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ASSESSMENT OF POLICY AND POTENTIAL AVAILABILITY TO GENERATE ELECTRICITY USING WIND ENERGY

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ABSTRACT –

The need for energy is expanding day by day with the increasing population and economic growth of the country. India has a high potential for installing wind energy power projects. Wind power covers about 45 percent of total renewable energy capacity. This review paper presents the development and status of wind power capacity in India as well as in the world. Wind energy is the best alternative to conventional sources as it has no harm to the environment and it is a clean energy project. In this paper government, innovative policies, and development in the wind power sector are discussed. The government of India shows its interest in offshore wind power installation to increase the capacity of the wind power sector. State-wise development policies and market growth of wind energy are discussed. India is currently the fourth-largest wind power-producing country in the world. This paper also describes the challenges in the wind power sector and new technologies for wind turbines. Wind energy is the most efficient and high-potential energy source in India.

Keywords - Indian Govt. policies and state-wise potential of wind energy, wind energy.

1. INTRODUCTION

In India most of energy is carried out from renewable source of energy. India power generation from renewable sources of energy is 10.325 billion units (Bu) in January 2020. As compared to last year Jan 2019 it increases by 9.46 percent as a report released by the Central Electricity Authority (CEA), an arm of the power ministry. Among renewable source of energy highest amount of power is generated from wind energy 3,943 million units (Mu) and after wind energy 3,932 million unit is generated by solar energy. In India total of 817 MW of wind energy is generated in the fourth quarter of 2019. As India has a high potential for Renewable resources so, the in near future wind energy, solar energy, and biomass energy are good alternative resources to full fill the demand for energy in India. Wind energy is Turing out to be a very promising alternative energy technology of the future. In recent years wind energy produced from the wind turbine has increased due to recent initiatives in wind turbine technology. Domestic policy sport to India helps to make it the world's fourth-largest wind-producing country. In India wind energy is raising as one of the most favorable energy resources because of its advantage of a clean energy environment. For the development of renewable energy in India, the government of India set up a ministry of new and renewable energy in 2006. The main objective of MNRE is to develop wind energy status in India. MNRE makes various policies and programs to develop wind energy power plants. India had gotten a 34.4 GW grid connecting wind power in 2018 through the efforts of MNRE. MNRE promotes wind energy in all the high potential wind energy states of India. India has a high potential for offshore wind energy on the coastal line of Gujrat and Maharashtra. MNRE makes a policy about offshore wind energy to increase wind production in India and to make India highly reliable on renewable resources. Wind energy is an eco-friendly and clean energy resource of energy and wind energy has high potential in India as compared to other resources.

2. WORLDWIDE STATUS OF WIND ENERGY

The total wind power is generated from all over the world in the end of 2019 is 650,8 Gigawatt according to the report produced by world wind energy association (WWEA).In the year 2019 total 59,667 megawatt wind energy is produced. More than 6 percent of world power demand is covered by wind turbine installed at the end of 2019. The wind power generation increased nearly a fifth as 2019 is a record year in offshore wind plants growths and in US and China the onshore power projects are installed in very large amount. The Global Wind Energy Council found that 2019 is a record year in the world wind power industry. Wind power generation was increased by 60.4 GW in 2019 almost 19 percent as compare to 2018 wind power capacity [4].

In the world US and China are the two most wind power producing countries. They both produce about two-third of the whole world wind energy growth .In these countries onshore wind power development is at very high level according a report by GWEC [5]. It is expect that 20 % of wind power increases in the year of 2020. But due to COVID-19 it becomes difficult to achieve it. An also all manufacturing industries of wind energy equipment and turbines have stopped their work. In 2018 total wind power generation in the world is 591 GW .China and India are the two Asian countries that are increasing their interest in wind energy after 2010 and after they have good growth level of wind energy. China had 145GW wind power installed in 2015 and now 5% of total energy in china had cover by wind power. Some countries had a good growth level of wind power such as Denmark have 41%,Ireland have 28%,Portugal have

24%,Germany have 21% and Spain have 19% in 2018.In Scotland wind power generation capacity is higher than its electricity consumption in November 2018.

