

Energy for Electricity

Objective

The student will describe energy transformations required to produce electrical energy for homes.

Curriculum Focus

Science
Technology

Materials

- Copies of “Electrical Generation Puzzle,” cut apart
- Pinwheel (optional)
- Hand generator (optional)
- Transformer from a household item such as a cell phone charger (optional)

Key Vocabulary

Boiler
Generator
Transformer
Turbine

Next Generation Science Correlations

- MS-PS1 - 2
- MS-PS2 - 3, 5
- MS-PS3.A-B
- HS-PS1 - 4
- HS-PS3 - 1-2
- HS-PS3.A-B, D



Introduction

Electrical generation requires many energy transformations. In this activity, students will complete a puzzle showing the steps in the generation process and see how electricity is delivered to homes. Though it is a simple puzzle, students generally have no idea how electricity is produced until they have completed this activity.

Procedure

1. Ask students if they believe that energy is important to their lives. How would their lives be different without electricity?
2. Ask students where electricity comes from and how it is made. Tell them that the process of generating and delivering electricity requires many energy transformations.
3. Distribute the “Electrical Generation Puzzle” and give students a few minutes to complete it.
4. Go through each step of the puzzle, asking students to give the type and form of energy going in and coming out of each step. Point out that burning the fuel in the boiler is a chemical change that breaks the bonds of the hydrocarbons in the fuel to release thermal energy (and waste products such as carbon dioxide and sulfur dioxide). Compare the turbine to a pinwheel, demonstrating how steam can turn the turbine to create mechanical energy. Explain that the purpose of the transformers is to increase or decrease the voltage. Step-up transformers are needed to replace voltage lost as electricity is converted to thermal energy by electrical resistance in the power lines. Many household electronic devices have step-down transformers, which are a miniature version of those on electrical poles. These small transformers commonly also contain components to convert the alternating current from an outlet into direct current.

5. Have students name some further energy transformations that occur once electricity is used in their homes.
6. Ask students how the process of generating electricity with different energy sources would vary from the fossil fuel power plant shown in the puzzle. Which pieces would be different or removed when using each one of the following: nuclear power, wind power, hydropower and solar power?
7. Have students discuss the environmental effects of using renewable versus nonrenewable fuels.
8. List advantages and disadvantages of each method of producing electricity. Each energy source has benefits and drawbacks that must be considered and balanced.
9. Help students identify some of the economic and social impacts involved in changing our fuel mix.

