

Lesson plan:

In small groups: puzzle

All together: reading

Watch the video about how a wind turbine works (3 minutes)

<https://www.youtube.com/watch?v=DILJjwsFI3w>

In pairs: cut the pros and cons of wind energy and give 1-2 slips to each pair. Put the titles: Pros of wind energy / Cons of wind energy on two desks. Students have to read and decide if they have a pro or a con and have to put each slip on the right desk. If possible, have them tell the class about their pro/con.

Use the material + the photos to make a poster. Have two students draw a windmill in a tulip field and a sailing boat. Stick the drawings on the poster, too. Have the class read the poster before hanging it on the wall.

Watch a funny Mr Bean video on Youtube (11 minutes)

<https://www.youtube.com/watch?v=2CnE-04eVM4>

Alternative sources of energy double puzzle

Inwaeebre

r e n e w a b l e
2 12 15

wtrear

w a t e r
3 14 6

ndwin

w i n d
13

losrar

s o l a r
7 11 16

erlhotmage

g e o t h e r m a l
5 4 10 9

bisosam

b i o m a s s
1 8



1	2	3	4	5	6	7	8	3	9
						v			
4	10	11	12	13	14	15	16		

Unscramble each of the clue words. Copy the letters in the numbered cells to other cells with the same number and you will find a well-known English saying.

The key:

Renewable
Water
Wind
Solar
Geothermal
Biomass

The saying: Better late than never

WIND POWER

Wind energy comes **from the sun**. As solar radiation heats the earth's surface, hot air rises and cool air fills the voids. This air movement is defined as wind energy.

Most of us know how powerful wind is and how devastating it can be. But wind is also a valuable source of **kinetic energy**. Humans have harnessed energy from the wind for centuries. We've all seen the picturesque **windmills** gently turning in colorful tulip fields in Holland. Windmills have historically been used to pump water or grind grain and are still used for those purposes. But the more modern windmills that use a **wind turbine** are able to generate **electricity**.

Most modern windmills are horizontal axis turbines. These turbines are mounted on a tall tower as a way to capture the faster and less turbulent wind, generally hundreds of feet in the air. The amount of electricity depends on the size of the wind turbine and the quality of the wind resource. A standard 2-megawatt turbine in the right place can provide electricity to power about 500 average homes for a year.

Wind farms, also called **wind plants**, refer to a large number of wind turbines that are built close together. Countries such as the U.S. and China are producing more and more energy from wind farms. In 2014, Chinese wind farms produced enough power to electrify more than 110 million homes!

Some energy experts feel that if we harness just a fraction of the available power from wind energy, there would be no need for any other source of electricity in the world!

Pros of Wind Energy

Cons of Wind Energy

1. Clean Source of Power

The production of wind energy is “clean”. Unlike using coal or oil, creating energy from the wind doesn’t pollute the air or require any destructive chemicals. It doesn’t produce any gases, so it doesn’t cause a greenhouse effect or acid rains.

2. Renewable Source

Wind is free. If you live in an area that gets a lot of wind, it is ready and waiting. Winds are caused by rotation of the earth, heating of the atmosphere by sun, and earth’s surface irregularities. We can harness wind energy and use it to generate power as long as sun shines and wind blows.

3. Cost Effective

Once the turbine is installed, it only requires some maintenance, there are no other costs. It doesn’t require energy to work. As long as the wind blows, it produces energy, and a single turbine can produce enough energy for hundreds of houses.

4. Extra Money for Land Owners

Land owners who rent an area to wind plants can make a considerable amount of additional cash. Also, it is possible to install one single turbine to produce energy for the house or business, and the extra can be sold to the electricity company. Wind turbines are available in various sizes that can be suitable for any situation.

5. Use of Modern Technology

Wind turbines are considered by some to be attractive. The newest models are white, slick, and modern looking. Moreover, wind energy makes new employments in this developing engineering field.

6. Rapid Growth and Huge Potential

Wind energy has seen enormous growth in the last decade. According to U.S. department of energy, cumulative wind power capacity increased by an average of 30% per year. Wind energy accounts for about 2.5% of the total worldwide electricity production.

7. Can be Built on Existing Farms

Wind turbines can be installed on existing farms or agricultural land in rural areas, where it can be a source of earning for the farmers. Wind plant owners make payment to farmers for use of their land for electricity generation. Unlike solar panels, wind turbines don't occupy much space and farmers can continue to work on the land.

1. Wind Reliability

Wind doesn't generally blow reliably, and turbines usually function at about 30% capacity or so. They must stop working when the wind is too strong for safety reasons. If the weather is not going to support you, you may end up without energy, so you have to depend on other energy sources, too. Serious storms or high winds may damage wind turbines, particularly when they are struck by lightning.

2. Threat to Wildlife

Wind turbines can be unsafe to natural life, especially birds and other flying creatures. Every year millions of birds and bats, even endangered species, are killed by the blades or by the turbulence caused by the spinning turbine. Since turbines are more efficient in areas where the winds blow constantly, they are often installed along the migratory routes of birds, who use constant air currents to travel. Measures have been employed to try to reduce the impact of wind turbines on wildlife. One example is better siting of wind turbines in areas with smaller wildlife populations. Another is upgrading older turbines with designs that are more wildlife-friendly. And some wind farms are shutting down during bird and bat migrations if they are located along migratory routes.

