A Report on Economic Analysis of Wind Power in India

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Abstract: According to the Central Electricity Regularity commission, India's electricity sector generates roughly 1.2 trillion kWh of electricity annually, which divides roughly into 1,000 kWh per person. This is specifically low by international standards; it is roughly one-quarter that of China and one-thirteenth that of the United State of America.

This statistic is showing that the huge unmet require for electricity that still exists in India. Add to this the fact that we are the fastest-growing large economy, and we may be looking at having to double our energy output by 2030 in order to sustain this pace of growth. While this calls for steps to expand the power sector's capacity, we can ill afford to go down the traditional carbon-spewing fossil fuel-driven growth path.

Globally there is now an increased awareness of the havoc that climate change and rising pollution can cause. Every country must cut back its carbon secretion levels and India is no exception. Looking ahead, therefore, renewable energy emerges as an obvious alternative. India must strive to transform its energy mix and should make sure that a majority of the additional capacity comes from renewable sources.

This paper will deal with the employment of wind energy as an alternative and renewable source of energy in India. The authors try to give a clear idea of what kind of measures are needed in India for alternative sources of energy like wind energy to be a success.

Keyword*: *Renewable Energy, Wind Energy, Economic Issues, Future Projections.

Introduction: The wind power development in the country was initiated in the early 1990s followed by the preface of 100% accelerated depreciation benefit for wind projects in 1994.[1] The present wind power installed capacity in the country is over 32.7 GW and wind energy constitutes around 55% of the total renewable capacity in the country.[1] The country currently has the fourth highest wind installed capacity in the world with total installed capacity of 34.98 GW as on October, 2018 against a target of 60 GW by 2022. Further, around 9.4 GW capacities are under implementation or have been tendered out. The Ministry plans to bid out 10 GW wind power capacity each year for 2018-19 and 2019-20, so that bidding gets completed for entire 60 GW capacity additions by March 2020, leaving two years' time for execution of projects. The recent assessment conducted by National Institute of Wind Energy (NIWE) indicates a gross wind power potential of 302 GW in the country at 100 meter above ground level. [2]

Wind energy is intermittent and highly site-specific and, therefore, an extensive Wind Resource Assessment Programme is essential for selecting the potential sites. Therefore, MNRE, Government of India, placed emphasis on Wind Resource Assessment since the beginning and today, India has an abundance of data, collected from over 800 wind monitoring stations installed all over India. The recent assessment conducted by NIWE, with actual land availability estimation using NRSC Land Use Land Cover (LULC) data, indicates a gross wind power potential of about 302 GW@ 100 m in the country. Most of this potential exists in seven windy states. The state-wise wind power potential at 100 m height is described in Table 1. [1]

1 Andhra Pradesh	44.23 GW
2 Gujarat	84.43 GW
3 Karnataka	55.86 GW
4 Madhya Pradesh	10.48 GW
5 Maharashtra	45.39 GW
6 Rajasthan	18.77 GW
7 Tamil Nadu	33.80 GW
Total	**(7 windy States) 292.97**
	8 Other States 9.28
	All India Total 302.25

Source: NIWE, MNRE, Government of India

Wind Energy Technology----A Technical Review:

History: In 1891, a Dane by the name of Poul LaCour built the first electricity-generating wind turbine. It was improved by Danish engineers and used to supply energy during energy shortages in World War I and World War II. The wind turbines built by the Danish company F.L Schmidt (now a cement machinery maker) in 1941-1942 can be considered the forerunners of modern wind turbines, and other companies, such as the American Palmer Putnam began building turbines as well, modifying the number of blades and tower height. The actual technology has also improved in large spurts. By the end of 1989, a 300 kW wind turbine with a 30-m rotor diameter was state-of-the-art. Ten years later, 1500 kW turbines with a diameter of around 70m are available from many manufacturers. Though 4-5 MW are expected within the next 2 years, the 1.5 MW turbines remain state of- the-art. In India, a typical wind turbine is of the 200 kW type. [3]

Current Technology:

Source: **NREL (Left) & Solwind Ltd. (Right)**

Vertical-axis wind turbines (VAWT) (left: Darrieus turbine)

In a VAWT, the shaft is mounted on a vertical axis, perpendicular to the ground. VAWTs are always aligned with the wind, unlike their horizontal-axis counterparts, so there's no adjustment necessary when the wind direction changes; but a VAWT can't start moving all by itsel

f -- it needs a boost from its electrical system to get started. Instead of a tower, it typically uses guy wires for support, so the rotor elevation is lower. Lower elevation means slower wind due to ground interference, so VAWTs are generally less efficient than HAWTs. On the upside, all equipment is at ground level for easy

installation and servicing; but that means a larger footprint for the turbine, which is a big negative in farming areas.[4] VAWTs may be used for small-scale turbines and for pumping water in rural areas, but all commercially produced, utility-scale wind turbines are **horizontal-axis wind turbines** (**HAWTs**).

Source: NREL

As implied by the name, the HAWT shaft is mounted horizontally, parallel to the ground. HAWTs need to constantly align themselves with the wind using a yaw-adjustment mechanism. The yaw system typically consists of electric motors and gearboxes that move the entire rotor left or right in small increments. The turbine's electronic controller reads the position of a wind vane device (either mechanical or electronic) and adjusts the position of the rotor to capture the most wind energy available. HAWTs use a tower to lift the turbine components to an optimum elevation for wind speed (and so the blades can clear the ground) and take up very little ground space since almost all of the components are up to 260 feet (80 meters) in the air. [4]

Literature Survey: Some serious studies have been conducted and some resourceful papers have been published by analyzing the economic aspects of wind power in India.

