

WIND ENERGY

What is wind energy?

Wind energy (or wind power) refers to the process of creating electricity using the wind, or air flows that occur naturally in the earth's atmosphere. Modern wind turbines are used to capture kinetic energy from the wind and generate electricity.

There are three main types of wind energy –

- **Utility-scale wind:** Wind turbines that range in size from 100 kilowatts to several megawatts, where the electricity is delivered to the power grid and distributed to the end user by electric utilities or power system operators.
- **Distributed or "small" wind:** Single small wind turbines below 100 kilowatts that are used to directly power a home, farm or small business and are not connected to the grid.
- **Offshore wind:** Wind turbines that are erected in large bodies of water, usually on the continental shelf. Offshore wind turbines are larger than land-based turbines and can generate more power.

What Is Windmill?

A windmill is defined as a machine that converts the kinetic energy of the wind into mechanical energy.

All the blades of windmill always rotate in a clockwise direction. The first windmill was designed in the year 1854 by Daniel Halladay from the United States.

Types of Windmills –

There are two basic types of windmills based on their axis of rotation, and they are :

- Vertical axis windmills
- Horizontal axis windmills

There four types of horizontal axis windmills:

- Post mill
- Smock mill
- Tower mill
- Fan mill

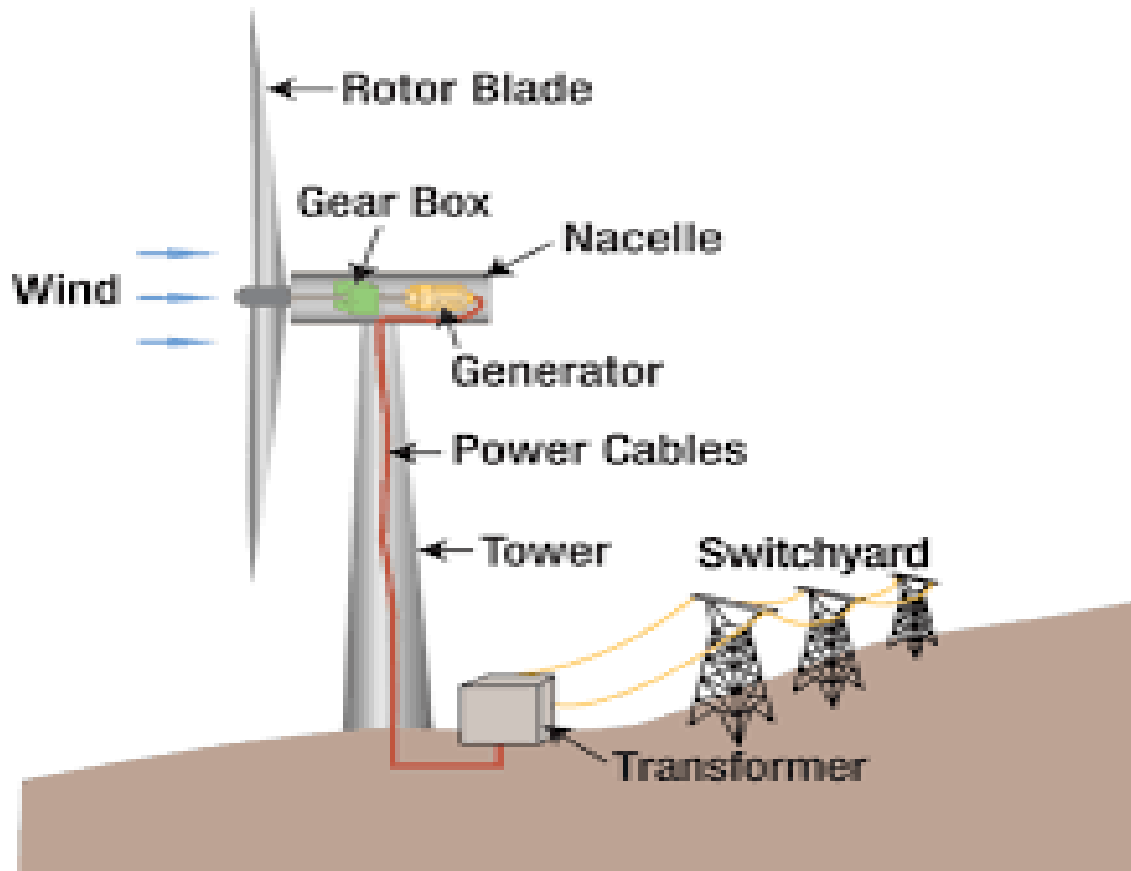
How Do Windmills Work?

