ENERGY ALTERNATIVES: THE COOL FUEL ROADTRIP

Geothermal and Solar Energy

Teacher's Guide

Grade Level: 6–12 **Curriculum Focus:** Science **Running Time:** 27 minutes

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Program Description

Shaun and his crew leave their gas tanks in San Francisco as they head for the Oregon border powered by geothermal energy. After that, Shaun and his dog, Sparky, rely on solar power as they follow the sun through Arizona.

Learning Objectives

After viewing the program and participating in discussion, students will be able to:

- Explain how geothermal energy is converted into electricity;
- Identify the economic benefits of alternative fuel production;
- Note the environmental advantages of using geothermal and solar energy;
- Utilize energy-saving techniques in their everyday lives.

Classroom Connections

How can geothermal energy produce electricity? Explain the process that converts steam into power.

How many different vehicles did Shaun use to get through California? What were the benefits and drawbacks of each mode of transportation?

What powers the team's RV? What is biodiesel made of?

What factors limited the range of Shaun's electric vehicles in California and Arizona? With a partner, discuss the strategies Shaun used to prolong the battery life of his vehicles.

Explain how a solar panel works. How does the panel convert heat and light energy into electrical energy? How does this relate to the second law of thermodynamics?

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What is sustainable architecture? What features of the Arizona house shown in the program help conserve energy?

In addition to using electric-powered vehicles, what other steps did Shaun, his team, and the featured drivers take in order to reduce their reliance on fossil fuels?

Classroom Activities

Consider the benefits and drawbacks of geothermal and solar power by organizing a class debate. Separate the class into two groups and assign each group either geothermal or solar power. Using the school library and trusted Internet sources, groups should research their assigned energy source and answer the following questions in a brief report:
-How is the energy source converted into electricity? List the steps.
-How much electricity can a typical power plant produce from your energy source?
-Can the source be found everywhere? Are certain areas better for this source than others?
-Do any factors limit the source being used as a primary energy producer?
At the time of the debate, each group should prepare a formal argument in favor of their energy source. Groups will present their research as well as critique the arguments of the opposing side.

Have students estimate their daily energy consumption to demonstrate how much power they require daily. Ask students to list the electrical appliances they use, the number of hours per day they use the appliances (see appendix on page five), and the rate at which the items use electricity in watts. To determine an appliance's energy use, multiply the appliance's wattage by the number of hours used per day and divide the product by 1,000. This figure is the item's estimated daily kilowatt-hour (kWh) consumption. Add up all of the results to find out how much power each student uses daily. After completing the activity, students should answer the following questions:
-Were you surprised by how much energy you use? Was the number higher or lower than you expected?
-Given that one photovoltaic module (panel) in Phoenix, Arizona, will produce an average of 0.8 kWh a day during the summer months, how many panels would you need to cover your energy use?
-How can you reduce your energy consumption? Are there any appliances you don't need to use on a daily basis?

Illustrate the many uses of solar energy by having students build a solar oven. Break the class into groups of four. Give each group two or three cardboard boxes, a roll of aluminum foil, cooking bags, glue, insulating material, a cooking thermometer, newspaper, plastic wrap, scissors, tape, wire hangers, and a wire cutter (Note: wire cutters should only be used under adult supervision). Using trusted Internet sources, have the groups research different solar cooker designs. The groups should sketch at least three different designs for their project, noting important aspects of each design (shape, materials, etc.). After students have completed

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their research, ask them to choose the design they think will best fulfill the following characteristics:
1) Be safe (no sharp edges, heat should not burn);
2) Must heat a hot dog to an internal temperature of 300 degrees Fahrenheit;
3) Must be able to heat up a cookie;
4) Must be able to melt the chocolate and marshmallow in a s'more.
The groups should complete a working drawing of their design, including the oven's dimensions and other necessary information.

After the groups have built their cookers with the materials provided, organize a "cook-off" on a day with favorable weather conditions. Students should record the amount of time required to cook each item (hot dog, cookie, and s'more) and determine the best design for speed cooking and food quality.

Target Vocabulary*

biodiesel - a fuel that is similar to diesel fuel and is derived from usually vegetable sources (as soybean oil)

combustion - an act or instance of burning

geothermal - of, relating to, or utilizing the heat of the earth's interior; also: produced or permeated by such heat (*geothermal* steam) (*geothermal* regions)

solar cell - a photovoltaic cell used as a power source

solar collector - any of various devices for the absorption of solar radiation for the heating of water or buildings or the production of electricity

sustainable - of, relating to, or being a method of harvesting or using a resource so that the resource is not depleted or permanently damaged (*sustainable* techniques) (*sustainable* agriculture); b: of or relating to a lifestyle involving the use of sustainable methods (*sustainable* society)

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Academic Standards

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National Academy of Sciences

The National Academy of Sciences provides guidelines for teaching science in grades K–12 to promote scientific literacy. To view the standards, visit this Web site: http://books.nap.edu/html/nses/html/overview.html#content.

This guide addresses the following standards:

- Physical Science: Chemical reactions
- Physical Science: Transfer of energy
- Science in Personal and Social Perspectives: Natural resources
- Science in Personal and Social Perspectives: Science and technology in local, national, and global challenges

AAAS Benchmarks

Benchmarks for science literacy, developed by the American Association for the Advancement of Science (AAAS), state what all students should know and be able to do in science, mathematics, and technology by the end of grades 2, 5, 8, and 12.

Appendix A: Typical Wattages of Various Appliances*

Aquarium = 50–1210 Watts
Clock radio = 10

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Coffee maker = 900–1200
Clothes washer = 350–500
Clothes dryer = 1800–5000
Dishwasher = 1200–2400 (using the drying feature greatly increases energy consumption)
Dehumidifier = 785
Electric blanket- Single/Double = 60 / 100
Fans
    Ceiling = 65–175
    Window = 55–250
Furnace = 750
Whole house = 240–750
Hair dryer = 1200–1875
Heater (portable) = 750–1500
Clothes iron = 1000–1800
Microwave oven = 750–1100
Personal computer
    CPU - awake / asleep = 120 / 30 or less
    Monitor - awake / asleep = 150 / 30 or less
    Laptop = 50
Radio (stereo) = 70–400
Refrigerator (frost-free, 16 cubic feet) = 725
Televisions (color)
    19" = 65–110
    27" = 113
    36" = 133
    53"-61"
    Projection = 170
    Flat screen = 120
Toaster = 800–1400
Toaster oven = 1225
VCR/DVD = 17–21 / 20–25
Vacuum cleaner = 1000–1440
Water heater (40 gallon) = 4500–5500
Water pump (deep well) = 250–1100
Water bed (with heater, no cover) = 120–380

*Source: U.S. Department of Energy

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