

Wind energy

Age-group: 12-15 years' old

Number of hours: 8-11 hours

Short description of activity: Students will learn about wind energy as a renewable source of electricity and power. They will take part in wind turbine design with tinkercad.com. Discuss about advantages and challenges in using wind energy.

CT-competences:

- Data analysis
- Abstraction
- Decomposition
- Pattern recognition

Goals

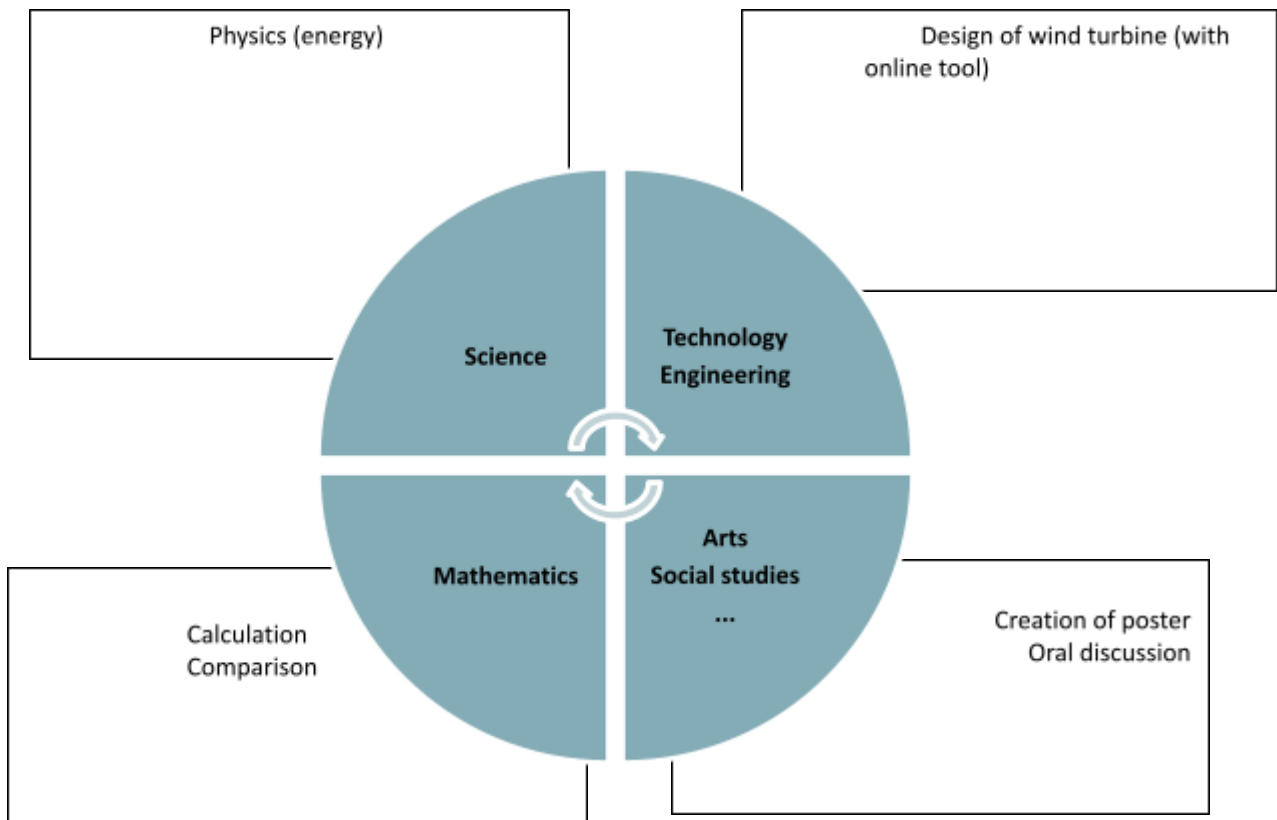
Wind energy is produced by the movement of air (wind) and converted into power for human use. Wind has been used as a source of energy for more than a thousand years, but was replaced by fossil fuels for much of the 20th century. Today, wind is making a comeback as a source of electricity and power. Wind is inconsistent and can be difficult to predict. Its speed and direction change frequently, depending on other conditions, such as temperature, humidity and season. Today, this unpredictability makes wind power a poor candidate to be the primary source of energy. However, it can be an excellent addition to traditional power sources.