Description of Electrical Generation Process

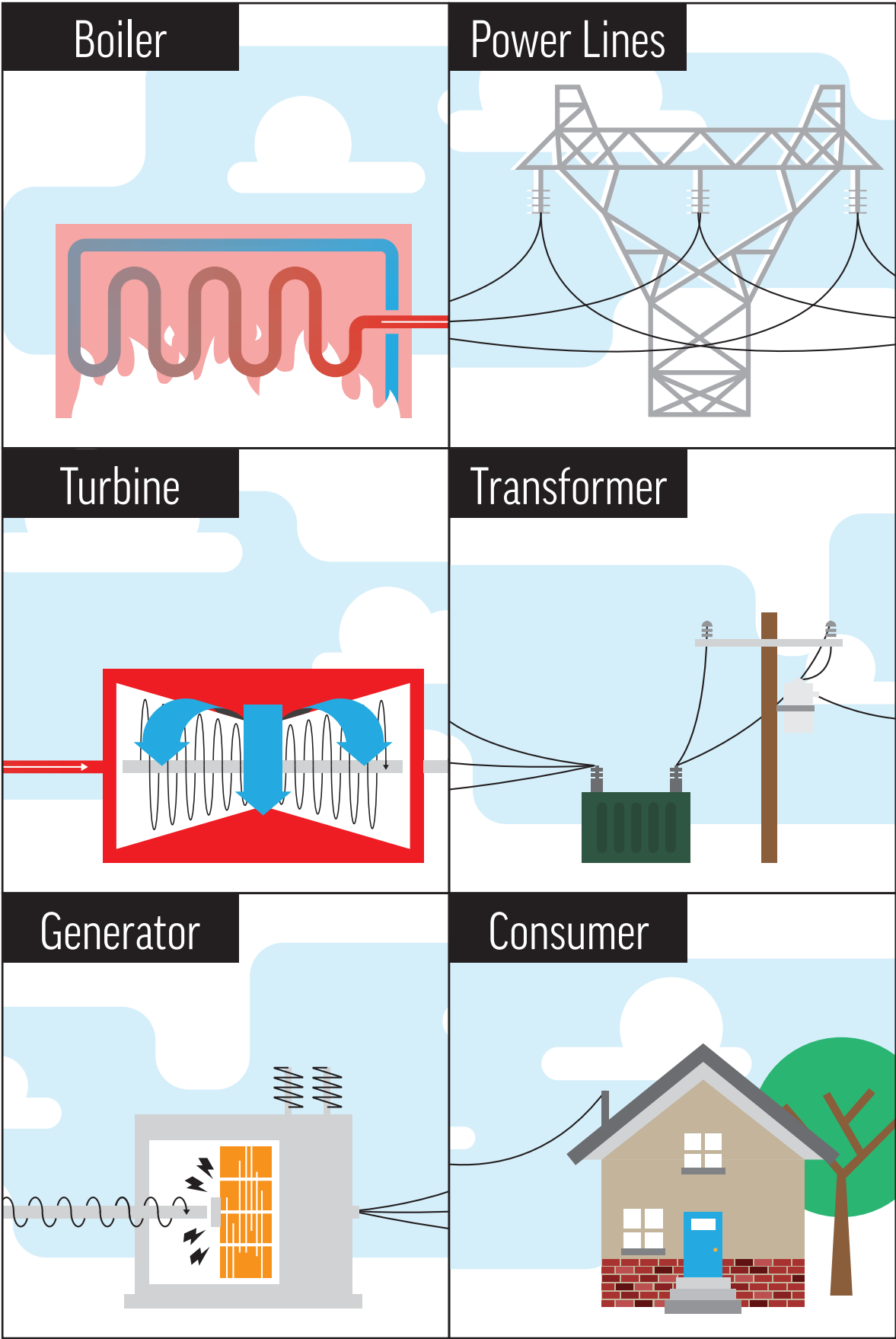
1. Boiler – converts chemical potential energy from fuel (fossil fuels, biomass, hydrogen) to thermal kinetic energy, changing water to steam. Light and chemical energy (new chemicals in the gases produced) are also formed but the energy does not contribute to the process of electrical generation.
2. Turbine – turned by steam, converting thermal kinetic energy to mechanical kinetic energy. Thermal energy from friction within the mechanism is produced as well but does not contribute to the electrical generation process.
3. Generator – turned by the turbine, it rotates a coil of wire in a magnetic field converting mechanical kinetic energy to electrical kinetic energy. Thermal energy from friction within the mechanism is produced as well but does not contribute to the electrical generation process.
4. Power lines – transmit electrical energy at several thousand Volts. Resistance heating in wires converts electrical energy back to thermal energy, resulting in a voltage drop and a loss of usable energy. High voltage lines from a power plant are called transmission lines. The transmission lines run to a substation which contains transformers and switches.
5. Transformer – substations and transformers may be step-up or step-down. Step-up transformers along the power lines increase voltage periodically; step-down transformers, on poles or in yards, reduce the voltage to a safe level for home use.
6. Consumer – converts electrical energy into many forms to run lighting and home appliances.

To Know and Do More

Investigate how transformers work. Check out explainthatstuff.com/transformers.html and science.howstuffworks.com for details including information on how power grids work.

If you have access to a voltmeter, have students design and build transformers. Test the voltage in and out of transformers and compare to the number of turns of wire on each core. Have students see if they discover a pattern.

