ACTIVITY 1: WHAT IS HAPPENING?

The effects of climate change

Purpose

Students will be able to

- Articulate a basic understanding of climate change
- Explain the effects that climate change is having around the world
- Identify areas of interest about which they would like to learn more

Implementation Notes

It is likely that many students will be familiar with the overall concept of climate change, however, they may not have a firm understanding of the many effects that we are currently experiencing due to climate change. This lesson introduces students to the ideas that will be explored throughout the program.

In the Classroom

Group Investigation

Before viewing the film or reading the accompanying chapter, lead students in a discussion about what they know about climate change. Ask students if they have noticed any changes in the climate, and have them give specific answers. List their responses on the board. Ask students what they would like to learn more about regarding climate change and if they have any questions they would like to answer during these lessons. List their responses on the board. Have a short discussion and tell them that they will be learning about these things in greater detail.

Film Clip

Have students watch Part 1 of the *WORLD ON FIRE - THE SCIENCE* film (7 minutes) and complete the Video Organizer Worksheet. Following the film continue your group discussion. Using the list that you created on the board before watching the film as reference, have students elaborate on their earlier ideas by discussing what they found most surprising about Part 1 and if any of their questions were answered. Ask if they have any additional questions. Discuss the following questions as a group

- What causes the ocean to rise, how much has it risen in the last century, how much do scientists predict the oceans will rise by 2100?

  Answers: - Ocean rising is caused by melting icecaps
  - Oceans have risen 4–8 inches in last century
  - Scientists predict oceans will rise more rapidly in the future, some predict 1–3 feet by 2100, while others predict 6 feet, and up to 23 feet if the Greenland ice sheet melts completely
- Have you heard the term climate refugee before, what does this term mean to you?
- What are some effects of climate change that we have experienced?
  Answers will vary based on location. In general answers will be regarding changing weather patterns, such as hurricanes, forest fires, and/or flooding
- What are other effects of climate change that have been experienced around the world?

  Answers: - Changing weather patterns causing flooding and/or drought
  - Increased intensity of hurricanes and forest fires
  - Extinction of plants and animals
  - Warming of the ocean which has killed 1/2 of the world's coral reefs
  - Spread of tropical diseases

Reading Deeper

Depending on the length of classroom time and the teacher's preference, this portion of the lesson can be completed by students as an in-class group exercise or as homework to be completed on their own. To reinforce what students have learned from Part 1 of the film, have students read Chapter 1 *WHAT IS HAPPENING?* of the *WORLD ON FIRE* book and answer the following questions in their notebook or complete the Reading Worksheet:

1. What evidence do we have for climate change?
2. How many degrees Fahrenheit has the earth warmed since 1750?
   Answer: 1.8°
3. When scientists measure concentrations of isotopes and oxygen in the air bubbles trapped inside ice, what do they learn? Where else can scientists learn this information?

   Answers: - The history of climate and levels of carbon dioxide in the air
   - Sediments in lakes and rings in trees
4. There are a lot of numbers and statistics in this chapter, which statistics do you find most disturbing and why?
5. Write three questions you still have about climate change.

VIDEO ORGANIZER for WORLD ON FIRE - THE SCIENCE

Part 1: The effects of climate change

List of effects caused by climate change

Notes on ocean rising

Terms I haven't heard before

Questions I still have

READING DEEPER for WORLD ON FIRE - THE SCIENCE

Chapter 1: What is Happening?

Read Chapter 1 of WORLD ON FIRE – THE SCIENCE and answer the following questions.

1. What evidence do we have for climate change?

2. How many degrees Fahrenheit has the earth warmed since 1750?

3. When scientists measure concentrations of isotopes and oxygen in the air bubbles trapped inside ice, what do they learn? Where else can scientists learn this information?

4. There are a lot of numbers and statistics in this chapter, which statistics do you find most disturbing and why?

Write three questions you still have about climate change

1.

2.

3.

ACTIVITY 2: WHY IS THE EARTH WARMING?

The greenhouse effect and how greenhouse gases warm the earth

Purpose

Students will be able to

- Develop a working knowledge of the greenhouse effect
- Explain types of greenhouse gases and how they are created

Implementation Notes

It is likely that many students have heard the term greenhouse gas but they may not be familiar with the greenhouse effect and which gases are greenhouse gases. This lesson Introduces students to the concept of greenhouse gases with the intent to aid students in understanding how these gases are warming the earth.

In the Classroom

Group Investigation

Before viewing the film or reading the accompanying chapter, lead students in a discussion about what they know about the greenhouse effect. Ask students if they have ever gotten in a car during summer and noticed that it was warmer inside of the car than outside? Explain that the greenhouse effect is similar to this and tell them that they will be learning about how in greater detail.