Students should:

- Understand how wind energy is produced;
- Know what is wind turbines and how wind energy is count;
- Be able to explain why wind energy is important (advantages);
- Be able to discuss why production of wind energy is challenging;
- Know what wind farms are and their situation in your country.

Realistic STEAM-context

Every time you can see more and more wind turbines when you travel across your country. What is the purpose of these wind turbines? Why are they built in these areas of your country? Who is responsible for them?



Methodology

Based on learning by doing (with different levels: from imitation to creation)

Part	Description	Timing
1	<p>Introduction</p> <p>The students will learn about wind and wind energy, main facts and introduction to all information that students will learn later in depth.</p> <p>Teachers can show video as an example: https://www.youtube.com/watch?v=5o8mSkrBKvc</p> <p>Optional: for younger students (age 12). Where is the best place to get the most advantage out of wind? What is needed in order to know this? Students can make their own anemometer to measure wind speed and carry out a weather survey to find the windiest places. Some videos how to make anemometer: https://www.youtube.com/watch?v=Af0LB3abBsk https://www.youtube.com/watch?v=-a3P-h5FCDw</p> <p>Students can do experiments to gather, record, classify and present data.</p>	1-2 hours

2	<p>Advantages and disadvantages of using the wind's energy to create electricity</p> <p>Discuss with students about the advantages and disadvantages of wind's energy.</p> <p>Suggestions for advantages:</p> <ul style="list-style-type: none"> ● Wind cannot be used up – it occurs naturally, whether we harness it for electricity or not. ● Wind is a clean source of fuel. Turbines have no emissions and do not pollute the air. This is globally important as more countries industrialize and increase their demand for electricity for homes, businesses, hospitals and schools. ● Wind energy is cheap! It is one of the lowest-priced renewable energy sources. ● Wind is generated all over the planet, and wind turbines can be installed economically almost everywhere. This makes it a key resource in developing economies. Nuclear energy, for instance, demands a workforce with substantial educational and engineering backgrounds, as well as an initial investment for nuclear power plants. Development of fossil fuel power plants can rely on factors such as the presence of coal, oil or gas; the equipment and technology to refine it; and the finances to import or export the raw or refined goods. <p>Suggestions for disadvantages:</p> <ul style="list-style-type: none"> ● Even though wind energy is cheap, the initial cost to build a wind farm is quite high. ● Wind farms require acres of land and must compete with other uses. When planning a wind farm in a hilly area, where winds are steady and strong, trees might need to be cut. This likely destroys habitats of dozens of species. ● Wind turbines can kill bats and birds. ● Offshore wind farms might damage the marine ecosystem. The seafloor must be disturbed and drilled to install a wind turbine. ● Some residents who live near wind farms complain about the noise or appearance of the machinery. ● Locations that produce great amounts of wind energy are often in remote areas, far away from the cities and people who could use it. Transmission lines have to be built to transfer the electricity to the cities. ● The biggest problem with wind energy is, of course, the wind itself. When the wind is not blowing, electricity cannot be generated. <p>Students can make a poster in groups to visualize advantages/disadvantages of wind energy or to promote wind energy in your country.</p>	2 hours
3	Wind turbines	2 hours

Wind energy is produced with wind turbines – tall, tubular towers with blades rotating at the top. When the wind turns the blades, the blades turn a generator and create electricity.

Horizontal-axis wind turbines (HAWTs) are the most familiar type of electricity-producing windmill. Most have three large blades that spin parallel to their towers, where the main rotor and generator are located.

Most HAWTs are painted white to help make them visible to low-flying aircraft. They stand about 61 to 91 meters tall, and the blades rotate at 10 to 20 rotations a minute.

The enormous, stiff blades on a HAWT usually face the wind. A wind vane or wind sensor determines which way the wind is blowing, and turns the turbine to face the oncoming wind.