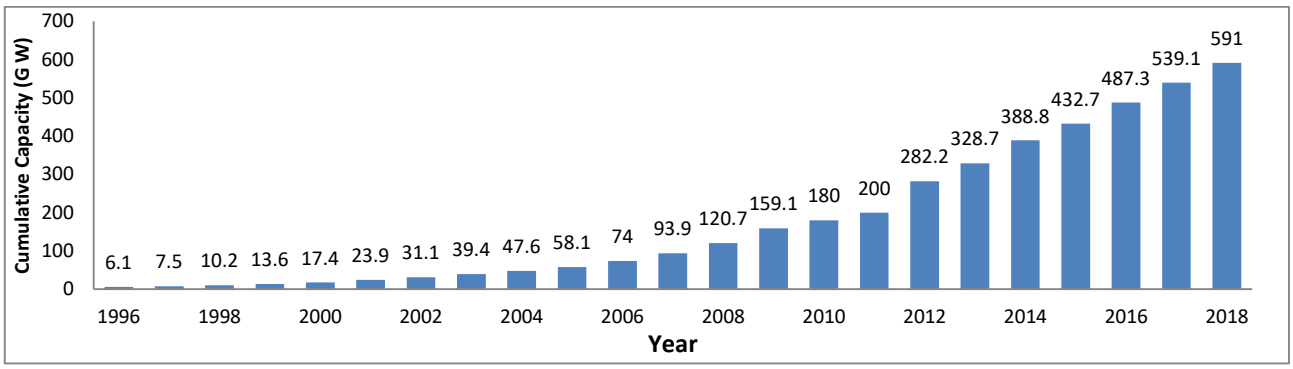

Fig. 1 Global wind power cumulative capacity

TABLE 1 Installed wind power capacity (MW) of top 10 countries till 2019

Country or Territory	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
China	44,733	62,733	75,564	91,412	114,763	145,104	168,690	188,232	211,392	236,402
European Union	84,278	93,957	106,454	117,384	128,752	141,579	153,730	169,319	178,826	-
USA	40,200	46,919	60,007	61,110	65,879	74,472	82,183	89,077	96,665	105,466
Germany	27,214	29,060	31,332	34,250	39,165	44,947	50,019	56,132	59,311	-
India	13,064	16,084	18,421	20,150	22,465	27,151	28,665	32,848	35,129	37,506
Spain	20,676	21,674	22,796	22,959	22,987	23,025	23075	23,170	23,949	-
United Kingdom	5,203	6,540	8,445	10,711	12,440	13,603	15,030	18,872	20,970	
France	5,660	6,800	7,196	8,243	9,285	10,358	12,065	13,759	15,309	16,643
Brazil	932	1,509	2,508	3,466	5,939	8,715	10,740	12,763	14,707	15,452
Canada	4,008	5,265	6,200	7,823	9,694	11,205	11,989	12,239	12,816	13,413

In 2019 total wind power generation is 19.4% is higher than the last year 2018. In 2019 total wind power produced is 60.4 GW and it becomes the second best year in the history of India to generate that amount of wind power. According to a report by GWEC 2020 will be a record year in wind power generation. Offshore wind power installation becomes the most important in increasing the capacity of wind power in the world. Offshore is expected to reach 80 GW in 2024 which is 6 GW in 2019 [4-6].

3. WIND ENERGY POTENTIAL IN INDIA

The government has decided on a target of achieving 60 GW of wind energy installation in India by 2022. As on Feb2020 total of 37,699MW wind energy is already installed and 9236 MW of wind energy project is under implantation and 1200MW of wind energy capacity is underbidding. India's wind power installation in the year 2019-20 rose to 2.07 GW, about 31% increase as compared to the year 2018-19 when about 1.58 GW wind power is installed. The cumulative installation in the year 2019-20 is 37.69 GW and in 2018 -19 is 35.63 GW [7]. In India, Wind power represents about 10.1 percent of total power installed in the year 2020.

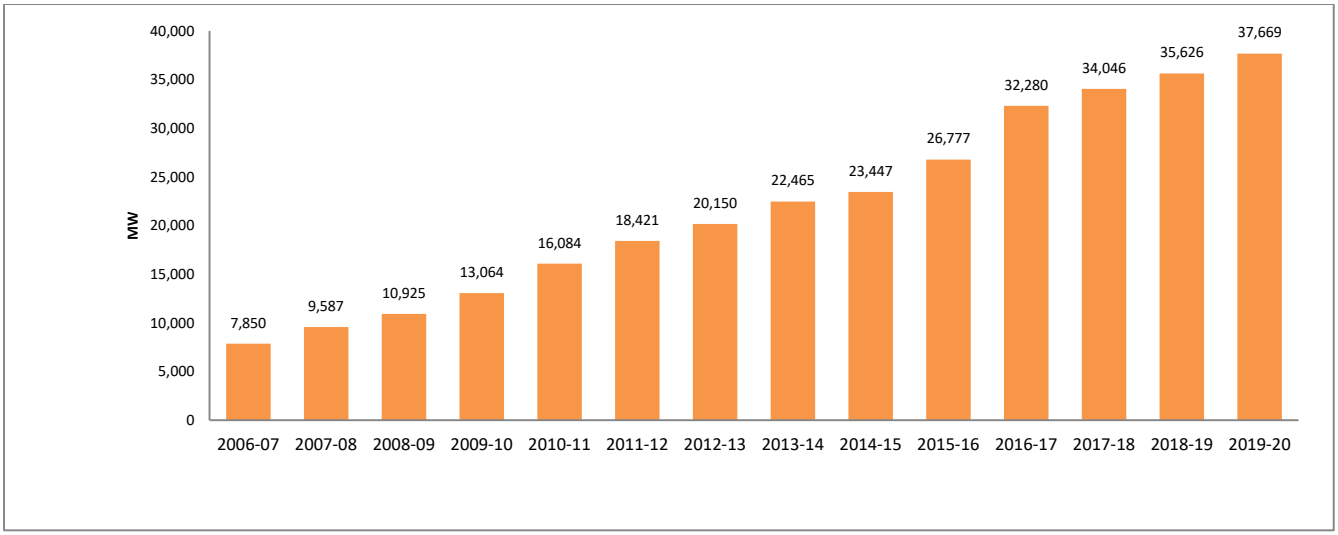

Fig. 2 Installed capacity (MW) of India

In Q1 2019 488 MW of wind energy is generated from wind power plant that increase by 52 percent in Q2 2019. In Q2 2019 wind power generation is 743 MW .In Third-quarter only 562 MW wind power capacity is installed which tends to decline of 24 %.In the last quarter, 575MW wind capacity was installed which increase 2.3% of wind power capacity the om last quarter. But in the first quarter of 2020, there is only189 MW of wind power is installed so it is a large decline of about 67.2% .In 2020 less amount of wind energy is produced due to covid 19 [8].

The target is 60 GW which is so far so it is difficult to achieve the yearly installation target. Due to Covid19, it seems to be difficult to achieve it. But Tamil Nadu is the highest wind energy-producing state in India. The installable wind potential of India is approximate to be 695 GW at 120 meters above ground level according to the NIWE report. In India, about 347 GW of wind project can be installed on cultivated land and about 340 GW of wind energy of capacity can be installed on wasteland. It could be possible if some effective steps are taken by the government and making some policies regards it.