Film Clip

Have students watch Part 2 of the *WORLD ON FIRE - THE SCIENCE* film (3 minutes [7:02–10:04]). Following the film continue your group discussion. Discuss the following questions as a group

- Is the greenhouse effect only bad?
- What are three types of greenhouse gases?
  Answers: Carbon dioxide, CO_2; methane, CH_4; and nitrous oxide, N_2O
- How do we know that the rise in temperature of the earth is caused by human activity?
  Answer: As the graph showed, there is a direct link between the rise of the earth's temperature and the amount of CO_2 in the atmosphere

Reading Deeper

Have students read Chapter 2 *WHY IS THE EARTH WARMING?* of the *WORLD ON FIRE* book on their own (10–15 minutes depending on reading level). Once everyone is finished reading, assign students to groups and give each member of the group the same reading worksheet to answer together. Worksheets include the following questions:

Group 1: Carbon Dioxide (CO_2)
Reading Worksheet Questions

1. According to Figure 3, what % of the greenhouse gas emission in 2004 was CO_2?
   Answer: 76.7%
2. What is the greatest source of carbon dioxide?
   Answer: People burning fossil fuels

Group 2: Methane (CH_4)
Reading Worksheet Questions

1. How many atoms does methane have?
   Answer: 5
2. What are the three sources of methane?
   Answer: Cows as they digest grasses, melting of permafrost, leakage from the mining process

Group 3: Hydrofluorocarbons (HFC's) and Chlorofluorocarbons (CFC's)
Reading Worksheet Questions

1. What are HFCs? What are CFC's
   Answer: Chemicals that are used in air conditioners and refrigerators
   Chemicals that remove ozone from the atmosphere
2. How much more potent is HFC than CO_2?
   Answer: 1,000 times more potent

Questions on all worksheets

3. Write an explanation of the greenhouse effect in your own words
4. How many atoms does a molecule have to have to trap infra red light and re-radiate it?
   Answer: 3
5. What does “carbon footprint” mean?
   Answer: The amount of emissions that contribute to global warming
6. Why do some countries have smaller carbon footprints than others?
   Answers: - Underdeveloped nations may not have electricity, cars, and no need of heating their homes
   - Countries nave non-fossil fuel based energy sources
   - Better public transportation systems that cut down on the amount of drivers using fossil fuels
7. Which two countries have the largest carbon footprints?
   Answer: The U.S. and China
8. What part of the world is experiencing global warming the most?
   Answer: The arctic, where sea ice is melting
9. Look at Figure 4, can you see a correlation between temperature and the amount of carbon dioxide in the air?

Group Share

Each group selects two representatives from their group to share their responses to the group's questions with the class. Each representative will read one of the answers aloud. Once each group has shared their responses, the teacher then leads a group discussion to answer each of the additional questions on the handout. As a closing activity, the teacher refers back to the opening film clip and asks how does this clip support or not support our ideas from today’s discussion?

READING DEEPER for WORLD ON FIRE - THE SCIENCE

Group 1: Carbon Dioxide (CO_2)

Read Chapter 2 of WORLD ON FIRE – THE SCIENCE and answer the following questions.

1. According to Figure 3, what % of the greenhouse gas emission in 2004 was CO_2?

2. What is the greatest source of carbon dioxide?

3. Write an explanation of the greenhouse effect in your own words

4. How many atoms does a molecule have to have to trap infra red light and re-radiate it?

5. What does "carbon footprint" mean?

6. Why do some countries have smaller carbon footprints than others?

7. Which two countries have the largest carbon footprints?

8. What part of the world is experiencing global warming the most?

9. Look at Figure 4, can you see a correlation between temperature and the amount of carbon dioxide in the air?

Record the Answers from the Other Groups

Group 2: Methane (CH_4)
1. How many atoms does methane have?

2. What are the three sources of methane?

Group 3: Hydrofluorocarbons (HFC's) and Chlorofluorocarbons (CFC's)
1. What are HFCs? What are CFC's?

2. How much more potent is HFC than CO_2?

READING DEEPER for WORLD ON FIRE - THE SCIENCE

Group 2: Methane (CH_4)

Read Chapter 2 of WORLD ON FIRE – THE SCIENCE and answer the following questions.

1. How many atoms does methane have?

2. What are the three sources of methane?

3. Write an explanation of the greenhouse effect in your own words

4. How many atoms does a molecule have to have to trap infra red light and re-radiate it?

5. What does “carbon footprint” mean?

6. Why do some countries have smaller carbon footprints than others?

7. Which two countries have the largest carbon footprints?

8. What part of the world is experiencing global warming the most?

9. Look at Figure 4, can you see a correlation between temperature and the amount of carbon dioxide in the air?

Record the Answers from the Other Groups

Group 1: Carbon Dioxide (CO_2)

1. What % of the greenhouse gas emission in 2004 was CO_2?

2. What is the greatest source of carbon dioxide?

Group 3: Hydrofluorocarbons (HFC's) and Chlorofluorocarbons (CFC's)

1. What are HFCs? What are CFC's?

2. How much more potent is HFC than CO_2?

READING DEEPER for WORLD ON FIRE - THE SCIENCE

Group 3: Hydrofluorocarbons (HFC's) and Chlorofluorocarbons (CFC's)

Read Chapter 2 of WORLD ON FIRE – THE SCIENCE and answer the following questions.

