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Name: _____

Date: ____ / ____ / ____ Class Hour: ____

Energy Bill, Part 2: The Real Cost of Energy

Student Lesson & Response Guide

Congratulations! You now know how a residential consumer is billed for their energy each month. You are also beginning to understand how much that energy costs. Now it's time to use information from an energy bill to look at costs that go far beyond dollars. Although you have only a little experience with energy bills, you'll never look at one the same way again!

To perform this activity, you'll access and use the **United States Environmental Protection Agency (EPA) Power Profiler** website. At this website, you'll learn about all of the energy resource fuels used to produce electricity in the United States. Each of these fuels is considered a primary energy resource.

- **Primary Energy Resource:** An energy resource in its original form, before it has been used or converted to another form.

In this context then, how should electricity be classified? Many people make the mistake of thinking about electricity the same way they think about energy resources like wind or coal. Instead, electricity is considered a secondary energy resource.

- **Secondary Energy Resource:** An energy resource that has been converted from a primary energy resource into another form.

Secondary energy resources cannot be extracted or harvested directly from Earth. They are always converted into a secondary form. Some examples are electricity, gasoline, and heat.

You'll be asked to classify each primary energy resource as either *renewable* or *nonrenewable* at the **EPA Power Profiler** website. Use the following definitions, and your own knowledge and research to classify them.

Materials:

Internet accessible digital device

Calculator

- **Renewable energy resources:** Energy resources that are replaced by natural processes at a rate comparable to their use.
- **Nonrenewable energy resources:** Energy resources that are limited and can eventually run out. These sources of energy cannot be replaced by natural processes on a time span of human significance.

Procedure:

Read, then follow the numbered instructions.

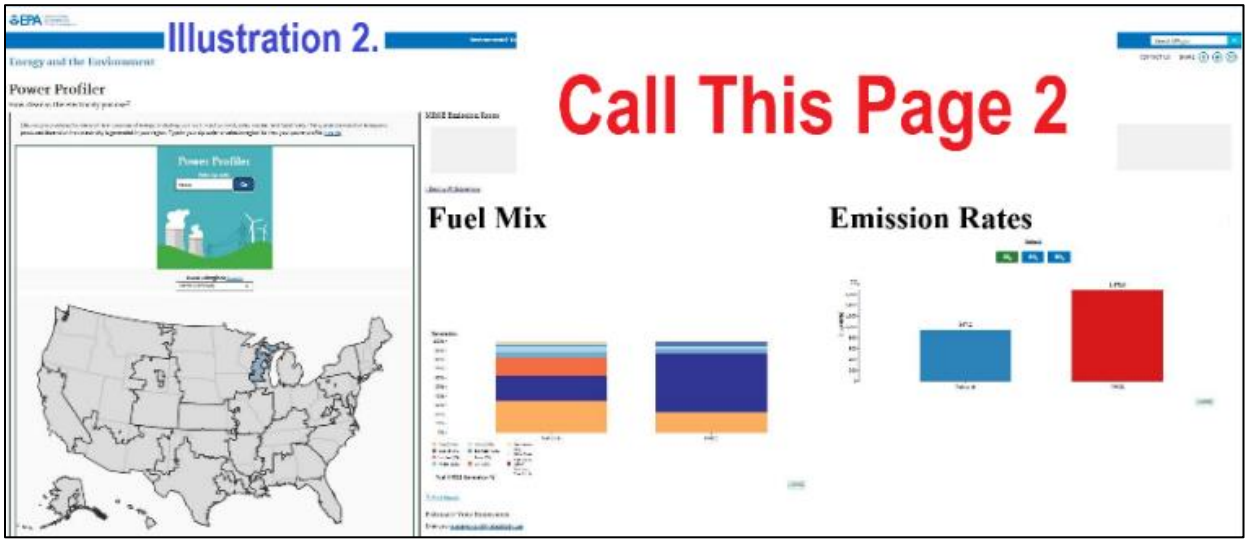
Electricity Production: Resources and Emissions

1. Navigate to the United States Environmental Protection Agency (EPA) Power Profiler website:

https://www.epa.gov/energy/power-profiler#/

2. You'll arrive at what we'll call **Page 1** of the website (see **Illustration 1.**). In a short time, you'll come back to use the Fuel Mix and Emission Rates graphs you see on this page. For now, enter your zip code where indicated on **Page 1**. Entering your zip code will take you to **Page 2.** It displays the two graphs you see in **Illustration 20**.

3. On the Fuel Mix graphs of **Page 2**, you'll be able to see how electricity is generated in your specific **eGRID** (emissions and Generation Resource Integrated Database) **subregion**. Take a moment to look over the Fuel Mix graphs and explore their interactive features.



4. Begin completing **Table 1**, below. Label each Fuel as either Renewable **[R]** (in green) or Nonrenewable **[NR]** (in black) in column two of **Table 1**. Check your labels for accuracy with your teacher before continuing.

5. Use the Fuel Mix graphs on **Page 2** to complete columns three and four of

Table 1. When finished, you'll be able to easily compare the resource fuel mix % used to generate electricity in your specific eGRID subregion to national fuel mix % averages.

