Empirical Study & Analysis of Wind Energy Opportunities in India

Abstract

This research paper discusses about the Wind Energy which is a renewable resource among the energy sources. The purpose of this research is to have a evaluation of opportunities for a sustainable, round the clock available energy source like wind energy in the growing energy demands across India. It contains the information about the role and importance of wind energy in the energy matrix of various sources where factors like cost, availability and pollution related issues energy industry is facing. With a primary data of local wind mill field visit, it gives a peek into the wind mill technical functioning and understanding of technologies and scale of manufacturing facilities available in India.

The secondary data collected by the researcher is critically analyzed for having an insight on the wind energy sector utilization scope and evaluated the present and future prospectus of harnessing the wind energy. Due to the short available time to the research, the geographical boundary limit of the study is focused within India only though there is ample scope for prevails for extending the research in the global level. Also, the data pertaining to last 7 years is considered for discussions in the research which is an appropriate time period for relevance of the study to project the future trends.

This research paper discusses on comparative aspects of wind energy with reference to other energies that are being generated and the government policy measures for incentivizing the wind energy business. Also, new areas for wind energy development with increasing opportunities and attractive investment potential in off shore areas are discussed.

Finally, research concludes on the role of wind energy in our daily lives and constraints and ways to overcome them by use of new technologies which is also a matter of further research. Also, it states on importance of need for a strategy of sustainable development to the mankind to have a pollution free qualitative life in the future to witness and efforts needed to make it realize by budding nation building pillars of generation next.

Table of Contents

1. Introduction

Since my early childhood, sight of big fans erected in a plain land, hills, sea shores always enticed me. Their gigantic blades rotating in circular fashion facing the wind brought vivid imaginations in my tender mind and excited me and I used slip into creative thoughts without knowing what was the purpose of it. Now as a grown-up child my perspectives are different whenever I spot a 3 blade fans revolving and I wish to be on top of its turbine one or the other day.

Energy is fundamental to daily life, whether it is providing lights for our classrooms, refrigeration for our food and medicine, pumps to irrigate our crops, or electricity to run our commercial and industrial enterprises. Energy is the lifeline for growth and development of any economy. Particularly in the case of developing countries, energy sector is more crucial in view of the ever-increasing energy needs and huge investments required to meet them. Broadly, energy includes coal, lignite, petrol, diesel, kerosene, LPG, natural gas, biomass and electricity. The electrical energy comprises of thermal power, hydropower, nuclear power, wind power, solar power and power from the wastes. Here, I am going to discuss about my works on Wind Energy.

1.1 Wind as an Energy Source:

Wind is air in motion. It is a clean, free, and readily available renewable energy source which has no waste by products, and causes no pollution. The origin of wind energy is sun. When the sun rays fall on the earth, its surface gets heated up and as a consequence, winds are formed. The main purpose of the wind energy is to create energy source which is pollution free and come with a reasonable price. The wind energy used in wind turbines are increasing their demand and becoming popular in the green energy world. Each day, around the world, wind turbines are capturing the wind's power and converting it to electricity. Wind power generation plays an increasingly important role in the way we power our world – in a clean, sustainable manner. The global movements towards sustainable energy are leaving fossil fuels behind in favor of renewable energy like solar or wind power. There will always be wind, whereas resources like oil will eventually run out.

1.2 Importance of Wind Energy among Energy Resources:

Wind energy is important because it holds immense potential in supplying electricity across the world. Unlike other sources of electricity that require fuel in processing plants, wind energy generates electricity through wind, which is free. Wind energy is the most cost-effective renewable energy source on global scale. Wind doesn't emit contaminants into lakes and streams, and it doesn't produce hazardous airborne pollutants and greenhouse gas emissions (a single 1-MW wind turbine can save around 2,000 tons of carbon dioxide in one year) and has overall positive environmental impact, despite the isolated cases of bird killings and noise pollution.

More wind energy means thousands of new energy jobs to help decrease current unemployment rate and boost our economy. Wind energy improves our energy independence and energy security. More power coming from wind farms means that there is a reduced need for expensive foreign oil import. Wind energy industry is together with solar energy the fastest growing renewable energy industry in the world as wind power capacity continues to grow rapidly at both regional as well as the global level.

