

# Wind to Energy

**Subject Area(s)** Science and Engineering

**Associated Unit Energy Sources**

**Lesson Title** Wind to Energy

**Header** Image 1

<p style="text-align: center;"><b>Image 1</b></p> <p style="text-align: center;"><b>Image file:</b> cub_windturbine_lesson01_image1.jpg</p> <p><b>ADA Description:</b> A picture of a wind turbine on the hillside at sunset</p> <p><b>Source/Rights:</b> © <a href="https://pixabay.com/en/wind-turbine-wind-energy-2218457/">https://pixabay.com/en/wind-turbine-wind-energy-2218457/</a></p> <p style="text-align: center;"><b>Caption:</b> An example of a wind turbine.</p>
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**Grade Level** 10 (9-12)

**Lesson #** 1

**Lesson Dependency**

**Time Required** Two to Three 50 minute class periods

## Summary

Students learn about the fundamentals of electricity generation through the conversion of mechanical energy to electrical energy. Students explore the impact of how technology can positively impact the world by learning about conversion of wind to energy. Students explore the technology behind wind energy, and work in groups to develop a windmill out of everyday items.

## Engineering Connection

Energy efficiency has always been a challenging yet intriguing problem for engineers of all disciplines. Engineers are involved in many aspects of renewable energy in an attempt to reduce carbon dioxide emissions from the use of fossil fuel and reduce the effects of global warming. Electrical engineers have put great efforts in finding ways to show how solar, wind and other such energy sources can be efficiently integrated into practical power systems. Civil engineers have been studying wind related aerodynamics phenomena to enhance wind turbines capacity under high wind speed during hurricanes.

**Engineering Category** =

1. Relating science and/or math concept(s) to engineering

## Keywords

Alternative Energy, Renewable energy, Energy Conversion, Electromagnetic Induction

## Educational Standards (List 2-4)

Source, year, standard number(s)/letter(s), grade band and text (its unique ID# is optional)

[State STEM Standards](#)

<http://purl.org/ASN/resources/S113EFA9>

Describe and compare renewable and non-renewable energy derived from natural and alternative sources such as oil, natural gas, coal, nuclear, solar, geothermal, hydroelectric, and wind; (Grades 11 – 12)

Design problems. The student demonstrates an understanding of design problems and works individually and as a member of a team to solve design problems. The student is expected to:

## **Pre-Requisite Knowledge**

### **Learning Objectives**

After this lesson, students should be able to:

- solve design problems individually and in a team;
- understand energy sources, energy conversion, and circuits and performs calculations related to work and power.
- understand how wind can generate electricity

### **Introduction / Motivation**

Have you ever wondered where electricity comes from? Have you imagined what would happen without electricity? Electricity exists in all aspects of our life, and we use it every day. We see electricity in action from the power that turn on the TV, the cable that charges your tablet, or the stove used to boil water in a kettle. Electricity is essential to our life. In 1831, an English scientist Michael Faraday invented the first electromagnetic generator which converts mechanical energy to electrical energy. The electromagnetic generator opened up endless possibilities to make our world a better place. What energy sources can be used to drive these generators besides fossil fuels? Wind energy is a type of renewable energy for it can be used to convert kinetic energy to electric energy without wasting other resources. Wind turbines only need to use the naturally occurring wind to generate electricity in the generator. For wind energy, there is no need to burn coal or other fossil fuels, and thus it is a more streamlined process to provide electricity. Wind turbine blades are aerodynamically designed to harness as much of kinetic energy from the wind as possible and convert it into electricity. However, the wind turbines do not have the mechanical strength to handle high forces during excessively windy condition; this is a drawback to the technology.

In general, using renewable sources has certain limitations such as mechanical incompatibility of wind turbines at high wind speed, the difficulty of harnessing solar energy in cloudy conditions, and how to store electricity to compensate those times when the energy cannot be generated simply due to weather conditions. Engineers play important roles in looking for solutions to improve the efficiency of harnessing these renewable sources to make their uses as easy as possible. Wind energy, with all of its benefits and drawbacks, is an excellent example of the challenges we face in the future and the potential rewards for solving these problems. Present the Renewable Energy PowerPoint.

