

## Generating Electricity: Evaluating the Sustainability of Today's and Tomorrow's Energy Sources

### Overview

In this activity, students will learn about the energy sources used by their local utility provider to generate electricity and will work in small groups to evaluate the sustainability of either a renewable or non-renewable energy source used to generate electricity. **This activity was adapted with permission from the lesson "Is It Sustainable?" from *Engaging Students through Global Issues, by Facing the Future*, (c) 2006.**

### Alignment to North Carolina Essential Standards for Earth and Environmental Science

- 2.2.1: Explain the consequences of human activities on the lithosphere (such as mining, deforestation, agriculture, overgrazing, urbanization, and land use) past and present.
- 2.2.2: Compare the various methods humans use to acquire traditional energy sources (such as peat, coal, oil, natural gas, nuclear fission, and wood).
- 2.2.5: Explain how human activities affect air quality.
- 2.4.2: Evaluate human influences on water quality in North Carolina's river basins, wetlands and tidal environments.
- 2.6.3: Analyze the impacts that human activities have on global climate change (such as burning hydrocarbons, greenhouse effect, and deforestation).
- 2.7.3: Explain how human activities impact the biosphere.
- 2.8.1: Evaluate alternative energy technologies for use in North Carolina

### Essential Questions

- What energy sources are used by society to generate electricity?
- What does the term sustainability mean?
- Which of these energy sources are sustainable?

### Materials

- *Evaluating Sustainability* Student Worksheet (provided), one copy for each student
- Sustainability Venn diagram (provided on worksheet) or large poster paper
- Small pink and green post-it notes and/or red and green markers
- Tape
- (optional) Internet and/or *Energy Infobook* by NEED (can be downloaded for free at <http://www.need.org/Energy-Infobooks>)

### Teacher Preparation

- You should be familiar with the various non-renewable and renewable energy sources used by society and be knowledgeable about the impacts of their production and use on the environment, the economy, and society.
- An excellent glossary can be found at [http://www.eia.gov/kids/energy.cfm?page=kids\\_glossary](http://www.eia.gov/kids/energy.cfm?page=kids_glossary)

### Duration

Part I – Background (45 minutes)

Part II – Independent research as in class group work or homework (will vary)

Part III – In-class presentations & discussion (will vary)

### Engagement & Pre-Assessment Ideas

Prior to conducting Part I you may choose to conduct one or more of the following engagement activities:

- Ask students to write down the energy sources used to generate electricity for their region and rate the sustainability of each based on their pre-existing knowledge. Their answers can be revisited at the end of the lesson.
- Conduct the [Power Source Activity](#) which asks students to diagram what exists behind an electrical outlet and trace the electricity back to its source.
- Ask students to journal about their use of and reliance on electricity over a 24 hour period and to consider the positive and negative impacts of electricity generation.