Vertical-axis wind turbines (VAWTs) have varied, unusually shaped blades that rotate in complete circles around a tower. The main rotor and generator are located near the ground. VAWTs do not have to face the wind to generate electricity. Vertical-axis wind turbines can be much smaller than their horizontal counterparts. They are often installed on the roofs of buildings.

Turbines cannot operate at every wind speed. If winds are too strong, they can be damaged. Therefore, the turbine has an automatic controller that turns on when winds are blowing at ideal speeds for generating electricity. This speed is usually 13 to 88 kilometers per hour. If the winds become stronger than that, the controller turns the turbine off.

Video how wind turbines work:

https://www.youtube.com/watch?v=qSWm_nprfqE

Build your wind turbine (design task) in <https://www.tinkercad.com/>

Students should consider what parts they have? What are the criteria to take into account while designing in Tinkercad? How to build the most effective wind turbine? Which radius is possible?

Some examples how to build (videos):

<https://www.youtube.com/watch?v=r389oFz7BUJ>

Examples from tinkercad.com:

<https://www.tinkercad.com/things/iTlrYewvrP0-wind-turbine>

<https://www.tinkercad.com/things/38dW1xjYcsL-wind-turbine>

<https://www.tinkercad.com/things/6pEDmz6Rgmn-windmill>

<https://www.tinkercad.com/things/1OVRolgcFWe-wind-matics-wind-turbine>

Students can discuss the results in pairs.

4	<p>How does wind energy count?</p> <p>Talk about the electric power formula. The formula for the electric power produced by wind turbine is $P = \pi/2 * r^2 * v^3 * \rho * \eta$, one watt is calculated as $1 W = 1 kg * m^2 / s^3$.</p> <p>Where r is radius, v is wind speed; ρ is air density; η is efficiency factor.</p> <p>Students can use calculator in order to calculate real examples: https://rechneronline.de/wind-power/</p> <p>Wind speed students can take from the weather forecast in your town.</p> <p>Air Density dependence by temperature: https://www.engineeringtoolbox.com/air-density-specific-weight-d_600.html</p> <p>Let's discuss the results.</p>	1-2 hours
5	<p>Wind Farms</p> <p>To generate a large amount of electricity, wind turbines are often constructed in large groups called wind farms. Wind farms are made up of hundreds of turbines, spaced out over often hundreds of acres.</p> <p>Wind farms are often located in agricultural areas, where the land between the turbines can still be used for farming. Grazing animals are unaffected by the large, slow-moving turbines. Wind farms can also be located offshore. These turbines use the stronger, more predictable, and more frequent winds that develop above the ocean.</p> <p>Technology is also being developed to create wind farms at extremely high altitudes. Jet streams are fast-moving winds that blow at elevations of 9753 meters. Scientists are developing a wind turbine that would be tied to the ground like a kite, but float thousands of meters in the air to capture jet streams' energy for electricity.</p> <p>Analyze wind farms situation in your country, use open data: https://www.thewindpower.net/country_list_en.php</p> <p>Possible questions: What is the tendency in your country? What is the biggest wind energy market player in your country? In which place is the nearest wind farm in your country (analyze the map)?</p>	2-3 hours
		8-11 hours

Organization

Materials:

- If students will create posters, they need staff for this.

Use of ICT: computers, laptop, tablets, interactive board.

Coaching

Stimulation of self-management: (concrete opportunities/remarks adapted to the project)

Stimulation of cooperation: (concrete opportunities/remarks adapted to the project)

Teamwork:

- Groups consist of 2-3 students.
- Competences needed in a group:
 - Analyzing and interpreting data in order to optimize
 - Reflect on process and results of the different stages of this activity
 - Individual contribution to the work

Formative assessment: (concrete description/summary adapted to the project)

Adaptations

- General ideas: Students could visit wind farms, if there is such a possibility.
- Ideas with younger/older children: (3-6 <-> 6-9 / 9-12 <-> 12-15)

Tips & tricks

(only mention when relevant, e.g. background information, ...)

Additional information. Wind energy virtual lab:

<https://www.youngscientistlab.com/sites/default/files/interactives/wind-energy/>