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An Analysis of Wind power generation and consumption scenario in Tamil Nadu State of India

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Abstract

India is one of the most energy hungry developing countries in the world. Around 300 million Indians lack access to electricity in a country where per-capita electricity consumption is one-fourth of the world's average. Tamil Nadu has 7,300 MW of installed wind energy capacity. Of this, nearly 90 MW was added in 2014. Total capacity consists of 11,900 wind turbines and 110 pooling stations. Consumption of wind energy in 2013-2014 was just 9000 million units as against more than 11000 million units in 2012-2013. This paper reviews and analyse the wind energy power generation and consumption scenario in Tamil Nadu of India and its challenges and issues. And also compares the capacity of wind turbine existing in the study area with the turbines of leading wind energy generating turbines of various countries. Finally, it provides suggestions and solutions to the existing problems in wind energy power generation and monitoring the power distribution in the study area.

Keywords: Wind Power, Renewable Energy, Electricity Consumption

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Introduction:

The Energy Information Administration of US (EIA) forecasts that the consumption of renewable energy will be about 14% of total world energy consumption by 2035. Around 300 million Indians lack access to electricity in a country where per-capita electricity consumption is one-fourth of the world's average. India was the fifth largest market globally in 2014, adding 2,315 MW of new wind power capacity to reach a total of 22.5 GW. Among renewable, wind power accounted for almost two-thirds of the installed capacity. The Indian government expects the share of renewable energy, presently at 6.9% of the total electricity production in the country, to grow to at least 15% in the next five years. India also wants to put in place 60,000MW of wind power capacity by then in a country that's the world's third largest emitter of greenhouse gases, behind only the US and China. Wind energy's share in the total power mix of the country was approximately 3% for the calendar year 2014 (National Load Dispatch Centre 2014, www.posco.in). India's investments in the renewable sector in the year 2014 reached almost USD 7.9 billion (EUR 6.5bn). The renewable energy sector investments rose by almost 13% in 2014 over the previous year (www.cleantechnical.com). The Indian Ministry of New and Renewable Energy (MNRE) of India plan to achieve 60,000 MW in total wind power installations by 2022. The leading states in terms of installed capacity were Tamil Nadu, Maharashtra, Gujarat, Rajasthan and Karnataka. Other emerging states include Andhra Pradesh and Madhya Pradesh.

This paper reviews and analyse the wind energy power generation and consumption scenario in Tamil Nadu of India and its challenges and issues. And also compares the capacity of wind turbine existing in the study area with the turbines of leading wind energy generating turbines of various countries. Finally, it provides suggestions and solutions to the existing problems in wind energy power generation and monitoring the power distribution in the study area.

Statement of Problem:

With prevailing threats of global warming and exhaustion of conventional energy sources, it becomes mandatory to exploit renewable sources and to develop technologies for efficient extraction of power from renewable sources.

Scope of the Study:

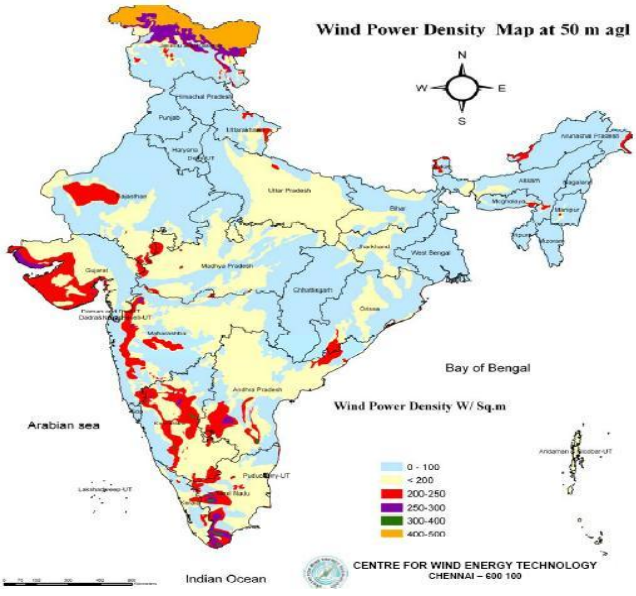
It is increasingly essential to develop renewable energy conversion systems since they provide environmental benefits as well as other benefits to humans like energy security, job creation, economic growth and lesser dependency upon the exhaustible energy resources.