But there was a big decline in the wind installation capacity after the Reverse auction mechanism is applied in the wind power sector after some years of growth in the wind power sector. When the reverse auction mechanism has not been introduced the projects of wind power are developed by private companies and those companies sell that power to the state. When in 2017 reverse auction mechanism is introduced all of that is changed and wind power sector growth goes in downward. Tariff caps have reduced participation in bidders and it resulted that tenders have gone under subscription. Due to coronavirus, there is a big decline in the wind power sector capacity which is about 67.2% in 2020. This virus also affect the economy of the country this year. It has a high effect on the GDP of the country. A report is released by (GWEC) that explains how this virus is effect the world wind power sector, also including the wind power sector of India. To that report in India, both local and international manufacturers of equipment of turbine and component manufacturers have suspended their work and activities in India. The government of India wants to develop offshore wind energy but there are several challenges such as high capital cost, data required to calculate the potential of these wind power projects is not available. There are many difficulties in front of the government in the development of wind energy in India is such as the absence of adequate evacuation and transmission infrastructure is the main reason for the control of wind energy in India. In India potential for producing wind energy is very high. Due to the coastal, line so in the coming future wind energy is the main source of producing energy in India [9].

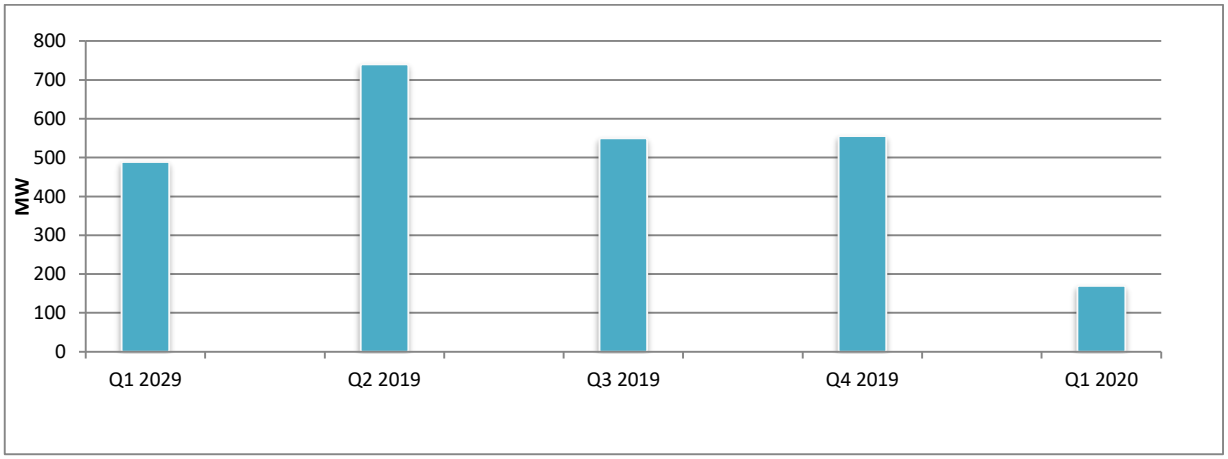

Fig. 3 Wind power Installations by Quarter (MW) in India

4. WIND ENERGY FUTURE STATUS AND CHALLENGES IN INDIA

India is the world's 4th largest wind power-producing country on the planet. The total installed wind power capacity in India is 37.669 GW on 29 Feb 2020, it is the 4th largest installed capacity in the world [9]. In India, the most wind power plant is located in the southern, northern, and western regions. The cost of wind power installation is declining as technologies of wind power plant installation are developed. During the auction in Dec 2017, the rate of wind energy reached a record low of rupees 2.43 per kWh without including direct or indirect subsidies. The central government of India applies guidelines in Dec 2017 for tariff-based wind power for decreasing the risk to developers and to make clearer the rules.

The future aspects of wind energy installation in India are to reach around 48GW to 54 GW in 2022. The Indian government set a goal to reach 60 GW of wind energy in 2022. So the target of achieving 60 GW of wind power is so far. The wind energy potential in India was first estimated by the national institute of wind energy at 50 m hub height is 49 GW but when the height grows potential of wind is also increased as at 80 m height the potential of wind grows up 120 GW. The major advantage of wind energy is that it has the inherent strength to support rural unemployment and increase the rural economy. India has an offshore wind power potential of around 70 GW in the area of coastal lines in Gujrat and Tamil Nadu. India aims to install 30,000 MW of offshore wind power in India by 2030. An offshore wind power project is canceled if it is found that it causes damage to environmental damage to marine ecology rules are made by the Ministry of New and Renewable Energy (MNRE). India plans to set up big power projects on offshore wind energy but causing damage to marine ecology is big concern of the government [10]. India has an ambitious target of achieving 175000 MW of energy from renewable sources by 2022. out of it, 60,000 MW of energy comes from onshore wind power plants. But to increase the production of wind energy capacity India has tried to harness the high potential of offshore wind energy as India has a 7500 km area of coastal line notified by the National offshore power policy. India wants to install 5000 MW offshore wind power capacity by 2022 and 30,000 MW by 2030. The government of India estimated around 106,000 MW of offshore wind energy from the Gujrat coastal line and 60,000 MW of offshore wind energy from Tamil Nadu.

