Frequently Asked Questions on Wind Power Programme (FAQ)

1. **What is wind?**
Wind is air in motion. Wind is mainly formed due to the Earth’s rotation and the uneven heating of Earth’s surface by sunrays. The sunrays cover a much greater area at the equator than at the poles. The hot air rises from the equator and expands toward the poles that cause wind.

   Air has a mass and mass in motion has a momentum.
   Momentum is a form of energy that can be harvested.
   \[ P_{\text{wind}} = \frac{1}{2} \times \rho \times A \times V^3 \]
   Where,
   \( P_{\text{wind}} \) = Power in the wind (W/m\(^2\))
   \( \rho \) = Air density (kg/m\(^3\))
   \( A \) = Projected area (m\(^2\)) (wind turbine rotor area)
   \( V \) = average wind speed (m/s)
   the power increases with cube of wind speed

2. **What is a wind turbine?**
A wind turbine is a system which transforms the kinetic energy available in the wind into mechanical or electrical energy that can be harnessed for any required applications. Mechanical energy is most commonly used for pumping water. Wind electric turbines generate electricity that can be utilized locally or transported to the desired location through grid.

3. **What are the different configurations of Wind Turbines?**
There are two basic configurations of Wind Turbines. One is Vertical axis wind turbine and the other is Horizontal axis wind turbine. The horizontal axis turbine has seen technological and economical growth and it has become the commonly used commercial turbines on large scale and the vertical axis turbines are still in the demonstration purpose and small scale applications.
4. What does wind turbine contains or components of wind turbine?

**Rotor:**
The blades and the hub together are called the rotor. It is the rotating component which converts kinetic energy available in the wind to mechanical energy. The rotor hub connects the rotor blades to the rotor shaft. It is also the place where the power of the turbine is controlled physically by pitching (A method of controlling the speed of a wind turbine by varying the orientation, or pitch, of the blades, and thereby altering its aerodynamics and efficiency) the blades. Hub is one of the critical components of the rotor requiring high strength qualities.
**Blades:**
Blade is a rotating component designed aerodynamically to work on the principle of lift and drag to convert kinetic energy of wind into mechanical energy which is transferred through shaft then converted to electrical energy using generator. Most turbines have either two or three blades. Wind blowing over the blades causes the blades to "lift" and rotate. Mechanical applications like pumping water, grinding uses more number of blades as it requires more torque. Blade length is key factor determining power generation capacity of a wind turbine.

**Nacelle:**
The nacelle is an enclosure that sits atop the tower and contains the gear box, low-speed shaft and high-speed shaft, generator, controller, and brake. Some nacelles are large enough for a helicopter to land on. The nacelle also protects turbine components from atmospheric weather conditions and reduces noise.

**Low-speed shaft:**
Low-speed shaft is the principle-rotating element which transfers torque from the rotor to the rest of drive train. It also supports the weight of the rotor. It is connected to the gearbox to increase the rpm.

**Gear box:**
Gear box steps up the speed according to the requirement of the electric generator. Gears connect the low-speed shaft to the high-speed shaft and increase the rotational speeds from about 30 to 60 rotations per minute (rpm) to about 1000 to 1800 rpm, the rotational speed required by most generators to produce electricity. The gear box is one of the costliest (and heavy) parts of the wind turbine and there are also "direct-drive" generators that operate at lower rotational speeds and don't need gear boxes.
Types: Planetary Gear Boxes, Parallel shaft gear.

**High-speed shaft:**
Transmits the speed & torque from the gearbox and drives the generator.

**Brake:**
During the periods of extremely high winds and maintenance, brakes are used to stop the wind turbine for its safety.

Types of Brakes: mechanical brake (Disc brake, clutch brake), Aerodynamic brake (Tip brake and spoilers)

**Generator:**
Generator converts the rotational mechanical energy into electrical energy. Usually wind electric generator produces 50-cycle AC electricity.
Types: Synchronous generator (Electrically excited, permanent magnet), asynchronous generator (Squirrel cage, Slip ring)

**Controller:**
The controller starts up the machine at cut-in wind speed (generally 3 m/s) and shuts off the machine at cut-out wind speed (generally 25 m/s) as per the design requirement. The controllers also operate the turbine to produce grid-quality electricity. The controller measures and controls parameters like Voltage, current, frequency, Temperature inside nacelle, Wind direction, Wind speed, The direction of yawing, shaft speed, Over-heating of the generator, Hydraulic pressure level, Correct valve function, Vibration level, Twisting of the power cable, Emergency brake circuit, Overheating of small electric motors for the yawing, hydraulic pumps, Brake-caliper adjustment etc.

**Anemometer:**
Anemometer is a sensor used for measuring the wind speed. Other than using it for wind resource assessment, it is normally fixed on top of the wind turbine to provide input to the controller for power regulation and braking beyond the cut out & survival wind speed.

Sectional view of wind generator  (Source: [http://www1.eere.energy.gov/](http://www1.eere.energy.gov/))
(See animation: [http://www.matkam.com/windt/windt.swf](http://www.matkam.com/windt/windt.swf))

**Pitch:**
Blades are turned or pitched, out of the wind to control the rotor speed and keep the rotor from turning in winds that are too high or too low to produce electricity.