### **Lesson Background & Concepts for Teachers**

A wind turbine works the opposite of a fan. Instead of using electricity to make wind, like a fan, wind turbines use wind to make electricity. The wind turns the blades, which spin a shaft, which connects to a generator and makes electricity. Wind turbines, like windmills, are usually mounted on a tower to capture the most energy. Wind turbines operate on a simple principle. The energy in the wind turns two or three propeller-like blades around a rotor (Refer to Figure 2). The rotor is connected to the main shaft, which spins a generator to create electricity. Wind turbines are mounted on a tower to capture the most energy.

At 100 feet (30 meters) or more above ground, they can take advantage of faster and less turbulent wind. A blade acts much like an airplane wing. When the wind blows, a pocket of low-pressure air forms on the downwind side of the blade. The low-pressure air pocket then pulls the blade toward it, causing the rotor to turn. This is called lift. The force of the lift is actually much stronger than the wind's force against the front side of the blade, which is called drag. The combination of lift and drag causes the rotor to spin like a propeller, and the turning shaft spins a generator to make electricity. A gear box, containing smaller gears, increases the slow angular rotation from the low-speed shaft to high-speed shaft over 100 times. An electromagnetic generator connected to the high-speed shaft rotates a coil of wire at about 1500 rpm (revolution per minute) in the magnetic field inside the generator and induces electrical current. This process transforms the kinetic energy of the wind to electricity. The direct current produced from the generator is conducted to the base of the wind turbines and transformed to alternating current by a transformer. The voltage of the alternating current is increased and sent to power grid to get transported to end consumers. This is how the wind is used to light cities, feed industry, schools, hospital, or other household appliances in a clean and sustainable way.

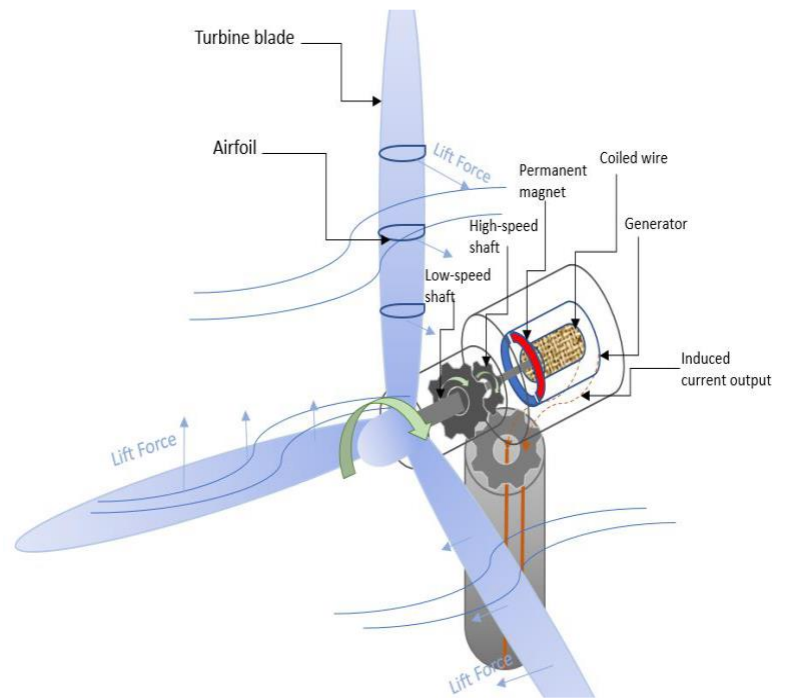
**Image** Figure 2

**Figure 2**  
**Image file:**  
cub\_Explodedwindturbine\_lesson01\_Figure2.jpg

**ADA Description:** A line drawing shows components of a wind turbine such as blades, aerodynamic lifting mechanism of the blades, high-speed and low-speed shafts, permanent magnet, and coil of wire inside the magnet connected to the low-speed shaft, and induced current output generated.

