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Review Article

WIND POWER IN INDIA: PROS AND CONS – AN OVERVIEW

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New technological developments in wind energy design have contributed to the significant advances in wind energy penetration and to get optimum power from available wind. In this study, an attempt has been made to analyze and review the development and dissemination of wind energy in India. The diffusion prospect of wind energy generation in the potential states of India is also analyzed.

Keywords: Doubly fed induction generator, Pollution free, Renewable

INTRODUCTION

Despite major capacity additions over recent decades, power supply struggles to keep up with demand. With depletion of energy sources worldwide, every effort is made to convert other forms of unconventional energy into electrical energy. So energy recovery schemes are becoming an important aspect of present day industrial processes. In the coastal areas, wind energy is available in abundance. For the conversion of this wind energy into electrical energy, an Induction Generator coupled with a wind-mill offers an ideal solution.

Why Wind Energy?

The majority of electricity is generated by burning coal, rather than more eco-friendly methods like hydroelectric power. This use of coal causes untold environmental damage through CO_2 and other toxic emissions.

The energy sector is by far the biggest source of these emissions, both in the India and globally, and if we are to tackle climate change it is clear we need to move away from burning limited fossil fuel reserves to more sustainable and renewable sources of energy.

How Wind Turbine Works

Wind power involves converting wind energy into electricity by using wind turbines. A wind turbine is composed of 3 propellers-like blades called a rotor. The rotor is attached to a tall tower. The tower looks like a very tall pole. On average wind towers are about 20 m high. The reason why the tower is so tall is because

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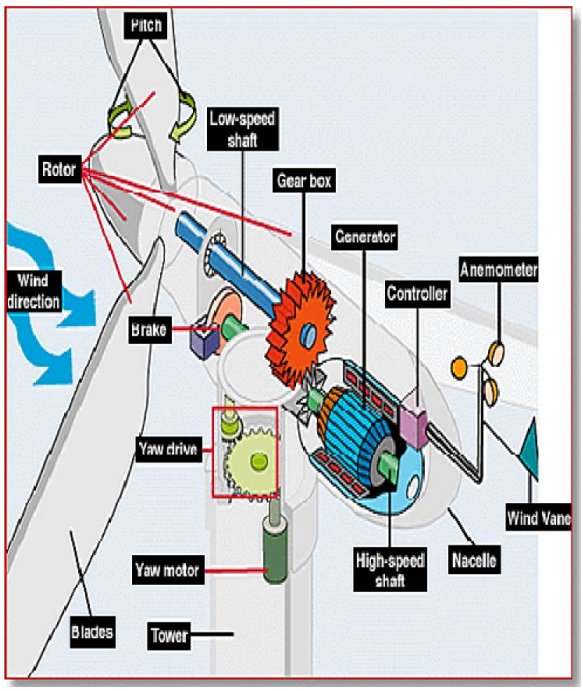
winds are stronger higher from the ground. The average wind speed needs to be above 5 m/s (18 km/h) to make installing a wind turbine worthwhile. The wind makes the rotor spin; as the rotor spins, the movement of the blades spinning gives power to a generator which makes energy. The motion of the wind turbine turning is called kinetic energy, this power is converted into electricity (Figure 1).

Figure 1: Wind-Turbine Components



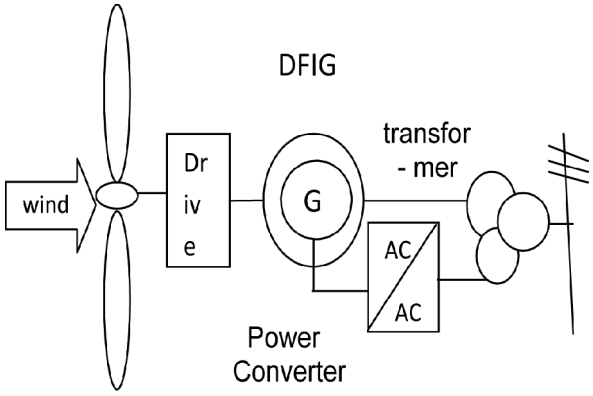
THE CONVERSION OF WIND INTO ELECTRICITY

There has been an increasing use of induction generator (or Asynchronous generators) particularly in wind power applications. In generator operation, a prime mover (turbine, engine) drives the rotor above the synchronous speed. Induction generators operate by mechanically turning their rotor in generator mode, giving negative slip. Among the types of IGs, Doubly Fed Induction Generator (DFIG) wind turbines are nowadays increasingly used in large wind farms because of their ability to supply power at constant voltage and frequency.