**Tower:**
The tower enables wind energy utilization at sufficient heights above ground, to absorb and securely discharge static and dynamic stress exerted on the rotor, the power train and the nacelle into the ground.

Types: Lattice tower, tubular tower, Guyed tower, Hybrid Tower

**Foundation (not shown in the picture)**

Foundation is needed to support and absorb the loads from the wind turbine. The choice of foundation type is much dependent on the soil conditions and water table location prevailing at the planned site of a wind turbine.

**Onshore Foundation Types:** Slab Foundation (preferred when the top soil is strong), Pile Foundation (Preferred when the top soil is of a softer quality)

**Offshore Foundation Types:** Monopile, Gravity base, Tripod

**Wind vane:**

Measures wind direction and communicate with the controller for orienting the turbine properly (yawing) with respect to the wind direction.

**Yaw drive:**

Yaw drive turns the nacelle with rotor according to the wind direction using a rotary actuator engaging on a gear ring beneath the nacelle. Yaw system keeps the turbine always facing the wind.

**Yaw motor:**

Yaw motor is to power the yaw drive.

5. **What are the different turbine technology options?**

- Axis orientation: Horizontal/Vertical
- Power control: Stall / Variable Pitch / Controllable Aerodynamic Surfaces / Yaw Control
- Yaw Orientation: Driven Yaw / Free Yaw / Fixed Yaw
- Rotor Position: Upwind / Downwind
- Transmission: with gear / without gear
- Type of Hub: Rigid / Teetered / Hinged blades / Gimbaled
- Generator Speed: Constant / Variable
- Number of Blades: One, Two, Three, multi-bladed.
- Location: on-shore / Off-shore

6. **What are the different types of generators used in wind turbine?**

1. Asynchronous generator (constant / variable speed / preferably high speed generators)
2. Synchronous generator (variable speed / slow speed)
3. Doubly fed induction generator

7. What are the different types of towers used in wind turbine?
   
1. Tubular steel tower
   Area of contact is more – hence more loading but evenly distribution – attractive – cost is more.

2. Tubular concrete
   Area of contact is more – high elasticity – loading high but even distribution – cost slightly less.

3. Lattice tower
   Area of contact is less – less loading – load distribution is uneven – transportation / fabrication easy.

4. Three legged tower
   Area of contact is less – less loading – load distribution is uneven – transportation / fabrication easy.

5. Guy wired tower
   Area of contact is less – less loading – load distribution even – transportation / fabrication easy and not suitable for huge wind turbines.

6. Hybrid tower
   A combination of tubular and lattice - Less obstruction - Strong
8. What is meant by a turbine’s swept area?
Area perpendicular to the wind direction that a rotor will describe during one complete rotation or the area of imaginary circle formed during the rotation of wind turbine is called swept area.

9. What is meant by Rated wind speed \( (V_r) \)?
Specified wind speed at which a wind turbine’s rated power is achieved.
Relationship between wind speed (x) and power (y) (source: powernaturally.org)

10. What is Survival wind speed or extreme wind speed?
The survival wind speed is the maximum wind speed that a wind turbine is designed to withstand.

11. How much power can a wind turbine generate?
The ability of a turbine to generate electric power is measured in Watts (The rate of energy transfer equivalent to 1 Ampere of electric current flowing under a pressure of 1 Volt at unity power factor). Watts being a small unit of power, kilowatts (kW = 1000 Watts) and Mega Watts (MW = 1 million Watts) are the most commonly used units to describe the generating capacity of wind turbines and any power generating unit in general.

Electricity production and consumption are most commonly measured in kilowatt-hours (kWh). A kilowatt-hour means one kilowatt (1,000 Watts) of electricity produced or utilized in an hour (To light up a 100 Watts bulb for 10 hours requires 1 Kilowatt-hour of electricity).

Watt-hour is the electrical energy unit of measure equal to 1 Watt of power supplied to, or taken from, an electric circuit steadily for 1 hour.

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.

Wind speed and a wind turbine size are the factors that determine the power generation capacity of a wind turbine installation. Usually, wind resource assessment is done prior to a wind system’s construction.

The power (energy/second) available in the wind will be given by the formula Power = 0.5 x rotor swept area (m²) x density (kg/m³) x velocity³ (m/s)

It can be noted that the power generated is cube of the wind velocity and because of this, even a small difference in wind speed will bring about a large difference in available energy and in electricity produced and therefore, a large difference in the cost of electricity generated.

12. What will be the power generation in a 100kW wind turbine?
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.

13. What is Yawing?

Alignment of rotor surface area facing the wind direction is called yawing. In detail, rotation of the rotor axis about a vertical axis (for horizontal axis wind turbine only) is called yawing.

14. Does wind turbines height affect the generation?

Yes, to achieve more power generation, the turbine should require more wind speeds with velocity, which will be available in a good elevation. If the rotor is placed at a height where the flow is least obstructed by obstacles and as the height increases the wind faces less friction from its nearest surface.

