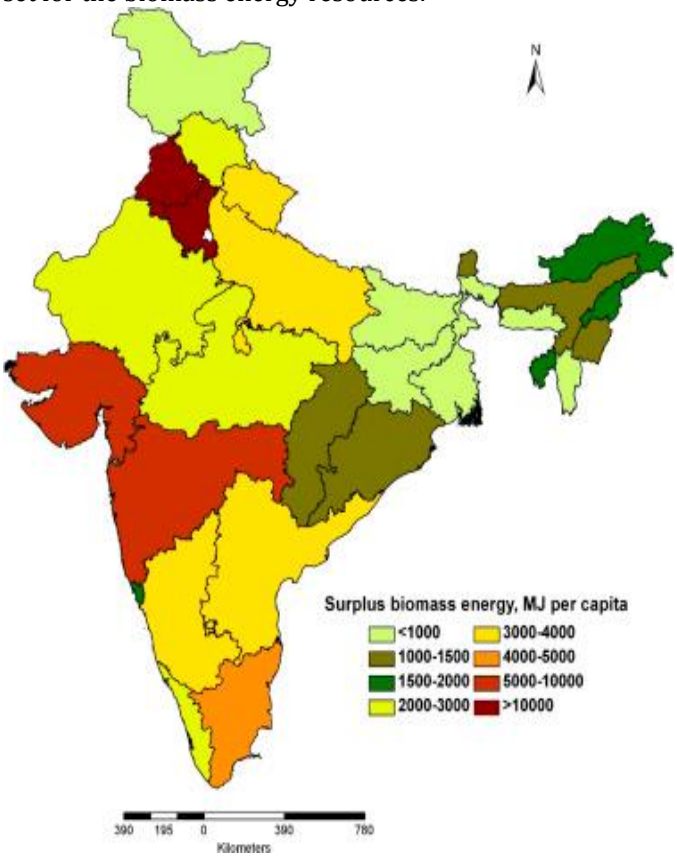

Fig -3: State-wise Surplus biomass energy

3.5 Tidal Energy

There are several ways in which electric energy can be extracted from tides, by constructing a big reservoir behind a barrage, then allowing tidal water to pass through turbines, in the barrage, in order to generate electricity. According to the current estimates, India's current tidal energy potential is around 8,000 MW. Due to lesser progress , a huge potential lies in the tidal energy sector. An agreement was recently signed to implement the country's first 3.75 MW mini-tidal power project, in the state of West Bengal.

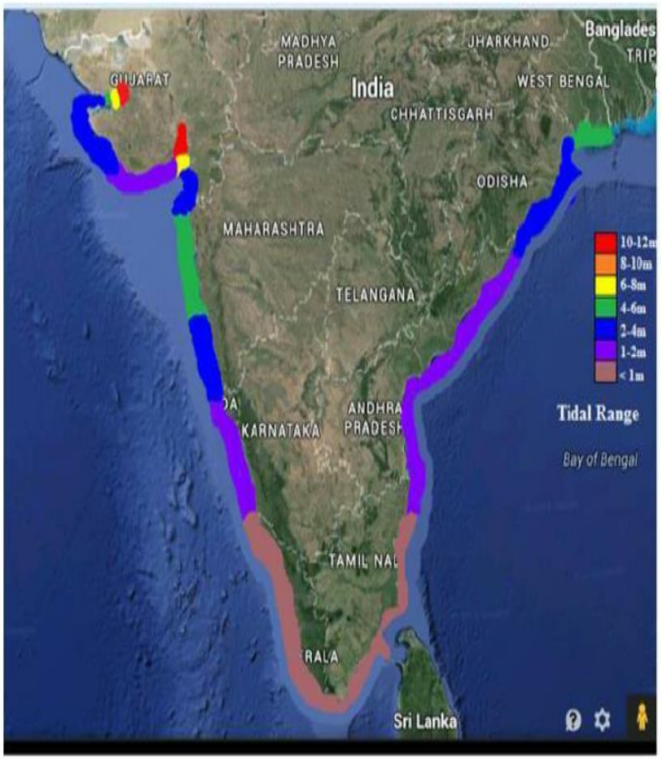

Fig -4: Tidal Energy Potential in the Coastal Region

3.6 Geothermal Energy

The water at high temperatures and the steam from the interiors of earth come to the surface at some places, and this can be used for the generation of electric energy, usage in residential and industrial heating, and also greenhouses. According to the estimates, currently India has a potential of 10,600 MW in the geothermal energy sector and a majority of it still needs to be exploited. The MNRE(Union Ministry of New and Renewable Energy) has recently drafted a national policy, which aims to exploit this energy resource by generating around 1,000 MW in phase-1 by 2022.

