UTAH OFFICE OF
ENERGY DEVELOPMENT

Digging into Renewables

Grade/Subject: Earth & Space Science

Strand/Standard ESS.4.3 Evaluate design solutions for developing, managing, and utilizing energy and mineral resources based on cost-benefit ratios on large and small scales. *Define the problem, identify criteria and constraints, analyze available data on proposed solutions, and determine an optimal solution.* Emphasize the conservation, recycling, and reuse of resources where possible and minimizing impact where it is not possible. Examples of large-scale solutions could include developing best practices for agricultural soil use or mining and production of conventional, unconventional, or renewable energy resources. Examples of small- scale solutions could include mulching lawn clippings or adding biomass to gardens. (ESS3.A, ETS1.A, ETS1.B, ETS1.C)

Lesson Performance Expectations: Students will learn about local energy sources in Utah and evaluate the environmental and economic costs of various forms of energy.

Materials: Chromebooks/laptops etc.
If not available, provide students with printed articles.

Time: 90-120 minutes or 3 class periods.

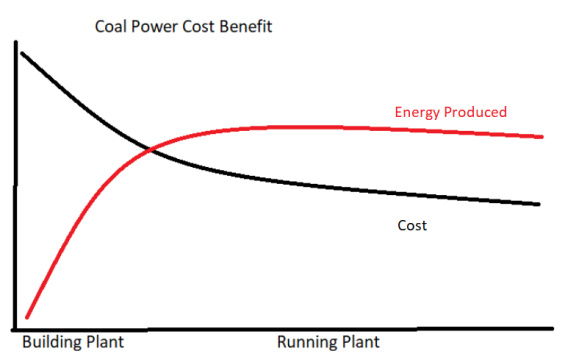
Teacher Background Information:

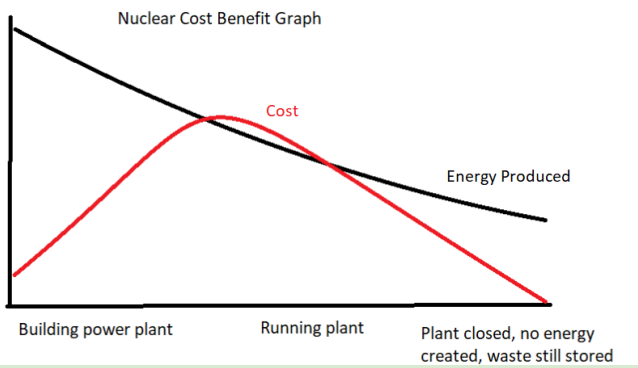
- https://www.xcelenergy.com/staticfiles/xe/Marketing/Managing-Energy-Costs-Schools.pdf
- Home - Office of Energy Development
- Utah's Energy Landscape
- DOE Energy Sources
- Explanation of what 'non-fuel' minerals are mined in Utah
    - Utah's Extractive Resources
- Between 1850 and 1950, the United States switched from 91 percent dependence on wood as a fuel to 96 percent dependence on oil, coal and natural gas. This shift occurred because fossil fuels were inexpensive, and technology had improved. Today, the United States uses fossil fuels for 72 percent of its energy needs (EIA Kids).
- Renewable energy is safe and plentiful, although currently less affordable or reliable than conventional energy resources. Today, renewable energy sources contribute to 10 percent of U.S. energy consumption (EIA Kids). Renewable energy production faces challenges like a lack of efficient, cheap, and widespread energy storage, workforce development hurdles, and technologies that decrease the price of other sources such as natural gas.
- There are five main renewable energy sources: **solar**, **biomass**, **wind**, **hydropower,** and **geothermal**. Each is captured successfully in our state.

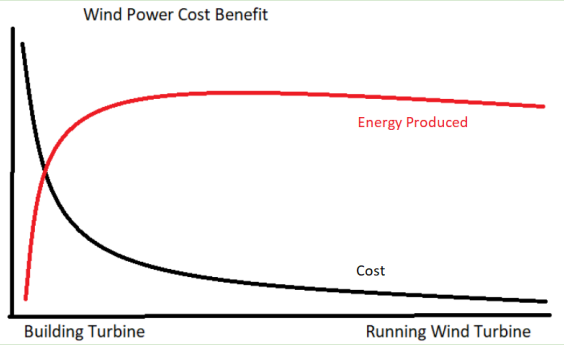
Student Background Knowledge: Students should be aware that electricity is widely used in our society.

Teacher Step by Step: A 3-d lesson should insist students do the thinking. Provide time and space for the students to experience the phenomenon and ask questions. The student sheet provided below provides guidance but is only an example of how students might respond.

1. **Introduce the Problem:** For most school districts, energy costs are a large expense. A school district is considering changing its energy source to cut electricity costs and have more money for student programs. Students must research how using these renewable sources will affect the school district.
2. Assign or have student groups sign up for different energy sources. Energy sources can include- coal, uranium, natural gas, the solar, wind, crude oil, oil shale, and biomass.
3. Give each group the pages from this document that discusses mining in Utah related to their energy source. ugspub.nr.utah.gov Try to print in color or have them access it on a computer.
4. Student research should address the questions listed on the worksheet. The line graph is an estimation of the cost of electricity over time. Most graphs will have high start-up costs as the equipment is built, and then costs are reduced during the plant's life. Power plants that rely on fuels (oil, coal, natural gas) will continue to have costs associated with their use. Use the example of coal or nuclear power provided in the key to explaining the concept of this graph.
5. This link may be helpful to understand the costs associated with renewable fuels. www.forbes.com
6. Student groups will create a poster or quick electronic presentation on renewable energy forms.
7. Give each student a Walkabout/Talk about the worksheet. Have students move throughout the classroom, looking at each group's poster. At each poster, students should score the energy source from 1-5, and they must rank each source so that each column has numbers 1-5.
8. After the walkabout, discuss the student data on a large poster board or electronically on a teacher's computer and compare the class's findings as a whole.