J K Jethani, MNRE, Askshay Urja (2017) has reported that the unit size of machines has gone up to 3.00 MW. Over 50 different models of wind turbines are being manufactured by more than 20 different companies in India, through (i) joint ventures under licensed production, (ii) subsidiaries of foreign companies, and (iii) Indian companies with their own technology. The current annual production capacity of domestic wind turbines is about 10,000 MW. The focus is to promote a technology suitable for low wind regimes of India. Wind turbines and wind turbine components are exported to the US, Australia, Europe, Brazil, and Asian countries. Due to a stronger domestic manufacturing sector, around 70%–80% indigenization has been achieved in the sector. Interestingly, the cost of Indian wind turbines is one of the lowest in the world.

V.P. Khambalkar*1, S.R. Gadge*, S.B. Dahatonde*, M.U. Kale*, and D.S. Karale+ had published paper (2007) at International Energy Journal 8 (2007) 285-290 economics of wind energy and thereby the feasibility of the power project were examined by estimating per unit cost of energy, net present value (NPV), benefit-cost ratio (B-C), internal rate of return (IRR), and payback period of the power system.

Poul Erik Morthorst of Risø´ DTU National Laboratory, Technical University of Denmark; Hans Auer of the Energy Economics Group,University of Vienna; Andrew Garrad of Garrad Hassan and Partners; Isabel Blanco of UAH, Spain had published report on Wind Energy—Part III, Economics of Wind Power, 2008, had discussed on the investment and cost structures of land-based and offshore turbines are discussed. The cost of electricity produced is also addressed, which takes into account the lifetime of turbines and O&M costs, and the past and future development of the costs of wind-generated power was analyzed.

Victor K. Mallet Term Paper, Sustainable Energy, 10.391J Spring 2001 had discussed on employment of wind energy as an alternative and renewable source of energy in India. The purpose of the paper is to give a clear idea of what kind of measures are needed in developing countries for alternative sources of energy such as wind to be a success.

Economics of Wind Energy in India—An Analysis: The analysis of wind power projects is specific to the State Policies and the potential wind resource sites along with the turbine characteristics. [6] Government of India has offered some economic benefits to the Wind Energy Projects such as

- Accelerated depreciation of up to 80% of the project cost if the project is commissioned before 30 September of the financial year, or 40% if the project is commissioned before 31 March of the financial year.
- Exempted from income tax on all earnings generated from the project for any single 10-year period during the first 15 years of the project's life
- Soft loans from IREDA, Finance up to 70% of the eligible project cost
- Moratorium period up to one year
- Generation Based Incentives (GBIs) for Grid based Wind Power Projects. [7]

India also has Generation based incentive schemes for the Wind Power Projects:

- Incentive of Rs 0.50 /kWh through IREDA with a total cap of INR 6.2 million /MW spread over a minimum of 4 yrs (i.e. an annual cap of INR 1.55 million/MW)
- Grid connected wind power projects can avail either accelerated depreciation or GBI
- Incentive is over and above the feed-in tariff specified by the respective SERCs
- Applicable only for captive and not for third party sale and merchant plants [8]
- The expansion of the wind industry has resulted in a strong ecosystem, project operation capabilities and a manufacturing base. State-of-the-art technologies are now available in the country for the manufacture of wind turbines. All the major global players in this field have their presence in the country. Over 24 different models of wind turbines are being manufactured by more than 12 different companies in India. Wind turbines and components are being exported to the US, Australia, Europe, Brazil and other Asian countries. Around 70-80% indigenization has been achieved with strong domestic manufacturing in the wind sector.[2]

Result & Discussion: The present Wind Energy scenario in India shows some following features:

A) Continuing demand- supply gap Escalation in the cost of fossil fuel-based power generation Availability of soft loans and government incentives Project gestation period is significantly shorter than conventional sources.
B) Risk of obsolescence in case of technological innovations in other forms of energy Wind power subsidies may be rationalized or pegged down.
C) Low capacity utilization of Wind Energy Plant Load Factor (PLF—18%--23%) , rising land costs, developmental issues forced outages due to technical factors such as weak grid integration, mechanical problem etc.
D) Substantial untapped market (Current Utilization 24%), CDM credits for Clean Technologies, attractive productivity of existing installations, by repowering existing ones.

Conclusion: In India, the major solution to the dependency on Thermal, Nuclear and Hydro energy resources is domestic production, development and operation of renewable energy resources. Wind energy is the most important resource of renewable energy resources. There are lessons to be learned both in the success of wind in India and in examining how it needs to overcome these stumbling blocks.

First and foremost the initiative for wind power adoption must come from the government. The energy sector needs to be highly deregulated to allow alternate energy producers to shoulder most of the financial burden and also to really encourage the development using a market-based approach. Through, wind mapping activities to determine the best windy sites for installation, and build private sector confidence in wind energy. It must provide the right fiscal incentives, in the form of tax breaks for example, as India did, in order to spur installation. Yet another weakness in the system is the manner of fixation of tariff and RPOs by SERCs without any reference to the CERC regulations. The target of 15 per cent of renewable power by 2020 can be achieved only if the wind sector is allowed to grow without brakes and policy withdrawals. The government needs to take an objective view on policies and regulations and ensure stability and continuity of the same over a period.

The second major thing that needs to occur is for the institutional infrastructure to be established as early as possible. Also, with local production of wind equipment and the involvement of the community that the technology will be serving, there will be a sense of ownership that is crucial to the survival of such projects and urgent need is research and development in the area of wind technology for future acceleration.

The third and final point would be that as well as rewarding capital investment, there must be corresponding reward for actual generation of electricity, else performance of turbines will be low, and will both cause financial loss for the entrepreneurs and burden the local electricity boards, whose grids will suffer as a consequence.

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