1. What are HFCs? What are CFC's?

2. How much more potent is HFC than CO_2?

3. Write an explanation of the greenhouse effect in your own words

4. How many atoms does a molecule have to have to trap infra red light and re-radiate it?

5. What does “carbon footprint” mean?

6. Why do some countries have smaller carbon footprints than others?

7. Which two countries have the largest carbon footprints?

8. What part of the world is experiencing global warming the most?

9. Look at Figure 4, can you see a correlation between temperature and the amount of carbon dioxide in the air?

Record the Answers from the Other Groups

Group 1: Carbon Dioxide (CO_2)

1. What % of the greenhouse gas emission in 2004 was CO_2?

2. What is the greatest source of carbon dioxide?

Group 2: Methane (CH_4)

1. How many atoms does methane have?

2. What are the three sources of methane?

ACTIVITY 3: DEFORESTATION & THE EFFECTS OF GLOBAL WARMING

Purpose

Students will be able to

- Discuss, in detail, the many effects of climate change
- Explain how deforestation contributes to global warming

Implementation Notes

This lesson clearly defines various effects of climate change in addition to presenting students with a clear understanding of the causes and effects of global warming. The lesson also introduces students to the concept of deforestation and how it contributes to global warming and why reforestation is important.

In the Classroom

Quick Write

Before reading the accompanying chapters, help students refresh their memories on effects of global warming that were discussed in previous lessons. Students are given a few minutes to write any of the effects they recall on their own piece of paper. This is a way to help students organize/access information from prior lessons or that they may have learned outside of the classroom. It's done silently and individually, with no questions/answers. This is not a test. Papers are not collected.

Quick Write Share

Lead students in a brief 5 minute discussion about the effects of climate change that they remember from previous lessons using their quick write assignment. Students can call out popcorn style, or go around the room sharing one item from his or her paper until the teacher is satisfied with the amount of answers. List their responses on the board. Tell students that they will be learning about these things in greater detail.

Reading Deeper

Have students read Chapters 3 *THE EFFECTS OF GLOBAL WARMING?* and Chapter 4 *DEFORESTATION AND REFORESTATION* of the *WORLD ON FIRE* book on their own (10–15 minutes depending on reading level). To help students organize the information while they are reading, have them answer the following questions on their own paper or complete the reading worksheet:

1. What is the main reason the oceans are rising?
   Answer: Mainly because land based ice is melting
2. Have students write their own explanation of thermal expansion.
3. What is acidification? What does it do to coral reefs?
   Answers: - When carbon dioxide dissolves into water, forming acid
   - Causes them to blanch (whiten) and die
4. Why is global warming causing flooding?
   Answer: As more water is evaporating from oceans, it is causing more rainfall worldwide
5. What is desertification? What causes this to happen?
   Answers: - When arable land becomes desert
   - Changing weather patterns caused by global warming
6. How do scientists think global warming will affect agricultural production?
   Answer: both flood and drought make farming impossible
7. What are the effects of global warming on storms? What about forest fires?
   Answers: - Hurricanes, tornadoes, cyclones, and other severe weather patterns become worse and more damaging
   - Forest fires have become much more extensive
8. What do you know about photosynthesis?
9. How do trees and other green plants use carbon dioxide?
   Answer: Green plants use sunlight to synthesize food from carbon dioxide and water
10. What do they put back into the atmosphere?
    Answer: Oxygen
11. How much of the world's carbon dioxide is absorbed by forests?
    Answer: 20–25%
12. Have students write their own explanation of deforestation and explain how it contributes to global warming.
13. What are 7 principal reasons for deforestation?
    Answers: Subsistence farming, large agribusiness farming, cattle raising, urban development, wood for heat and cooking, charcoal, and construction
14. List three harmful effects of deforestation.
    Answer: Soil erosion, desertification, and loss of biodiversity

Share Out

Discuss the chapters as a group by asking students to share their answers to each question they answered on their own while reading. Make sure that all students are participating equally to the group discussion.

Continue to next page for Research Project

Research Project

To encourage students to learn more about these important ideas, have them each select one of the following research projects to complete. Depending on the length of classroom time and the teacher's preference, this portion of the lesson can be completed by students as an independent in-class exercise or as homework to be completed on their own.