India is the 2nd largest country in wind turbine production base after china in the Asia continent and 4th in all over the world. The annual wind turbine manufacturing capacity of India is about 10 GW. Solar energy and Inbox energy are top turbine suppliers in India. India started to take interest in offshore wind power projects in 2010 and a 100 MW offshore power plant is planned to develop in Gujrat in 2014. The project action has taken a target to implement it from 2013 to 2018. Wind energy development in India is started in 1990 has significantly increased in the last few years. India has set a target of 60GW of wind power installed capacity by 2022 [10]. But now there is a sharp decline in the development of wind power. India has faced some challenges in the sector of wind power.

There are some challenges in the development of wind power in India.

- The lack of adequate evacuation and transmission infrastructure is the main barrier to the development of wind power in India. The highest potential state Gujrat, Tamil Nadu, Rajasthan, remains less tapped due to a lack of adequate evacuation and transmission infrastructure.
- The wind power sector is still recovering from the recent observation of drawbacks of both accelerated depreciation and grid-based incentive scheme.
- Some nodal agencies of the state are not able to maintain the record, the data, the information collected about the wind energy status, and future development in India.
- The availability of land is the major challenge in the development of wind power generation in India.
- The issue of chain supply also plays an important role in the development of wind power in India.

That is the key challenge that are produce barriers to the development of wind power in India. In India status of wind energy capacity is satisfactory but some additional attention from the government is required to make the better status of wind production in India. Government should make policy about it and needs to require more interest in offshore wind energy potential, as in India potential of offshore wind energy is high.

5. STEADY MARKET GROWTH FOR WIND

In Indian history, the period of wind rush is called from 1994 to 1996. These years wind market in India is increasing rapidly because private investors are taking interest in wind power projects. The central government of India made new policies and designed new schemes and provide them without any tax means at zero tax planning opportunities for private investors. Ministry of new and Renewable Energy formed new rules and regulations for the clearance of projects for the development of the wind power sector in 1995. But in 1996 rules and guidelines are modified and according to new guidelines all states level agencies have given the additional duty to check the projects before approving them every six months check about the capacity addition in the state and always be concerned about installed projects and approved projects which are installing in future [11]. So with those new guidelines, the production of wind energy is slowing down because the investor who installed power projects on zero tax now government imposed a minimum alternate tax of 12.9% on all projects. The government also reduces the profit from marginal tax credit from 43 percent to 35 percent.

In India need for renewable energy is increasing rapidly, so Wind demand for renewable energy has increased, beneficial

government policy and decreasing cost of equipment have helped in the wind market size and wind energy equipment. The growing power demand and the reduction in the cost of wind farms make wind energy is the most effective source of energy. The major restraining factor for wind energy is the availability of fossil fuels. The investment required is high and production is low as compared to the traditional sources. The wind power technologies are fast progressing and thus it makes the production from wind power plants is cheaper and the technology of storing wind energy is available so that wind energy increase the wind power market in India.

Wind Power growth in India saw steady growth for three decades (1985-2015). India is in the 4th position on the planet in wind energy, with 37.5 gigawatts (GW) of limit installed, most wind energy is driven by incentives such as accelerated depreciation and generation-based payments, and attractive feed-in tariffs (FiT). In 2015 India targeted a goal of installing a renewable energy capacity of 175 GW by December 2022. From 175 GW, the wind power sector produces 60 GW of total installed capacity in India. At that time in India 37, GW of energy capacity is already installed. But in the last few years, some policy missteps were taken so it is difficult to achieve that target energy. In India, about 13 GW to wind energy projects is already approved they are under development, and around 10 GW of capacity wind projects are expected to be in future by tendered in the coming month to achieve the target according to a report by the ministry of new and renewable energy [12].

But the industry does not look so confident to achieve its goal. The wind power sector is losing its boom because of a dropping in capacity addition, the manufacturing sector is falling, lack of investors in the auction. Only 45 GW of wind installation can be achieved by the government till March 2022 according to research on the crisis. So the government is not able to achieve its goal of 60GW. India has a high wind energy potential of 302 GW at 100 meters hub height and 695 GW at 120 meters says by. K Balarama, director-general, National Institute of Wind Energy (NIWE) that all this potential is commercially feasible. Most of the wind energy is produced by the seven states. These states produced around 97 percent of total wind energy installation in India. These states are Gujarat, Karnataka, Maharashtra, Andhra Pradesh, Tamil Nadu, Rajasthan, and Madhya Pradesh. In India, wind installation is at its peak in 2016-17, in this year about 5.5GW of wind power capacity is installed. With this growth in the wind power sector, the government has set a target of achieving 60GW by 2022. But it does not seem to achieve it.