15. Will a wind turbine produce power in the rain season?

Yes, but the generation will be less when the air is humid and has larger percentage of water molecules. if the air is dry and has no water molecules, a wind turbine will produce more power.

16. What is the life of a Wind Turbine?

Generally, the present wind turbines are designed to last for a period of 20 years. It can also be designed for more than 20 years, only thing is the machine will be far more bulky and costlier than what is available now and would be prohibitive as a alternative to explore economically.

17. What happens when the winds become too much for the wind turbines?

When the wind speed is high beyond cut-out speed, the turbine stops producing power and goes into an inert state to avoid components’ stress and damages. Normally the machines are manufactured with safety incorporation to cater to most of the conceivable emergencies.

18. Can we mount a small wind turbine on our roof top?

Yes, small wind turbines are mountable on roof top for domestic applications. Right now, in India, mostly small wind turbines are stand alone which stores power in battery and in some of the western countries even small wind turbines are connected to the local grid. Small wind turbine with capacity ranging from 300 W to 25 kW are now available in Indian market and gaining popularity.
19. What is a wind farm?
The most economical application of wind turbines is in groups of large machines. They are called ‘Wind farms’ or ‘wind power plants’. Wind plants can vary in size from a few Mega Watts to hundreds of Mega Watts in capacity.

20. Where does the power generated from a wind turbine go?
Normally, the powers produced by large wind turbines are connected to the state / central electricity grid whereas smaller wind turbines normally charged into a battery. Now a day lots of encouragement steps are being initiated to couple small wind turbine into grid. The power concentrated to the grid can be sold to the state utility / any private party / can also be used for captive use by paying wheeling charges alone.

21. Are winds available throughout the year?
Wind is a variable in nature and varies time to time and place to place. It is predominantly driven by the monsoon and winds in India are influenced by strong South-West summer monsoon (April to September) and weaker North-East winter monsoon.

22. How to measure the winds at a site?
To estimate the energy production of a wind farm, developers must first measure the wind resource on the selected location. Meteorological towers equipped with anemometers, wind vanes, and sometimes temperature, pressure, and relative humidity sensors are installed. Data from these sensors / equipments must be recorded for at least one year to calculate an annually representative wind speed frequency distribution.

Since onsite measurements are usually available for a short period, data are also collected from nearby long-term reference stations (like airport, metrological stations etc.) if available. These data are used to adjust the onsite measured data so that the mean wind speeds are representative of a long-term period for which onsite measurements are not available.

23. What are the techniques used for wind resource assessment?
There are three basic steps to identify and characterize the wind resource in a given region. In general, they are prospecting, validation and optimization. In prospecting, the identification of potential windy sites within a fairly large region, in the range of several square kilometers areas would be considered. Generally this is carried out
by meteorologists who depend on various sources of information such as
topographical maps (in India, Survey of India map), climatological data from
meteorological stations (e.g. India Meteorological Department), and satellite
imageries, etc. A site visit also will be conducted at this stage and a representative
location for wind measurement would be identified.

Validation process involves a more detailed level of investigation like wind
measurements and data analysis. The most imperative and final step is micro survey
and micrositing. The main objective of this step is to quantify the small scale
variability of the wind resource over the region of interest. In micro survey, a small
region in and around a wind monitoring station (generally 10 km radius) will be taken
as a reference station for horizontal and vertical assessment. Finally, micrositing is
carried out to position the wind turbines on a given area of land to maximize the
overall energy output of the wind farm. In complex terrain, micrositing may involve
two or more measurements, as a single site wind data cannot give good results.

There are several industry standard Software in the market for resource modeling
over a small region (micro survey) and later for micrositing. Wind Atlas Analysis
Application Programme (WAsP), Resoft Wind Farm, Wind PRO and GH Wind
Farmer are some of the models available in the market. As the mathematical
equations used in these models are linearised, there are some limitations in using
these models in all atmospheric and topographic conditions. Even if these models
have some limitations, they can give good results if ‘handled’ circumspectly

24. How do estimate energy production from a wind farm?
The following calculations are needed to accurately estimate the energy production
of a proposed wind farm project:

a. Correlations between onsite meteorological towers:
Multiple meteorological towers are usually installed on large wind farm sites. For
each tower, there will be periods of time where data is missing but has been
recorded at another onsite tower. Least squares linear regressions can be used to fill
in the missing data. These correlations are more accurate if the towers are located
near each other (a few km distance), the sensors on the different towers are of the
same type, and are mounted at the same height above the ground.

b. Correlations between long term weather stations and onsite
meteorological towers:
Because wind is highly variable year to year, short-term (< 5 years) onsite
measurements can result in highly inaccurate energy estimates. Therefore, wind
speed data from nearby longer term weather stations (usually located at airports) are used to adjust the onsite data. Least squares linear regressions are usually used, although several other methods exist as well.