Electrical Generation Puzzle



Energy Source Cards - Electrical Generation

Geothermal

Created with heat from inside the earth



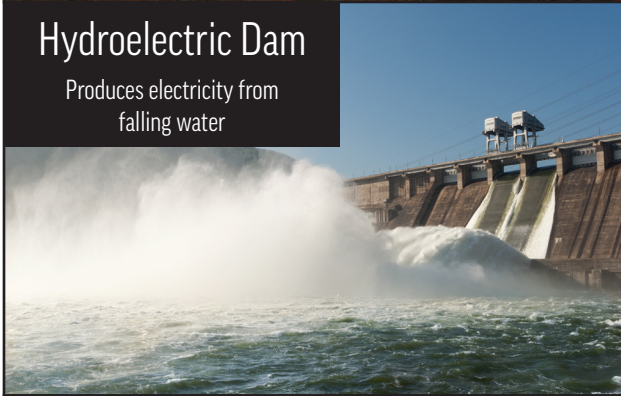
Biomass

Organic material with stored energy



Hydroelectric Dam

Produces electricity from falling water



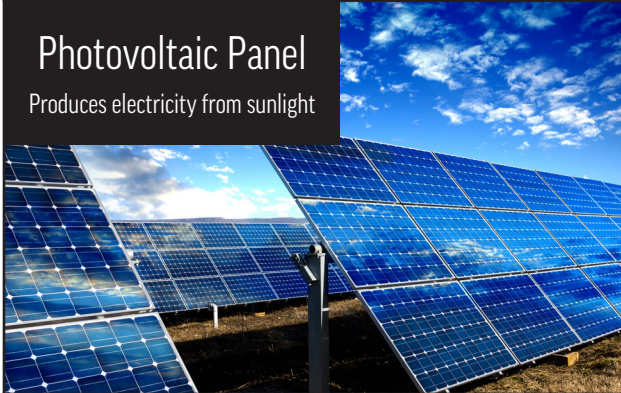
Wind Generator

Produces electricity from wind



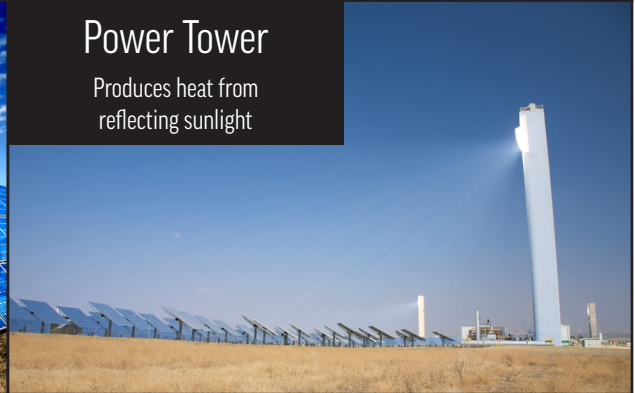
Photovoltaic Panel

Produces electricity from sunlight



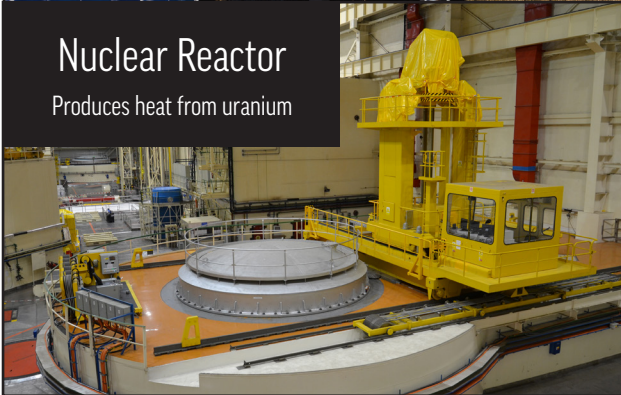
Power Tower

Produces heat from reflecting sunlight



Nuclear Reactor

Produces heat from uranium



Hydrogen Fuel Cell

Produces electricity from hydrogen and oxygen in a chemical reaction