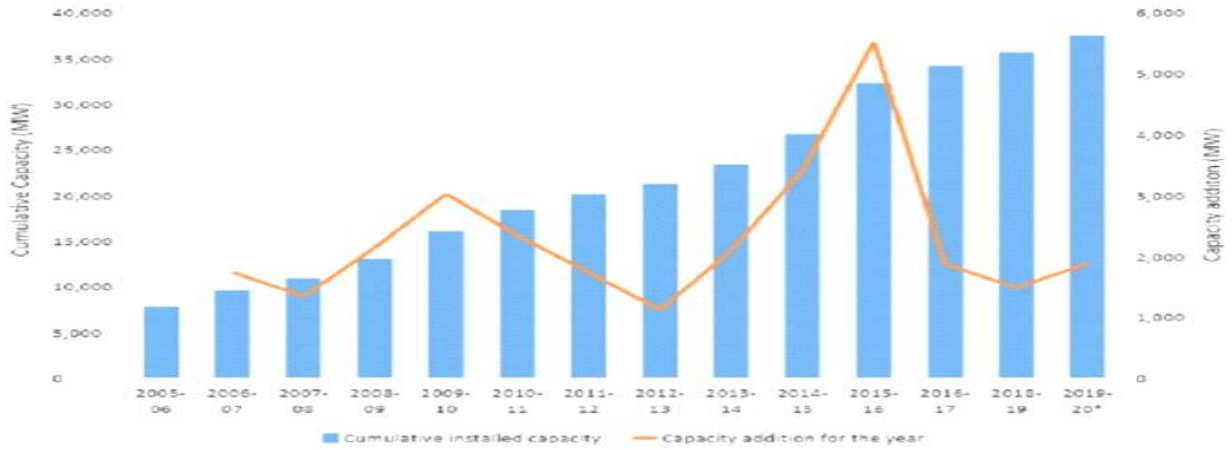

Fig. 4 Capacity addition and total installations of wind energy in India

In 2017-18 only 4GW of wind power is installed which is only 47 percent of the target and in 2018-19 only 37 percent of the target. But there is a big decline in the growth of wind energy in 2020 because in 2020 only 3GW is installed [13].

6. EFFECT OF COMPETITIVE BIDDING AND OTHER ISSUES

After the success of competitive bidding models in solar energy power projects, the government wants to take this model to wind energy power projects so that in Dec 2017 80 projects with of capacity 12GW have been given to wind developers by auction. In the beginning, auctions are very oversubscribed as the manufacturers have been interested to decline their inventory so that developers make a high bid. So due to this tariff rates are low [13]. But they face difficulties in executing like availability of land at a reasonable price, Inadequacy of the transmission network joined with increasing market risk, delay in payment, that's are the reason for increasing the tariff rate. Due to this solar energy corporation of India limited has adjourned its new 1.2 GW wind interstate transmission system because developers are not taking interest in this project. It is adjourned fourth time continuously. So for rising the wind sector in India required steps are needed to be taken by the government as it is a time of concern about the problems.

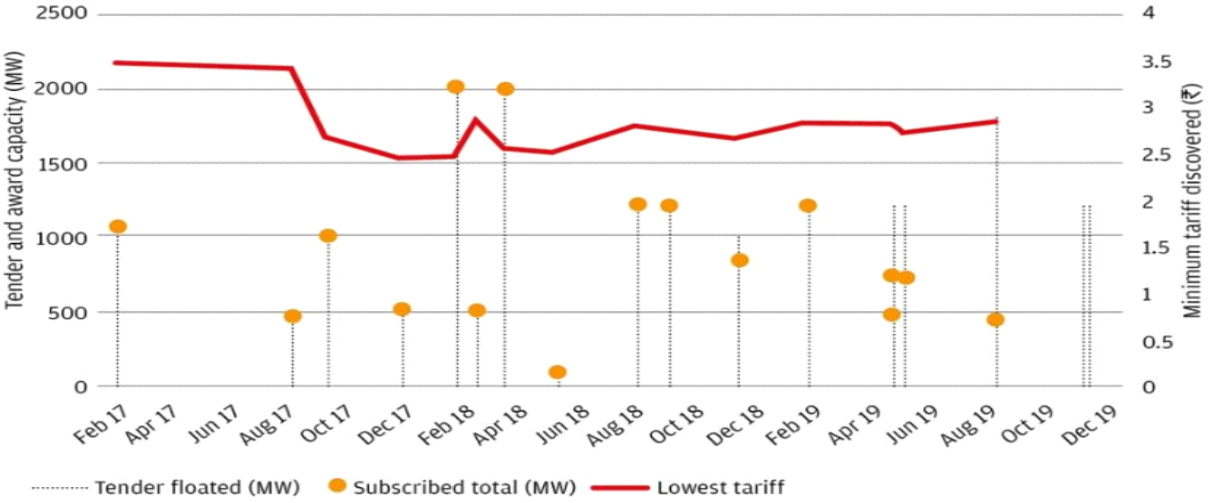

Fig. 5 Yearly tender floated, subscribed total and lowest tariff of wind energy by the government of India

7. INDIAN WIND ENERGY POLICIES PROGRAMS

India is the first country in the world which set up a ministry for the development of renewable energy resources. India introduces the ministry of Nonconventional energy resources in 1990 currently renamed as Ministry of New and Renewable Energy. India beginning only a national wind power policy but by the time both onshore and offshore wind power policies are developed. For offshore wind energy, India has a policy that come in 2015 which is known as the National offshore wind energy policy framework. The objective of this policy is to develop wind energy along the coastline in the Indian economic zone.

India has determined a target of achieving 40 percent of total energy generation in India from renewable energy sources by 2030 in the Paris agreement. But the blueprint of the Central Authority of Electricity India targeted to achieve 57 percent of total electricity generation from renewable energy resources [14].

8. A SOLAR-WIND HYBRID POLICY ISSUED IN 2018

The main objective of this policy is to provide the connection to the large grid-connected wind, solar, photovoltaic, hybrid system for the utilization of wind and solar resources both. The wind-solar hybrid system helps to improve grid stability and provides variability in the wind power sector. During 2016-17 ministry of national renewable resources(MNRE) had taken many various policies inactive in the wind power sector and various policies like the Repowering policy, New guidelines for the development of wind energy power projects, Draft wind-solar hybrid policy. Introduction of bidding in the wind energy sector, in a five-year plan $44.79 million is expended in the R&D wind energy power sector. In five year plan, about $539 million have expended on new and Renewable energy programs [14]. The country has currently the 4th largest wind producing country in the world. The ministry plans to bid out to install 10 GW power capacities each year in 2018 and 2019 to achieve its target of 60 GW by 2020. A recent report by the National Institute of bid, energy states that India has a wind power potential of 302 GW at a height of 100m above ground level. The capacity addition till 20017 is through feed-in tariff mechanism, so that tariff regime has been shifted from feed-in tariff to biding route. The guidelines are provided by the government for the tariff-based bidding process for power supply from the grid and connected with wind energy power projects. The government of the state gives guidelines for the tariff-based competitive bidding process for procurement of power from grid-connected wind energy power projects. In 2017 government make a determination of providing the framework for the wind power supply through a clear process of bidding. A bid is made up for the 1st 1200 MW Greenfield wind-solar hybrid project that has been drilled by SECI.