The number of blades of the windmill was determined after many trial and error methods. It was found that three blades worked the best and that's how every windmill has three blades. The energy source for windmill is wind. When the blades come in contact with the wind, the blades move such that the shaft starts to spin, resulting in the production of electricity. The generator converts the mechanical energy into electrical energy.

Components of Windmill

Following are the components of windmill:

- **Blades:** These are the essential component of the windmill, and they control the functioning of rotor speed.
- **Rotor:** Rotor is also known as a propeller.
- **Anemometer:** This component is used for measuring the wind speed.
- **Tower:** This is the support system holding the blades and propeller together.



Uses of Windmill

The main purpose of windmill is to convert wind energy into electrical energy, and when electrical energy is obtained, the following are the ways it is used:

- For pumping of groundwater.
- Extraction of oil from the seeds.
- Milling of the grains.

Windmills vs. Wind Turbines

Sometimes people use the terms “windmill” and “wind turbine” interchangeably, but there are important differences. People have been using windmills for centuries to grind grain, pump water, and do other work. Windmills generate mechanical energy, but they do not generate electricity. In contrast, modern wind turbines are highly evolved

machines with more than 8,000 parts that harness wind's kinetic energy and convert it into electricity.

What is a wind farm?

Oftentimes a large number of wind turbines are built close together, which is referred to as a wind project or wind farm. A wind farm functions as a single power plant and sends electricity to the grid.

Advantages of Wind Energy –

1. Wind Energy Is Renewable & Sustainable

The wind is both a renewable and sustainable resource. Unlike reserves of fossil fuels (such as coal, oil, and gas) it will never run out. This makes wind turbines a viable option in helping to meet our future energy demands.

2. It's Good For The Environment

Wind energy is one of the most environmentally friendly energy sources known to man. This is based on the simple fact that wind turbines don't create pollution whilst generating electricity.

Most non-renewable energy sources need to be burnt. This process releases gases such as carbon dioxide (CO₂) and methane (CH₄) into the atmosphere. These gases are known to contribute to climate change. In contrast, wind turbines produce no greenhouse gases when generating electricity.

We should note that both noise and visual pollution are two environmental disadvantages of wind turbines. However, these factors don't have a negative impact on the earth, water table or the quality of the air we breathe.

3. It Reduces Fossil Fuel Consumption

Generating electricity from wind energy reduces the need for us to burn fossil fuels. This not only reduces carbon emissions but also helps to conserve dwindling supplies of the

earth's natural resources. As a result, reserves of fossil fuels like coal, oil, and natural gas will last much longer.

4. Wind Energy is Free

Unlike non-renewable energy sources, the wind is readily available and free for everyone to use. People use the wind each and every day for recreational purposes (such as sailing and windsurfing.) Utility companies use it to power wind turbines which are often installed as part of onshore or offshore wind farms.

Wind farms can feature hundreds of turbines and generate vast amounts of renewable electricity. Utility companies are able to sell this on to customers at a competitive price.

5. Wind Turbines Have A Small Footprint

Wind turbines have a relatively small land footprint. Although they can tower high above the ground, the impact on the land at the base is minimal. They are mostly found in fields, on hilltops, or out at sea. At these locations, they pose hardly any inconvenience to the surrounding land. Farmers can still farm their fields, livestock can graze the hills, and fishermen can still trawl the sea.

6. Both Industrial & Domestic Wind Turbines Are Available

Wind turbines aren't just limited to large wind farms. Smaller, less powerful turbines can be found in many places. They are a good fit for farms, factories, and large private residences. Portable wind turbines are also available and can power small devices on the go.

Small domestic wind turbines can help to provide part of a building's electricity supply. Such installations are often coupled with other renewable energy technologies. You can often find them installed alongside solar panels and geothermal heating systems.

7. Wind Energy Can Provide Power to Remote Locations

Wind turbines can play a key role in bringing power to remote locations. This can benefit everything from small villages to remote research facilities. It might be impractical or too expensive to connect these locations up to a mains electricity supply. In such cases, wind turbines may have the answer.

8. Wind Technology is Becoming Cheaper

The first-ever wind turbine became operational in 1888. Since then, they have become more efficient and much more affordable. As a result of this, the wind power industry has boomed. Nowadays, wind farms and standalone turbines can be found in most countries.

