Airborne Wind Energy Educator Guide

A resource for using QUEST video in the classroom

Watch it online http://science.kqed.org/quest/video/airborne-wind-energy/ | 10:53 minutes

In the search to replace fossil fuels with renewable power, wind energy has proven to be a valuable resource. But as we know, wind doesn’t blow everywhere all the time. To harness reliable, consistent wind energy scientists and engineers are now looking up to harness a new wind resource -- the high altitude jet stream.

In this segment you’ll find…

- how conventional wind turbines operate.
- similarities and differences between conventional and airborne wind turbines.
- benefits and challenges of wind energy.
- prototypes of airborne wind turbines.

Did you know that wind on Earth is a complex form of solar energy? It’s formed by differences in atmospheric air pressure, usually generated by the Sun. Earth is heated unevenly, with warmer temperatures in places like the Bahamas and cooler temperatures in places like Antarctica. Hot air rises while cooler air falls, and the push between heated and cooled air creates wind. Another component of wind creation is the constant rotation of our planet. Earth’s rotation toward the east (plus uneven air temperatures between the equator and the poles) means that the strong high altitude winds of the jet stream blow east to west. Finally, a third factor of wind is Earth’s uneven surfaces. With valleys, mountains, and other landforms, Earth’s surface isn’t uniform. This means that air passes unevenly in the atmosphere. As pockets of heated air move up and cool air falls, wind starts, stops, and shifts in different ways because of Earth’s rotation and its uneven surface.

Even though wind is inconsistent, it’s still a renewable energy source that will never run out. Wind turbines harness the kinetic energy, or motion, of wind. A wind turbine is like a fan only it works in the opposite way. Instead of using electricity to move, it makes electricity with the power of wind. Wind makes turbine blades rotate. The rotation spins a connected shaft inside a generator to create alternating current (AC) electricity. Individual farms, homes, and commercial businesses in windy locations can use small wind turbines to supply their own electricity. Large-scale utility wind farms typically include hundreds or thousands of wind turbines, underground electricity transmission systems between the turbines, and a power substation that connects the wind farm to the larger power grid. Such farms are built in areas where the wind blows an average of at least 13 mph (21 kph) all year. Most conventional wind turbines are about 300 feet (91.4 m) tall and have rotor blades at least 200 feet (61 m) long. They require large tracts of land and rely on lower atmospheric winds, which are less intense than high altitude winds. With the advent of smaller, airborne wind turbines, it may soon be possible to capture high altitude winds. With this, scientists are hoping to cash in on the estimated 800 terawatts of wind power potential that is thought to exist at 2,000 feet (609.6 m) and more above sea level.
VOCABULARY

Altitude
distance measurement
denoting the height of
an object or a point
above a reference
level, such as the
height of a cloud above
sea level

Atmosphere
the gaseous envelope
that surrounds a planet
or other celestial body

Differential heating
differences in the
amount of heat
received in particular
areas when different
surfaces are heated by
the Sun

Kinetic energy
the energy of motion

Mechanical energy
the energy an object
possesses due either to
its motion or position

Prototype
an original or
preliminary model of
something that serves
as a basis or standard
for later designs or
systems

Turbine
machine for producing
continuous power in
which a wheel or rotor
is made to revolve by a
fast-moving flow of
water, steam, gas, wind
or other fluid

PRE-VIEWING

- How do alternative energy resources differ from fossil fuels?
- What alternative energy resources do you know about? How do they work?

VIEWING FOCUS

NOTE: You may choose to watch the video segment twice with your students: once to get an overview of the topic and again to focus on facts and draw out opinions.

- How do modern, conventional wind turbines work?
- What are some benefits of wind energy? Why is conventional wind energy not more widely used?
- How do airborne wind turbines differ from conventional wind turbines? What are some challenges associated with airborne turbines?
- What do you think the future of wind technology will bring? Do you think the high altitude jet stream will soon be a viable energy source?

For all media see:
- Segment Summary Student Sheet
  http://science.kqed.org/quest/files/imp/QUEST_SegSum_StudentSheet.pdf
- Personal Response Student Sheet

LESSON PLANS and RESOURCES from QUEST, PBS and NPR

Big Dreams for Small Wind Turbines NPR
Not all wind turbines are found on wind farms. In fact, some are used to power just one building. This August 27, 2009, broadcast from NPR’s All Things Considered discusses the smaller side of the wind power industry.

Giving Rise to the Jet Stream PBS LearningMedia
http://www.pbslearningmedia.org/content/ess05.sci.ess.watcyc.risejet/
This interactive resource shows students how the high-speed winds of the high altitude jet streams are formed.

How a Wind Turbine Works PBS LearningMedia
http://www.pbslearningmedia.org/content/5a84c19f-e238-49d0-8509-4880e58ea97e
This video resource from Wyoming PBS examines the parts of a conventional wind turbine and shows how they work together to generate power.

Off the Grid PBS LearningMedia
http://www.pbslearningmedia.org/content/eng06.sci.engin.systems.windmill/
In this interactive activity, students are challenged to design wind energy systems that will generate enough energy to power their electrical needs.

Steve Sawyer Sees Huge Potential for Wind Power PBS LearningMedia
http://www.pbslearningmedia.org/content/1d4006e7-653c-452b-adf0-8aa8f26d2d16/
Steve Sawyer, the secretary general of the Global Wind Energy Council, discusses the potential for wind energy in the United States and around the globe.
Why Use Multimedia in Science Education

- Read about the importance of using multimedia in the 21st century science classroom.

How to Use Science Media for Teaching and Learning

- A collection of tips, activities and handouts to actively engage students with multimedia.

Science Multimedia Analysis

- Give your students the tools to recognize the purposes and messages of science multimedia.

Create Online Science Hikes with Google Maps

- Do you like the science hike Explorations on the QUEST site? Use this place-based educational guide to create similar science-based maps with youth.

Media-Making Toolkit for Science Education
http://science.kqed.org/quest/education/media-making-toolkit/

- Are you interested in integrating media making into your classroom or science education program? Find instructions, worksheets and rubrics for implementing simple media-making projects with students.

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www.ebparks.org

Exploratorium
www.exploratorium.edu

Girl Scouts of Northern California
www.girlscoutsnorcal.org

Golden Gate National Parks Conservancy
www.parksconservancy.org

The J. David Gladstone Institutes
www.gladstone.ucsf.edu

Lawrence Berkeley National Laboratory
www.lbl.gov

Lawrence Hall of Science
www.lawrencehallofscience.org

Monterey Bay Aquarium
www.mbayaq.org

Monterey Bay Aquarium Research Institute
www.mbari.org

Oakland Zoo
www.oaklandzoo.org

Stanford University’s Woods Institute for the Environment
http://woods.stanford.edu

The Tech Museum of Innovation
www.thetech.org

UC Berkeley Natural History Museums
http://bnhm.berkeley.edu/

MORE EDUCATIONAL RESOURCES FOR USING QUEST MULTIMEDIA TO ENHANCE 21st CENTURY SKILLS IN TEACHING AND LEARNING

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