Initial studies are carried out by the government for promoting offshore wind projects at the coastal line of Gujrat and Tamil Nadu. There is a high potential for offshore wind energy. Lidar is commissioned on the monopole platform in 2017 in the gulf of the Khambhat region of the Gujrat coast. NIWE desired to implementation of a wind offshore power project of capacity 1 GW in the Gulf of Khambhat in Gujrat National target of the offshore wind power project is 5 GW till 2022 and for 2030 the target of installation of an offshore wind power project is 30 GW.

9. DIFFERENT POLICIES AND SCHEMES ARE PROMOTED BY THE CENTRAL / STATE GOVERNMENT OF INDIA REGARDING THE DEVELOPMENT OF WIND ENERGY

The development of the wind industry and the coming of new technologies in the wind turbine sector it make easier for the project's operational abilities and manufacturing base. In the manufacturing of wind turbines state of art, technologies are found in the country. For the development of wind energy in India different policies and schemes are promoted by central and state governments.

I.Electricity Act (2003)

The electricity act 2003 is enacted by the parliament of India. Its aim is to develop the electricity sector of India. In this guidelines and rules were formed for the generation, distribution, and trading of energy in India. This act aims to take concern and effective steps toward the development of the electric industry by developing the competition and protecting of interest of consumers in supply and tariff rationalization. The objective of this is to promote completion in the sector of electricity generation, to ensure the supply of electricity to all areas, to protect the interests of consumers. In this act separation of electricity trading and open access is introduced. The role of the central government is to make a national policy by discussing with the states. The role of the CEA in this act is of recommending effective policy, for controlling electricity sector performance, consulate with the government about energy generation issues, maintain data on the power sector.

II.Integrated Energy policy (2006)

This policy is introduced in 2006 its aim was to promote the alternative source of energy and improve the efficiency of energy and developed renewable sources to fulfilling the requirements of energy. The aim of this integrated policy is to develop energy resources and to reduce the cost of the generation of energy. The Planning Commission of India said in a report that to meet the energy requirement of India to increase its energy supply by 3 to 4 times and the generation of electricity by 4 to 5 times. That the country will need to increase its primary energy supply by 3 to 4 times. If the government will succeed to achieve this target then all the energy needs of the people of India of fulfilled by 2032 [15].

The objectives are

- To provide clear and aimed subsidies in India for the development of energy.
- To increase the efficiency of energy
- By this policy the intensity of energy is decreased by around 20 percent.

III. Generation based incentive

Ministry of new and renewable energy has implemented the Generation-based incentive scheme. This scheme's main objective is to increase the base of investors. This policy is for grid-interactive wind and for solar projects. Under this policy, a loan of 20 lakh is provided under this scheme. This scheme is controlled by the Indian renewable energy development agency. It is for the development of sun-based power projects and wind-based power projects. The power projects that are under this project provide electricity at the rate of 50 paise Kwhr. The total distribution in a year will not exceed $1/4^{th}$ of the limit of incentive. The GBI scheme will be applicable for the entire 12^{th} plan period and target 15,000 MW.

The objective of the GBI scheme are –

- To increase the base of investors.
- The generation-based incentive is helping to incentivize the actual generation of projects.
- This policy makes easier the entry of self-reliant power producer investors into the necessary sector.

IV.Renewable energy certificates

A renewable energy certificate is to promote energy in India. This policy is set up to accelerate the renewable energy resources in India. This policy is introduced in India by Central Electricity Regulatory Authority in 2010 under the Electricity act 2003. It is a market-based mechanism that helps the state to meet its requirements of energy. This policy is also known as the green energy certificate as by this policy energy is generated from renewable energy sources that produce no greenhouse gases. Every renewable energy certificate state the 1 MWh of renewable energy generation [16].

The main objective of this policy is to

- To control the geographical limitation.
- To increase flexibility for investors.
- To develop competition between renewable energy resources.
- To successfully execution redundant power supply.

RECs mechanism has four steps.

- Accreditation
- Registration
- Issuance
- Trading and Redemption

V. National Clean Energy Fund

This fund is released by the national government in 2010-11 for promoting clean energy resources of energy and for reducing the dependence on coal. The fund has been created out under the polluter pays principle. This fund is for funding research and innovative

projects for clean energy technologies in both public and private up to extent of 40 % of the total project. Some modification is done by the government in this fund as a tax on coal is doubled and new policies and programs are promoted in this fund for the development of wind energy and to make India less dependent on coal, fossil fuels. India is moving towards clean energy resources.

Features are –

- Through this fund the power project which is adopting the new innovative idea and promoting in development of clean energy technology are eligible for the funding.
- The projects which are getting funds from any other government fund are not eligible for funding under the national clean energy fund.

VI. National wind-solar hybrid policy

This policy was issued in 2016 by MNRE. With this policy hybridization of wind energy and solar energy formed. Because it was found that hybridization of both energies gives better stability of energy. In India plants that are installed with wind energy and solar energy have enough places so that hybrid plants can be formed. The government makes many policies and schemes for the development of solar wind hybrid projects. For Hybrid projects, the incentives and policies are the same as those for solar and wind projects. This policy's main objective is to give a framework for the development of large grid-connected projects of solar, wind, and hybrid projects. In solar-wind hybrid projects, wind turbine generators and solar photovoltaic systems are worked at the same grid. The goal of this policy is to develop a 10GW capacity of the wind-solar hybrid project by 2022. Gujrat and Andhra Pradesh are the states which launch their hybrid policy for developing hybrid projects in their states. Hybrid plants give good efficiency as compared to single wind and solar plants.

