

# [Wind energy](https://assignbuster.com/wind-energy/)

Definition of Wind Energy “ Wind Energy - Energy received from the movement of the wind across the earth. This energy is a result of the heating of our oceans, earth, and atmosphere by the sun. Turbines convert the kinetic energy of wind into mechanical or electrical energy that can be used for power. " The German physicist Albert Betz calculated in 1919 the possible maximum amount of energy that can be extracted out of wind energy. He came to the result of 59. 3% that can be extracted and named this calculation Betz' law. Further the extracted energy is converted into electricity with an efficiency of 70% and would give all together a total efficiency of 41%. Observing the world's physical supply of wind energy you will come to the result that 200-times more wind energy is supplied then what the planet earth's population consumes . Definition of Wind Actually wind is a function of the sun thus wind is a solar energy. This signifies that wind is a cause of the differential heating of the earth's surface. Local winds are due to the faster heating of the onshore and slower heating of the offshore because of their specific temperature. Onshore warm air which is less dense rises up into the sky. Where cool air from the sea's surface with a higher pressure moves to the onshore and fills in the place of the warm air. This is caused by the nature which is always trying to find a balance thus a wind accrues. http://www. hydro. com. au/system/files/ images/Flash/convection-static. jpg History of Wind Energy More then 3000 years ago the history of wind energy in form of using wind mills began in Persia today's known Iran. Wind energy which is one of the oldest energy forms was used to pump water or to grind grain. Soon this technology spread over Middle East, Central Asia and then to China. The windmills were turning horizontal and the axis was fixed vertically. In the late 12th century wind mills finally reached Europe where the Britain’s and French were the first country's to establish this wind energy system. The difference to the wind mills out of Persia and Asia were that now the rotors were spinning vertical and the axis was mounted horizontally which is also now the most common used technique. Wind mills that were able to produce electricity weren't invented until the late 19th century. At the same time on two different continents in 1987 two scientists for one Charles F. Brush out of America and for the other Prof. James Blyth out of Scotland had a breake through in the windmill technology. The break through was to generate electricity with the help of wind energy. Mr. Brush had developed a wind mill that was able to generate 12kW and light up 350 bulbs. Prof. Blyth's invented windmill didn't have as much capacity and was only able to light up 10x25V light bulbs. WI / IM — Advanced English for Engineers — University Pforzheim — Handout Wind Energy 1 The research in renewable energy weren't that significant because of the cheap fossil fuels thus there was no demand in this sector. After the oil crises occurred in 1973 the demand of renewable energy rose again and so did the interest in developing more efficient wind power technology's. In 1990 there were already a number of 405 in Germany installed wind turbines with a total capacity of 55MW. Up to June 2011 22, 284 wind turbines were been installed with a capacity of 29, 071MW and a total feed-in into the grid in 2011 of 47TWh which was a market share of 7. 7 percent of the total electricity supply in Germany by the total electricity consumption of 614TWh. Taking a view on only renewable electricity supply you will notice that in 2011 wind energy had a market share of 39. 7 percent. The wind industry is also the major employer in the renewable energy sector with more then 100, 000 employees. Different parts of a wind turbine 1. Foundation: The foundation of the wind power station is very important because it needs to take a lot of pressure on a small surface. It is important to divide pressure equally to stabilize the power station. 2. Tower: The tower is mainly made up of steel and concrete. The tower is the platform for the nacelle. Throughout the whole tower all the cabling and wirering is laid down. At the bottom is an entrance with either a ladder or steps for maintenance. Some towers can reach heights of up to 130 meters. 3. Nacelle: On top of the tower the nacelle is placed and is designed in such a way that it can rotate to accommodate the wind. In the nacelle you will find all technical components to generate the electricity. 