## Procedure Part I

1. Either working in pairs on laptops or as an entire class, visit EPA's *Power Profiler* at <http://www.epa.gov/cleanenergy/energy-and-you/how-clean.html> and enter your local zip code to determine what energy sources ("fuel mix") are used for electricity generation in your area. *Depending on your zip code, you may be asked to indicate your utility provider (e.g., Progress Energy).* In NC, results will reveal that approximately 95% of electricity is generated by coal and nuclear power.  
\*Note: Your students may have fun comparing their local power profile with that of other regions in the country (e.g., more hydropower, 98101(Seattle); predominantly coal, 24701 (WV); gas, 79603 (TX)).
2. The EPA's *Power Profiler* demonstrates that a variety of energy sources are used to generate electricity and that much of society's energy comes from **non-renewable fossil fuels and nuclear energy**; ask students to review the fuel mix for their region and identify which energy sources are renewable and which ones are non-renewable.
3. Ask students to discuss why they think the use of **non-hydro renewable energy sources** such as solar and wind power is low. Invite students to share their answers aloud, while you write their responses on the board or overhead. Answers will likely include cost of technology, lack of trained workforce, geography, local, state and federal policies, etc.
4. Fossil fuels release carbon dioxide and other harmful pollutants (like nitrogen oxide and sulfur dioxide) when burned. The second graph of the EPA's *Power Profiler* shows the air emissions rate associated with the fuel mix profile. Ask students to reflect on why their region has higher or lower emissions rates of carbon dioxide, nitrogen oxide and sulfur dioxide compared to the national average. Students can be prompted to return to the zip codes provided in step 1 and compare air emissions profiles. Furthermore, you may also want to encourage students to consider other pollutants that are generated that are not quantified here (e.g. mercury from coal-burning power plants).
5. Because of the role of **atmospheric carbon dioxide** in accelerating **global warming**, tell your students that "cleaner" and renewable energy sources are being sought by utility providers and consumers. We are now hearing the word "sustainability" and see it applied to the discussion of energy. Either individually or in partners, have students brainstorm the definition of sustainability. Invite students to share their answers aloud, while you write their responses on the board or overhead, being sure not to remark whether responses are correct or incorrect.
6. As a class, construct one definition for sustainability based on student responses collected on the board. In summary you may want to offer other definitions for consideration by the class:
  - **Meeting the needs of the present generation without compromising the ability of future generations to meet their needs.** World Commission on Environment and Development: Our Common Future, 1987
  - **Sustainability envisions the enduring prosperity of all living things.** American Institute of Architects
  - **Sustainability is about more than just quality of life. It is about understanding the connections between and achieving balance among the social, economic, and environmental pieces of a community.**  
<http://www.sustainablemeasures.com>
7. Explain that when evaluating the sustainability of an activity/product/service, the positive and negative aspects (including unintended consequences) of this activity on **the economy, the environment, and society** are considered. Present students with a Venn diagram (*provided*) depicting the three components of sustainability. The Venn diagram can be used to illustrate that these three components are connected and should not be treated in isolation (for more information visit: <http://www.sustainablemeasures.com/node/42>). Examples of these connections include: an educated society is essential for a thriving economy and a thriving economy is dependent upon conservation of natural resources.
8. Inform students that an activity/product/service can be more sustainable than others and thus, every activity/product/service can be placed somewhere on a sustainability scale:



9. To help students gain experience in evaluating the sustainability of an activity, the class will evaluate one human activity together – driving to school. Distribute copies of the worksheet, *Evaluating Sustainability* and ask students to complete *Think-Pair-Share #1* with a partner. Students may choose to use the question prompts provided below as they consider the impact of driving to school on the environment, the economy, and society (questions adapted with permission from the lesson "Is It Sustainable?" from *Engaging Students through Global Issues*, by Facing the Future, (c) 2006). Give students approximately 10 minutes to brainstorm with their partner before moving into a class discussion (see step 9).

### Environment

- What resources are used?
- Are the resources used able to be renewed or regenerated?
- Are plants and/or animals damaged?
- Is biodiversity maintained?
- Does the activity cause air pollution, water pollution, or soil erosion?

### Environment, *continued*

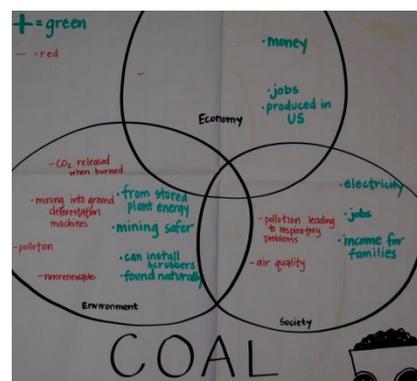
- Does the activity generate waste?
- What happens to the waste?
- Will this activity help to conserve natural resources (air, water, land)?

### Economy

- What is the economic impact of this activity?
- Does the activity create meaningful and satisfying work for individuals?
- Does the activity allow people to do their jobs more efficiently?
- Does the activity contribute to a community's economic development?
- Does the activity rely on products or services that have negative effects on the environment or society?

