To our teachers:

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Name: *_____

Date: *____ / ____ / ____ Class Hour: *____

Wisconsin Public Service
SolarWise for Schools
and the
Center for Renewable Energy
Advanced Technological Education

Energy Bill, Part 2: The Real Cost of Energy

Student Lesson

Congratulations! In **Energy Bill, Part 1: The Cost of Energy** you learned how a residential consumer is billed for their energy each month. You're also beginning to understand how much that energy costs.

Now in this three part lesson, you'll use information from an energy bill to look at costs that go far beyond dollars. You'll survey the resources that provide energy for your everyday life. You'll examine the air pollution that unavoidably happens with your use of those resources. Along the way you'll apply terminology that will help you better understand and discuss important energy issues. You'll also come up with actions that conserve energy and come to appreciate their potential effects.

Although you have little experience studying energy, you'll never look at your energy use or an energy bill the same way again!

To begin this activity, you'll access and use the **United States Environmental Protection Agency (EPA) Power Profiler** website. At this website, you'll learn about each of the energy resource fuels used to produce electricity in the United States. All of these fuels are considered primary energy resources.

It's for just this reason that it's important for you to understand the difference between a Primary Energy Resource and a Secondary Energy Resource before going further.

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

For example, petroleum (oil) is a primary energy resource. So is natural gas. But how about electricity?

Many people make the mistake of thinking about electricity the same way they think about primary energy resources like coal, nuclear, or wind. Electricity cannot be a primary energy resource. Electricity is made by converting a primary energy resource into another form—the form we call electricity. So, how should we classify electricity? Electricity is 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 the Earth. They're always converted into a second, (secondary) form. Some examples of secondary energy resources are electricity, gasoline, and heat.

Before going further, it's also important for you to understand the difference between a renewable energy resource and a nonrenewable energy resources. You'll be asked to classify primary energy resources as either renewable or nonrenewable from the **EPA Power Profiler** website.

● **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.

Refer to these definitions to classify energy resources as renewable or nonrenewable when asked.

To start the lesson, you'll need the internet navigation nstructions from this document, the **Student Lesso** that follow.. You'll also need your **Student Resposne** Guide, a calculator, and an internet accessible digital device.

It's time to discover the **Real Cost of Energy**. Read and then carefully follow the numbered instructions that follow.

Part One: Electricity Production—Regional Resources and Emissions

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

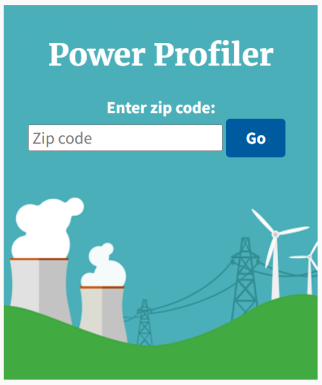
https://www.epa.gov/egrid/power-profiler#/

2. You'll arrive at what we'll call **Page 1** of the website (**Illustration 1.**).

Illustration 1.

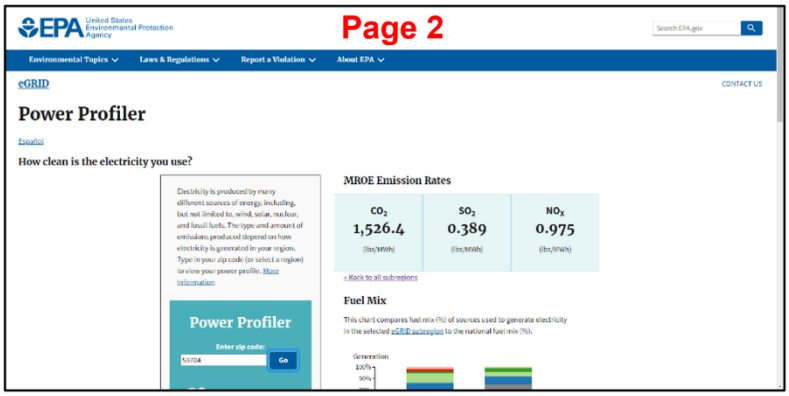
In a short time, you'll come back to use the Fuel Mix and Emission Rates graphs you see on this page. For now, enter your zip code where indicated on **Page 1 (Illustration 2.)**

Illustration 2.



Entering your zip code will take you to **Page 2 (Illustration 3.).**

Illustration 3.



It displays the **Fuel Mix** and **Emission Rates** graphs you see next in **Illustration 4**. and **Illustration 5.**

Illustration 4.

