



A Study of India's Renewable Wind Energy and its Challenges

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ABSTRACT

The most crucial component of socioeconomic development and global economic expansion is energy. The important role that renewable energy sources may play is to reduce scarcity of energy by supplying this energy to the mankind which is abundance. These sources will promote energy independence while also assisting in a number of other areas, such as reducing climate change, hastening the development of rural areas, enhancing health conditions, and being the finest means of achieving sustainable development. Nowadays wind power is a significant and expanding source of renewable energy. In electricity distribution networks, large wind turbines (with outputs of up to 6–8 MW) are frequently erected. Power transmission networks with a capacity of hundreds of megawatts are being directly connected to an increasing number of onshore and offshore wind farms that are serving as power plants. This paper provides a study of India's wind energy, wind turbine, blade design ideas and challenges in wind energy.

Keywords: Renewable energy, Turbine, Blade Design, Carbon Footprint, On/Offshore Wind Energy

Introduction

With the usage of fossil fuels becoming more and more unsustainable and the resulting effects on the environment, wind energy has emerged as a viable, sustainable, and affordable source of energy. The energy produced by the wind is known as wind power. It is among the first energy sources that humans have used, and it is currently the most well-established and effective renewable energy source. The name of the mythological Greek character Aeolus, the guardian of the winds, is the source of the academic term for wind energy, eolic energy.

Wind Energy

- Clean and non-polluting fuel source
- No Water Required
- Offsets Carbon footprint
- Key Mitigation tool to reverse Climate Change
- Socio economic growth enabler

Global Wind Day

Global Wind Day celebrated on 15th June 2023 by the Ministry of New and Renewable Energy (MNRE) with the theme of "PawanUrja: Powering the Future of India" in association with the Shakti Sustainable Energy Foundation, at Le-Meriden, New Delhi.



Fig 1. Wind farm

Wind Energy in INDIA

The Department of Non-Conventional Energy Sources (DNES) was established in the early 1980s with the goal of lowering the nation's reliance on primary energy sources like coal, oil, and other fossil fuels. Originally known as the Department of Non-Conventional Energy Sources (DNES), the Ministry of Non-Conventional Energy Sources (MNES) was renamed as the Ministry of New & Renewable Energy (MNRE) in 2006. In India, renewable energy is rapidly expanding, and wind energy has emerged as the most practical means of addressing issues like the depletion of fossil resources, the importation of coal, greenhouse gas emissions, environmental degradation, etc. By immediately reducing dependence on fuel and transportation, wind energy, a sustainable, inexpensive, and non-polluting source, may produce green and clean electricity.

By 2030, the Indian government has set a goal of 500 GW of renewable energy, of which 140 GW will come from wind. The National Institute of Wind Energy (NIWE) first calculated the wind potential in India at 50m hub height, or 49 GW, but the survey shows that at 80m hub height, the potential increases to 102 GW, and at 100 Metre hub height, it increases to 302 GW.

Additionally, a recent NIWE research at 120m height suggested a potential 695GW. The inherent ability of wind energy to sustain rural jobs and advance the rural economy is one of its key benefits. Additionally, wind energy uses no water, in contrast to all other energy sources, and water is a resource that will become increasingly scarce.

Overall, India's wind energy industry has a promising future thanks to the identification of energy security and self-sufficiency as the key factors. The main benefits of wind energy are that it is free to use and that no CO₂ emissions are produced. In comparison to other renewable energy sources, wind farms can be constructed rather quickly, the area can also be utilised for farming, serving a dual use. (Source for the Data: CEA, NIWE, MNRE)

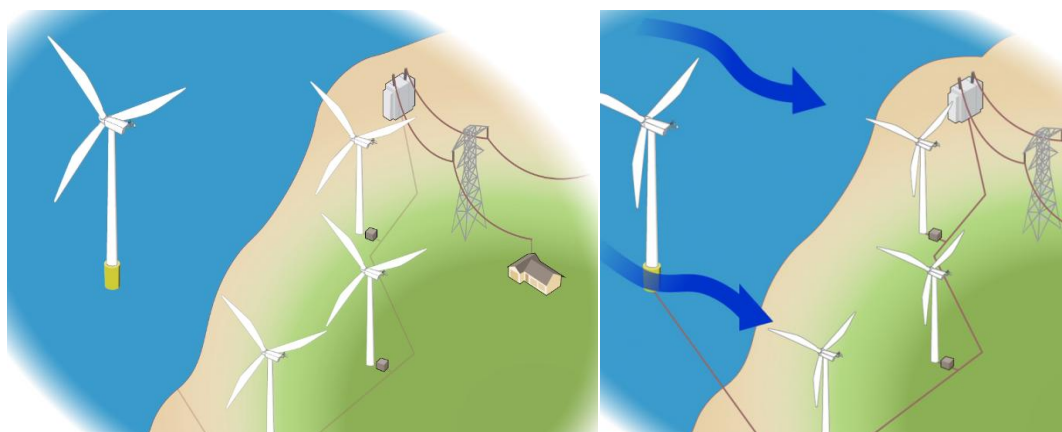


Fig 2. Wind energy generation

The Power of Wind - Wind turbines use the wind, a free, abundant, and environmentally friendly renewable energy source, to produce electricity. The ability of a set of wind turbines to generate power for the utility grid is demonstrated in this aerial image of a wind turbine factory. Transmission and distribution lines transport the electricity to buildings such as residences, workplaces, schools and so forth.