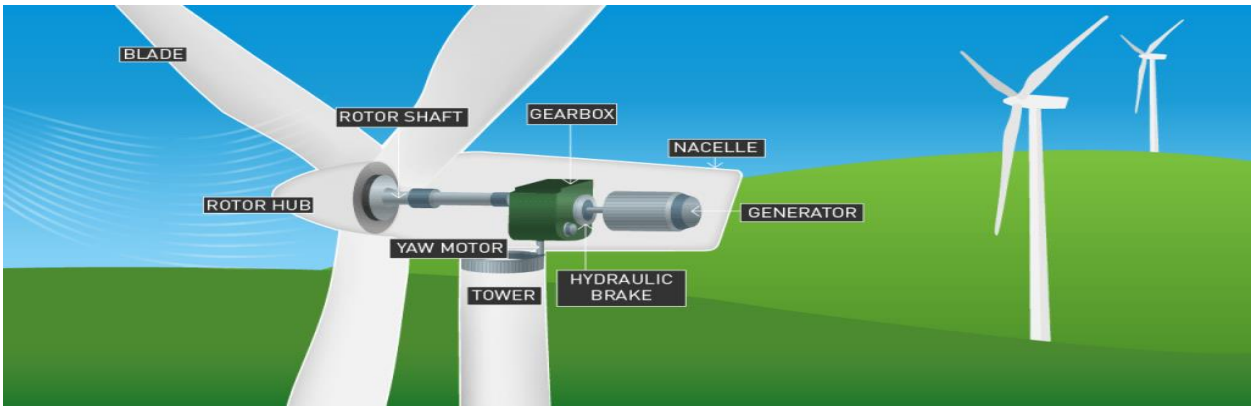
2. Methodology of this research: The methodology followed here during research is primary data collection by field visit of nearby 5 windmills at Navinal and 2 wind mills near Bhadreshwar enroute to Gandhidham from Mundra to understand the functioning of the wind turbine and its practical technology related aspects. Further as secondary sources of data, extensive browsing through the energy websites of government and research establishments done.

2.1 Generation of wind power:

Wind power is harnessed by setting up a windmill which is used for pumping water, grinding grain and generating electricity or by a wind turbine which is the most common electricity-generating method. The wind turbine converts the wind's kinetic energy into electrical energy. When the wind blows, the turbine's blades spin clockwise, capturing energy. This triggers the main shaft of the wind turbine, connected to a gearbox within the nacelle, to spin. The gearbox sends that wind energy to the generator, converting it to electricity. Electricity then travels a transformer,

where voltage levels are adjusted to match with the grid. Harvesting wind energy is possible only in the areas that receive fairly continuous wind such as islands, coastal areas and mountain passes. Areas with constantly high speed preferably above 20 km per hour are well-suited for harnessing wind energy. The production of wind power is quite unpredictable because it depends upon the wind speed. When wind speed is low, less electricity is generated.

Fig1. Parts of a Wind mill



2.2 Technology development and manufacturing base for Wind Power:

The Wind Turbine Generator technology has evolved and state-of-the-art technologies are available in the country for the manufacture of wind turbines. Around 75% localization has been achieved with strong domestic manufacturing capacity for wind energy turbines and its components in the country. All the major global players in this field have their presence in the country and over 31 different models of wind turbines are being manufactured by more than 13 different companies. The unit size of the largest machine has gone up to 3.46 MW.

Wind turbines and components manufactured in India are also being exported to various countries. The current annual production capacity of wind turbines in the country is about 8000 MW to 10,000 MW.

3. Results of the research: The results of this research focused on getting the current status of India's efforts on identifying wind energy as a potential contributor in the energy matrix of the country and its efforts to capture the wind energy resources by actual implementation.

3.1 Potential of Wind Energy in India:

Wind is an intermittent and site-specific resource of energy and therefore, an extensive Wind Resource Assessment is essential for the selection of potential sites. The Government, through National Institute of Wind Energy (NIWE), has installed over 800 wind-monitoring stations all over country and issued wind potential maps at 50m, 80m and 100m above ground level. The recent assessment indicates a gross wind power potential of 302 GW in the country at 100 meter above ground level. Most of this potential exists in seven windy States as given in the table below:-

Table 1. Wind power potential in India at 100 and 120 M Above Ground Level

Sl. No	State	At 100M AGL(GW)	At 120 M AGL(GW)
1	Andhra Pradesh	44.23	74.90
2	Gujarat	84.43	142.56
3	Karnataka	55.86	124.15
4	Madhya Pradesh	10.48	15.40
5	Maharashtra	45.39	98.21
6	Rajasthan	18.77	127. 75
7	Tamil Nadu	33.80	68.7
	Total (7 windy States)	292.97	651.72
	Other States	9.28	43.78
	All India Total	**302.25**	**695.50**

