Oklahoma Ag in the Classroom

Geothermal Energy

Objective

Students will construct a steam turbine and simulate conditions of geothermal energy.

Background

Geothermal energy uses the natural temperatures in the earth or water to heat and cool buildings. The word "geothermal" comes from the Greek words geo (earth) and therme (heat). Geothermal energy may be used directly for electricity generation or indirectly by heat pumps (also known as geoexchange systems or ground source heat pumps).

In agriculture, geothermal energy may be used for heating greenhouses, for fish farming and algae production (aquaculture) and for heating the soil in open-field plant root systems.

Most direct-use geothermal relies on high temperature ground water to either heat buildings directly or to generate electricity. Direct-use geothermal heating is limited to areas that have naturally occurring hot springs or easy access to high temperature ground water in the 100 – 250°F range. This water is good for use in spas, greenhouses, or building heating systems. In some cases it can be used to heat entire portions of cities.

Geo-exchange systems—or geothermal heat pumps—are the most commonly-used form of geothermal energy used in homes and commercial buildings. These systems use the ambient temperature in the earth or water to heat or cool a building. Heat is removed from a substrate during the winter to heat a building and then during the summer the heat is removed from the building and put back into the substrate. The substrate is usually the earth but can also be water. A mix of water and antifreeze is used as the heat transfer fluid.

The Oklahoma State Capitol uses more than 600 geothermal heat pumps to heat and cool the building. Oklahoma is a center of ground source heat pump research and development, although it is not a major consumer of geothermal energy. The International Ground Source Heat Pump Association was formed in Oklahoma and is based on the campus of Oklahoma State University.

The United States has significant geothermal resources but several factors have limited the growth of geothermal generating capacity:

- Technology costs—New technology, referred to as enhanced geothermal systems (EGS), which may allow greater use of geothermal resources in other areas, is now in early development. Current cost estimates for EGS are generally higher than those for conventional geothermal plants and other more mature renewable technologies like wind power.
- Location.—Geothermal plants can be very site-specific, and have generally been limited to areas with accessible deposits of high temperature ground

Oklahoma Academic Standards

GRADE 4
Physical Science: 3-2,3,4.
Earth Science: 3-1

MIDDLE SCHOOL
Physical Science: 3-6

HIGH SCHOOL
Physical Science:3-1,2,4,5.
Earth Science: 3-2

water.

- Transmission access.—Lack of access to transmission lines limits growth.
- Completion lead times.—Completing a geothermal power generating project takes four to eight years, longer than completion timelines for solar or wind.
- Risk.—Even in well-characterized resource areas, there is significant exploration and production risk, which can result in high development costs.

