You may delete this page from the document that follows after reading.

It contains plain language about the copyright we've adopted from

Creative Commons.

It also contains a link to the summary for our copyright license. This summary should be consulted if you intend to copy and redistribute this material in any medium or format, or adapt, remix, transform, or build upon this material.

Click Here for information on the Creative Commons License we've adopted.

From **Creative Commons**:

This is a human-readable summary of (and not a substitute for) the license. Disclaimer.

You are free to:

- **Share** — copy and redistribute the material in any medium or format
- **Adapt** — remix, transform, and build upon the material

The licensor cannot revoke these freedoms as long as you follow the license terms.

Under the following terms:

- **Attribution** — You must give appropriate credit, provide a link to the license, and indicate if changes were made. You may do so in any reasonable manner, but not in any way that suggests the licensor endorses you or your use.
- **NonCommercial** — You may not use the material for commercial purposes.
- **ShareAlike** — If you remix, transform, or build upon the material, you must distribute your contributions under the same license as the original.

No additional restrictions — You may not apply legal terms or technological measures that legally restrict others from doing anything the license permits.

Energy Conversions and Beyond

Instructor's Guide and Answer Key

Objectives:

- Students will be able to perform conversions from one scientific unit to another.
- Students will convert to the two most common energy units in science, the BTU and the Joule, from the units used on a typical energy bill.
- Students will calculate energy, resources, and air emissions savings from the use of an energy efficient appliance.
- Students will calculate energy, resources, and air emissions savings from the installation of a solar photovoltaic system.
- Students will understand that energy savings not only result in cost savings, but resources and emissions savings. These three always go together.
- Students will understand that large quantities of resources and emissions are saved from the application of even small energy savings measures.
- Students will understand that very large quantities of resources and emissions are saved from the installation and use of a relatively small solar PV system.

The Main Thing:

On the surface, this appears to be a conventional lesson in unit conversions, but it is much more. An introduction to the BTU and conversions to it will enable students to do important energy comparisons. Further conversions in this lesson permit students to calculate the resources and air emissions they are responsible for producing, using a typical energy bill. Students will also calculate cost, resources, and air emissions savings through the application of simple energy conservation measures. Finally, they will determine the cost, resources, and air emissions savings that result from installing a solar photovoltaic system at their home. These conversions are intentionally designed to stimulate further student curiosity, interest, and astonishment, in energy conservation and solar energy.

Activity and Teacher Notes:

If you are a teacher new to this lesson, it makes good sense for you to perform the lesson on your own before using it.

The teacher of this activity will have to decide first on an individual or group approach to its completion. If a group approach is chosen, it is still expected that each student individually complete the written exercises.

You will need to produce a copy of the required energy bill in advance for your students to use in completing this activity. The energy bill accompanies this lesson, and is an October (between seasonal extremes) bill. It serves as a good average bill for the year for an average family home.

The final five pages of the student lesson are titled:

Instructions for filling in boxes 6g. – 6j.

On these pages students follow visual instructions to obtain four pieces of information from the United States Environmental Protection Agency. To get this information in its most accurate and current form, students navigate to the US EPA Greenhouse Gas Equivalency Calculator. Then they place the values into **Table 6** of their student lesson. Later, they use these values as calculation conversions.

The four pieces of information are:

- **lbs. of Coal Burned* / KWH of Electricity** used
- **lbs. of CO_2 Emissions Equivalent** / KWH of Electricity** used
- **Cubic Feet of Natural Gas / Therm of Natural Gas** used
- **lbs. of CO_2 Emissions Equivalent** / Therm of Natural Gas** use

Following are the definitions for the lbs. of CO_2 Equivalent and lbs. of Coal Burned we'll use in the lesson. <u>Review these definitions carefully with your students before they start the lesson.</u>

***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.

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

You may have to spend time in advance of the lesson teaching your students that the electricity they use is produced from a variety of resources. If you would like to view your actual electricity production resource mix, click here:

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

After a short introduction, this activity can be student self-paced. However, if it is being used to introduce students to the methods of unit conversions for the first time you will have to take time to teach your students dimensional analysis.