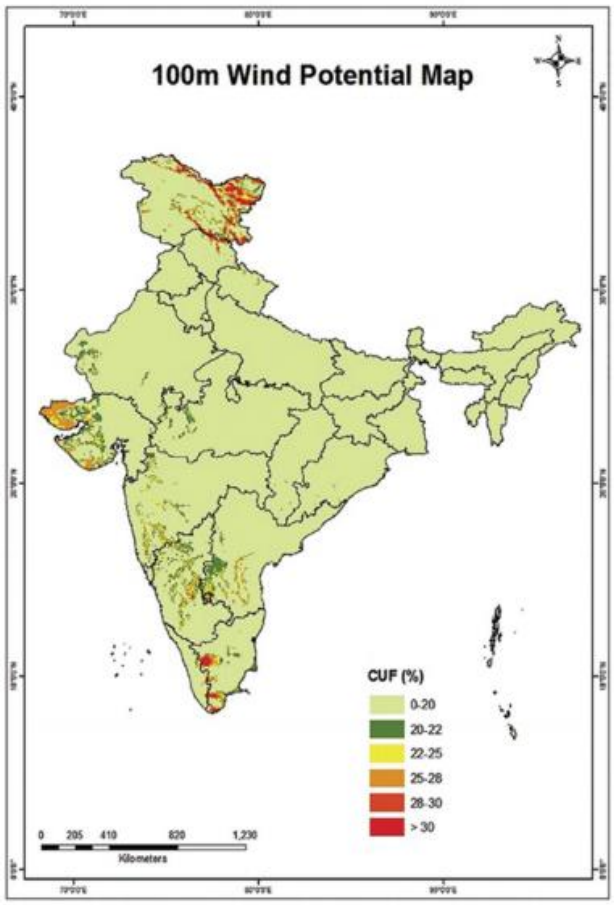


Fig1.Wind Potential Map at 100M above ground level

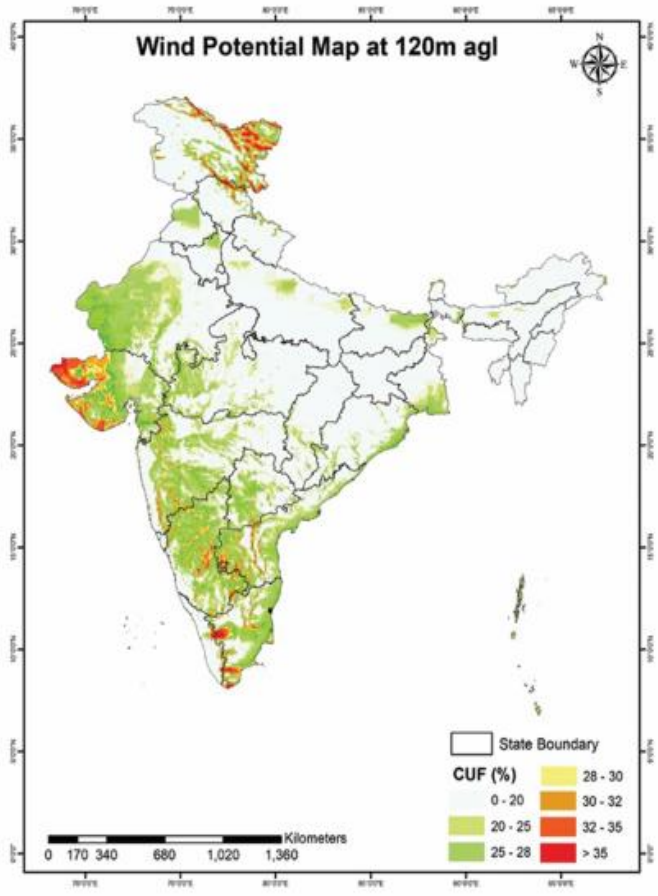


Fig2.Wind Potential Map at 120M above ground level

3.2 Installed capacity of Wind Power in the country:

India's wind energy sector is led by indigenous wind power industry and has shown consistent progress. The expansion of the wind industry has resulted in a strong ecosystem, project operation capabilities and manufacturing base of about 10,000 MW per annum. The country currently has the fourth highest wind installed capacity in the world with total installed capacity of 38.62 GW (as on 31st December, 2020) and 64.64 billion Units were generated from wind power during 2019-20.

Table3.Installed Capacity

Sl. NO	State	MW
1	Andhra Pradesh	4092.450
2	Gujarat	8192.52
3	Karnataka	4868.80
4	Kerala	62.500
5	Madhya Pradesh	2519.890
6	Maharashtra	5000.330
7	Rajasthan	4326.82
8	Tamil Nadu	9428.44
9	Telangana	128.10
	Other States	4.300
	All India Total	**38624.15**

Table 4. The year-wise electricity generation from wind energy source

Sl. NO	Year	Generation (MU)
1	2014-15	33768
2	2015-16	33029
3	2016-17	46004
4	2017-18	52666
5	2018-19	62036
6	2019-20	64639
7	2020-21 (up to Nov20)	46367

4. Discussions: As emphasized in the research, though the potential for harnessing the wind power in the country is enormous, reaping its practical implementation over the years is only about 13% which indicates that there is lot of scope for further strategy in the sector. Also, annual energy consumption share from wind energy is yet to reach 5% among overall consumption.

