

## Program

## Five

# Energy Transformations: Your Public Electric Utility Teacher's Guide



Every town requires reliable electric power to meet its needs. We count on this power to run our homes, hospitals and places of work. Without this source of power our lives would be dramatically different.

[City of Bowling Green \(Ohio\), Electric Division,](#) recognizes this and has built a reliable system using a variety of means to generate power. Each of these involves an energy transformation -- a transformation of energy from one form to another. Sometimes power is extracted from a [renewable source](#) such as solar, wind and water, and used to drive a turbine that produces electricity. Other times energy from non-renewable sources, such as coal, natural gas or nuclear fuel, is used to drive a turbine that produces electricity.

Choosing a means to generate power is a difficult decision that must be based on data. It requires the careful building of a reliable system that will satisfy the public's needs.

### Program Objectives

Students will learn that:

- Science and scientists are at work in northwest Ohio solving the problems posed by declining resources and high energy costs.
- Businesses and governments routinely apply the process of scientific investigation to assess risk and cost to the community and environment.
- Science skills learned in high school are needed in the workplace.

### Ohio Science Standards

#### Earth Science

##### Benchmark D

Describe the finite nature of Earth's resources and those human activities that can conserve or deplete Earth's resources.

##### Indicator 5, Grade 10

Explain how the acquisition and use of resources, urban growth and waste disposal can accelerate natural change and impact the quality of life.

## **Physical Science**

### Benchmark F

Explain how energy may change form or be redistributed but the total quality of energy is conserved.

### Indicator 15, Grade 9

Trace the transformations of energy within a system (e.g., chemical to electrical to mechanical) and recognize that energy is conserved. Show that these transformations involve the release of some thermal energy.

## **Science and Technology**

### Benchmark A

Explain the ways in which the processes of technological design respond to the needs of society.

### Indicator 2, Grade 9

Identify a problem or need, propose designs and choose among alternative solutions for the problem.

## **Materials**

- Computer with access to the Internet
- Paper and pen
- Handouts

## **Pre-Viewing Activity – Prepare to Learn**

The most important component in this lesson is the local content; the places seen in this video are an easy drive from anywhere in Ohio. You can look up at the power lines that run past your home and imagine paths that they follow, perhaps to the wind farm located in Bowling Green or the Davis Besse nuclear power plant in Port Clinton.

We count on reliable energy to not only play our video games, listen to music or watch television, but to preserve and cook our food, heat our homes and provide power to our towns and cities. In recent years, our dependence on non-renewable resources, such as natural gas, has increased dramatically, as have the monetary costs associated with their use.

The higher cost of energy affects the job market and our ability to purchase goods and services. Our lives are directly linked to energy costs. The advantage of a renewable source, such as the wind or solar, is that it is free. The relationship between energy availability and cost is an important one to establish; once understood, it helps us emphasize the need for renewable energy and its beneficial effects on society.

Another important component of this piece is how the City of Bowling Green, Electric Division, relies upon a diverse array of resources to supply its customers, creating a system that balances older technology with newer technology.

With this diverse array of technologies comes an opportunity to examine a wide variety of energy transformations. Examples include chemical to heat to mechanical, as in the case of coal and natural gas, thermal energy from the sun to produce the wind, and energy from the wind to produce the mechanical energy driving turbines to produce electricity.

Finally, remind your students that no system is perfect as only a portion of energy is converted to power with the balance being dissipated into the atmosphere as heat.

### **Vocabulary**

- Peak power capacity
- Base loaded
- Hydro
- Organic matter
- Efficiency
- Capacity
- Load
- Fossil fuel
- Renewable resources
- Non-sustainable energy

### **Related Discussion Items**

- How important is reliable power to your family's well being?
- Energy cost of manufacturing, do energy costs effect jobs?
- What is renewable energy?
- What is non-renewable energy?
- What are the advantages of a utility using renewable energy to generate electricity?
- What are the advantages of a utility using non-renewable energy to generate electricity?
- What are the disadvantages of a utility using renewable energy to generate electricity?
- What are the advantages of a utility using non-renewable energy to generate electricity?
- What are some of the energy transformations that take place when generating electricity?
- What effect on the environment, e.g. land use or air quality, can a public utility have?

### Activity

Create a cognitive map as a follow-up to the guided discussion. Some possible items might be the social and environmental benefits of sustainable energy versus non-renewable sources. This discussion might evolve around how cost savings might benefit job creation.

### Quiz

1. Most of the resources used by City of Bowling Green, Electric Division, come from *renewable* sources such as coal and diesel.

True or **False**

2. Bowling Green has diversified its power resources so that nearly 20% of its power now comes from *renewable* resources.

**True** or False

3. Wind and solar, as effective generators of electricity, meet a large quantity of Bowling Green's total power needs.

True or **False**

4. Non-renewable resources, such as fossil fuels, are more efficient producers of electricity than renewable resources, such as solar.

**True** or False

5. Unlike wind turbines, nearly 100% all of the energy that goes into a diesel or coal fired combustion turbine is converted into useable energy.

True or **False**

### Related Lesson Plans

#### [Renewable Energy Sources](#)

(ORC# 467)

In this lesson, students use Internet resources to investigate renewable sources of energy. This lesson is designed to help students investigate and evaluate renewable energy sources. Most students can name several renewable resources, but have little understanding of them. It's important for students to examine controversial issues associated with renewable energy sources from multiple perspectives; by exploring benefits, drawbacks, and social ramifications, students will develop a deeper appreciation for these complex issues.

## Converting Energy

(ORC# 3459)

The purpose of this promising practice lesson is to introduce students to energy through the idea of energy transformations and conversions, and to develop students' ideas of what energy is and how it can be measured. This investigation could be the beginning of a unit on energy. The lesson begins with students exploring several activities on the Atom's Family website. For best results students should carry out the investigations described in the website. Students then pick up some foundational information about energy as they read part of the *Energy Story*, an online book. Finally students design and conduct an experiment around a question they devise about heating water. Safety considerations should be reviewed with students before they begin their experiments.

### **Educational Resources**

#### Additional Resources Using: D3A2



**Search String** = conservation of energy  
electric power substation design  
environmental management  
human impact on environment

The **D3A2** helps educators analyze data, and then points them to resources such as lesson plans, assessments and activities designed specifically to address the academic need identified by the data. In addition to linking content to data analysis, educators will have general search capabilities to locate education content resources aligned to the Ohio's Academic Content Standards. Examples of the state resources queried are:

INFOhio

<http://www.infohio.org/>

Ohio Resource Center

<http://ohiorc.org/>

### **Other Resources**

Green Energy Ohio

<http://www.greenenergyohio.org/page.cfm?pageId=3>

U.S. Department of Energy

<http://www.eere.energy.gov/windandhydro/>

The National Wind Technology Center - Research facility managed by the National Renewable Energy Laboratory for the U.S. Department of Energy.

<http://www.nrel.gov/wind/>

Ohio Public Utilities Commission  
<http://www.puco.ohio.gov/Puco.cfm>

Ohio Public Utilities Commission- The Science of Energy  
<http://www.puco.ohio.gov/PUCO/Consumer/Information.cfm?id=4588&terms=science+of+energy&searchtype=1&fragment=False>

Dr. E's Energy Lab  
<http://www1.eere.energy.gov/kids/>  
National Renewable Energy Laboratory Education Programs  
<http://www.nrel.gov/education/>

Texas State Energy Conservation Office: Lesson Plans for Teachers  
<http://www.infinitepower.org/lessonplans.htm>