c. Vertical shear to extrapolate measured wind speeds to turbine hub height:
The hub heights of modern wind turbines are usually 80 m or greater, but cost effective meteorological towers are only available up to 60 m in height. The power law and log law vertical shear profiles are the most common methods of extrapolating measured wind speed to hub height.

d. Wind flow modeling to extrapolate wind speeds across a site:
Wind speeds can vary considerably across a wind farm site if the terrain is complex (hilly) or there are changes in roughness (the height of vegetation or buildings). Wind flow modeling software is used to calculate these variations in wind speed.

e. Energy production using a wind turbine manufacturer’s power curve:
When the long term hub height wind speeds have been calculated, the manufacturer’s power curve is used to calculate the gross electrical energy production of each turbine in the wind farm.

f. Application of energy loss factors:
To calculate the net energy production of a wind farm, the following loss factors are applied to the gross energy production
- wind turbine wake loss
- wind turbine availability
- electrical losses
- blade degradation from ice / dirt / insects
- high / low temperature shutdown
- high wind speed shutdown curtailments due to grid issues

25. What is Type Testing of wind turbines and its need?
Type testing of wind turbine is similar to any product testing in engineering practices. Any new wind turbine model has to be type tested so as to get certified. Unless and until it is certified, it cannot be installed in any wind farm site, as per the quality regulations. Quality regulations vary from country to country.
**26. What is “Capacity factor”?**

Capacity factor is a way to measure the productivity of a wind turbine or any other power production facility. It compares the plant’s actual production over a period of time with the amount of power the plant would have produced if it had run at the full capacity for the same amount of time.

\[
\text{Capacity Factor} = \frac{\text{Actual amount of power produced over time}}{\text{Power that would have been produced if turbine Operated at maximum output 100\% of the time}}
\]

A conventional utility power plant uses fuel, so it will normally run much of the time unless it is idled by equipment problems for maintenance. A capacity factor of 40\% to 80\% is typical for conventional plants (thermal, nuclear, large hydro etc.).

A wind turbine is “fueled” by the wind, which blows steadily at times and not all the times. Most modern utility-scale wind turbines operate with a capacity factor of 25\% to 40\% although they may achieve higher capacity factor during windy season. It is possible to achieve much higher capacity factors by combining wind with a storage technology such as pumped hydro or compressed-air energy storage (CAES).

It is important to note that while capacity factor is almost entirely a matter of reliability for a fueled power plant, it is not for a wind plant. For a wind plant, it is a matter of economical turbine design. With a very large rotor and a very small generator, a wind turbine will run at full capacity whenever the wind blew and would have a 60-80\% capacity factor, but it would produce very little electricity. The most electricity per rupee invested is gained by using a larger generator and accepting the fact that the capacity factor will be lower as a result. Wind turbines are fundamentally different from fueled power plants in this respect.

**27. What is ‘availability factor’?**

Availability is a measure of the reliability of a wind turbine or other plant. It refers to the percentage of time that a plant is ready to generate (that is, not out of service for maintenance or repairs). Modern turbines have an availability of more than 98\%-higher than most other types of power plant. After two decades of constant engineering refinement, today’s wind turbines are highly reliable.

**28. The wind does not blow all the time. How can it really contribute to a utility’s supply?**
Utilities must maintain enough power plant capacity to meet expected customer electricity demand at all times, plus an additional reserve margin. All other things being equal, utilities generally prefer plants that can generate as needed (that is, conventional plants) to plants that cannot (such as wind plants).

Recent studies concluded that when turbines are added to a utility system, they increase the overall statistical probability that the system will be able to meet demand requirements. They noted that while wind is an intermittent resource, conventional generating systems also experience periodic shutdowns for maintenance and repair.

The exact amount of capacity value that a given wind project provides depends on a number of factor, including average wind speeds at the site and the match between wind patterns and utility load (demand) requirements.

**29. Why is the plant load factor of wind turbines so low when compared to a conventional power generation plant like thermal, nuclear?**

The wind turbine do not have the winds throughout the year as does a thermal plant and hence cannot be operational for the same kind of periods as would a conventional power plant. Hence the plant load factor is comparatively lesser for a wind turbine to that of a thermal power plant.

**30. Can a wind turbine be mounted on a moving structure and be used to produce power like on trains, buses etc?**

It is not a economically feasible idea to produce power from a moving platform because the resistance generated to the advancement of the moving platform due to the wind turbine would have to be overcome by consumption of more power than that the wind turbine mounted on its top would produce. Hence the net power produced from the adventure would be in the negative domain.

**31. What are the different types of testing carried out on a wind turbine?**

Basic tests are Power Curve Measurements, Yaw Efficiency Test, Safety and Function Testing, Load Measurements, Noise Measurements, Power Quality Measurements

**32. What is PCM?**

Power Curve Measurements (PCM) determines the power performance characteristics of wind turbines when connected to either the electric power network or a standalone system, as per IEC 61400-12-1, performance evaluation of specific
turbine done at specific locations, estimated annual energy production (AEP) for the Wind Turbine.

33. What are the parameters to be measured for PCM?
Wind Speed at hub height, Wind Speed at reference height, Wind direction, Air temperature, Relative humidity, Air pressure, Rotor Speed, Active power, Reactive power, Frequency, Brake status and Generator status.