4.1 Comparative analysis on wind energy:

Wind power generation capacity in India has significantly increased in recent years. As of 31 December 2020, the total installed wind power capacity was 38.789 GW, the fourth largest installed wind power capacity in the world. Wind power capacity is mainly spread across the Southern, Western and Northern regions. Wind power costs in India are decreasing rapidly. The levelized tariff of wind power reached a record low of ₹2.43 per kWh (without any direct or

indirect subsidies) during auctions for wind projects in December 2017. However, the levelized tariff increased to ₹2.77 per kWh in March 2021. In December 2017, union government announced the applicable guidelines for tariff-based wind power auctions to bring more clarity and minimize the risk to the developers.

4.2 Incentives available for Wind sector:

The Government is promoting wind power projects in entire country through private sector investment by providing various fiscal and financial incentives such as Accelerated Depreciation benefit, concessional custom duty exemption on certain components of wind electric generators. Besides, Generation Based Incentive (GBI) Scheme was available for the wind projects commissioned up to 31st March 2017. In addition to fiscal and other incentives as stated above, following steps have also been taken to promote installation of wind capacity in the country. Firstly, Technical support including wind resource assessment and identification of potential sites through NIWE, Chennai. Secondly, in order to facilitate inter-state sale of wind power, the inter-state transmission charges and losses have been waived off for wind and solar projects to be commissioned by June, 2023.

4.3 Offshore Wind development in India:

India is blessed with a coastline of about 7600 kms surrounded by seawater on three sides and has tremendous power generation potential from off shore wind energy. Considering this, the Government had notified the National Off shore Wind Energy Policy as per the Gazette Notification dated 6th October 2015. As per the policy, Ministry of New and Renewable Energy will act as the nodal ministry for development of Off shore Wind Energy in India and work in close coordination with other government entities for Development and Use of Maritime Space within the Exclusive Economic Zone (EEZ) of the country in an effective manner for production of enormous quantity grid quality electrical power for national consumption.

National Institute of Wind Energy (NIWE), Chennai has been designated as the nodal agency to execute various pre-feasibility activities relating to resource assessment, surveys and studies

within EEZ (Exclusive Economic Zone), demarcation of off shore potential blocks and facilitating off shore wind energy project developers for setting up off shore wind energy farms.

Off shore wind in India has a potential of approximately 70 GW mainly of Tamil Nadu and Gujarat coasts. Eight zones each of the coasts of Gujarat and Tamil Nadu have been identified as potential off shore zones. Measurement of wind resources through Lidar at Gulf of Khambhat of Gujarat coasts, survey of subsea surface and soil, Geo-physical survey of 365 sq kms of area (required for a 1.0 GW project) and geo technical studies at various locations have been carried out of Gujarat Coast. Similar studies and surveys are planned for areas of the coast of Tamil Nadu for which Government of Tamil Nadu has already allocated land to NIWE. The Ministry has constituted a committee to analyze a suitable strategy for off shore wind energy programme for the country.

5. Conclusion

Overall, wind energy as a source for electricity production could be a future solution for the diminishing fossil fuels, a cleaner source of energy and reduced economic costs. However, there are serious limitations such as the reliability of wind, where to build wind farms and the inability to store electricity. It seems that a combination of sustainable sources of energy from wind, solar, hydro and biomass would help to reduce our reliance on fossil fuels and be an effective substitute in electricity production. Overall, societies need to integrate renewable energy for a greener less polluting society by increasing wind energy share to minimum 10% from the current less than 5%. Industries need to adopt the government policy for better implementation.

Wind energy development continues to spread in new ways and to new places to meet the energy needs of people around the world. Wind energy technology is adapting and refining to become more efficient and economical. One example of this: high-altitude devices, which take advantage of the more powerful and more consistent winds at higher altitudes. This class of emerging wind-harnessing technology, also called Airborne Wind Energy Systems (AWES).

For India, wind power and other renewable energy technologies play a key role in supporting future generations. Increasing wind power production will help to provide the country with a source of cheap and renewable electricity. It will also help to reduce the country’s reliance on

traditional energy sources – such as coal. This, in turn, will help to improve the quality of the nation's air and reduce land pollution at the same time. It is said that between 2020 and 2050, fossil fuel demands will push prices higher than ever seen before. During this period, India will be well placed as a producer of its own renewable energy. This will help to offset the increasing costs of fossil fuel consumption.

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