An extensive answer key follows. It is based on data current at the time of this writing, and suggests the math processes to be used by students to arrive at the correct answers.

You are free to edit, add, and subtract from the lesson to suit who you teach and how you teach them (see our copyright). Set yourself and your students up for success in your classroom!

Name: ______________________________

Date: ____ / ____ / ____ Class Hour: ____

Energy Conversions and Beyond

Student Response Guide

Note answers are included in brackets.

At first glance, the language of energy is messy and difficult. Quantities of energy are expressed in many different units. These units grew out of different needs (power industry, academic needs, nutrition science, etc.), at different times, and from different places. Even today, many obscure units are still used because they fit a particular need so well. To make sense of energy, you need to be able to translate, or convert, between these different languages or units.

In **Part One** of your lesson you will learn about the two quantities of energy that are used on a typical energy bill, the KWH (kilowatt-hour) and the Therm. You'll learn to convert these energy quantities into two other practical energy units that have stood the test of time, the BTU and the Joule. Performing these conversions will help you to learn and comprehend the language of energy.

Part Two of **Energy Conversions and Beyond** takes you beyond just the language of energy. Here you'll go beyond what you learned in Part One to assess the real costs and benefits of energy decision making.

Part One

The BTU (British Thermal Unit) and the Joule are the two units typically used as reference units for most energy comparisons. The scientific community does not generally favor the BTU because it is the older, English unit of measure. The definition of a BTU is probably easy for you to understand, though:

1 BTU = the quantity of energy needed to raise 1 lb. of water, 1 degree Fahrenheit*

*with water at its maximum density

The Joule is the SI unit for energy, but its definition may be harder to visualize, or comprehend:

1 Joule = energy expended in 1 sec by an electric current of 1 ampere in a circuit with a resistance of 1 ohm

To get started, we will simply learn and work with the equivalence that links these two:

$1\ BTU = 1055\ J$

Another way of stating this is to write this equivalence as two "conversion factors," or ratios that are equal to one (1).

$\frac{1\ BTU}{1055\ J}$
$\frac{1055\ J}{1\ BTU}$

With this information you can now begin converting from BTU's to Joules, and vice versa.

1. Perform these conversions according to your teacher's directions:

1a. 3 BTU is equal to how many Joules?

$$\frac{3\ \cancel{BTU}}{1}\ x\ \frac{1055\ J}{1\ \cancel{BTU}} = [3165\ J]$$

1b. How many Joules is 14.7 BTU?

$$\frac{14.7\ \cancel{BTU}}{1}\ x\ \frac{1055\ J}{1\ \cancel{BTU}} = [15,509\ J]$$

1c. 7800 J is equal to how many BTU?

$$\frac{7800\ \cancel{J}}{1}\ x\ \frac{1\ BTU}{1055\ \cancel{J}} = [7.4\ BTU]$$

1d. How many BTU is 28,550 J?

$$\frac{28550\ \cancel{J}}{1}\ x\ \frac{1\ BTU}{1055\ \cancel{J}} = [27.1\ BTU]$$

Let's consider the energy quantities you find on an energy bill, the kilowatt-hour (KWH) and the Therm.

Energy utility companies express how much electricity a customer uses in KWH units.

One KWH of electricity is equal to 1000 Watts of electricity used for one hour. In other words, it is equal to the amount of energy needed to light ten 100 Watt light bulbs for one hour.

Energy utility companies express how much natural gas a customer uses in units of Therms. One Therm is equal to 100,000 BTU. One Therm is also roughly equal to 100 cubic feet of natural gas, or methane.