Government subsidies are also helping to reduce the cost of wind energy technologies. Lots of countries across the world provide incentives for the construction of wind turbines.

9. Wind Turbines Are Low Maintenance

Wind turbines are relatively low maintenance with modern turbines lasting several months between maintenance checkups. Although older turbines can experience reliability issues, technological advancements are helping to improve this.

10. Wind Energy Has Low Running Costs

As wind energy is free to use, its running costs are low. All utility companies need to do is purchase, install, and maintain their wind turbines. They can then benefit from a free source of energy instead of having to buy fuel.

11. It Has Huge Potential

Wind energy is all around us making it widely accessible. Wind turbines do require significant wind speeds to be efficient and therefore the placement of a turbine is important. However, most regions contain locations suitable for wind turbines and wind farms.

The important aspect here is that wind energy is less limited than some other renewable energy sources. For example, geothermal power plants are most efficient where there is significant geothermal activity close to the surface of the Earth. Another example is hydroelectric dams which require a suitable river and catchment area to form a reservoir.

12. It Can Increase Energy Security

By using wind energy to generate electricity, we are helping to reduce our dependence on fossil fuels. In most cases, countries source coal, oil, and/or natural gas from other countries. War, politics and overall demand for such commodities dictate their price. This can sometimes cause serious economic problems and/or supply shortages.

By using local renewable energy sources, a country can reduce its dependency on external supplies of natural resources. As a direct result of this, the country can increase its energy security.

13. The Wind Energy Industry Creates Jobs

The wind energy industry has boomed since wind turbines became commercially viable. As a result of this, the industry has created jobs all over the world. Jobs now exist for the manufacturing, installation, and maintenance of wind turbines. You can even find jobs in wind energy consulting.

Disadvantages of Wind Energy –

1. The Wind Fluctuates

Wind energy has a similar drawback to solar energy in that it is not constant. Although the wind is sustainable and will never run out, wind speed does change. This can cause serious problems for the efficiency of a wind turbine. Utility companies invest a significant amount of time and money in researching which locations are suitable for wind power.

For a wind turbine to be efficient, it needs to have an adequate supply of wind energy. For this reason, we often find wind turbines on top of hills or out at sea. In these locations, there are fewer land obstacles to reduce the force of the wind.

2. Wind Turbines Are Expensive

Although costs are reducing, wind turbines are still very expensive. First, an engineer must carry out a site survey. This may involve having to erect a research turbine to measure wind speeds over a period of time. If deemed adequate, a wind turbine then needs to be purchased, transported and installed. All of these processes contribute to the high cost of buying and installing wind turbines.

When we take the above into account for offshore wind farms, the costs become much greater. Installing structures out at sea is far more complex than on land. Some companies have even commissioned bespoke ships capable of transporting and installing wind turbines at sea.

3. Wind Turbines Pose a Threat to Wildlife

We often hear that wind turbines pose a threat to wildlife – primarily birds and bats. However, researchers now believe that they pose less of a threat to wildlife than other manmade structures do.

Installations such as cell phone masts and radio towers are far more dangerous to birds than wind turbines. Nevertheless, wind turbines still contribute to mortality rates among bird and bat populations.

4. Wind Turbines Are Noisy

One of the main disadvantages of wind turbines is the noise pollution they generate. You can sometimes hear them from hundreds of meters away depending on the wind direction. Combine multiple wind turbines with the right wind direction and the audible effects can be much greater. This issue is one of the biggest impacts of wind energy.

Noise pollution from wind turbines has ruined the lives of many homeowners. Although steps are often taken to install them away from populated areas, they do sometimes get built too close to where people live. This is why new wind farms often come up against strong public objection.

5. Wind Turbines Create Visual Pollution

Another drawback of wind turbines is the visual pollution they create. Although lots of people like the look of wind turbines, others don't, with many seeing them as a blot on the landscape. This, however, tends to come down to personal opinion. As we build more wind farms, public acceptance is becoming more common.

Conclusion

So there we have a list of the different pros and cons of wind energy. Whilst there are many disadvantages to consider, the wind remains one of the cleanest and most environmentally friendly sources of energy available today.

Whether you love or loathe the presence of wind turbines and their blades, this technology is key in our fight against global warming. By generating more of our power from the wind, we are able to reduce our reliance on conventional power plants that consume fossil fuels and pollute the earth.