Profile of the Study Area:

Tamil Nadu is the Eleventh largest state of our country and seventh most populous state of India. It contributes the fourth largest to India's GDP. With agriculture emerging as the largest consumer of power in the state, Tamil Nadu holds the distinction of being one of the first states to undertake massive rural electrification programme. Currently the Tamil Nadu Electricity Board (TNEB), a state sector enterprise, is the main energy provider and distributor. Tamil Nadu, India's leading state in wind power installation, plans to add another 1,000 MW this year to its total capacity. This decision comes at a time when the wind power industry in the state has been struggling with respect to inadequate power evacuation facilities and late payment by the power utility. Tamil Nadu has 7,300 MW of installed wind energy capacity. Of this, nearly 90 MW was added in 2014. Total capacity consists of 11,900 wind turbines and 110 pooling stations. Consumption of wind energy in 2013-2014 was just 9000 million units as against more than 11000 million units in 2012-2013. Tamil Nadu gets 44% of its total energy requirement from renewable energy, with close to 90% of it coming from wind energy, pushing thermal energy to second place. This is much higher than the national average for renewable energy consumption of 12%. Tamil Nadu's share in the country's total installed wind energy is about 40 per cent with an installed capacity of 7,248 MW.

Objectives of the Study:

1. To understand the current wind power generation and consumption in the study area.
2. To compare the capacity of wind turbine existing in the study area with the turbines of various leading wind energy generating countries.
3. To analyse the challenges and issues in the production of wind energy in the study area.
4. To offer suggestions and solutions to the existing problems in wind energy power generation and monitoring the power distribution in the study area.



Review of Literature:

The country has been facing growing shortages over the past five years. During the year 2007- 08 (1st year of 11th Plan), the peak deficit was about 18,000 MW (16.5%) and the average energy shortage in the country was about 73 Billion kWh (10%). During the year 2008-09 (2nd year of 11th Plan), the peak deficit was about

13,000 MW (12%) and the average energy shortage in the country was about 86 Billion kWh (11%). During the year 2009-10 (3rd year of 11th Plan), the peak deficit was about 15,157 MW (12.7%) and the average energy shortage in the country was about 84 Billion kWh (10.1%). (National Electricity Plan Vol 1).

Wind energy has emerged as most successful renewable energy option and the fastest renewable technology for generating grid connected power. Many agencies have been established and numbers of programs have been laid by Government of India for facilitating and promoting the rapid development of wind power technology. The Centre for Wind Energy Technology (CWET) is an Autonomous Research and Development Institution established under Tamil Nadu Societies Registration Act, 1975 under the Ministry of New and Renewable Energy, Government of India. C-WET's Wind Turbine Test Station (WTTS) near Kayathar in Tamil Nadu was also established with the technical assistance of RISO National Laboratory, Denmark. An Offshore Wind Energy Steering Committee (OWESC) was constituted under the Chairmanship of the Secretary, MNRE to propose policy framework for offshore wind energy development in the country. Also, the MNRE supports the R and D projects through C-WET for in house R and D projects and also through research institutions, national laboratories, universities and industries. (National Electricity PlanVol1).

In past few years, there has been an appreciable growth in Indian renewable energy sector that encouraged the investors to invest into this region. It can be observed that the cumulative grid interactive power capacity of renewable energy has been increasing tremendously and the installed capacity is 31,702 MW as on 31st March, 2014. (MNRE, 2013-14).

The Indian Wind Atlas measures the onshore wind power potential to be 49,130 MW at 50 m a height of 50 m and 1,02,000 MW at 80 m height. (C-WET, 2012-13).

A 100 kW wind turbine produces 100 kWh or units of electricity after running for an hour, at its rated wind speed of about 12 – 14 m/s. Likewise, a 250kW turbine at its rated wind speed of about 12m/s produces 250 kWh after 1 hour of operation.

"We were able to increase by nearly 40 percent the area of the rotor in less than five years," "That lets us deliver a more efficient wind turbine to our customers. When you increase the area of the rotor, you are able to get more energy at lower wind speed." (Albert Fisas-Camanes, Director of Innovation for Alstom Wind North America.)

The US Energy Information Administration (EIA) estimates that in 2008, 10% of the world's energy consumption was from renewable energy sources. EIA forecasts that by 2035, consumption of renewable energy will be about 14% of total world energy consumption.

The power produced by a wind turbine depends on the turbine's size and the wind speed through the rotor. In India, we have the commercial large wind turbines from 225 kW to 2.5 MW. In the global market, 6 MW wind turbines are operating and turbines of 10 MW are in laboratory stage.

National Institute of Wind Energy (NIWE), an autonomous research and development institution of the ministry of new and renewable energy, would be doing wind power forecasting on a pilot basis in the state. The Chennai-based R&D institute has tied up with Spain-based forecaster Vortex Technologies to help forecast generation in 62 MW wind farm connected to a pooling sub-station in Kayathar. The wind generators alleged evacuation loss of 3 billion units annually in Tamil Nadu, which has a total wind generation installed capacity of 7,373 MW. Last year, Tangedco recorded highest generation of 4,318 MW.