Following are the equivalence and conversion factors linking these two energy units to the BTU and Joule:

$$1\ KWH = 3412\ BTU = 3{,}600{,}000\ J\ (3.6\ X\ 10^6\ J$$

Conversion factors:

$$\frac{1\ KWH}{3412\ BTU}$$

$$\frac{1\ KWH}{3{,}600{,}000\ J}$$

$$\frac{3412\ BTU}{1\ KWH}$$

$$\frac{3{,}600{,}000\ J}{1\ KWH}$$

$$1\ Therm = 100{,}000\ BTU = 105{,}500{,}000\ J\ (1.055\ X\ 10^8\ J$$

Conversion factors:

$$\frac{1\ Therm}{100{,}000\ BTU}$$

$$\frac{100{,}000\ BTU}{1\ Therm}$$

$$\frac{1\ Therm}{105{,}500{,}000\ J}$$

$$\frac{105{,}500{,}000\ J}{1\ Therm}$$

2. Now perform these conversions according to your teacher's directions:

2a. 840 KWH is equal to how many Joules?

$$\frac{840\ \cancel{KWH}}{1}\ x\ \frac{3,600,000\ J}{1\ \cancel{KWH}} = [3,024,000,000\ J]$$

2b. How many BTU is 100 KWH?

$$\frac{100\ \cancel{KWH}}{1}\ x\ \frac{3412\ BTU}{1\ \cancel{KWH}} = [341,200\ BTU]$$

2c. 100 Therms is equal to how many BTU?

$$\frac{100\ \cancel{Therms}}{1}\ x\ \frac{100,000\ BTU}{1\ \cancel{Therm}} = [10,000,000\ BTU]$$

2d. How many J is 0.38 Therms?

$$\frac{0.38\ \cancel{Therms}}{1}\ x\ \frac{105,500,000\ J}{1\ \cancel{Therm}} = [40,090,000\ J]$$

3. Which contains more energy, a KWH or a Therm? Explain how you know in convincing detail or show how you know mathematically in the box below.

[* There are several ways it can be shown that a Therm contains a lot more energy. Perhaps the simplest is through the conversions students were given in the lesson:

$1\ Therm = 100,000\ BTU$ vs. $1\ KWH = 3412\ BTU$]

4. Consult the energy bill for a typical family home provided for this activity. Locate the KWH of electricity used and the Therms of natural gas used. Convert each quantity to BTU below.

4a. KWH to BTU:

$$\frac{900\ \cancel{KWH}}{1}\ x\ \frac{3412\ BTU}{1\ \cancel{KWH}} = [3,070,800\ BTU]$$

4b. Therms to BTU:

$$\frac{60\ \cancel{Therms}}{1}\ x\ \frac{100,000\ BTU}{1\ \cancel{Therm}} = [6,000,000\ BTU]$$

5. Did this family use more energy from electricity or from natural gas? Explain how you know in convincing detail or show how you know mathematically in the box below.

[This family used more energy from natural gas, as calculated in #4, above.   **6,000,000 BTU of energy used for natural gas vs. 3,070,800 BTU for electricity.**]

Part Two

In this part of the lesson, you will use conversions and simple math to produce the kind of data used in making real energy management decisions. By the end of the lesson, you'll stand face to face with the real costs of using energy—and the real benefits of saving it.

6. Consult the energy bill for a typical family home provided for this activity again.

6a. Locate the total cost of all the electricity used (Total Electric Service Charges).

Post it into **Table 6,** box **6a.**

6b. Locate the total cost of all the natural gas used (Total Gas Service Charges).

Post it into **Table 6,** box **6b.**

6c. Locate the total KWH of electricity used (Electricity Used (KWH)).

Post it into **Table 6,** box **6c.**

6d. Locate the total therms of natural gas used (Gas Used (CCF) or Therms).