VII. Wind bidding scheme

The wind bidding scheme was introduced by the ministry of new and renewable energy in June 2016. According to this scheme, wind power projects of capability above 1 GW connected with a central transmission utility are decided to set up by the Indian government [17].

The main objectives of this scheme are –

- Digitalization through bidding of India.
- Transmission of electricity generated by wind to least windy states.
- Declaration of SECI as the nodal agency.
- Helping the windy states in accomplishing their RPO targets from non-solar power resources.

*VIII.**Policy for repowering of wind energy projects***

Ministry of new and renewable energy releases the policy for repowering of wind energy projects for information of stakeholders and the general public. The objective of this policy is to promote the maximum utilization of wind energy resources by creating a facilities framework for repowering. The repowering power projects are carried out through respective state nodal agencies in the promotion of wind energy in the state. For repowering projects, the Indian Renewable Energy Development organization will give an extra interest rate of 0.25% [14].

IX.Offshore wind energy development

In 2015 Ministry of New and Renewable Energy resources established a policy for offshore wind energy development named as National offshore wind energy policy. As India has a high potential for offshore wind energy on the coastal line of Gujrat and Tamil Nadu. NIWE is named as a nodal agency for developing offshore power projects in the Economic zones or in states. National offshore wind energy policies find the area of the high potential of offshore wind power capacity. For checking the potential of wind power projects government set up power projects for demonstration purposes in the area of Gujrat and Tamilnadu. In Gujrat, a 100 MW capacity power project is established for this purpose. This policy was made up by inspired the success of onshore wind energy development in 1990. So the government also wants to take initiative in offshore wind energy development. By the implementation of the implementation type power project, it was found that the south and southwest of Tamilnadu have a high potential for offshore wind energy than Gujrat. But the Ministry of New and Renewable Energy set up its first offshore power project in Gujrat of capacity 1 GW. In India potential of offshore wind energy is very high because of coastal lines. This policy is set up to increase the production of offshore wind energy in India without disturbing the marine life and ecosystem of marine [16].

10. STATE LEVEL WIND POWER GROWTH IN INDIA

I. Tamil Nadu

Tamil Nadu is leading in the wind energy sector of India. It is the highest wind energy-producing state in the country. Tamil Nadu produces 29% of total wind energy produced in India. In Tamil Nadu government is also realised the importance of renewable resources as they are the best alternative to nonrenewable resources. In Tamil Nadu government set up an agency that's name is Tamil Nadu Energy Development Agency (TEDA) in 1985. The largest wind power plant in India has also situated in Muppandal in Tamil Nadu its capability is around 1500MW which is the highest in the country. Tamil Nadu's total wind power capacity is 9231.77. The addition of new capacity in the wind sector in 2018-19 is the highest by Tamil Nadu. From a total new capacity of 871.85 MW from all over India in power India half of it 427.80MW is added by Tamil Nadu [19].

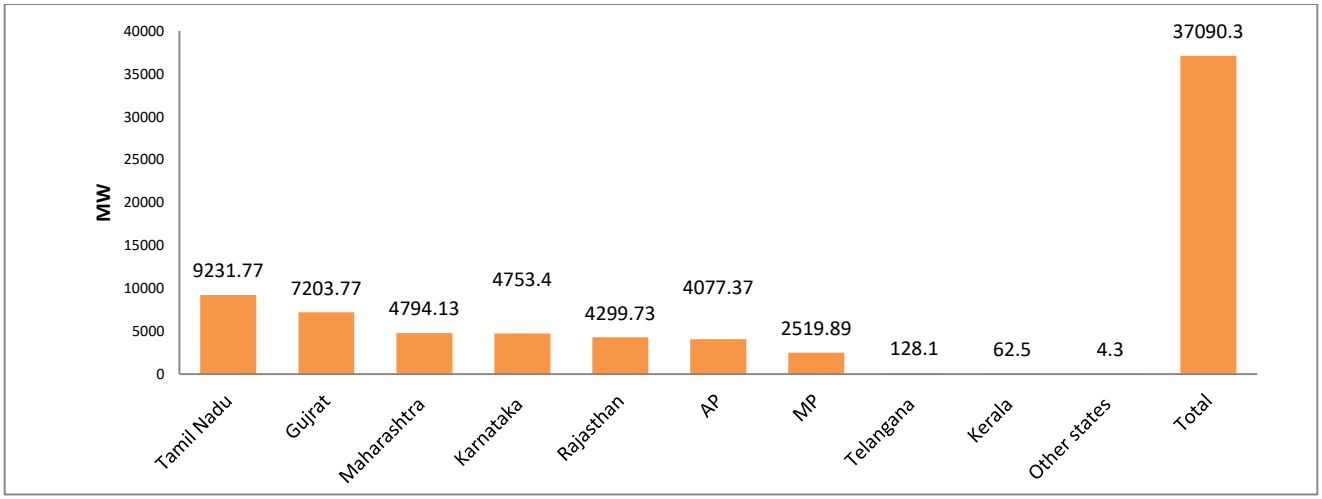

Fig. 6 State wise installed wind power capacity [18]

II.Maharashtra

Maharashtra is the third-largest wind-producing state in India. In Maharashtra total wind power installed is 4794.1 3MW.For the development of renewable resources Maharashtra government set up an agency **Maharashtra Energy Development Agency.** In Maharas,htra all the major equipment of wind and all major wind turbinesmanufactureduring such as Renew power,Suzlon,Vestas,Leitner Shrram .Maharashtra state government make many effortsdevelopment wthe ind energy sector in Maharashtra [20].