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**Caption:** Figure 2. An exploded view of a wind turbine. As the blades rotate, gear system increases slow angular rotation from the low-speed shaft to high-speed shaft over 100 times which in turn rotates the coiled wire inside the permanent magnet to transform kinetic energy to electric energy by electromagnetic induction.



## Vocabulary / Definitions

Word	Definition
Turbine	A turbomachine with at least one moving part called a rotor assembly, which is a shaft or drum with blades attached. Moving fluid acts on the blades so that they move and impart rotational energy to the rotor.

Electromagnetic Induction	A process where a conductor placed in a changing magnetic field causes the production of a voltage across the conductor.
Renewable Resources	A substance of economic value that can be replaced or replenished in the same or less amount of time as it takes to draw the supply down.
Energy Conversion	The process of changing one form of energy into another, such as nuclear energy into heat or solar/wind energy into electrical energy.

### **Associated Activities**

You are working as a team of engineers who have been given the challenge to design a windmill out of everyday items in the classroom. Your windmill will need to be able to withstand wind from a fan for at least one minute while winding a string or wire to lift a light object such as a metal washer. You are working on a budget and will have to carefully select and virtually buy materials from your teacher to create your design. You may return materials, exchange materials with other teams, but will need to determine the "cost" of your windmill – the least expensive design that meets the challenge will be considered the most efficient design. Your windmill may be vertical (pointing upward from a table) or horizontal (pointing off the edge of a table). Planning Stage & Documentation: Meet as a team and discuss the problem you need to solve. Then develop and agree on a design for your windmill. You'll need to determine what materials you want to use -- keep in mind that your design must be strong enough to withstand wind from a fan or hairdryer and the base cannot move so it will have to be secured to a table or shelf. Sketch your design in your engineering notebook, and be sure to indicate the description and number of parts you plan to use. Present your design to the class. You may choose to revise your teams' plan after you receive feedback from class.

### **Lesson Closure**

What drawbacks does a wind turbine have as a reliable source of energy?

What technologies exist that might compensate for these drawbacks?

What advantages does the windmill have as a renewable source of energy?

### **Assessment**

#### **Pre-Lesson Assessment**

*Discussion Questions:* Solicit, integrate and summarize student responses. Have students research and discuss the following questions together in small groups.

- Have you ever seen the wind used as source of energy?
- Why do you think society needs other forms of energy?
- What factors need to be considered when dealing with wind turbines?
- Who do you think designs these types of wind turbines?

#### **Post-Introduction Assessment**

*Quiz:* After completion of the Renewable Energy PowerPoint presentation in the Introduction/Motivation portion of the lesson and students have presented their designs have students complete a Quiz.

#### **Lesson Summary Assessment**

*Device Design & Presentation:*

Have students imagine they are materials science and structural engineers. Challenge groups of 3-4 students to design on paper their own wind turbine. Then have the teams present their designs to the class. Ask the groups to consider the following in their design:

- From what material are blades made?
- How does weight and length of blades affect your wind system?
- What foundation is needed to support your wind system?
- How much power can be generated?

### Homework

None

### Lesson Extension Activities

None

### Additional Multimedia Support

Use Internet for research.

### References

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<http://www.tryengineering.org>

### Attachments

Renewable Energy (ppt)

Quiz (doc)

### Other

N/A

### Redirect URL

N/A

### Contributors

Sergio Escamilla, Duy Nguyen, Mark Mimms

### Supporting Program

2017 Natural Hazard Engineering Research Infrastructure – K-12 Teachers

### Acknowledgements

This lesson plan was developed and modified based on the lesson "Electricity and Renewable energy: Wind (Lesson)" by Duy Nguyen and Mark Mimms. Inspired by 2017 NHERI Summer Institute.