4. http://static. ddmcdn. com/gif/ wind-power-horizontal. gif Rotor blades: The rotor blades are attached to the front side of the nacelle. The blades are designed in such a way that when wind blows they start rotating. The rotor blades are so aerodynamic that they can even accommodate winds effectively. There are two aerodynamic forces at the rotor blades. One is lift that acts vertical to the direction of the wind flow and the other one is the drag that acts parallel to the wind flow. The rotor blades are shaped like airplane wings and mainly made out of fiber-reinforced composites. How many blades for the best possible output? The number of blades influences the efficiency of a wind turbine. If you attach a lot of blades to the rotor you will catch the wind better because you have a larger surface area to capture the wind. WI / IM — Advanced English for Engineers — University Pforzheim — Handout Wind Energy 2 However , with each further blade that is attached the cost will increase and the energy production increases not proportionally with the number of blades. Therefore the best number of blades is three because they have the lowest cost with a high energy production. (Cost-efficiency) An additional factor is also the stability of the wind turbine. Wind turbines with an odd number of blades rotate regular and turbines with even numbers do not. This is also an aspect why wind turbines have three blades instead of 2 or 4. There are two different systems how the rotation is controlled. The stall control and the pitch control. Pitch: The system tells the blades to alter the pitch so that they become unaligned with the wind. This requires the blades mounting angle to be adjustable. Stall: In Stall control the blades are mounted to the rotor at a fixed angle but are designed so that the twists in the blades themselves will apply the brakes once the wind becomes too fast. 5. Hub: The hub is situated in the center of all the rotor blades. And is also joined to the generator. It transfers the energy out of the wind into the generator there by producing electricity. ( I. E. The hub is the motor.) Technical components of the nacelle Now to the technical aspects of the nacelle. Inside you will find the driving shaft a breaking system, a gear box, the control system and generator. The diving shaft transports the mechanical energy to the gear box. The breaking system is there to control the speed of the blades to prevent an overload of the generator. A wind turbine has two measurement systems. An anemometer that measures the wind speed and a wind van that puts the turbine into the current direction of the wind. As soon as there is a wind of more than 2 meters per second, the computer is activated and puts the system with the yaw motor in place. Before the rotor can start to rotate the blades need to turn in position with the help of the pitch or stall control. Secondly the wind pushes on the aerodynamic blades a high and low pressure force is created on the blades themselves. The rotor blades start to rotate. With the start of the rotation the kinetic energy from the wind was transformed to mechanical energy. There are two different types of motor systems with and without a gear box. First of all to the plants with a gear box. There is the main shaft form the hub with a big gear. This is the so called low-speed shaft. This gear propels a smaller gear which is connected to the generator. Due to the different sizes of the gears, the smaller one has to make more revolutions in the time when the big one only spins once. For example if the low speed shaft has 15 revolutions per minute the gear box converts the speed up to 1, 500 revolutions per minute. Secondly , to the new model that is increasingly used. This is without a gear box system and uses’ a synchronized magnate generator. The magnet transfers the energy directly into the generator without passing gear box to speed up the generator. This system has a greater advantage over the motor driven system because there is less wear and tear, lower maintenance and even works in low wind conditions. And it also doesn’t overheat as much. WI / IM — Advanced English for Engineers — University Pforzheim — Handout Wind Energy 3 http://www. unendlich-viel-energie. de/uploads/media/Windpower. jpg How does a generator work? A simple generator consists of magnets and a conductor. The conductor is typically a coiled wire, such as a copper wire. Inside the generator, the driving shaft connects to an assembly of permanent magnets that surrounds the coil of wire. The electrons in the conductor start moving in one direction, when a magnet is passing through it. The electrons change their direction when the magnetic field is changed by the rotation of the North and South pole. The electrons then change their direction and an alternating current is produced. Inductor Rotor Slip rings and brushes DC for magnetic field Drivingshaft AC voltage http://upload. wikimedia. org/wikipedia/ commons/ thumb/c/c2/Generator. png/300px-Generator. png Electric energy 4 WI / IM — Advanced English for Engineers — University Pforzheim — Handout Wind Energy Onshore These are wind energy plants on land. This plays a leading role in the production of renewable electricity in Germany. They cover 8 % of the total energy produced in Germany. Onshore wind turbines have been criticized