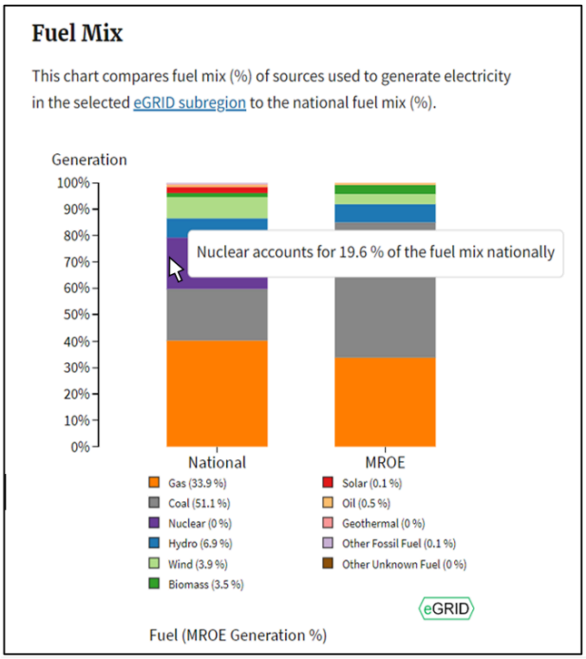
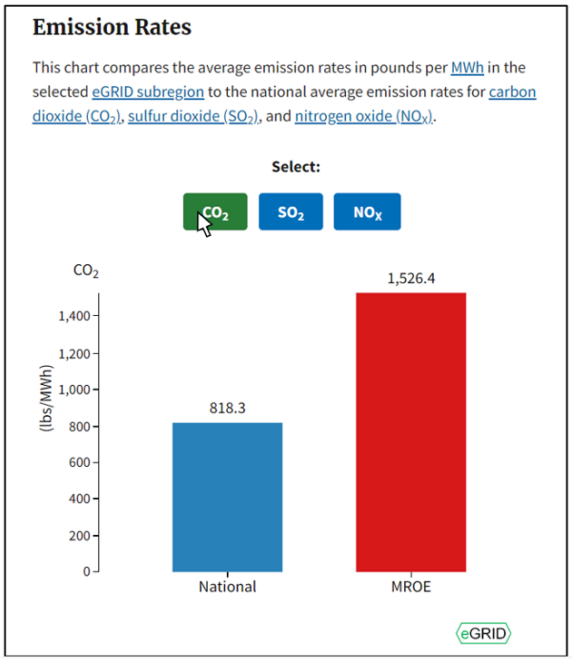


Illustration 5.



3. On the **Fuel Mix** graphs of **Page 2 (Illustration 4.)**, 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.

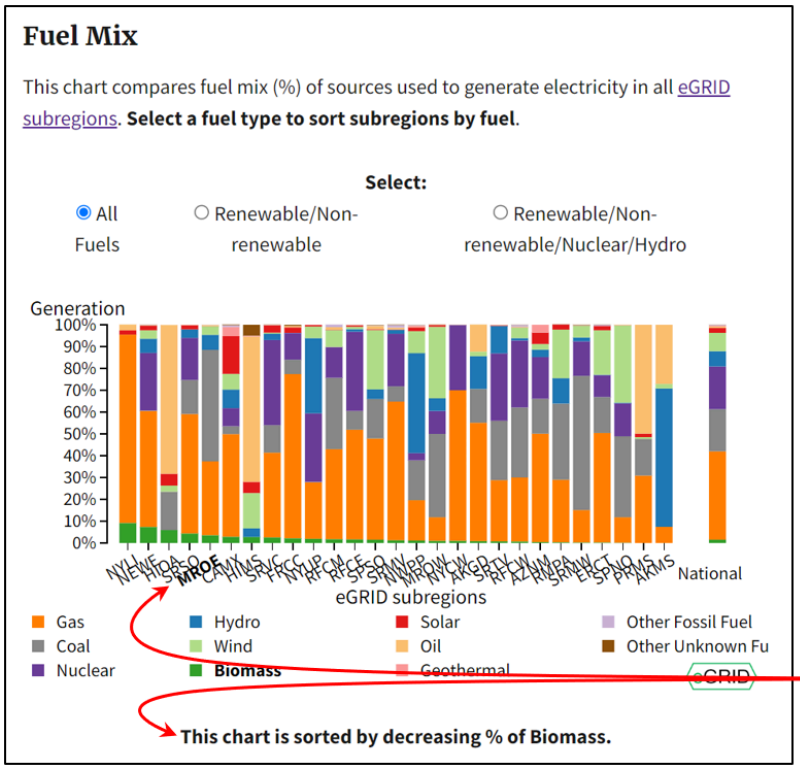
4. Begin completing **Table 1, Electricity Resource Fuel Use In My Region** in your **Student Response Guide.** Label each fuel as either Renewable **[R]** (in green) or Nonrenewable **[NR]** (in black) in column two of **Table 1**. Check your labels for accuracy with your teacher before continuing.

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 percentages used to generate electricity in your specific eGRID subregion to national fuel mix % averages.

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 **(Illustration 6.)**.

Illustration 6.



For example, eGRID subregion **MROE** is among the top five subregions generating electricity with **Biomass** fuel.

8. Go through each fuel source shown in the **Fuel Mix** graph **(Illustration 6.)**. Note any fuel source for which your eGRID subregion is in the top 5, or in the bottom 5 for generating electricity among all subregions. For any in the top 5, place this notation **[top 5]** next to the percent you listed for that primary fuel in **Table 1**. For any in the bottom 5, place this notation **[bottom 5]** next to the percent you listed for that primary fuel in **Table 1** of your **Student Response Guide**.