The Detail of bye back rates for wind energy:

State	Buy back rate (Rs.per Kwh)
Andhra Pradesh	3.50
Gujarat	3.50
Karnataka	3.70
Kerala	3.14
Madhya Pradesh	4.35
Maharashtra	2.86-4.29
Rajasthan	4.08/3.87
Tamil Nadu	3.39
Punjab	4.23
Haryana	4.27

Wind Power capacity trend state wise

States	As on 31st March of the Year								
	2007	2008	2008	2010	2011	2012	2013	2014	2015
	Capacity in MW								
Andhra Pradesh	123	123	123	236	200	245	447	783	435
Gujarat	637	1253	1567	1864	2176	2966	3174	3447	3093
Karnataka	821	1011	1327	1473	1730	1934	2135	2324	2113
Kerala	2	11	27	28	33	35	35	35	35
Madhya Pradesh	57	188	213	229	276	376	386	423	386
Maharashtra	1488	1756	1939	2078	2311	2733	3022	4065	2976
Rajasthan	470	539	738	1088	1525	2071	2684	2783	2355
Tamil Nadu	3493	3873	4305	4907	5904	6988	7162	7275	7253
Others	1	1	1	4	0	3	4.3	4.3	6
Total	7091	8754	10242	11807	14158	17365	19051	21141	22645

Source: Wind-power industry focus.net & Indian Wind Energy Association, 2014

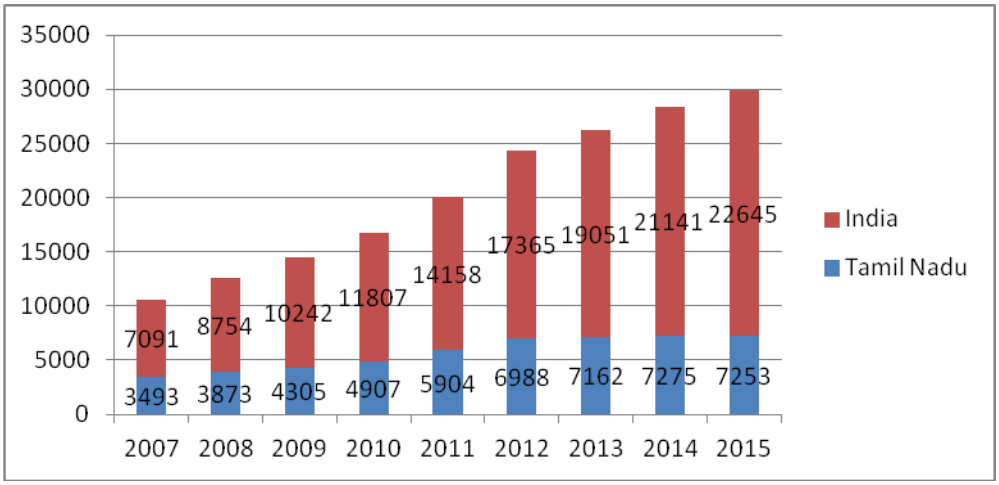


Figure 1 Wind Power capacity trend of India and Tamil Nadu

Source: Wind-power industry focus.net & Indian Wind Energy Association, 2014

As of 31 March 2015 the installed capacity of wind power in India was 22,644.63 MW, mainly spread across Tamil Nadu (7,253 MW), Gujarat (3,093 MW),Maharashtra (2,976 MW), Karnataka (2,113 MW), Rajasthan (2,355 MW), Madhya Pradesh (386 MW), Andhra Pradesh (435 MW), Kerala (35.1 MW), Orissa(2MW), West Bengal (1.1 MW) and other states (3.20 MW). It was estimated that 6,000 MW of additional wind power capacity would have been installed in India by 2014.

Tamil Nadu generates around 32.03% of India's total wind capacity during the year of 2014-2015. The Government of Tamil Nadu realized the importance and need for renewable energy, and set up a separate Agency, as registered society, called the Tamil Nadu Energy Development Agency (TEDA) as early as 1985. Now, Tamil Nadu has become a leader in Wind Power in India. In Muppandal wind farm, Tamil Nadu the total capacity is 1500MW, which is the largest in India. As per TEDA, the total installed capacity in Tamil Nadu is 7253MW.