The gearbox adjusts the rotational speed to that which is appropriate for the generator, which uses magnetic fields to convert the rotational energy into electrical energy. The power output goes to a transformer, which converts the electricity from the generator at around 700 V to the appropriate voltage for the power collection system, typically 33 kV. The grid provides the necessary reactive power to the generator.

The electricity is sent through transmission and distribution lines to homes, businesses, schools, and so on. Electricity from the turbines is fed into a utility grid and distributed to customers, just as with conventional power plants (Figure 2).

Figure 2: Variable Speed Wind Turbine with Doubly Fed Induction Generator



BENEFITS OF WIND POWER

Wind power has many advantages that make it a lucrative source of power for both utility-scale and small, distributed power generation applications. The beneficial characteristics of wind power include:

- Wind energy is a green energy source and does not cause pollution. Wind power doesn't produce any emissions. A one megawatt (1 MW) wind turbine for one year can displace over 1,500 tons of carbon dioxide, 6.5 tons of sulphur dioxide, 3.2 tons of nitrogen oxide, and 60 pounds of mercury (based on the US average utility generation fuel mix).
- Endless fuel—it is not run down with time. Wind power is renewable and there is no way we can run out of it (since wind energy originates from the sun).
- Abundant domestic supply (16 times current electric demand!).
- The power is essentially free once the infrastructure is paid for.
- The operational costs associated with wind power are low.
- Today's high efficiency turbines spin at lower speeds and use smooth poles to support the turbine instead of the lattice-style structures used earlier—which actually made nice bird nesting grounds.
- The potential of wind power is enormous—20 times more than what the entire human population needs.
- Wind turbines are incredible space-efficient. The largest of them generate enough electricity to power 600 US homes.
- Wind power only accounts for about 2.5% of total worldwide electricity production, but is growing at a promising rate of 25% per year (2010).
- Prices have decreased over 80% since 1980 and are expected to keep decreasing.
- Good domestic potential: Residential wind turbines yields energy savings and protects homeowners from power outages.

ISSUES THAT NEED CONCERN

- The major challenge to using wind as a source of power is that it is intermittent and does not always blow when electricity is needed. Wind cannot be stored (although wind-generated electricity can be stored, if batteries are used), and not all winds can be harnessed to meet the timing of electricity demands Wind is a fluctuating (intermittent) source of energy and is not suited to meet the base load energy demand unless some form of energy storage is utilized (e.g., batteries, pumped hydro).
- The manufacturing and installation of wind turbines requires heavy upfront investments—both in commercial and residential applications.
- Wind turbines can be a threat to wildlife (e.g., birds, bats). Birds and bats having been killed (avian/bat mortality) by flying into the rotors.
- Environmental concerns: Although wind power plants have relatively little impact on the environment compared to fossil fuel power plants, there is some concern over the noise produced by the rotor blades Noise is regularly reported as a problem by neighboring homes.
- Visual impacts: How wind turbines look (aesthetics) is a legitimate concern for some people.
- Supply and transport issues: Most of the wind farms in India are located in remote

locations that are quite far away from load centers, i.e., from areas of electric power demand (such as cities). Due to a weak transmission and distribution network, it is difficult to transmit the power from wind farms to the load dispatch centers.

- Finally, wind resource development may compete with other uses for the land, and those alternative uses may be more highly valued than electricity generation. However, wind turbines can be located on land that is also used for grazing or even farming.
- In most states, availability of land for wind farms is a contentious issue. Even if private lands are available, conversion of land use status from agricultural to non-agricultural is a time consuming process. Further if the land is close to a protected area or forestlands then obtaining clearance from forest authorities for using the forestland for wind power generation is time consuming.

Most of these problems have been resolved or greatly reduced through technological development or by properly siting the wind plants.

STORAGE

The main disadvantage of wind power is that the wind does not blow consistently or steadily. That is to say, energy has to be produced and stored when the opportunity arises and later used when demand levels increase. Energy storage technology has been and is continuously being developed.

Pumped Hydro Storage

Currently, the most practical application for wind energy storage is wind powered hydro storage. This method is similar to the utility practice of pumping water to an upper reservoir at night during “off peak” demand when electrical rates are lower and then releasing the water through a small hydro turbine to generate electricity during peak demand hours when the rates are higher.