1. Find five densely populated areas where people may be forced to move inland because of rising ocean levels. Which nations are most vulnerable? Which cities in the United States are the most vulnerable and why? Could New York be in danger?
2. Locate areas where coral reefs have undergone significant blanching due to acidification. Is there any way to bring these reefs back to normal? Why are coral reefs important? What are people doing to try to save coral reefs?
3. Explain what ocean current disruption is. Write an explanation of how global warming will, in fact, make some places on earth become colder. Are there places in particular that are more vulnerable than others?
4. Tropical diseases are moving northward. Have students select one of the following diseases to research: malaria, dengue, West Nile virus, Zika, or chikungunya. Explain what the symptoms are. Are there long-term effects? Where did the specific disease originate, and how did it move north? Can this be prevented in the future?
5. Research the history and effects of deforestation in one of the following places: Madagascar, Peru, Bolivia, Indonesia, Malaysia, Brazil, the Democratic Republic of Congo, or Colombia. Explain how has the deforestation process changed over time in these places? What are they doing to stop deforestation? What can be done to reverse some of the harmful effects of deforestation?

READING DEEPER for WORLD ON FIRE - THE SCIENCE

Chapters 3 & 4: Deforestation & The Effects Of Global Warming

Read Chapters 3 & 4 of WORLD ON FIRE – THE SCIENCE and answer the following questions.

1. What is the main reason the oceans are rising?

2. Have students write their own explanation of thermal expansion.

3. What is acidification? What does it do to coral reefs?

4. Why is global warming causing flooding?

5. What is desertification? What causes this to happen?

6. How do scientists think global warming will affect agricultural production?

7. What are the effects of global warming on storms? What about forest fires?

8. What do you know about photosynthesis?

9. How do trees and other green plants use carbon dioxide?

10. What do they put back into the atmosphere?

11. How much of the world's carbon dioxide is absorbed by forests?

12. Have students write their own explanation of deforestation and explain how it contributes to global warming.

13. What are 7 principal reasons for deforestation?

14. List three harmful effects of deforestation.

ACTIVITY 4: HOW WE USE ENERGY & WHERE IT COMES FROM

Purpose

Students will be able to

- Evaluate how individuals contribute to global warming
- List types of nonpolluting sources of energy
- Build critical thinking skills to start to consider what they can do to slow climate change

Implementation Notes

This lesson is interesting because students will start to understand that the things they do everyday contribute to global warming. These activities are designed to get students thinking about small changes that they can make to help slow climate change.

In the Classroom

Reading Deeper

Have students read Chapter 5 *HOW WE USE ENERGY* of the *WORLD ON FIRE* book on their own (5–10 minutes depending on reading level). Once everyone is finished reading, complete the following activity as a group

Group Exercise

Lead a discussion about the main points of this chapter. Have students look at Figure 10 in the text. Ask students what is the greatest cause of carbon emissions and what is the least? Discuss how much of the average American's carbon emissions come from home heating and cooling. As a group, lead students in creating a chart on the board of the energy used in all the processes required for us to have food. This should include:

- Energy used in the farming process
  Farm machinery, tractors, harvesters, pumps for irrigation and spraying water, airplane fuel for spreading insecticide
- Transporting food to grocery stores and markets
  Fuel for trucks or airplanes
- Energy used at grocery stores and markets
  Refrigerators and freezers, watering systems, lights in markets, cash registers
- Energy used by consumers related to food
  Bringing food to consumers' homes, home refrigerators, appliances to cook food like ovens, stoves, and microwaves, dishwashers to clean up after meals

Once you have created the chart as a group, ask students to estimate what percentage of the total energy is used by each step in the process. Which do they think uses the most? The least? Have students propose ways to reduce the energy required.

Group Reading

Have students take turns reading Chapter 6 *WHERE OUR ENERGY COMES FROM* of the *WORLD ON FIRE* book aloud (5 minutes depending on reading level).

Group Exercise

Once you are finished with the reading, complete the following activity as a group. Have students look at Figure 11. Discuss the three main sources of U.S. energy consumption in 2017. Have students name some nonpolluting sources of energy and how much of our total energy comes from them. Ask students if they are familiar with any of these nonpolluting sources of energy, and have them give specific answers. List their responses on the board. Have a short discussion and tell them that they will be learning about these things in greater detail in lessons to come.

ACTIVITY 5: HOW ELECTRICITY IS MADE

Purpose

Students will be able to

- Explain the basic principle of how electricity is generated

Implementation Notes

It is likely that many students do not know how electricity is made and that they may find this a complex process to understand. In this lesson, students will be able to explore this concept in several ways, through film, reading, and group discussion.

In the Classroom

Film Clip

Have students watch Part 3 of the *WORLD ON FIRE - THE SCIENCE* film (2 minutes [10:05–12:15]). Once finished with the film, discuss the following questions as a group

- Have you heard of Michael Faraday?
  Explain that he was an important English scientist who had little formal education, but his contributions to the study of electro magnetism and electrochemistry make him one of the most influential scientists in history
- What is inside a generator?
  Answer: A coil of wires
- What goes outside of the coil of wires?
  Answer: Magnates
- What do you think heats the steam that pushes the wire through the magnets in the generator? Write their answers on the board to come back to later
  Answer: Different types of fuels: coal, oil, gas, etc.