Materials

- coffee can
- funnel
- duct tape
- dry ice

Procedures

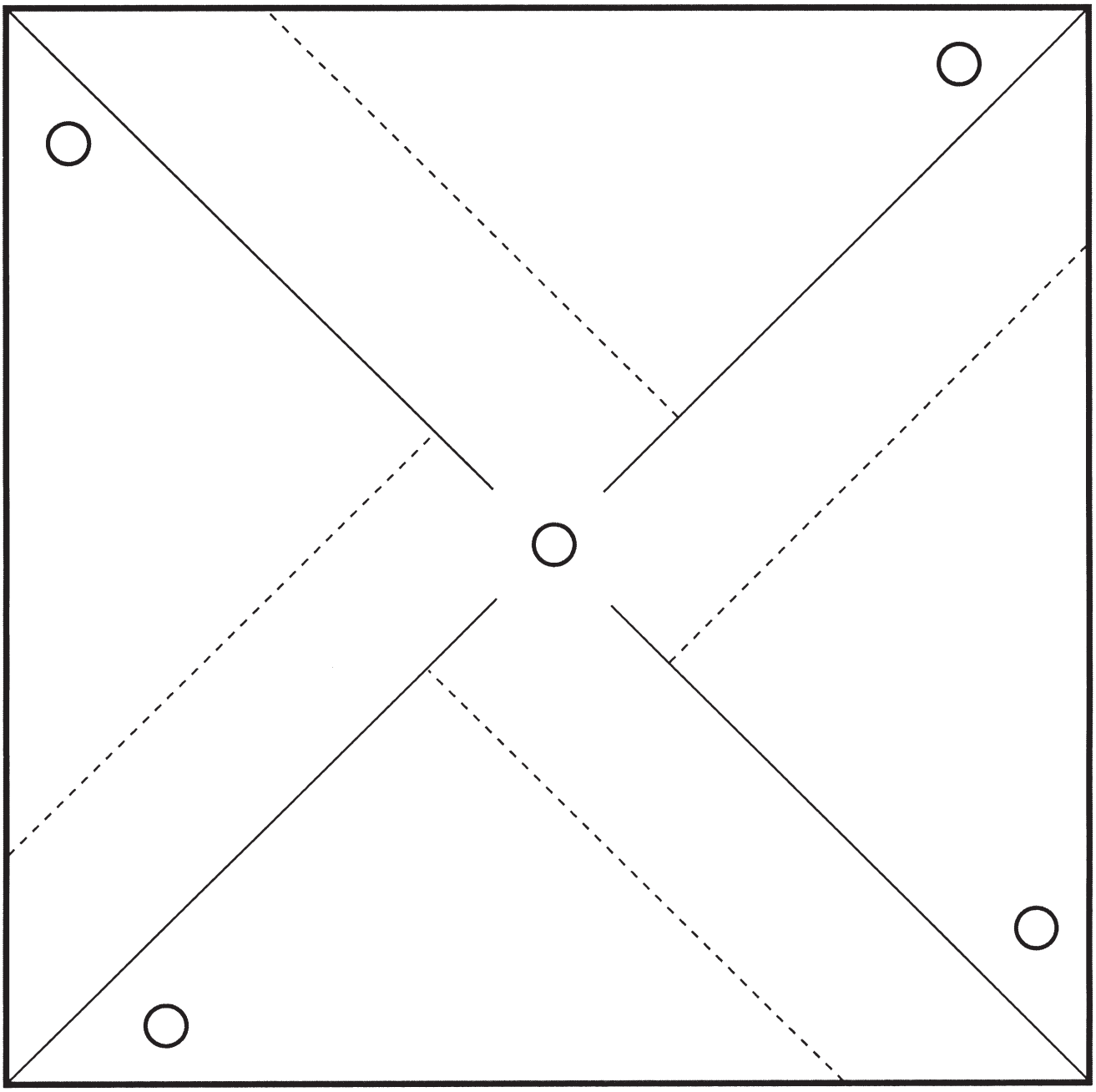
1. Read and discuss background and vocabulary.
2. Students will build a steam-powered turbine, as follows. Discuss the importance of steam to a power plant. To push turbines with sufficient force; it must be funneled to, create a high-pressure steam, and then released through a small opening, bursting out and expanding at great velocity. The turbine design in the activity below is not strong enough to produce or create power or electricity; however, it will demonstrate how various/unconventional power sources can cause a turbine to rotate.
   —Follow the instructions included with this lesson to build a basic pinwheel.
   —Put the lid on the coffee can
   —Use a drill or hammer and nail to carefully punch a hole in the lid as close as possible to the center.
   —Place inverted funnel on top of the coffee can over the hole. Secure with duct tape around the bottom.
   —Remove the coffee can lid and place dry ice in the coffee can using tongs or gloves.
   —Close coffee can lid.
   —Hold the pinwheel over the funnel. Use both hands to hold the straw with the pinwheel in the center.

Vocabulary

ambient— relating to the immediate surroundings of something
energy— the ability to do work
geothermal— using the heat of the earth's interior
substrate— a substance or layer that underlies something, or on which some process occurs

Pinwheel Pattern

Cut on the solid lines, being careful not to cut the center circle. Poke holes in the circles with a sharp pencil or hole punch. Follow the instructions below to make your pinwheel.



1. Insert a straw through the center hole.
2. Fold each corner along the dotted line and insert the straw through each corner hole.
3. Wrap rubber bands around the strawon both sides of the pinwheel to keep it in place in the center of the straw.

Oklahoma Ag in the Classroom is a program of the Oklahoma Cooperative Extension Service, the Oklahoma Department of Agriculture, Food and Forestry and the Oklahoma State Department of Education.