Assessment of Student Learning. The summary should have a clearly stated claim with one energy source identified. Three evidence statements should come from the data collected on the graph and their research. The reasoning should be thoughtful and complete based on which evidence and why they think it is most compelling.

Standardized Test Preparation:

Digging into Renewables

1. Which energy resources are available in Utah? Choose all that apply.
    a. Solar*
    b. Wind*
    c. Oil*
    d. Geothermal*
    e. Coal*
    f. Natural Gas*

2. Traditional hydrocarbons currently meet what percentages of Utah's energy needs?
    a. 10%
    b. 30%
    c. 60%
    d. 90%*

3. What advantages do alternative energy sources have? Choose all that apply.
    a. The primary energy source is free.*
    b. They are available everywhere.
    c. The equipment needed to capture the energy is inexpensive.
    d. They produce fewer emissions.*

4. What must most alternative energy sources be transformed into before consumers can use them?
    a. Steam
    b. Electricity*
    c. Heat
    d. Energy

Extension of lesson: Students may visit eia.gov to identify energy sources located near them in Utah. A field trip to one of these sites would be fascinating. Students may watch this video for a first-hand account of what it was like as a miner, Oral History of a Utah Miner.

Career Connections: Potential careers related to this activity are Solar Installer, Wind Turbine Repair Technician, and Hydro-Electric Field Engineer

Digging into Renewables

Name_____

Problem:
Electricity use affects schools, communities, and states. As a widely used energy source, the cost of producing n and transmitting electricity affects all users. How can advances in electricity contribute to positive cost and environmental impacts?

Choose an alternative energy source to research like: solar, wind, hydropower, geothermal, and biomass are all well-known sources. All these sources produce electricity.

My energy source: _____

Visit the following link. Find the pages that relate to the energy source you have chosen.
https://ugspub.nr.utah.gov/publications/circular/c-127.pdf

Use a search engine or links your teacher provides to do additional research.

Research Questions

1. Where in Utah is this energy resource available? Give a specific location as well as a general area.

2. How did they decide where in Utah to produce this type of energy?

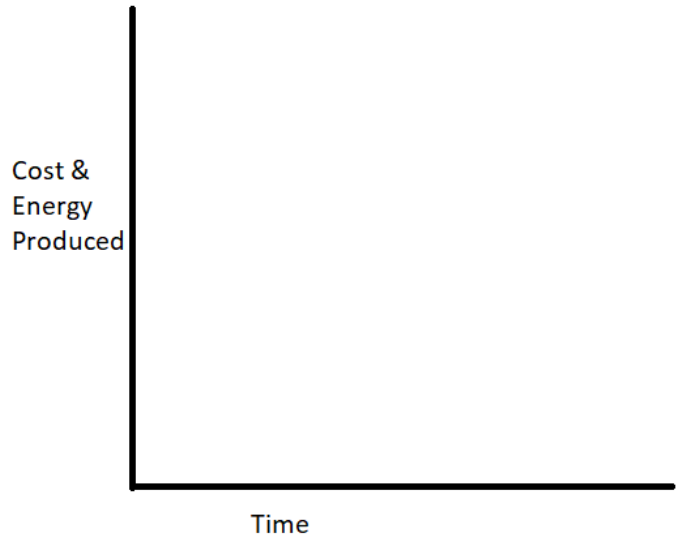
3. How does your energy source create electricity?

4. What is the environmental impact of this energy source? How can it be kept to a minimum?

5. How much does it cost to start using this as an energy source? What equipment/ generators/ power plant is needed?

6. What is the cost to use this type of energy once the initial setup is done? Try to find this in kilowatt-hours (kWh).

Create a poster or electronic presentation with your group that explains the information you researched above. On your poster, draw a graph of Cost and Energy produced over time. This graph does not need specific numbers but shows the overall shape. Draw one line for cost and one line for the amount of energy produced. Try to think of the entire lifespan of the energy generation.



Walk and Talk

Move around the classroom and look at the posters/presentations created by other groups. Some energy sources will be presented more than once. Be sure to visit each energy source at least once. Based on the information provided, evaluate the different alternative energy sources. Use a point scale of 1-5, with 5 being the best and 1 being the worst. Each column should have numbers 1-5. Add the points in the score column.

Source	**Is this low cost?**	**Is this a Utah resource?**	**Impact on the environment**	**Score**	**Something new/interesting I learned**
Wind					
Geothermal					
Solar					
Biomass					
Hydropower					

Summary

Make a **claim** stating a power source that is beneficial to Utah.

What **evidence** supports your claim? (at least 3 ideas)

What is your **reasoning**? (be complete as you describe your thinking)