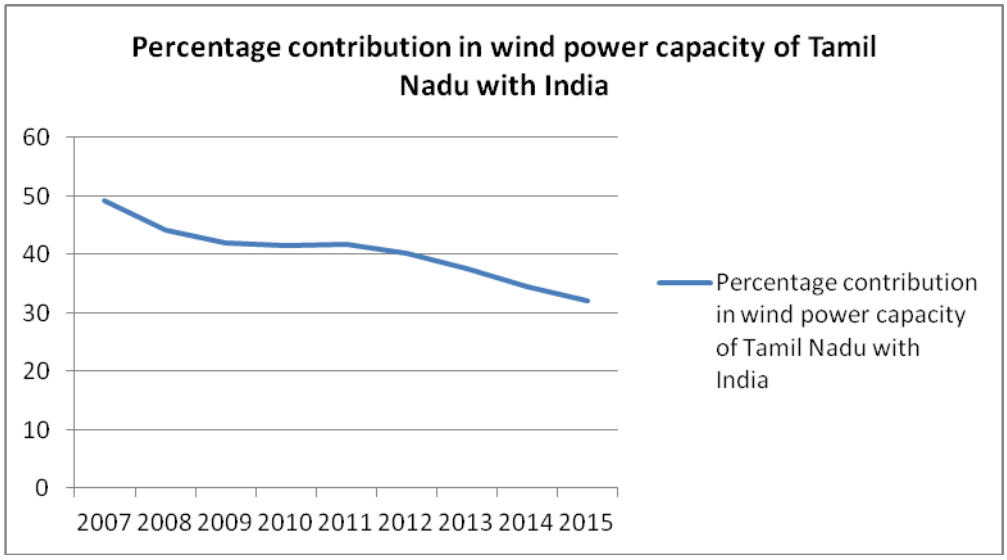


Figure2. Percentage of wind power capacity of Tamil Nadu against total India's wind power capacity

Source: Wind-power industry focus.net & Indian Wind Energy Association, 2014

The percentage wind power capacity of Tamil Nadu against India is slowly declining. The reasons and required plan of actions may be detected and rectified by experts of this field.

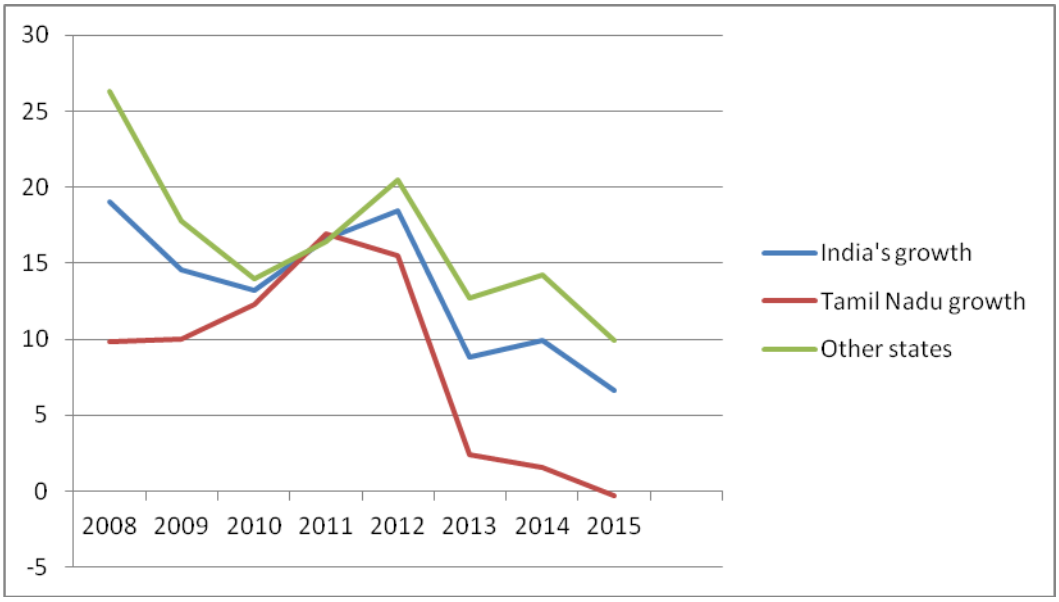


Figure 3. Declining growth rate of wind power capacity:

Source: Wind-power industry focus.net & Indian Wind Energy Association, 2014

The above graph clearly shows the impact of declining growth rate of wind power capacity of Tamil Nadu on the national wind power capacity. Overall growth rate of wind power capacity is declining at a high rate from 2012. As the rate of growth of wind power capacity decreases the goal of achieving the target may be postponed. Hence a pre action plan has to be framed to accelerate the growth rate of wind power capacity in any factors of possibilities.