due to their visual impact and their impact on birds and bats. Furthermore the most negative affect is that they could not generate constant electricity because there is no consistent flow of wind. There is also constant danger if such wind turbine crashes. Offshore Offshore wind energy plants are situated in the oceans generally greater in dimension to take a higher wind speed due to the constant winds there is a higher energy production. An offshore wind turbine has an average increase in production from 10% to 20%. This is needed to compensate the higher installation cost for the foundation. The greatest advantage is that offshore has constant wind conditions. Moreover there is a less visual impact and nobody is annoyed by the shade or by the noise. A negative aspect is that an offshore wind turbine has higher building cost compared to onshore wind turbines. Starting with the plant foundation and transporting the energy from the sea to the land grid and higher maintenance costs. Repowering The expression “ Repowering" refers to power plant in general and includes all measures which improve the efficiency and capacity by means of retrofit to the latest technology. Possible modifications on wind turbines are limited, thus repowering affects the whole plant in general and essentially the entire wind farm. Progressing technology provides the option for operators to improve the profitability of their site, or to cope with new technical or legal conditions. Frequently planned and often locally supported is to restore the landscape. The reduction of the number of plant is linked with a significant growth of hub heights and a reduction of the rotational speed. Wind Energy Grid Integration The generation of wind energy electricity is very fluctuate due to the natural unequal wind supply not like the conventional electricity supply which is coordinated by its actual demand. The electricity that runs through the transmission lines can not be stored so it must be consumed directly or else wind energy produced electricity is disconnected from the grid. By law conventional energies should be taken of the grid by an over production before renewable energies. But sometimes there is now other possibility then to disconnect wind energy which has caused a loss of approximately 150GWh in 2011. The grid disconnections are to prevent peaks and over production of wind energy over straining the transmission lines. Wind park owners that had to switch of there wind power turbines received 10 million Euro of refunds by the grid operating company's. ECOFYS studies have estimated an average growth of 69 percent from year to year of wind energy being disconnected from the grid due to hardly any progress in the grid development. The needed grid optimisation that can only be realized by the feed-in management is already at its limits. Also the outdated transmission line technology has to be reconstructed. If new technology's for transmission lines are implemented problems of overheating and wear and tearing wouldn't be there due to much higher power ratings. Furthermore the extension of the grid could make it WI / IM — Advanced English for Engineers — University Pforzheim — Handout Wind Energy 5 possible to be connected to as good as every wind park in Germany. This netting can then make the wind energy feed-in much more flexible. Environmental Impact On the one hand there is an extreme environmental pollution going on in China-Mongolia while mining the ore for the rare earth Neodymium. Neodymium is being used for the strong permanent magnet(PM) Neodymium-Iron-Boron. This PM is applied in the direct-drive technology which is more efficient by less rotations. 97 percent of the total demand of Neodymium comes out of ChinaMongolia where the governmental regulations are not that strict and are rarely adhered by the mining company's. This means that there is no desire of environmentally friendly production. While extracting the ore and then separating the Neodymium from the ore, toxic substances are set free into the atmosphere and also drained into the close by water. Further more radio active uranium and thorium is also a toxic waste which is used during the extraction process. All the surrounding population, the workers and further the flora and fauna are exposed to the extremely toxic contaminating environment. In Germany 60 percent of the installed wind power turbines are direct driven. But because of the huge market share of 60 percent of Enercon who uses mainly directdrives without PM's there aren't that many permanent magnet direct driven wind turbines installed. On the other hand there is the perspective view of the CO2 free energy generation which is 40 to 70 times more than the invested energy during the total life cycle of a wind power plant. The whole invested energy consists of the manufacturing, transportation, building of the foundation, the installation, the regularly maintenance and the disposal of the wind power plant. The recovery of the invested energy is after less than 6 months. An offshore wind turbine which generates a much higher capacity and because the wind on the sea is more consistent the recovery is even after 2-3 months. In comparison with conventional generated electricity plants like gas and coal the ratio is here only 0. 