### Society

- Does the activity contribute to people's quality of life?
- Do some people benefit from this activity at the expense of others?
- Does the activity affect people's cultures?
- Are individuals and communities involved in making decisions about the activity?
- Does the activity offer more options/opportunities to certain groups of people than others?



10. Next, project the Venn diagram at the front of the room and ask students to tell some positive and negative impacts that they came up with – write these impacts down with either a green (positive) or red (negative) marker on the appropriate area in the Venn diagram; alternatively, students could use red and green markers to complete their own Venn diagram. Remember that some impacts may fall within more than one category and should be placed in the overlap regions on the Venn diagram. By looking at the number and location of green (positive) impacts, the class should be able to come to a consensus about whether driving to school is economically, environmentally, and/or socially sustainable. You can also discuss how some unsustainable aspects of driving can be made more sustainable (e.g. using energy efficient cars and cleaner burning fuels).

### Procedure Part II

11. Students will now repeat this activity by evaluating the sustainability of society's use of a specific energy source for *Think-Pair-Share #2*. Working in groups of 4 to 5 students (to increase the number of perspectives), students will evaluate an energy source used by society to generate electricity: **Coal, Natural Gas, Petroleum (oil), Nuclear, Solar, Wind, Hydro, Biomass, and Geothermal**. Assign each group one of the energy sources from above and instruct them to use the same questions that guided their decision-making process during *Think-Pair-Share #1* to ultimately determine where this energy source would fall on the sustainability scale. If you have a large class, you may assign one energy source to more than one group. Instruct students to rely on their existing knowledge or to conduct research to better evaluate this energy source. You may choose to provide each group with relevant pages from the NEED Project's, *Energy Infobook* (available for free download at: <http://www.need.org/Energy-Infobooks>).
12. Each group will now construct a Venn diagram for their assigned energy source. For every positive and negative impact that students come up with, ask them to write that impact down using either a green marker or green post-it note to indicate a positive impact and a red marker or pink post-it note to indicate a negative impact and place on the appropriate area in the Venn diagram (provided on the back of the worksheet or on poster paper). Remind students that some impacts may fall within more than one category and should be placed in the overlap regions on the Venn diagram. By considering the cumulative positive and negative impacts, students should be able to predict the overall sustainability of this energy source compared to other energy sources.

### Procedure Part III

13. On the board, write (or place a sign) on the left that says "unsustainable" and on the right write "sustainable." This represents a sustainability scale.
14. Once students have had some time to evaluate the sustainability of their energy source, direct them to establish where this energy source should be placed on the sustainability scale. Ask them to bring their completed Venn diagram to the front of the room and place it at this position on the scale provided at the front of the classroom so that they can see how their assigned energy source compares to others. Alternatively, you may ask students to present their completed Venn diagrams to their classmates as they place it on the sustainability scale and let them rearrange their position as they hear from the other groups. It is also interesting to see where groups evaluating the same energy source initially place their Venn diagram on the sustainability scale.
15. As a class go over the various energy sources and the placement of their corresponding Venn diagrams. You may address the following questions to the class:
- How did your group decide where to place your assigned energy source on the sustainability scale?

- Did one category (e.g., environment) outweigh the others as you made your decision about its placement?
- Where do non-renewable energy sources fall on the scale? Do you agree with the placement of these energy sources? Why or why not?
- Where do renewable energy sources fall on the scale? Do you agree with the placement of these energy sources? Why or why not?
- Where does nuclear energy fall on the scale? Is nuclear energy a sustainable energy source?
- What technologies can be implemented to minimize the negative impacts of burning fossil fuels (e.g., advanced coal or “clean” coal technology like carbon capture and sequestration)?
- What renewable energy sources are being used/considered for your region or state? What, if any, concerns might people have about these energy sources being utilized in their communities? Are there ways any negative impacts could be minimized?
- Why should we as consumers strive to be more energy efficient? What actions can you take to conserve energy?