Table 1.

Resource Fuel:	Renewable **[R]** or Nonrenewable **[NR]**	My eGRID Subregion Average %:	National Average %:
Biomass	*	*	*
Coal	*	*	*
Gas (Natural Gas)	*	*	*
Geothermal	*	*	*

Resource Fuel:	Renewable **[R]** or Nonrenewable **[NR]**	My eGRID Subregion Average %:	National Average %:
Hydroelectric	*	*	*
Nuclear	*	*	*
Oil	*	*	*
Other Fossil Fuel	*	*	*
Other Unknown	*	*	*
Solar	*	*	*
Wind	*	*	*

6. Click on ≪ Back to All Subregions on **Page 2**. This will return you to **Page 1**.

7. Take a few moments to explore the interactive features of the Fuel Mix graph displaying all US eGRID subregions.

8. Go through each fuel source shown in the Fuel Mix graph. Note any fuel source for which your eGRID subregion is in the top 5, or bottom 5 for generating electricity among all subregions. For any in the top 5, place this notation **[top 5]** (in red) next to the percent you listed for that primary fuel in **Table 1**. For any in the bottom 5, place this notation **[bottom 5]** (in red) next to the percent you listed for that primary fuel in **Table 1**.

9. Of course, using any combination of primary fuel sources to generate your electricity results in waste gases being released to the air. Three of these waste gases are especially significant, commonly measured, and recorded. They are:

- CO_2, carbon dioxide
- SO_2, sulfur dioxide
- NO_X, nitrogen oxide

You will review these next.

10. Return to **Page 2**.

11. Take a few moments to explore the interactive features of the Emission Rates graphs. Use the Emission Rates graphs on **Page 2** to complete **Table 2**. However, before posting your figures make the following change:

Convert numbers in the Emission Rates bar graph given in lbs./MWH to lbs./KWH. To do this, simply divide lbs./MWH by 1000 before posting into

Table 2. All values you post to the table will then be in units of lbs./KWH.

You may recall that you buy electricity in units of KWH on your energy bill. When

Table 2 is complete, you'll be able to easily compare the CO_2, SO_2, and NO_X emission rates in your eGRID subregion to national emission rate % averages.

Table 2.

Waste gas emission:	My eGRID Subregion Average lbs./KWH:	National Average lbs./KWH:
CO_2	*	*
SO_2	*	*
NO_X	*	*

12. Click on ≪ Back to All Subregions. This will return you to **Page 1**.

13. Take a few moments to explore the interactive features of the Emission Rates graph displaying all US eGRID subregions.

14. Review each waste gas emission. Note any emission for which your eGRID subregion is in the top 5, or bottom 5 for generating electricity among all subregions. For any in the top 5, place this notation **[top 5]** (in red) next to the percent you listed for that emission in **Table 2**. For any in the bottom 5, place this notation **[bottom 5]** (in red) next to the percent you listed for that emission in **Table 2**.

In the next part of the lesson, you'll quantify and personalize the resources needed and emissions required to deliver energy to a home in your area.

Annual Energy Use: Resources and Emissions

Naturally, a typical family will use different amounts of electricity (KWH) and natural gas (Therms) during different times of the year. Shown below in **Table 3** is the energy use profile of a typical family from this area.

15. Total up the KWH of electricity used for the year in **Table 3**. Post your total at the bottom of the table. Do the same for Therms of natural gas used. Double check your totals before moving ahead!

Table 3.

Month:	KHW used:	Therms Used:
January	700	160
February	750	155
March	800	140
April	850	75
May	1000	50
June	1060	30
July	1120	25
August	1160	30
September	1050	50
October	900	60
November	850	150
December	800	155
This Year	*** Answer**	*** Answer**

16. Next, your teacher will provide you with current information from the US EPA Greenhouse Gas Equivalency Calculator. Copy the values for Lbs. of CO_2 Equivalent and Lbs. of Coal Burned for both 1 KWH of electricity and 1 Therm of natural gas into **Table 4**. Your teacher will probably spend time explaining what these values mean. Their definitions are found just below **Table 4**.

Table 4.

Quantity of Energy	Lbs. CO_2 Equivalent*	Lbs. Coal Burned**
1 KWH	*	*
1 Therm	*	*

***Pounds of Carbon Dioxide Equivalent** defines the mass of CO_2 that would have the same warming potential as a given *mixture* of emissions for the consumer use of a stated quantity of energy.

****Pounds of Coal Burned** is the average mass of coal—and only coal—that would have to be burned to produce some stated quantity of energy.

17. Perform the calculations necessary to answer the following key questions.

Your teacher will probably demonstrate how to perform some of the calculations, explaining unit labels and show-your-work requirements.