Reading Deeper

Have students read Chapter 7 *HOW ELECTRICITY IS MADE* of the *WORLD ON FIRE* book on their own (2–5 minutes depending on reading level). Once everyone is finished reading, complete the following activity as a group

- Ask students again, what do you think pushes the wire through the magnets in the generator and reference the list you made before
- Ask students which method of producing electricity does not involve passing a wire through a magnetic field
  Answer: Solar panels

Reinforcing the Concept

Have students fill out the worksheet by completing the diagram of the generator. Since some students may be apprehensive about asking questions in front of the group, the worksheet also includes a section where students write three questions they still have about how electricity is made.

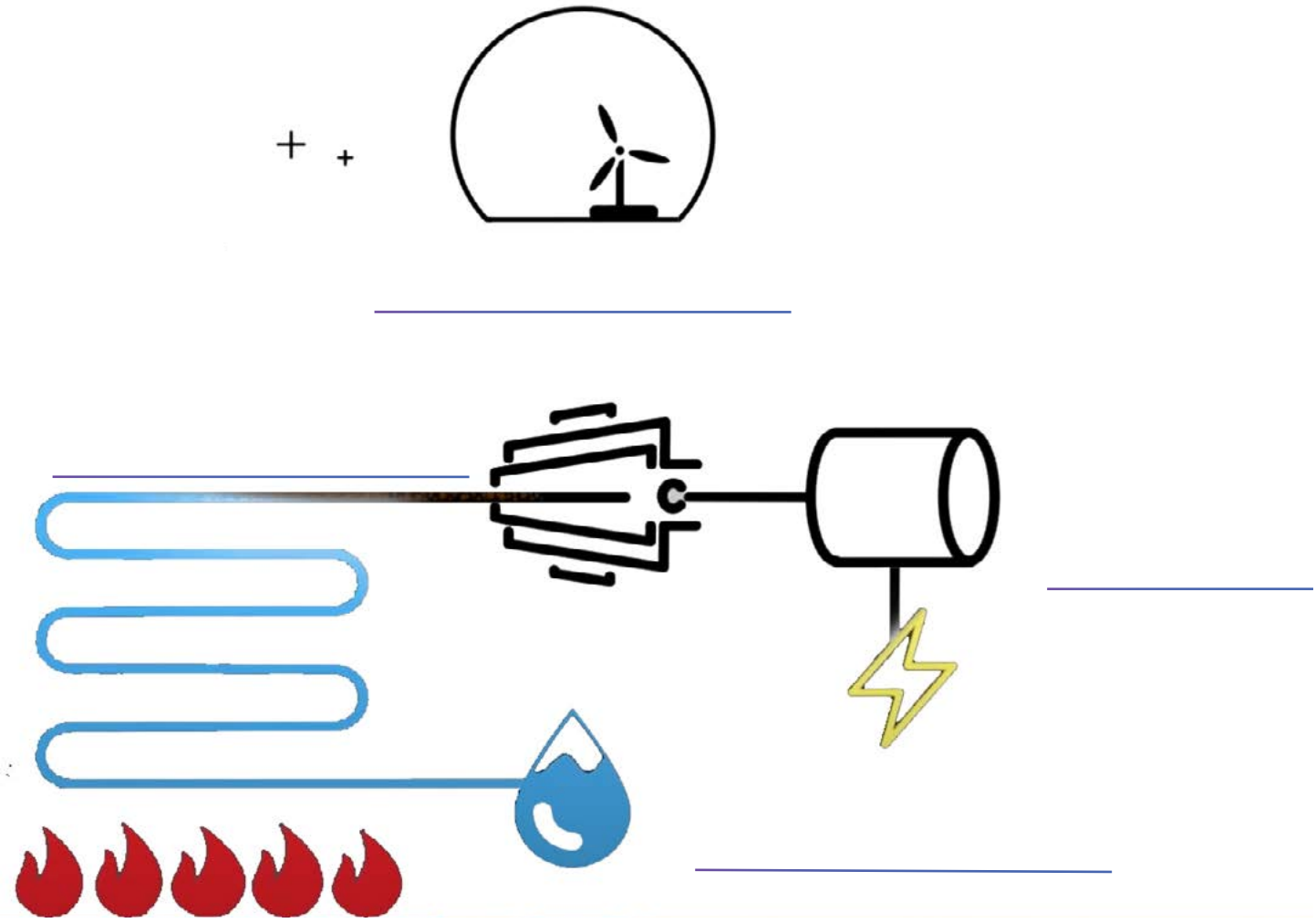
Research Project

To encourage students to learn more about how electricity is made, have them complete the following research project. Depending on the length of classroom time and the teacher's preference, this portion of the lesson can be completed by students as an independent in-class exercise or as homework to be completed on their own. Have students research Faraday's theories about the production of electricity. What exactly is a turbine? It may also be interesting to ask students to find research Faraday's work in chemistry as well.