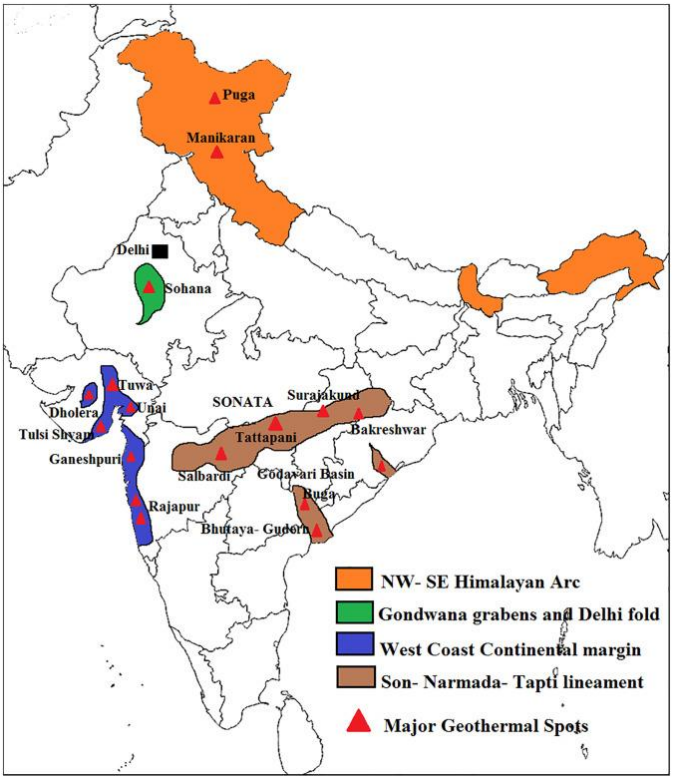

Fig -5: Major Geothermal Spots and Areas

3.7 Wave Energy

Wave energy is the indirectly available energy derived from solar energy- by the interaction of the water surface and the wind. Wave energy can either be generated from variations of pressure under the water surface or directly from surface waves. Devices known as wave energy converters can be used as they can capture the wave power for the generation of electricity and also to extract useful work such as water desalination and/or pumping of water. Indian coastline spans 7,500km with an estimated potential of wave energy found to be about 40,000 MW.

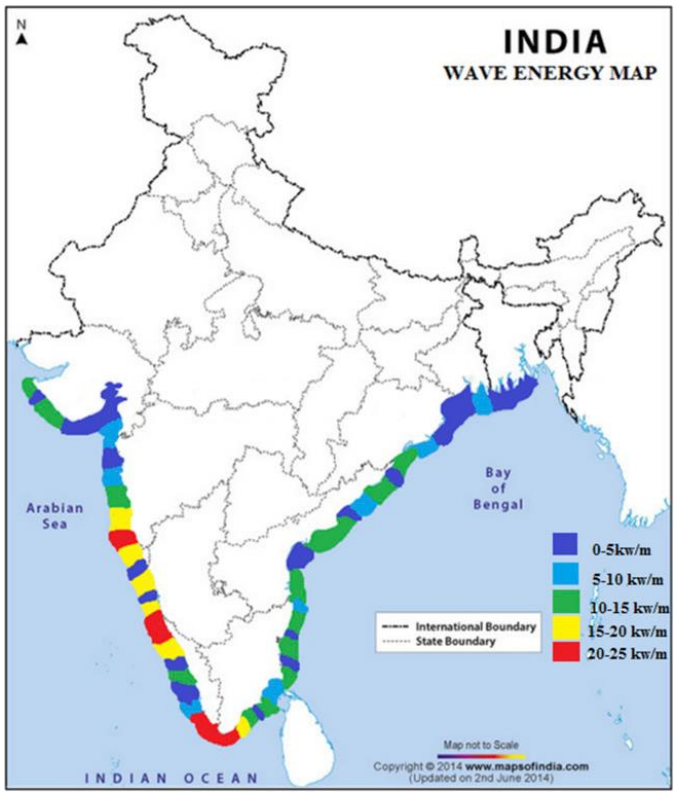

Fig -6: Wave Energy Potential Map

ACKNOWLEDGEMENT

The authors wish to acknowledge Dr. J.P. Kesari and Delhi Technological University for their complete support throughout their work.

REFERENCES

[1] www.geni.org/globalenergy/library/energytrends/currentusage/renewable/Renewable-Energy-Potential-for-India.pdf
[2] https://energsustainsoc.biomedcentral.com/articles/10.1186/s13705-019-0232-1
[3] https://ren21.net/Portals/0/documents/irecs/renew2004/The%20Potentials%20of%20Renewable%20Energy.pdf
[4] https://www.researchgate.net/figure/Tidal-Energy-Potential-in-India_fig7_292527041
[5] https://www.researchgate.net/figure/Map-showing-wind-power-potential-at-100-m-AGL-26_fig3_332702533
[6] https://www.researchgate.net/figure/Wind-power-potential-in-India-Source-Centre-for-Wind-Energy-Technology-C-WET_fig3_6174926
[7] https://www.electricalindia.in/indias-hydro-power-potential/
[8] http://terienvis.nic.in/index3.aspx?sslid=4017&subsublinkid=1335&langid=1&mid=1
[9] https://www.electricalindia.in/the-potential-of-renewable-energy-sources-in-the-energy-sector-in-india/