34. What is Yaw Efficiency Test?
Yaw efficiency test is to determine the ability of the wind turbine to follow the wind which can be important for the fatigue loads of the wind turbine.

35. What are the studied parameters in a Yaw efficiency test?
Wind Speed at hub height, Wind Speed at reference height, Wind direction, Air temperature, Relative humidity, Air pressure and Yaw Direction.

36. What is Safety and Function testing?
Safety (protection) test is to determine the protection system, functions and its effectiveness.
Function testing is to demonstrate the functions involved in operation of wind turbine by means of manual test.

37. What are the parameters to be measured for Safety and Function testing?
Wind Speed at hub height, Rotor Speed, Active power, Reactive power, Flap wise bending moment, Edge wise bending moment, Shaft torsion, Brake status and Generator status.

38. What are Load measurements?
Load measurement is to describe the methodology and corresponding techniques for the experimental determination of the mechanical loading on wind turbines.

39. What is the general setup needed for wind turbine measurements?
40. What are the parameters to be measured in Load Measurement test?
Wind Speed at hub height, Rotor Speed, Active power, Reactive power, Flap wise bending moment, Edge wise bending moment, Shaft torsion, Shaft bending moment-XX, Shaft bending moment-YY, tower bending moment, Brake status and Generator status.

41. What is power quality?
Ability of a power system to operate loads, without damaging or disturbing them, a property mainly concerned with voltage quality at points of common coupling & ability of the loads to operate without disturbing or reducing the efficiency of the power system, a property mainly, but not exclusively, concerned with the quality of current waveform.

42. What are the power parameters that affect power quality?
Voltage, frequency, Interruption by Flicker, Harmonics, Transients

43. What is the India power scenario?
India meets most of its domestic energy demand through its 92 billion tonnes of coal reserves (about 10% of world's coal reserves). India’s oil reserves, found in Bombay High off the coast of Maharashtra, Gujarat, Rajasthan and Eastern Assam meet 25% of the country’s domestic oil demand. India’s total proven oil reserves stand at 11 billion barrels, of which Bombay High is believed to hold 6.1 billion barrels and Mangala Area in Rajasthan an additional 3.6 billion barrels. India's huge thorium
reserves is also a major energy source. About 25% of world’s reserves is expected to fuel the country’s ambitious nuclear energy program in the long-run. India’s dwindling uranium reserves stagnated the growth of nuclear energy in the country for many years. However, the Indo-US nuclear deal has paved the way for India to import uranium from other countries. India is also believed to be rich in certain renewable sources of energy with significant future potential such as solar, wind and bio fuels (jatropha, sugarcane).

In India, 10% of installed power capacity is from renewable, in which wind is contributing 7%. To highlight, India is holding fifth position in terms of installed wind power capacity as on March 2011 with an installed capacity of 13065 MW.

### 44. What is the state wise installed capacity in India?

Up to 31.3.2011 a total capacity of 14156 MW has been installed, as per the following break-up.

<table>
<thead>
<tr>
<th>State</th>
<th>Capacity (MW)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tamil Nadu</td>
<td>5904</td>
</tr>
<tr>
<td>Maharashtra</td>
<td>2317</td>
</tr>
<tr>
<td>Gujarat</td>
<td>2176</td>
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<tr>
<td>Karnataka</td>
<td>1727</td>
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<tr>
<td>Rajasthan</td>
<td>1525</td>
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<tr>
<td>Madhya Pradesh</td>
<td>276</td>
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<tr>
<td>Andhra Pradesh</td>
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</tr>
<tr>
<td>Kerala</td>
<td>35</td>
</tr>
<tr>
<td>Others</td>
<td>4</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>14156</strong></td>
</tr>
</tbody>
</table>

### 45. What is the estimated Indian wind energy potential?

Wind power installable potential of the country has been estimated with reference to Indian Wind Atlas and insitu measurements. On a conservative consideration, a fraction of 2% land availability for all states except Himalayan states, Northeastern states and Andaman & Nicobar Islands has been assumed for energy estimation. In Himalayan states, Northeastern states and Andaman & Nicobar Islands, it is assumed as 0.5%. However, the potential would change as per the real land availability in each state. The installable wind power potential (name plate power) is calculated for each wind power density range by assuming 9 MW (average of 7D x 5D, 8D x 4D and 7D x 4D spacing, D is rotor diameter of the turbine) could be installed per square kilometer area.
<table>
<thead>
<tr>
<th>States / UTs</th>
<th>Installable Potential (MW)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Andaman &amp; Nicobar</td>
<td>2</td>
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<tr>
<td>Andhra Pradesh</td>
<td>5394</td>
</tr>
<tr>
<td>Arunachal Pradesh*</td>
<td>201</td>
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<tr>
<td>Assam*</td>
<td>53</td>
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<tr>
<td>Chhattisgarh*</td>
<td>23</td>
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<td>Gujarat</td>
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<td>Himachal Pradesh *</td>
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<td>Jammu &amp; Kashmir *</td>
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<td>Orissa</td>
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<td>Uttar Pradesh *</td>
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<tr>
<td>West Bengal*</td>
<td>22</td>
</tr>
<tr>
<td>Total</td>
<td>49130</td>
</tr>
</tbody>
</table>