READING DEEPER for WORLD ON FIRE - THE SCIENCE

Chapters 7: How Electricity is Made

Complete the diagram of a generator by filling in each blank to describe what is happening in the step of the process.



Write three questions you still have about how electricity is made

1.

2.

3.

ACTIVITY 6: FOSSIL FUELS

Coal, Petroleum, and Natural Gas

Purpose

Students will be able to

- Identify types of fossil fuels and how they are collected

Implementation Notes

There is a lot of information in this lesson. Depending on the length of classroom time and the teacher's preference, this lesson can be broken into multiple parts.

In the Classroom

Film Clip

Have students watch Part 4 of the *WORLD ON FIRE - THE SCIENCE* film (9 minutes [12:16–21:49]). Once finished with the film, discuss the following questions as a group

- Where are fossil fuels found and what are they from?
  Answer: Underground
  Plants that lived between 300–350 million years ago (the Carbonaceous Period)
- What are the three kinds of fossil fuels?
  Answers: Coal, Oil, Natural Gas
- Why are each of these fossil fuels bad?

Write the many answers on the board so students can see what has already been listed

Reading Deeper

Have students read Chapter 8–11 of the *WORLD ON FIRE* book on their own (15–20 minutes depending on reading level) while completing the worksheet to help them organize the information in these chapters for future discussion. Worksheet questions:

1. In your own words, write a detailed explanation of how fossil fuels are formed. Will fossil fuels last forever? Why or why not?
2. Before we used fossil fuels to create energy, why didn't burning wood increase the amount of carbon dioxide in the air?
   Answer: The carbon dioxide released into the air by burning wood was pulled from the air by photosynthesis in to the plants and trees
3. Why is coal the most polluting source of energy? Give a thorough explanation.
4. What effect does sulfur dioxide have on the environment?
   Answer: It creates acid rain which kills fish
5. What poisonous heavy metal is contained in coal?
   Answer: Mercury
6. What are the effects of burning coal on people's health?
   Answer: Causes lung disease
7. How does China rationalize its heavy use of coal?
   Answer: That the use of coal is necessary because China is an underdeveloped country that needs coal power to catch up to more developed countries
8. How was petroleum formed?
   Answer: Formed when large quantities of dead zooplankton and algae are buried underneath sedimentary rock and subjected to intense heat and pressure for millions of years.
9. What is sedimentary rock?
   Answer: Rock formed from rocks that washed off mountains by wind and rain over millions of years
10. What are 4 components of petroleum?
    Answer: Gasoline, kerosene, asphalt, and tar
11. Beyond methane, what else does natural gas also contain?
    Answers: ethane, propane, butane, pentane
12. What is shale?
    Answer: A type of rock that contains natural gas
13. In your own words, explain fracking. What are its advantages and disadvantages? Do you think the advantages outweigh the disadvantages or vice versa?

Research Project

To encourage students to learn more about fossil fuels, have them complete the following research project. Depending on the length of classroom time and the teacher's preference, this portion of the lesson can be completed by students as an independent in-class exercise or as homework to be completed on their own. Have students do some research on how an internal combustion engine (in cars and trucks) works. Ask them to write an explanation in their own words and to include a diagram. What are the components of the exhaust from an internal combustion engine? Have them list them and tell their effects on the environment and on people's health.

READING DEEPER for WORLD ON FIRE - THE SCIENCE

Chapters 8–11: Fossil Fuels

Read Chapters 8–11 of WORLD ON FIRE – THE SCIENCE and answer the following questions.

1. In your own words, write a detailed explanation of how fossil fuels are formed. Will fossil fuels last forever? Why or why not?

2. Before we used fossil fuels to create energy, why didn't burning wood increase the amount of carbon dioxide in the air?

3. Why is coal the most polluting source of energy? Give a thorough explanation.

4. What effect does sulfur dioxide have on the environment?

5. What poisonous heavy metal is contained in coal?

6. What are the effects of burning coal on people's health?

7. How does China rationalize its heavy use of coal?

8. How was petroleum formed?

9. What is sedimentary rock?

10. What are 4 components of petroleum?

11. Beyond methane, what else does natural gas also contain?

12. What is shale?

13. In your own words, explain fracking. What are its advantages and disadvantages? Do you think the advantages outweigh the disadvantages or vice versa?

ACTIVITY 7: SAVING ENERGY

Everyone can make a difference

Purpose

Students will be able to

- Identify changes they can make to conserve energy and slow global warming
- Understand larger changes that can be made to slow global warming

Implementation Notes

This lesson is a good way to help students realize that they can make a difference in the campaign against global warming. Though teachers will lead the group activities, it is important to let students think of the ways that they can conserve energy on their own.