3-0. 4 in the whole life cycle.. Advantages 1. The wind energy is for free and can be captured easily. 2. When the wind turbine is built it does not emit any greenhouse gases and other pollutants. 3. The wind turbines can be very tall and due to this they take only a small area of land. This helps that the land below can still be used for agriculture. 4. Rural areas that are not connected to the grid can use wind turbines to produce their own electricity. Disadvantages 1. There is no constant wind flow and due to that there is no constant energy production. 2. Wind turbines are noisy. 3. To supply larger communities a wind farm is needed to provide enough electricity. 4. During peak production times an energy storage system is needed. 5. Kills every year more than 100. 000 birds. 6. Wind turbines can crash. Policy The European Union has the aim to limit the temperature increase by two degree Celsius. Therefore they set three goals to achieve this aim before 2020. To reduce the greenhouse emissions by 20%, increase of energy efficiency by 20% and to produce 20% renewable energy. To reach this aims the 2000 introduced “ EEG" law is very important, because it supports the production of renewable WI / IM — Advanced English for Engineers — University Pforzheim — Handout Wind Energy 6 energy in Germany. This law should help to boost the construction of renewable energy plants to reduce the CO2 emissions and also should help become more independent from energy supplies from foreign countries. Nowadays the wind energy is still subsidized by this law with 5 Cent per kWh. They also get help from different credit institutions, for example the “ KfW" bank offers special credits with a low interest rate. Now a closer view to Baden-WÃ¼rttemberg Baden WÃ¼rttemberg has approximately 370 wind energy plants. Due to this Baden WÃ¼rttemberg is lagging behind the other countries as you can see on this graph. To catch up to the leaders the “ GrÃ¼n/Rote" government of Baden WÃ¼rttemberg introduced a new strategy. They offer a so called wind chart. This chart should help to identify where a wind turbine could be installed and where the best positions for a wind turbine are. They also made it easier to get the permission to build a wind power plant. The “ GrÃ¼n/Rote" government has the aim to increase the wind energy production up to 10% by the year 2020. The Future of Wind Energy The Fraunhofer institute did a research on the assumption if it is realistic to use a total of 2 percent of viable land in Germany for installing wind power plants. They came to the result that even 7. 9% could be used for this purpose. In the observation there was included that these areas have the right wind conditions and also aren't in restricted conservation areas. Using the possible and realistic landscape for onshore wind energy installations in the future could give a capacity of 198GW and by a realistic annual runtime at 2, 071h electricity of 390TWh. All over this would mean that if the amount in 2011 consumed electricity would be the same amount in the future then 63 % could be supplied by the installed wind turbines. Important are also decentralized wind power plants to make it more easier to feed into the grid. Additional a decentralised energy storage with newest technology by loading up these storages with wind energy when there is a overproduction. Today energy can only be stored in hydro power plants but these are rarely existing and can't be built everywhere. New energy storages must be developed to resolve this problem. A transmission line connection to Norwegians huge hydro power plant could be one solution to store energy. Here for a Transmission line must be installed from Germany to Norway. Planed for the future is an installations up to the year of 2020 will of an offshore capacity of 10, 000MW and an onshore capacity of 45, 000MW which would mean a CO2 free electricity production of 150TWh(24% of the total consumption of 2011 of 614TWh). In the wind power industry the expectations of new created jobs are at an estimated 60, 000 by the year 2030 which would mean then a total of 160, 000. By 2020 the government has the goal to have 1million electro driven cars on the streets in Germany which would mean a possible storage capacity for wind generated electricity of 3TWh. The idea is to charge the batteries at night when the consumption of energy is at a minimum so that produced wind energy is not lost. In 2050 the aim is to supply Germany electricity demand with over 50 percent out of wind generated energy thus it will be the primary energy supplier of the future. 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