9. Of course, using any combination of primary fuel sources to generate your electricity results in waste gases being released into 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, relevant nitrogen oxides (nitric oxide, NO, and nitrogen dioxide, NO_2,)

You'll review these next.

10. Return to **Page 2**.

11. Take a few moments to explore the interactive features of the **Emission Rates** graphs **(Illustration 5**, earlier**)**. Use the **Emission Rates** graphs on **Page 2** to complete **Table 2, Electricity Resource Fuel Emissions In My Region** in your **Student Response Guide**. However, before posting your figures make the following change:

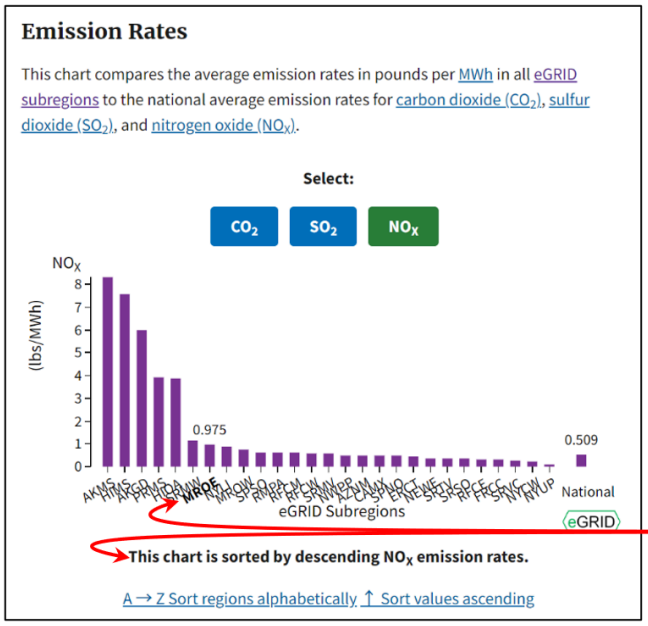
> Convert numbers in the Emission Rates bar graph given in lbs./MWH (megawatt-hour) to lbs./KWH (kilowatt-hour). To do this, simply divide lbs./MWH by 1000 before posting into **Table 2**. All values you post to the table will then be in units of lbs./KWH.

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.

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 **(Illustration 7.)**.

Illustration 7.



For example, eGRID subregion **MROE** is not among the top five, nor is it among the bottom five subregions in **NO_x** emissions.

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]** next to the percent you listed for that emission in **Table 2**. For any in the bottom 5, place this notation **[bottom 5]** next to the percentage you listed for that emission in **Table 2** of your **Student Response Guide.**

So far, you've learned what resource fuels are used to produce electricity in your region and nationally. You've also learned about three of the primary chemical emissions given off while producing electricity in the area you live. Last, you've determined whether or not your region is especially high or low with any of those emissions.

In the next part of this lesson, you'll quantify and personalize the energy resources needed and pollution emissions required to deliver energy to a reasonably typical American home.

Part Two: Annual Energy Use—Family Resources and Emissions [The Real Cost of Energy for a "Typical" Family of Four]

Please read our disclaimer:

There is no typical family of four in the United States. But in this lesson you will see fairly average energy use data from a family of four that could reside in many locations in our country. This typical family pays monthly for the electricity and natural gas it uses. It is understood your situation may be very different than this family's.

Our purpose is to have you approximate the energy resource use and pollution emissions for a somewhat typical American family in a trouble free way. You may have a very different family situation. You may be using different resource fuels than are used in this fictitious story. You might have energy data that is higher or lower than used in this exercise.

Nevertheless, you and your family are responsible for the minute by minute consequences of your energy resource use and pollution emissions. This activity is designed to introduce you to their real magnitude and cost.

15. **Table 3** displays **Typical Family Monthly Electricity and Natural Gas Used** for an imaginary family of four. It shows the KWH (of electricity) and Therms (of natural gas) they used monthly. Total the KWH of electricity used for the year. Post your total at the bottom of **Table 3**. Do the same for Therms of natural gas used. Double check your totals before moving ahead!

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

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 Equivalent is the average mass of coal—and only coal—that would have to be burned to produce a stated quantity of energy.

The equivalents your teacher gives you are close approximations. However, they should not be used for any type of formal analysis or reporting.

17. Perform the calculations necessary to answer questions **17a.** and **17b.** in your **Student Response Guide**. Your teacher will probably demonstrate how to perform some of the calculations, explaining unit labels and show-your-work requirements.

18. Perform the calculations necessary to answer questions **18a.** and **18b.** in your **Student Response Guide**.

19 & 20. Perform the calculations necessary to answer the *key summary questions* in your **Student Response Guide**.

Part Three: Lesson Summary Questions

Proceed now to the **Lesson Summary Questions.** The questions are found in your **Student Response Guide.**