In the Classroom

Charting Changes

Teachers display Figure 18 on the board, or distribute individual handouts depending on classroom resources and educator preference, so that students can see the diagram. As a class, ask students to select ten things from the chart that they can do right now to save energy and reduce global warming. Write the ten choices on the board so that everyone can see the selections that the class chose. Break students into smaller groups and ask them to work together to rate the selections from 1, the most effective thing they can do to save energy, to 10 the least effective change they can make to save energy. Have students develop thoughtful answers.

Share Out

Have students from each group share their answers with the class. Make sure that all students are participating equally to the group discussion.

Reading Deeper

Now that students have reflected on things that they can do to slow global warming, have them read Chapter 12 *SAVING ENERGY* of the *WORLD ON FIRE* book on their own (5–10 minutes depending on reading level). This will help students understand larger changes that can be made by society as a whole. Using the list that you created on the board before the reading assignment as reference, have students elaborate on their earlier ideas by discussing what they found most surprising in the reading and ask if there is anything they think should be added to their list.

Reinforcing the Concept

Have students continue thinking about what they can do to conserve energy and slow global warming. Depending on the length of classroom time and the teacher's preference, this portion of the lesson can be completed by students as an independent in-class exercise or as homework to be completed on their own. Have students write answers to the following questions

1. One way to save energy is to consume fewer goods. What are five consumer goods that you could easily live without and why?
2. List three more ways that you could save energy that were not mentioned in class. Why are these important and how do they save energy?

ACTIVITY 8: ALTERNATIVE SOURCES OF ENERGY

Purpose

Students will be able to

- Identify types of alternative sources of energy
- Understand the pros and cons of each type of renewable energy
- Explain how energy is stored on a small and large scale

Implementation Notes

There is a lot of information in this lesson. Depending on the length of classroom time and the teacher's preference, this lesson can be broken into multiple parts as needed.

In the Classroom

Film Clip

Have students watch Part 5 and 6 of the *WORLD ON FIRE - THE SCIENCE* film (22 minutes [21:50–43:27]). To help students organize the information while they are watching the film, have them complete the video organizer worksheet with the following questions:

1. What is a solar panel made from?
   Answer: Silicon
2. What is the downside to solar panels?
   Answers: - They only work when there is sunlight
   - They take up farmland
3. How much does the power produced by solar panels cost?
   Answer: Free
4. How long has wind been used to power things?
   Answer: Since ancient times
5. What turns the rotor in a wind turbine?
   Answer: the Turbines
6. What is the downside to wind energy?
   Answers: - Turbines only work when there is wind
   - Turbines are noisy and can't be near homes
7. What is the source of nuclear reactors?
   Answer: Uranium and other elements found in the earth
8. What is the downside of nuclear power?
   Answers: - It is very controversial
   - Can be very dangerous
   - Radioactive material can be leaked into the environment and kill people
   - Fear it can be stolen by terrorists and made into a weapon
   - Waste materials are radioactive
9. How much of the energy in the Unites States if produced by nuclear power?
   Answer: 20%
10. What is hydroelectricity?
    11. Answer: Electricity from the movement of water moving downhill
12. What is the downside of hydroelectricity?
    Answer: Dams and reservoirs disrupt fish and displace people
13. How many places are left to build large dams in the United States?
    Answer: None
14. What is biomass?
    Answer: Plant material that grew recently or is still growing and is used to create ethanol
15. What does ethanol come from in the United States?
    Answer: Corn
16. Why is biomass environmentally beneficial?
    Answer: Because the plants used in the burning process absorb the same amount of carbon dioxide while growing
17. Other than corn, what plants can be used in biomass?
    Answer: Kelp and algae
18. What is geothermal energy?
    Answer: Energy that comes from under the ground
19. Where can the heat for geothermal energy be captured?
    Answer: Near the borders of tech-tonic plates California, Philippines, Iceland
20. Where are two tidal power stations?
    Answer: France and South Korea
21. How do we store energy?
    Answer: Batteries and the use of reservoirs

Once finished with the film, discuss the following questions as a group.

- Which form of renewable energy do you find most appealing? Why?
- Which form of renewal energy do you find the most unappealing? Why?
- Do you think there is a type of renewable energy that would be best for New York City to use? Why?
- In your own words, why do you think these types of energy are better than fossil fuels?

Reading Deeper

Now that students have had an introduction to types of renewable energy, explain that they are going to read Chapters 13–19 of the *WORLD ON FIRE* book on their own (5–10 minutes depending on reading level). They will answer questions on the worksheet to help them organize their thoughts while they are reading. Answer the following worksheet questions in your own words:

1. How do solar panels work and what is concentrated solar power?
2. How do wind turbines work?
3. How is nuclear power is generated?
4. How does a hydroelectric dam work?
5. What is biomass and how does using biomass as an energy source combat global warming?
6. What is geothermal energy?
7. What are the different ways in which geothermal energy is obtained?
8. Where does the power to make electricity from the movement of the tides come from?
9. How tidal power work?

