

WIND ENERGY



WHAT IS WIND ENERGY?

The movement of air is called wind. **Wind energy or wind power is the process of generating electricity from the air flow** – or wind - that occurs naturally in the earth's atmosphere. Modern wind turbines are used to capture the energy from wind and convert mechanical power to electricity using electric generators.¹

*The cost of wind power has reduced considerably in the last 10 years and is much more competitive with other generating technologies as it **does not require the purchasing of fuel and there are minimal operating expenses.***²

WHAT IS A MODERN WIND TURBINE

Modern wind turbines are mechanical machines, mostly with three blades and electro-mechanical convertors mounted on top of a tower, at a height of 10 to 150 meters, to harness maximum wind power. These modern wind turbines can be installed on land (Onshore) or in the ocean floor (Offshore).³

Wind turbines are classified into two types:

HORIZONTAL-AXIS TURBINES

These turbines most commonly use three blades that are identical to propeller blades used for airplane engines. Horizontal-axis turbines are used for on and offshore wind farms and are the most commonly used turbine type.

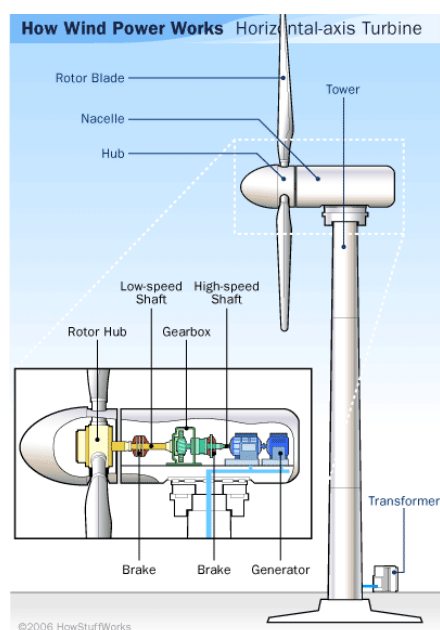


Figure 1: Horizontal axis turbine (<https://science.howstuffworks.com/environmental/green-science/wind-power2.htm>)

VERTICAL-AXIS TURBINES

The vertical-axis turbine blades are connected to the top and bottom of a vertical rotor. However, due to improvements in the horizontal-axis turbine technology and performance, vertical-axis turbines are much less commonly used.

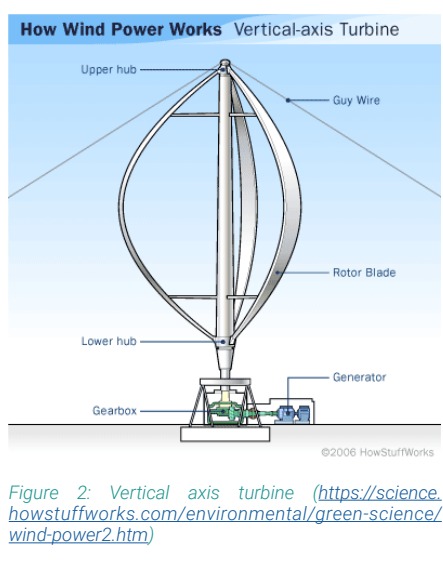


Figure 2: Vertical axis turbine (<https://science.howstuffworks.com/environmental/green-science/wind-power2.htm>)

KEY FACTS

Every single unit of wind energy produced **saves around 2 liters of water** compared to conventional energy sources.

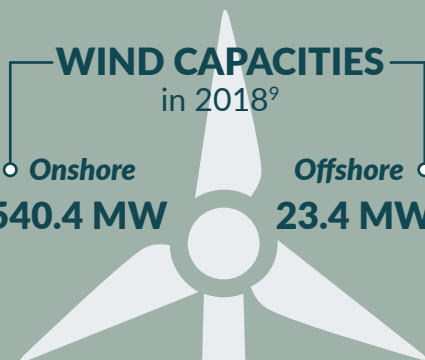


In 2018, 11 million people were employed by the wind industry worldwide.⁷

Electricity produced from wind turbines avoided an estimated **200 MILLION tCO_{2eq}** in 2018 which is equal to the CO₂ emissions produced by **≈43 MILLION CARS.**⁸

WIND CAPACITIES
in 2018⁹

Onshore 540.4 MW Offshore 23.4 MW



A wind farm project **compensates its carbon footprint in six months or less**, providing years of zero-emission energy.⁸

APPLICATIONS OF WIND ENERGY TECHNOLOGIES

WIND & SUSTAINABILITY

1 LARGE SCALE WIND ENERGY

ONSHORE WIND ENERGY

In onshore windfarms, the wind turbines are erected on land. A wind farm is formed by installing many wind turbines together, in an optimized pattern, as a large scale (MW and/or GW) power plant, connected to the conventional electricity grid.⁴



Figure 3: Utility scale wind turbines at the Cedar Creek Wind Farm in Grover, Colorado. Photo by Dennis Schroeder / NREL.

OFFSHORE WIND ENERGY

In offshore windfarms, the wind turbines are erected on the seabed. Open seas are gifted with strong and continuous winds, which have a high energy yield in relation to onshore wind.⁵

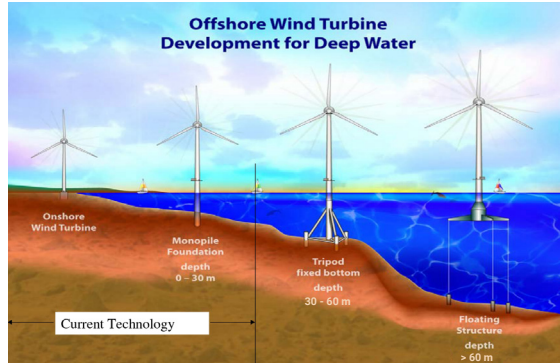


Figure 4: Offshore wind system configurations including shallow water, transitional depth, and floating systems (<https://www.nrel.gov/wind/offshore-tools-methods.html>)

Aside from the carbon released when producing the turbines, wind energy is clean and reliable.



Wind energy is **cost-effective** and has a life-span of up to 25 years.

Just like solar energy, wind energy is an **infinite energy source.**



Wind energy is a **significant driving force in sustainable economic growth.**

Wind energy is also sustainable from an **environmental point of view** as wind-farms can be installed in open field, offshore and even in forests without destroying the environment.¹⁰



2 SMALL AND DISTRIBUTED WIND ENERGY

SMALL WIND FARMS (UP TO 50 kW)

Aerogenerators (small wind turbines), typically up to 50 kW are used for homes, small farms, high rise buildings and other off-grid locations. In distributed wind energy, small wind turbines, as stand-alone, can also be installed with decentralized solar photovoltaic power plants, known as hybrid power plants.

50-100 kW SMALL WIND FARMS

They can be used as on-grid or/and off-grid in case of commercial and industrial projects for captive usage.



Since wind speeds are usually higher offshore than on, it can be beneficial to locate windfarms up to several kilometers offshore. This approach is particularly attractive for countries with a long coastline, where potential onshore sites are limited by dense population, visual intrusion, and failure to gain planning permissions.



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