Compressed Air Energy Storage

Compressor could operate from wind power.

Flywheels

Flywheels are mechanical devices that store energy in a rotating mass. Energy can be absorbed from a wind generated electric motor that spins a flywheel.

Battery Storage

Wind power is converted into electricity by magnets moving past stationary coils of wire known as the stator. As the magnets pass the stator, AC electricity is produced. It is then converted into DC electricity which can be used to charge batteries which store the electrical energy or can also be fed into a grid interactive inverter for feeding power into the electricity grid.

Statistics

Wind Energy has been the fastest growing renewable energy sector in the country. With a cumulative installed. The 12th Five Year Plan proposals envisage around 15,000 MW of grid-interactive renewable power capacity addition from wind energy alone.

India is the 3rd largest annual wind power market in the world, and provides great business opportunities for both domestic and foreign investors. The Indian wind power sector experienced record annual growth in 2011 with the addition of more than 3 GW of

new installations. Diverse incentives supported As of March 2012, renewable energy accounted for 12.2% of total installed capacity, up from 2% in 1995. Wind power accounts for about 70% of this installed capacity. By the end of August 2012, wind power.

Interestingly more than 95 percent of the nation's wind energy development to date is concentrated in just five states in southern and western India – Tamil Nadu, Andhra Pradesh, Karnataka, Maharashtra, and Gujarat (LBNL, 2012). These five states accounted for over 85% of the total installed capacity at the end of the last plan period. Rajasthan is another emerging State with rising wind turbine installations. capacity of over 18,000 MW, wind power currently accounts for almost 70% of the total installed capacity in the renewable energy sector.

Review Article in Newspaper (Economic Times)

Past few years, the wind energy sector thrived even as other sectors missed targets due to incentives such as Generation-Based Incentives (GBI) and Accelerated Depreciation (AD). But from April 2012, the government rolled back the GBI, which gave independent power producers a benefit of 50 paise for every unit of power generated. The accelerated depreciation benefit, which allowed project developers to write off 80% of the project value in the first year as depreciation and reduced their tax burden, was also withdrawn. The industry has been seeking restoration of both incentives since April and despite the ministry of new and renewable energy supporting the request, the policy has not been approved by the government.

MANUFACTURERS OF WIND TURBINES IN INDIA

Manufacturer	Rating (kW)
Enercon	800 Synchronous
GE Wind	1,500 DFIG
GE Wind	1,600 DFIG
Suzlon	1,250/2,100 Asynchronous
Suzlon	1,500 Asynchronous
Suzlon	2,250 DFIG
Vestas India	1,650/1,800 Asynchronous
RRB Energy	1,800 Asynchronous
Gamesa	850 DFIG
Gamesa	2,000 DFIG
Global Wind Power	2,500 kw Synchronous
Inox Wind Limited	2,000 DFIG
Kenersys-India	2,000 Synchronous
Leitner-Shriram Synchronous	1,350/1,500
ReGenPowertech	1,500 Synchronous
WinWinD	1,000 Synchronous

ABB Induction Generators

Asynchronous generators up to 7 MW for fixed speed concept, doubly-fed concept and also for Industries and utilities. With its 30 years of experience, in-depth know-how, global manufacturing footprint and thorough understanding of both wind turbine applications and power systems, ABB serves wind power customers at every stage of the process. ABB is the leading supplier to the wind power industry of electrical products and

solutions. Turbines are comprised of many subsystems working in unison so that the turbine efficiently and safely produces power. ABB products are used throughout these subsystems, from the emergency stop button to the generator ll converter concept.

FUTURE ISSUES

Most of the current installations are of the stand-alone type. By the end of the 11th Plan period a cumulative capacity of 1647 kW of wind-solar hybrid systems had been installed.

Lastly India's wind sector has tremendous job creation potential as the domestic industry grows. There is likely to be higher demand for trained manpower and accordingly, the technical training and academic curriculum across the States may need to be modified.

Most of the wind farms in India are located in remote areas that are quite far away from load centers. Due to a weak transmission and distribution network, it is difficult to transmit the power from wind farms to the load dispatch centers. This is one of the key constraints for the future of wind power development in the country. In the past, with vertically integrated utilities, a single organisation was responsible for the planning and operation of networks and giving access to generators, and therefore the technical requirements did not have to be particularly clearly.

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