Continue to next page for Individual Projects

Individual Projects
Once they are finished with the reading, explain that students will each make a table, independently, about the advantages and disadvantages of the alternative sources of energy mentioned in this lesson. Write the types of energy on the board for students to reference. They are: solar panels and concentrated solar power, wind turbines, nuclear energy, hydroelectric power, biomass, geothermal power, and tidal power.

Explain that students will need to give their table a title; make four columns labeled energy source, advantages, disadvantages, and my rating. They will make a separate row for each energy source to tell the advantages and disadvantages of each and rate each from 1-5 based on their assessment of how effective it is (5 being the most effective and 1 being the least effective).

Encourage students to re-read any of the information (including the statistics) in chapters 13-19 carefully so that you can make an informed decision. Be very clear and complete. There may be several advantages or disadvantages for each energy source. Discuss results as a class. Why do you think these forms of energy are called renewable sources of energy? What are nonrenewable sources of energy?

Group Reading
Have students take turns reading Chapter 20 *STORING ELECTRICITY* of the *WORLD ON FIRE* book aloud (5 minutes depending on reading level). Once you are finished with the reading, lead a class discussion about the following questions

- How is electricity stored on a small scale?
  Answer: Rechargeable batteries
- How is electricity stored on a large scale?
  Answer: Pumping water from lower levels into a reservoir at a higher location until energy is needed, at which time water is let out of the reservoir

WORLD ON FIRE - THE SCIENCE

Watch Part 5 and 6 of the *WORLD ON FIRE - THE SCIENCE* film and answer the following questions:

1. What is a solar panel made from?
2. What is the downside to solar panels?
3. How much does the power produced by solar panels cost?
4. How long has wind been used to power things?
5. What turns the rotor in a wind turbine?
6. What is the downside to wind energy?
7. What is the source of nuclear reactors?
8. What is the downside of nuclear power?
9. How much of the energy in the Unites States if produced by nuclear power?
10. What is hydroelectricity?
11. What is the downside of hydroelectricity?
12. How many places are left to build large dams in the United States?
13. What is biomass?
14. What does ethanol come from in the United States?
15. Why is biomass environmentally beneficial?
16. Other than corn, what plants can be used in biomass?
17. What is geothermal energy?
18. Where can the heat for geothermal energy be captured?
19. Where are two tidal power stations?
20. How do we store energy?

READING DEEPER for WORLD ON FIRE - THE SCIENCE

Read chapters 13–19 of the *WORLD ON FIRE - THE SCIENCE* film and answer the following questions:

1. How do solar panels work and what is concentrated solar power?

2. How do wind turbines work?

3. How is nuclear power is generated?

4. How does a hydroelectric dam work?

5. What is biomass and how does using biomass as an energy source combat global warming?

6. What is geothermal energy?

7. What are the different ways in which geothermal energy is obtained?

8. Where does the power to make electricity from the movement of the tides come from?

9. How tidal power work?

ACTIVITY 9: ORGANIZATIONS THAT MAKE A DIFFERENCE

Purpose

Students will be able to

- Identify organizations that can make a difference in global warming
- Explore career paths involved in the fight against global warming

Implementation Notes

This activity exposes student to possible career opportunities that help lead the campaign against global warming.

In the Classroom

Reading Deeper

Have students read Chapters 21 and 22 of the *WORLD ON FIRE* book on their own (10–15 minutes depending on reading level). Once everyone is finished reading, answer the following areas as a group

- There are many proposals for changing the climate of the earth through geoengineering. Discuss each one, and ask students if they think it is realistic. Why or why not? Have them vote on the feasibility of each proposal and keep track of their responses on the board. What are the results of their voting?
- Ask students which jobs and organizations sound interesting to them. Have them explain why those are the most interesting.

Culminating Project

Tell students: Make a series of posters about the problems of global warming or the solutions to these problems and post them around your school. Be a graphic designer: Be sure to use illustrations, and pay attention to the relationship of the illustrations to the text. You want your poster to have a strong impact. (Teachers can make this a contest.)

Discuss with students why people would refuse to believe that global warming and climate change are true despite all the scientific information to the contrary, or ask them to research and write about it, with specific examples of climate change deniers and their reasoning.

Tell students: You can write to your senator or Congressperson to suggest legislation to combat global warming. Go online and find out how to do so. Then write a letter to him or her including a clear explanation of the problem. Offer concrete solutions that can be made into laws. (Teachers can use this activity as a lesson in persuasive writing even if the letters are not sent. Discuss the nature of persuasive writing first.)