3. Noise and Visual Pollution

Wind turbines make a sound that can be between 50 and 60 decibels. They are noisier when they spin slowly and more silent when they spin faster. The newest models produce less noise, but a single turbine near a house or a whole plant can be really annoying, since they work day and night. Moreover, some people believe that wind turbines are ugly or at least unattractive, and they may ruin the beauty of natural landscapes.

4. Expensive to Set Up

Wind turbines and other materials needed to make wind energy are extremely costly. Installation is also expensive and difficult and maintenance must be made by specialized firms with appropriate machinery, which is also expensive. Wind plants are often built on top of mountains or in the sea, so transport is another problem.

5. Safety of People

Severe storms and high winds can cause damage to the blades of wind turbines. A malfunctioning blade can be a safety hazard to the people working nearby, because it can fall.

6. Suitable to Certain Locations

Wind energy can only be harnessed at certain locations where speed of wind is high. Since they are mostly setup in remote areas, transmission lines have to be built to bring the power to the residential homes in the city which requires extra investment to set up the infrastructure.

7. Effect on Environment

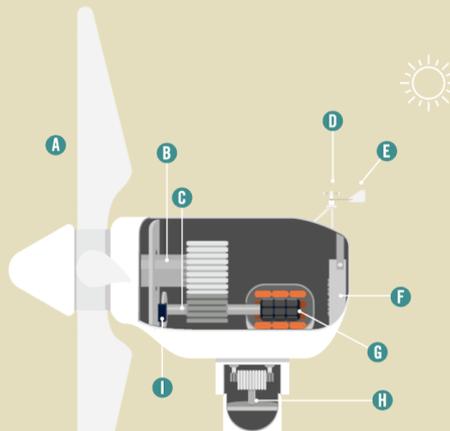
A lot of open area is necessary to set up a wind plant. When this is done on mountains where the winds are more reliable, lots of trees can be cut down. This makes wind energy less green than it seems.



HOW WIND TURBINES WORK

Seeing wind turbines at work can be an awesome sight. Their sheer size alone is often impressive. Just how does the wind move those blades, especially the massive ones that require a semi truck with a 100-foot trailer to transport? What exactly goes on behind the scenes to generate electricity? How does it all work?

We'll show you!



A BLADES

Catch wind and use the energy to turn the low-speed shaft.

B LOW-SPEED SHAFT

Spins along with the rotor and turns the high-speed shaft using a gear system.

C HIGH-SPEED SHAFT

Transfers the spin of the low-speed shaft to the generator at a much higher RPM. (1000-1800)

D ANEMOMETER

Measures the speed of the wind and transmits this data to the controller.

E WIND VANE

Measures the wind's direction and communicates this to the yaw drive.

F CONTROLLER

Starts and stops the turbine so it only operates at desirable wind speeds - between 8 and 55 mph, generally.

G GENERATOR

Produces electricity using the turning motion of the high-speed shaft and electromagnetic induction.

H YAW DRIVE

Correctly orients the turbine with respect to the wind using data from the wind vane.

I BRAKE

Stops the rotor in case of emergency or high winds.

BLADE AERODYNAMICS

SIDE VIEW OF A BLADE



The shape of the blade forces wind up and over it, **speeding it up** on one side.

This causes a difference in air pressure: **lower on top and higher on bottom**, forcing the blade to lift towards the low pressure air.

WIND FARMING



After electricity is produced in the turbine's generator, it is sent to collect in a **substation**.

From there, it is sent to a **utility grid**, which then distributes the power to customers.

DID YOU KNOW...



Small, personal turbines can feed electricity directly into your home.

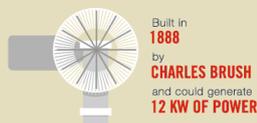
If your utility company has a **net metered system**, you can even feed power back into the grid, setting your meter in reverse.

HOW TALL ARE THEY?

Industrial wind turbines are often **200 ft. tall or more**, with blades that extend the total height past **300 ft.!**

This helps them take advantage of faster winds and less turbulence.

FIRST ELECTRICITY-PRODUCING WIND TURBINE



Built in **1888** by **CHARLES BRUSH** and could generate **12 KW OF POWER**

WHO GENERATES THE MOST WIND ENERGY?



NUMBER OF WIND-RELATED JOBS



73,000 at the end of 2014

NUMBER OF WIND TURBINES IN THE U.S.



SOURCES

<http://cleantechica.com/2014/06/22/americas-first-wind-turbine-generated-electricity-1888/> <http://www.ewe.com/resources/statefactsheets.aspx?itemnumber=890&navitemNumber=5267> <http://www.ewe.com/resources/Content.aspx?ItemNumber=5258> <http://energy.gov/eere/wind/how-do-wind-turbines-work> <http://science.howstuffworks.com/environmental/green-science/wind-power3.htm> <http://goldpower.net/news/how-does-a-wind-turbine-generate-electricity/>





Wind turbines at the Royd Moor Wind Farm in South Yorkshire, England. (Stephen Meese / Shutterstock)