Modern Technologies and challenges:

Modern wind turbines are increasingly cost-effective and more reliable, and have scaled up in size to multi-megawatt power ratings. Since 1999, the average turbine generating capacity has increased, with turbines installed in 2013 averaging 1.87 MW of capacity. Wind Program research has helped facilitate this transition, through the development of longer, lighter rotor blades, taller towers, more reliable drive trains, and performance-optimizing control systems. Furthermore, improved turbine performance has led to a more robust domestic wind industry that saw wind turbine technology exports grow from $16 million in 2007 to $500 million in 2013.

Challenges and issues of wind power production:

1. Main challenge is the high cost of finance.
2. High interest rates and limited availability of debt financing are challenges for developers in the country. Tamil Nadu power sector utilities suffer from poor financial health.
3. Poor financial health, state owned utilities are unwilling to purchase higher cost wind power.
4. Grid integration issues and the development of wind turbines to cater to the lower wind speed wind regimes in large parts of India are the technical challenges. To exacerbate these problems by a weak grid code and noncompliance by producers and grid operators is also a challenge.
5. India’s inverted duty structure allows for lower import duties on wind turbine components and higher duties on raw materials, thereby encouraging OEMs to import components instead of manufacturing them locally.
6. Logistical challenges continue to be experienced during transport of bigger structures including blades, nacelles and towers.

7. The reasons for inadequate infrastructure include incomplete projects such as the Establishment of 400 kilovolts (kV), 230kV, 110kV and 11kV substations at Kanarpatti, Kayathar and Karungulam. Due to the shortage of evacuation facilities, nearly 15-20% of wind energy generated is lost.(S.Bridget Leena & Arundhati Ramanathan, 21st Aug 2013).

Suggestions:

✓ Wind power plants exhibit changing dynamics, nonlinearities, and uncertainties .Hence smart grid require advanced control strategies to solve effectively. The use of more efficient control techniques would not only increase the performance of these systems, but would increase the number of operational hours of wind plants and thus reduce the cost per kilowatt-hour (KWh) produced.

✓ Wind is an intermittent resource. Wind behaviour changes daily and seasonally. Wind energy can be viewed as aggregate resources with other renewable energy from the point of view of a power grid, with levels that vary within a 10 minute to 1 hour time frame, so they do not represent the same form of intermittency as an unplanned interruption in a large base-load generator.

✓ Research in technology is still in progress. Hence existing generation and delivery infrastructure (i.e. legacy) of RE systems must be adaptive to work with new technologies.

✓ Being flexible to changing technologies require identifying the vital interface between technology components.

✓ Achieving association across service providers, end-users and technology suppliers is difficult in particularly in growing international market place. Exchange of knowledge and information can allow multiple parties to connect their devices and system for proper interaction, but attaining interoperability is difficult.

✓ Strategies need to account for a variety of policy objectives (affordability, sustainability, growth and cultural values).

✓ Assigning value to externalities, such as environmental impacts, is difficult, but necessary, in balanced decision- making.

✓ Understanding and accounting for the beneficial aspects of smart grid investments as a mechanism for job creation and advancing a technically skilled workforce needs development.

✓ Greater awareness about capabilities of smart grid and there benefits for improving energy-efficiency and renewable resource integration policies.

✓ Research and development activities: the speed with which new ideas and deployment tactics are being generated. Some modern innovation and invention has to be made like recent innovation for power saving method using new type of battery (found out by Harvard University researchers) that could make it economical to store a couple of days of electricity from wind forms and other sources like solar power.

✓ Forecast wind power generation will help TANGEDCO exploit wind potential to the maximum while reducing loss due to backing down of wind mills.

Conclusion:

It is the time hour for transition from petroleum-based energy systems to one based on renewable resources to decrease reliance on depleting reserves of fossil fuels and to mitigate climate change. Wind energy has the potential to create many employment opportunities both at urban as well as rural areas. Innovative financing and mainstreaming of wind power are very essential. It is very important to boost the efforts for further development and promotion of wind energy sources. The roll of research centres like

The Energy and Resource Centre (TERI), Centre for Renewable Energy and Environment Development (CREED), Auroville Centre for Scientific Research (CSR) etc has increased India's grid-interactive power supply to nearly 32 GW. In terms of wind power generation, India has reached to the fifth position. Wind energy will contribute a major roll towards the sustainable future of India. Thus, India's energy policies need to be shaped to ensure energy security, keeping the environment clean, better management of power distribution, power evacuation and attaining energy self-sufficiency. Some modern innovation and invention has to be made like recent innovation for power saving method using new type of battery (found out by Harvard University researchers) that could make it economical to store a couple of days of electricity from wind forms.

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