Wind Turbine Working

A wind turbine turns wind energy into electricity using the aerodynamic force from the rotor blades, which work like an airplane wing or helicopter rotor blade. When wind flows across the blade, the air pressure on one side of the blade decreases. The difference in air pressure across the two sides of the blade creates both lift and drag. The force of the lift is stronger than the drag and this causes the rotor to spin. The rotor connects to the generator, either directly (if it's a direct drive turbine) or through a shaft and a series of gears (a gearbox) that speed up the rotation and allow for a physically smaller generator. This translation of aerodynamic force to the rotation of a generator creates electricity.

Advantages of Wind Power

1. **Wind energy produces well-paying jobs.** In India, the wind sector employs more people, and that number is rising. The second fastest increasing occupation is wind turbine service technician. By 2050, there might be hundreds of thousands more jobs in the wind industry, which offers jobs ranging from asset manager to blade fabricator.
2. **A clean and renewable energy source is wind power.** Wind turbines use the mechanical energy of the wind to turn a generator and produce electricity. In addition to being a plentiful and limitless resource, wind also generates power without consuming any fuel or polluting the environment. The main renewable energy source is still wind, which aids in lowering our dependency on fossil fuels. Annually, wind energy helps save 329 million metric tonnes of carbon dioxide emissions, which is the same amount of emissions produced by 71 million cars and contributes to acid rain, pollution, and greenhouse gas emissions.
3. **Local communities gain from wind energy.** Each year, land leasing payments and state and local tax payments from wind farms are

anticipated to total \$1.9 billion. Communities that invest in wind energy can utilise the extra money to fund local infrastructure projects, lower homeowner taxes, and fund school budgets.

4. **Wind energy is economical.** One of the most affordable energy sources currently accessible is generated by utility-scale, land-based wind turbines. Additionally, as wind energy research and technology evolve, its cost-competitiveness continues to rise.
5. **Different environments are used by wind turbines.** In functioning landscapes with many uses including agriculture, wind energy generation works effectively. In rural or isolated places, such as farms and ranches or coastal and island villages, where high-quality wind resources are frequently found, wind energy is simple to integrate.

Challenges of Wind Power

1. **Other cheap energy sources must compete with wind energy.** Wind and solar power projects are currently more economically competitive than gas, geothermal, coal, or nuclear power plants when evaluating the cost of energy connected with new power plants. However, in some places that are not sufficiently windy, wind projects might not be cost-competitive.
2. **Ideal wind settings are frequently found in isolated areas.** To meet demand, it is necessary to deliver electricity from wind farms to metropolitan areas, but installation difficulties must be overcome. The cost of increasing land-based wind energy might be greatly reduced by upgrading the nation's transmission network to connect regions with plentiful wind resources to major population centres. Additionally, grid hookup and transmission capacities for offshore wind energy are developing.
3. **Turbines make noise and change the appearance of a space.** Although the environmental effects of wind farms are distinct from those of conventional power plants, there are still worries about the noise generated by the turbine blades and the visual effects on the environment.
4. **Local fauna may be impacted by wind farms.** Although wind energy projects have less of an impact on wildlife than other energy initiatives, study is still required to reduce wind-animal interactions. The negative effects of wind turbines on animals are being lessened thanks to technological advancements, strategic placement of wind farms, and ongoing environmental research.

The future of wind energy

The value of wind power data

For wind turbine operators, gathering operational wind energy data from their machines and turning it into useful information helps to boost profits, save expenses, and lessen risk. Collecting operational wind energy data from wind turbines and transforming it into valuable information helps increase revenue, reduce costs and lower risk for wind turbine operators. The Digital solutions is for wind assets, a collection of apps that integrate with the hardware and service offerings to make the most of data and analytics, improving the productivity, security, dependability, and profitability of the assets.



Fig. 3. Wind Turbine

Storage of clean wind energy

Wind turbine operators must dispatch and deliver sustainable energy when and where it is required. When paired with wind power generation, a battery energy storage system gives unprecedented application flexibility and unlocks new commercial value. With the use of clean wind energy storage, it may improve asset performance, manage energy flow, stabilise the electrical grid, and generate new revenue.

Finest designs for wind turbine blades

Wind turbine blade dependability is necessary for harnessing the wind onshore or offshore, at any speed, anywhere in the world and experience breeds dependability. The technology developed by LM Wind Power is fundamental to the development of each type of wind turbine blade. The performance and dependability of the LM Wind Power blade are determined by aspects like wind turbine blade materials, aerodynamics, blade profile, and construction, all of which call for an incredibly high level of precision.

Dependable wind turbine designs for effective wind power

The basic blade design hasn't changed since LM Wind Power started manufacturing wind turbine blades in 1978, but we've kept up our efforts to create the world's longest wind blades. The biggest design difficulty for each wind turbine blade length is striking the ideal balance between aerodynamics and windturbine blade design. How successfully a wind turbine blade can extract energy from the wind and effectively generate wind power depends critically on its aerodynamic qualities. By creating and testing the best materials for wind turbine blades, the new design of dependable wind turbine blades that utilising cutting-edge design tools are manufactured.



Fig. 4. Turbine blades

Conclusions

The most effective energy conversion system is one that uses wind energy to generate electricity because it uses little energy, emits little carbon dioxide, and generates a lot of total energy. The most important phase in terms of the effects wind energy has on the environment, both for onshore and offshore wind power facilities, is the construction of the wind turbine. When compared to the overall environmental effects of both offshore and onshore wind power facilities, the environmental impacts produced during the stages of transportation and operation cannot be regarded as significant. The most effective energy conversion system is one that uses wind energy to generate electricity because it uses little energy, emits little carbon dioxide, and generates a lot of total energy. Finally, it's critical to promote additional investigation into possible environmental studies. Therefore, it is advised to first take into account study findings and environmental impact assessments when thinking about building a new wind farm or taking into account an existing one.

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