* Wind potential has yet to be validated with measurements

**Installable potential at 50 m level**

**46. What is the energy payback time for a wind turbine?**

The ‘energy payback time’ is a term used to measure the net energy value of a wind turbine or other power plant. i.e., how long does the plant have to operate to generate the amount of electricity that was required for its manufacture and construction? Several studies have looked at this question over the years and have concluded that wind energy has one of the shortest energy payback times of any energy technology. A wind turbine typically takes only a few months to “pay back” the energy needed for its fabrication, installation, operation and retirement.

**47. What are the advantages of wind energy?**

The following are the advantages of wind energy

- No fuel cost
- Environment friendly and pollution free
- Potential exists to harness wind energy
- Lowest gestation period and capacity addition can be in modular form
- Cost of generation reduces over a period of time
- Low O&M Costs
- Limited use of land
- Accommodation of other land uses
- Employment
- New market
- Local Infrastructure & economy development

48. **What are the environmental benefits of wind power?**

Wind energy system operations do not generate air or water emissions and do not produce hazardous waste or deplete natural resources such as coal, oil, or gas, or cause environmental damage through resource extraction and transportation. Wind's pollution-free electricity can help reduce the environmental damage majorly caused by conventional power generation.

The most important thing about wind energy is it does not emit Green House Gases. The build-up of greenhouse gases is not only causing a gradual rise in average temperatures, but also seems to be increasing fluctuations in weather patterns and causing more severe droughts. Particulate matter is of growing concern because of its impacts on health. Its presence in the air along with other pollutants has contributed to make asthma one of the fastest growing childhood ailments in industrial and developing countries alike, and it has also recently been linked to lung cancer. Similarly, urban smog has been linked to low birth weight, premature births, stillbirths and infant deaths. Use of large scale wind generation will bring about a significant alleviation to this problem.

49. **In what other ways does wind energy benefit the economy?**

Wind farms can revitalize the economy of rural communities, providing steady income through lease to the landowners. Farmers can also grow crops or raise cattle next to the towers. Wind farms may extend over a large geographical area, but their actual "footprint" covers only a very small portion of the land, making wind development an ideal way for farmers to earn additional revenue.

50. **What are the environmental impacts of wind power?**

Wind power plants, like all other energy technologies, have some environmental impact. However, unlike most conventional technologies (which have regional and even global impacts due to their emissions) the impacts of wind energy systems are
local. This makes them easier for local communities to monitor and, if necessary, to mitigate.

The local environmental impacts that can result from wind power development include:

1. **Erosion:** which can be prevented through proper installation and landscaping techniques. Erosion can be a concern in certain habitats such as the desert, where a hard-packed soil surface must be disturbed to install wind turbines.

2. **Bird and Bat kills:** Birds and bats occasionally collide with wind turbines, as they do with other tall structures such as buildings. Wind's overall impact on birds is low compared with other human-related sources of avian mortality. No matter how extensively wind is developed in the future, bird deaths from wind energy are unlikely to ever reach as high as 1% of those from other human-related sources such as hunters, buildings, and vehicles. The number of accidents caused by wind is very negligible. Still, areas that are commonly used by threatened or endangered species should be regarded as unsuitable for wind development.

3. **Visual impacts:** This can be minimized through careful design of a wind power plant using turbines of the same size and type and spacing them uniformly generally results in a wind plant that satisfies most aesthetic concerns. Computer simulation is helpful in evaluating visual impacts before construction begins.

4. **Noise:** This was an issue with some early wind turbine designs, but it has been largely eliminated as a problem through improved engineering and through appropriate use of setbacks from nearby residences. Aerodynamic noise has been reduced by adjusting the thickness of the blades' trailing edges and by orienting blades upwind of the turbine tower. A small amount of noise is generated by the mechanical components of the turbine. A wind turbine 250 meters from a residence is no noisier than a kitchen refrigerator.
51. Will a wind power project interfere with electromagnetic transmissions such as radio, television, or cell-phone signals?

First, this is not a problem for modern small (residential) wind turbines. The materials used to make such machines are non-metallic (composites, plastic, wood) and small turbines are too small to create electromagnetic interference (EMI) by "chopping up" a signal. Large wind turbines, such as those typically installed at wind farms, can interfere with radio or TV signals if a turbine is in the "line of sight" between a receiver and the signal source, but this problem can usually be easily dealt with improving the receiver's antenna or installing relays to transmit the signal around the wind farm. Use of satellite or cable television is also an option.

52. Will the wind turbine erected near my house cause any trouble to us?

Wind turbine erection and commissioning is strictly as per the rules and regulations laid out by the state electricity boards and a NOC (No objection Certificate) to erect is always given only after affirmation by the agency that it will be the cause of consternation to local human habitats.