III.Gujarat

Gujarat is second-largest wind-producingcing state in Gujrat total wind energy capacity is 7203.77 MW. Gujrat's efforts to make renew energy-dependent estates state give a sharp rise in the wind energy sector. Gujrat has the benefit of the coastline area . In Gujrat, the coastline area is of 1600km which makes it suitable and makes it best to produce electrical energy from wind energy as near coastline wind speed is prominent for the set up of wind power turbines. Gujrat power corporation limited (GPCL) have set up 20.70 MW wind power mills in various location of the Gujrat .GPCL has also planned to set up onshore wind power mills in Gujrat.GPCL is also decided to explore new renewable energy resources under clean climate initiatives. Therefore GPCL has started its primary activities to set up offshore wind power projects in Gujrat with the help of the central government [21].

IV.Rajasthan

Rajasthan is the fifth largest wind energy-producing country in India. Rajasthan's total wind energy production is 4299.73MW. In 2019-20 Rajasthan government give a budget for renewable energy resources development. Rajasthan government decided to set up 1426 MW wind power projects in the next five years. The wind and hybrid policy 2019 targets to development of new wind projects and hybrid policy in the state. The policy will define the benefits use of renewable energy resources and minimize the use of non-renewable energy resources [22].

V.Madhya Pradesh

Madhya Pradesh is the seventh-largest wind-producing state in India. Madhya Pradesh's total wind energy capacity is around 2519.85 MW. To make Madhya Pradesh government makes some unique concept that in Madhya Pradesh 15 MW wind power project is set up at Magda in Bhopal [23].

VI.Kerala

Kerala is the ninth largest wind power-producing state in India. Kerala's total wind energy production is 62.50 MW. The first wind power project in Kerala is set up in 1997 at kanji ode in the Palakkad district. In Kerala agency has decided to set up 16 sites to install wind power projects through private developers [24].

VII.Odisha

The state of Odisha has a large coastal line. So Odisha has a higher potential for producing wind energy. The government of Odisha takes an interest in offshore wind power generation capacity. Odisha has the potential for wind power is about total 1700 MW wind power capacity. In the present total generation of energy from wind power is only 4 MW. As Odisha has a large amount of reservation of coal and many thermal power plants are present in Odisha Odisha is a power-rich state. But as wind energy is free from greenhouse gases and works as a clean energy project Odisha also moving toward wind energy projects [24].

VIII.West Bengal

West Bengal also has a high potential for producing wind energy. But their current production of wind energy is very small. The government of Bengal set up a wind power project at Dadan patra Bar near mandarmoni in East Midnapore district. Dadan patra Bar wind project had a wind speed of 19 km per hour and an estimated 50MW in its first phase. The total potential of west Bengal wind energy is about 450 MW [26].

WBREDA install 8×250 KW wind energy generators at freserganj.WBREDA has getting a proposal of producing two electrical generation projects with a capacity of 1×250 KW each at ganga sager and beguakhali Sagar under south 24 Parganas district.

IX.Jammu and Kashmir

In Jammu and Kashmir the area of Kargil and Ladakh have a good potential of wind energy. Ladakh have good potential have wind energy due to valley terrain and its temporal variation that have estimated about 5311 MW potential of wind energy at height of 50m and a height of 120m the potential is increased and it is about 100,000 MW potential of wind energy in Jammu and Kashmir report by NIWE. IN winter speeds of winds are higher in Jammu and Kashmir so that are useful for the wind energy potential in that state. Jammu Kashmir is situated at a high level so heat energy is required more in this state so to fulfill its requirement government have the good alternative of renewable energy sources [27].

11. CONCLUSION

In India, the requirement for energy is very high and to fulfill the energy demand of the country we are required to make sufficient management of it. Renewable energy is the best alternative of it achievingieve energy requirements in India. India has good potential for renewable energy like wind energy and solar energy. They are the leading sector of renewable energy in India, both wind and solar energy cover about 60 percent of the total energy produced in India. The government of India also started too involved to make India that depend on renewable resources at the place of fossil fuels, coal, etc that are conventional sources of energy. The government makes policies about it to increase the production of renewable resources. It has been found that with an increase of technologies wind turbines size is increased, and that decreases the cost of production of wind energy. The cost per kW is varying around $1413.8/kW to $1908.6/kW. Future challenges are how to minimize the cost and make it more beneficial. The cost of wind turbines is about 68 to 84 percent of the total cost. So it is important to develop more efficient and superior to make wind power costs low. For developing wind energy it is the best time for the government to make policies that take interest of producers in the wind power projects. So that producers take interest in producing wind energy. India is currently in 4^{th} position in the world in producing wind energy. The coastal line area, it makes more potential for producing wind energy in India. With only one wind turbine u can power up 200 homes every wind turbine's life is about 20 to 25 years.

Wind energy is a great source of fulfilling India's energy needs and developing its economy. The future of wind energy is dependent upon many factors one of which self-reliant on its energy factor. As long as the wind blows wind turbine can harness the wind to produce electricity. Unlike conventional sources wind power plant not produced greenhouse gases and it is completely toxin-free. Wind energy is the best alternative to conventional sources. In the future wind energy is the main source of energy in India. Because it is native energy that is present everywhere on earth. So that it reduces the import of energy to create local employment. Wind energy is the most important alternative to conventional sources. Wind power plants produce energy in a safe and environmentally sustainable manner.

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