17a. ***How many pounds of coal would have to be burned to produce the total KWH of energy used by the family this year? ****

[Show math work as required. Provide answer with correct unit label.]

$$* \quad \frac{\text{~~KWH~~}}{1} \quad X \quad * \quad \frac{\text{lbs. Coal}}{1 \text{ ~~KWH~~}} \quad =$$

*** Lbs. Coal Burned**

17b. ***How many pounds of coal would have to be burned to produce the total Therms of energy used by the family this year? ****

[Show math work as required. Provide answer with correct unit label.]

$$* \quad \frac{\text{~~Therms~~}}{1} \quad X$$

18. Perform the calculations necessary to answer these key questions.

18a. ***How many pounds of CO_2 emissions would have to be released to the air to produce the total KWH of energy used by the family this year? ****

[Show math work as required. Provide answer with correct unit label.]

* ~~KWH~~ / 1 **X** * Lbs. CO_2 / 1 ~~KWH~~ **=**

* **Lbs. CO_2 Equivalent**

18b. ***How many pounds of CO_2 emissions would have to be released to the air to produce the total Therms of energy used by the family this year? ****

[Show math work as required. Provide answer with correct unit label.]

*

*

19 & 20. Perform the calculations necessary to answer these key questions.

19. ***How many pounds of coal would have to be burned to provide the family with energy this year? ****

[Add 17a. to 17b.]

[Provide your answer with correct unit label.]

*

20. ***How many pounds of CO_2 emissions would have to be released to the air to provide the family with energy this year? ****

[Provide your answer with correct unit label.]

*

Lesson Summary Questions

1. Consider your answers for numbers 19 and 20 in the procedure. Why are renewable energy resources considered to be “clean energy” technologies?

*

2. Which renewable energy technology do you believe, has the greatest potential to increase in your area in the next 5-10 years? A little research may be required to write a good answer. A good answer will also require you to organize your writing.

*

3. Natural gas may be burned and used directly in a home for space heating. Natural gas is also used to make electricity. In this way it can also be used indirectly for space heating with an electric heater. Use what you learned on page one of this lesson to answer the following question.

Fundamentally, what is the difference between natural gas used directly for space heating, and natural gas used indirectly for space heating with an electric heater?

You must use the phrases *primary energy resource* and *secondary energy resource* in your answer to question 3.

*

4a. List all of the primary sources of energy employed to produce the electricity you use:

*

4b. Which primary source were you most surprised to find produces electricity for your area?

*

4c. Explain why it was a surprise to you.

*

5a. Enter primary resources in the top 5 and bottom 5 for your eGRID in **Table A**.

Table A.

Resource fuel from my eGRID Subregion in the *top 5* nationally for generating electricity	Resource fuel from my eGRID Subregion in the *bottom 5* nationally for generating electricity
*	*
*	*
*	*

5b. Describe something meaningful and significant where you live for each of the resources listed in your eGRID top 5 or bottom 5. A little research may be required to write a good answer. A good answer will also require you to organize your writing.

*

6. Briefly describe why each of these waste gases is considered significant enough that their release is measured and recorded. A little research may be required to write a good answer. Good answers will also require you to organize your writing.

6a. CO_2, carbon dioxide:

*

6b. SO_2, sulfur dioxide:

*

6c. NO_X, nitrogen oxide:

*

7a. Enter the waste gases released to the atmosphere you found were in the top 5 and bottom 5 for your eGRID in **Table B**.

Table B.

Waste gases from my eGRID Subregion in the *top 5* nationally for generating electricity	Waste gases from my eGRID Subregion in the *bottom 5* nationally for generating electricity
*	*
*	*

7b. Describe something meaningful and significant for where you live for each of the waste gases in your eGRID top 5 or bottom 5. A good answer will require you to organize your writing.

*

8. Without too much trouble, you can probably come up with several actions that will save energy for most families. Describe five actions that can save meaningful amounts of energy on a family's energy bill.

8-1. *

8-2. *

8-3. *

8-4. *

8-5. *

9. When you save energy, what else are you saving at the same time?

*

10 & 11. Consider your calculations for numbers 19 and 20 in the procedure. For number 19, you calculated the pounds of coal burned to provide the family with energy this year.** For number 20, you calculated the pounds of CO2 emissions released to the air to provide the family with energy this year.*

But then, this family put your energy savings ideas from question 6 into practice! Doing so, saved them 10% of the energy they had been using.

10a. Using this information, calculate the new total pounds of coal burned to provide the family with energy this year.

0.9 X * Lbs. Coal Burned =

*** Lbs. Coal Burned**

10b. Using this information, calculate the pounds of Coal that were never burned because of the 10% energy savings.

0.1 X * Lbs. Coal Burned =

*** Lbs. Coal Saved**

11b. Using this information, calculate the pounds of CO2 emissions that were never released to the air because of the 10% energy savings.

0.1 X * Lbs. CO_2 Emissions =

*** Lbs. CO_2 Saved**

11c. Using this information, calculate the new total pounds of CO2 emissions released to the air to provide the family with energy this year.

0.9 X * Lbs. CO_2 Emissions =

*** Lbs. CO_2 Released**

12. Look at your answer to question 9 again. Make sure your answer to that question is complete based upon your answers to questions 10 and 11.

*

13. Describe the most important idea, concept, principle, or fact you learned while completing this lesson. Explain why it is important for you (and probably other people) to know and understand.

*