53. What is Indian Wind Atlas?

C-WET has prepared the Indian Wind atlas. It will be useful for the identification of windy locations and the development of wind energy in the country. The Indian Wind Atlas is a result of combined efforts of C-WET and RisØ DTU National Laboratory for Sustainable Energy, Denmark on the investigation of Indian wind climatology with a
specific focus on wind resource assessment for harnessing wind energy. It gives an updated overview of the wind climatological situations of India based on reliable measured wind data and using contemporary numerical mesoscale models. It also seeks to provide an up to date methodology for applying to primary data and results of mesoscale model for the purpose of wind resource assessment. Numerical Wind Atlas methodologies have been used to prepare Indian Wind Atlas and it is devised to solve the issue of insufficient wind measurements.

54. Can I get wind resource data from C-WET?

The wind resource data collected by C-WET is available to any public at a marginal cost, while privately measured data is utilized by themselves for their business development and is generally not available to the public. Apart from that you can get 7 volume of Wind Resource Books and Indian Wind Atlas.

55. What are the details of C-WET’s certification of wind turbines?

Wind turbines are large, dynamic structures installed in open spaces. They are exposed to various external conditions of nature and are expected to work safely and efficiently for at least twenty years. Type certification of wind turbines, is becoming more and more relevant in India, with the wind turbine industry is reaching new heights with the introduction of more new wind turbine models and increased unit size. C-WET’s Type Certification ensures quality, safety and reliability of the wind turbine and provides confidence to various stakeholders investing in the technology. Indian wind turbine certification employs the IEC system for issuing type certificates for wind turbines. The Indian Certification scheme was prepared in the year 2000 and has seen some amendments over time. It is an evolving system and takes into account the experiences made so far, and hence it is termed a provisional scheme. The Type Approval – Provisional Scheme (TAPS-2000), the Indian certification scheme for wind turbines was approved and issued by MNRE. According to TAPS-2000, the Provisional Type Certification (PTC) of wind turbines is being carried out according to the following three categories (which has been elaborately dealt with by the concerned unit in its presentation):

<table>
<thead>
<tr>
<th>Category</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Category-I</td>
<td>PTC for wind turbine already possessing type certificate or approval</td>
</tr>
<tr>
<td>Category-II</td>
<td>PTC for wind turbine already</td>
</tr>
</tbody>
</table>
possessing type certificate or approval, with minor modifications / changes, including provisional type testing / measurements at the test site of C-WET / Field

56. Where can I get the wind power density map of India?
You can download it from [http://cwet.res.in/web/html/departments_wpdm.html](http://cwet.res.in/web/html/departments_wpdm.html)

57. Is Ministry organizing some training courses on wind?

C-WET, an autonomous institution of Ministry has successfully organized seven international and ten national training courses which includes one special training course for officials from MNRE, KREDA & LREDA and a special international training course for AOI engineers from Egypt. The unit has so far trained about 700 national and 100 international participants from 35 countries.

The programs cover all aspects of wind energy generation from technology, installation, foundations, operations and maintenance, financing, wind resource assessments, clean development mechanism etc. The course materials of these programs are well sought after by all stake holders who intend to contribute to the wind energy sector. For activities such as risk assessment, in more employment and feasibility studies, talent with a background in finance and economics is necessary. C-WET includes topics of importance to such people in its training programmes. In general the national training programmes are intensive 2 to 3 days programme with most of the faculty drawn from C-WET and a few experts from Industry and Academia. The duration of international courses are usually 2 to 3 weeks involving factory visits, wind farm visits, hands on tutorials and field demonstrations.

C-WET usually conduct two national and two international training courses every year. Notification about the training programmes can be seen at [www.cwet.tn.nic.in](http://www.cwet.tn.nic.in) / cwet.res.in
58. How many sites in the country have been considered suitable for setting up commercial wind power projects:

An annual mean wind power density greater than 200 watts/ m\(^2\) at 50 m height has been recorded at 233 wind monitoring stations, covering sites in 14 States/UTs, viz. Tamil Nadu, Gujarat, Orissa, Maharashtra, Andhra Pradesh, Rajasthan, Lakshdweep, Karnataka, Kerala, Madhya Pradesh, West Bengal, Andaman & Nicobar, Jammu and Kashmir and Uttaranchal. These sites could be considered suitable for setting up commercial wind power projects.