### Assessment Options

- Ask students to respond to one or more of the questions in Step 14 in writing.
- Ask students to summarize their evaluation of their assigned energy source in writing.
- Ask student groups to prepare oral presentations or posters about their energy source.
- Ask students to summarize the energy sources used to provide electricity for their region and discuss their overall sustainability. This would make an ideal pre- and post-assessment as it would capture gains in knowledge and also changes in perspective.

### Culminating Activities

- If possible, tour a local power plant. Power plants at local universities may be open for student tours.
- Tour a local facility that utilizes/produces an alternative energy source.
- Invite someone who works in the energy sector or at a local electric utility provider to speak to the class.
- Watch the film, *Earth: The Operators’ Manual* available at <http://earththeoperatorsmanual.com/>

### Differentiation

#### Students with Special Needs

- Place students in mixed ability partners for activity completion.
- Think-Pair-Share Activity #2 could be completed as an entire class; project the Venn diagram at the front of the room and have students post positive and negative attributes of the energy source onto the diagram.

#### AIG

- Students can work individually and assess the sustainability of an energy source of their choice.
- Ask students to summarize their evaluation of their energy source in writing.

### Resources

*Energy Infobook* from National Energy Education Development (NEED) Project

<http://www.need.org/Energy-Infobooks>

US Department of Energy

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

Energy Information Administration (EIA)

<http://www.eia.doe.gov/>

*An excellent, student friendly GLOSSARY of energy terms*

[http://www.eia.gov/kids/energy.cfm?page=kids\\_glossary](http://www.eia.gov/kids/energy.cfm?page=kids_glossary)

National Renewable Energy Laboratory (NREL)

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

American Nuclear Society

<http://www.new.ans.org/>

American Wind Energy Association

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

## Evaluating Sustainability

Adapted with permission from the lesson "Is It Sustainable?" from *Engaging Students through Global Issues*, by Facing the Future, (c) 2006.  
www.facingthefuture.org/

### Think-Pair-Share #1

With a partner, discuss the question: Is driving to school a sustainable activity?

You'll need to be able to explain your decision to the class.

*As you consider this question, think about the impact of driving to school on the environment, the economy, and society:*

#### Environment

- What resources are used?
- Are the resources used able to be renewed or regenerated?
- Are plants and/or animals damaged?
- Is biodiversity maintained?
- Does the activity cause air pollution, water pollution, or soil erosion?
- Does the activity generate waste?
- What happens to the waste?
- Will this activity help to conserve natural resources (air, water, land)?

#### Economy

- What is the economic impact of this activity?
- Does the activity create meaningful and satisfying work for individuals?
- Does the activity allow people to do their jobs more efficiently?
- Does the activity contribute to a community's economic development?
- Does the activity rely on products or services that have negative effects on the environment or society?

#### Society

- Does the activity contribute to people's quality of life?
- Do some people benefit from this activity at the expense of others?
- Does the activity affect people's cultures?
- Are individuals and communities involved in making decisions about the activity?
- Does the activity offer more options/opportunities to certain groups of people than others?

NAME: \_\_\_\_\_

### Think-Pair-Share #2

1. Your teacher will assign you an energy source.

List the energy source you will evaluate here:

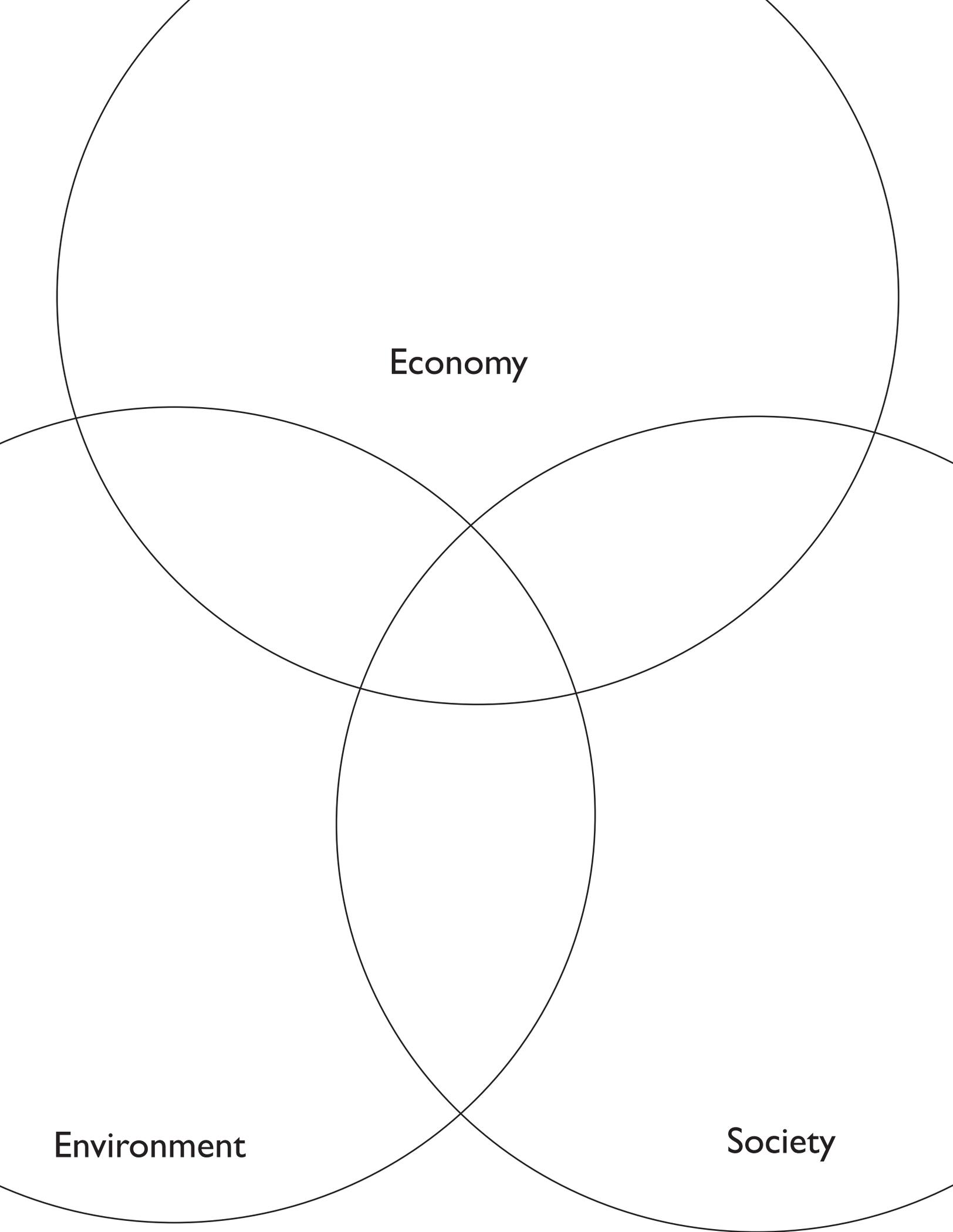
---

2. Use your textbook and/or the Internet to conduct research about this energy source, if necessary.

3. Based on what you know about this energy source, think about the impact of the production and use of this energy source on the environment, the economy, and society. For each positive/negative impact that you come up with write that impact down using either a green marker or green post-it note to indicate a positive impact and a red marker or pink post-it note to indicate a negative impact and place on the appropriate area in the Venn diagram (provided on the back of this sheet or on poster paper). Remember that some impacts may fall within more than one category and should be placed in the overlap regions on the Venn diagram.

4. By considering the positive/negative impacts that you came up with, decide where your energy source should be placed on the sustainability scale below— draw an X indicating its position on the scale below. Next, take your completed Venn diagram and, using tape, place it at this position on the scale provided at the front of the classroom so that you can see how your energy source compares to others being evaluated by your classmates.





Economy

Environment

Society