59. What are the details of the present buy back rate of wind power in different States?

The details of buy back rates for wind power in different States is given below:

<table>
<thead>
<tr>
<th>State</th>
<th>Buy back rate (Rs. per Kwh)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Andhra Pradesh</td>
<td>3.50</td>
</tr>
<tr>
<td>Karnataka</td>
<td>3.70</td>
</tr>
<tr>
<td>Madhya Pradesh</td>
<td>4.35</td>
</tr>
<tr>
<td>Maharashtra</td>
<td>2.86-4.29</td>
</tr>
<tr>
<td>Rajasthan</td>
<td>4.08/3.87</td>
</tr>
<tr>
<td>Tamil Nadu</td>
<td>3.39</td>
</tr>
<tr>
<td>Gujarat</td>
<td>3.50</td>
</tr>
<tr>
<td>Kerala</td>
<td>3.14</td>
</tr>
<tr>
<td>Punjab</td>
<td>4.23</td>
</tr>
<tr>
<td>Harayana</td>
<td>4.27</td>
</tr>
</tbody>
</table>

60. What are the details of Central Financial Assistance for setting up of wind power projects?

There is no capital subsidy for setting up of wind power projects. The capacity additions has been achieved through commercial projects by private investors. The government provides fiscal incentives such as 80% accelerated depreciation, 10 years tax holiday on income from generation from wind power projects, concessional custom duty on import of specified components, excise duty exemption for manufacture of wind electric generators and parts thereof, etc. This apart, preferential tariff is being provided to increase wind
energy generation in the potential States. Recently, a generation based incentive (GBI) scheme has been introduced.

61. What is the (i) capital cost of the wind power project, (ii) cost of electricity generation and (iii) average capacity utilization factor of wind power projects.

The average capital cost of wind power project varies from around Rs. 5.5 crore to Rs. 6 crores per MW. The cost of generation of wind power projects varies from Rs. 3.00 to Rs. 4.00/unit depending upon site, capital cost, interest rate, etc. The average utilization factor in the country is about 21% which varies from 17% to 26% depending upon the wind power density, the type and size of turbines and the availability of grid.

62. What is the main reason to introduce GBI?

The accelerated depreciation benefit can be availed by the companies which have profits from their own or from their sister companies. A good category of investors like independent power producers (IPPs) and foreign direct investment (FDI) were not able to avail of the accelerated depreciation provision. In order to increase the investor base, the Ministry introduced a pilot scheme for up to 50 MW for Generation Based Incentive of 50 paise per unit for such class of investors in July 2008. This was strongly welcomed and proposals up to 350 MW were received last year itself. It was, therefore, felt that the ceiling of 50 MW be removed. The Ministry felt that with the removal of ceiling, both the incentives of accelerated depreciation and GBI would run simultaneously, till the end of 11th plan period, though in a mutually exclusive manner. It is hoped that after the 11th Plan period, the sector would be in a position to grow with the tariff support only for which the Central Regulator has provided new guidelines.

63. What role has accelerated depreciation played in the sector?

Though provision of accelerated depreciation has not incentivized cost reduction and higher efficiency, it has undoubtedly been instrumental in creating a large capacity and a strong manufacturing base in India.

64. What is the need for both the benefits?

Due to global economic melt down, this sector is also seeing a decline in the capacity addition. Some extra efforts are to be made to strengthen the sector. Therefore, it is felt
that, a stimulus in the shape of operating in parallel both options should be available to the investors as a stimulus package. Moreover, Accelerated depreciation upto 11th Plan will give a transition period for investors to shift from accelerated depreciation benefit to GBI.

65. **How has the rate of GBI (Rs. 0.50 per unit) and maximum limit of Rs. 62.00 crore per MW been fixed.**

The quantum of GBI per unit of electricity has been worked out by computing net benefit available to the wind power producers under the accelerated depreciation in NPV terms and distributing the same over a period of ten years. The limit of Rs. 62.00 lakh per MW is the maximum benefit per MW which an investor can get under accelerated depreciation benefit.

66. **How is the scheme being implemented ?**

Indian Renewable Energy Development Agency (IREDA), a financial institution under the administrative control of MNRE, is implementing the GBI scheme. The funds provided in the budget of MNRE will be released to IREDA. The existing system followed by various state utilities for data collection of electricity generation for the purpose of disbursal of tariff is followed as the basis for disbursal of GBI.

67. **What safeguards are taken to avoid the misuse of the scheme ?**

Following safeguards have been taken:

(i) The GBI scheme is applicable only for those wind power producers who do not avail the accelerated depreciation benefit under the Income Tax Act. Investors are required to furnish documentary proof to this effect that no accelerated depreciation has been availed. Apart from other required documents for disbursement, the company has to submit a copy of their Tax returns duly certified by the same Chartered Accountant who have filed the company’s Tax returns indicating that Accelerated depreciation has not been availed.

(ii) A system has been introduced whereby all wind power producers are required to register with details online with IREDA. IREDA gives an acknowledgement, which should form a part of the documents for claiming accelerated depreciation.

(iii) A system has been put in place to provide a unique identification number for turbines to be set up under GBI. This will also help to identify turbines availing
GBI and Accelerated depreciation separately and to collect generation data and enable comparative performance.

68. Do the projects with accelerated depreciation also help in generation?

It is to be mentioned that the benefit of 80% accelerated depreciation in the first year is given by the Govt. to many other renewable and other technologies and wind power alone is not the only sector receiving this benefit. Accelerated depreciation is availed at the corporate tax level, which is around 33%. An investor gets 33% of 80%, which is about 26% of capital invested. Added to this is the debt at around 14% rate of interest, which is about 70% of the project cost for which the revenue stream is the income from sale of electricity generated by the project. Therefore availing the accelerated depreciation alone will not make a project financially viable.