Post it into **Table 6,** box **6d.**

6e. Using data you located on the energy bill, determine the cost / KWH of Electricity. Post that cost into box **6e.** of **Table 6.** *Double-check your math! You'll be using this answer later as a conversion factor to calculate other answers.*

6f. Using data you located on the energy bill, determine the cost / Therm of natural gas. Post that cost into box **6f.** of **Table 6.** *Double-check your math! You'll be using this answer later as a conversion factor to calculate other answers.*

6g. – 6j.: Follow the **Instructions for filling in boxes 6g. – 6j.** found on separate pages to post values to **boxes 6g. – 6j.** in **Table 6.**

Table 6

Electricity	Versus	Natural Gas
6a. **[$ 127.02]** [cost of electricity for the month]	**Monthly cost**	6b. **[$ 46.61]** [cost of natural gas for the month]
6c. **[900 KWH]** [of electricity used for the month]	**Monthly use**	6d. **[60 therms]** [of natural gas use for the month]
per KWH "costs"	**Versus**	**per THERM "costs"**
6e. **[$ 0.141 / KWH]** [of Electricity]	**MONEY**	6f. **[$ 0.777 / Therm]** [of Natural Gas]
6g. **[0.779 lbs. of Coal / KWH]** [of Electricity]	**RESOURCES**	6h. **[100 ft^3 / Therm]** [of Natural Gas]
6i. **[1.6 lbs. of CO_2 equivalent / KWH]** [of Electricity]	**EMISSIONS**	6j. **[11.7 lbs. of CO_2 equivalent / Therm]** [of Natural Gas]

7. Consult the energy bill for a typical family home provided for this activity again. Assume the October energy bill for this typical family home is a good average for all the energy bills for the year. Based on the monthly use for this family on the energy bill, calculate:

7a. The money this family pays per year for the electricity they use.

7b. The pounds of coal this family burns per year for the electricity they use.

7c. The pounds of carbon dioxide this family is responsible for putting into the air for the electricity they use each year.

Your answers go in the boxes to the left. Show all of your math work to the right.

Answer	Math Work
7a. [$ 1522.80 / year] [for Electricity]	$\frac{900\ \cancel{KWH}}{1\ \cancel{month}}\ x\ \frac{\$\ 0.141}{\cancel{KWH}}\ x\ \frac{12\ \cancel{months}}{1\ \cancel{year}} =$
7b. [8413.2 lbs. Coal / year] [for Electricity]	$\frac{900\ \cancel{KWH}}{1\ \cancel{month}}\ x\ \frac{0.779\ lbs}{\cancel{KWH}}\ x\ \frac{12\ \cancel{months}}{1\ \cancel{year}} =$
7c. [17,280 lbs. CO_2 eq. / year] [for Electricity]	$\frac{900\ \cancel{KWH}}{1\ \cancel{month}}\ x\ \frac{1.6\ lbs}{\cancel{KWH}}\ x\ \frac{12\ \cancel{months}}{1\ \cancel{year}} =$

8. Using the energy bill again, calculate:

8a. The money this family pays per year for the natural gas they use.

8b. The cubic feet of natural gas this family uses per year.

8c. The pounds of carbon dioxide this family is responsible for putting into the air for the natural gas they use each year.

Your answers go in the boxes to the left. Show all of your math work to the right.

Answer	Math Work
8a. **[$ 559.44 / year]** [for Natural Gas]	$\frac{60\ \cancel{Therms}}{1\ \cancel{month}}\ x\ \frac{\$\,0.777}{\cancel{Therm}}\ x\ \frac{12\ \cancel{months}}{1\ \cancel{year}} =$
8b. **[72,000 ft^3 / year]** [for Natural Gas]	$\frac{60\ \cancel{Therms}}{1\ \cancel{month}}\ x\ \frac{100\ ft^3}{\cancel{Therm}}\ x\ \frac{12\ \cancel{months}}{1\ \cancel{year}} =$
8c. **[8424 lbs. CO_2 eq. / year]** [for Natural Gas]	$\frac{60\ \cancel{Therms}}{1\ \cancel{month}}\ x\ \frac{11.7\ lbs}{\cancel{Therm}}\ x\ \frac{12\ \cancel{months}}{1\ \cancel{year}} =$

Let’s say Patrick and Candace are heads of the household whose energy bill you have been considering. They want to save on their family’s energy use.

They implement these “no cost” changes to their lifestyle and habits:

- Lower their winter heating season temperature setpoint.
- Make a deliberate effort to keep doors closed during the heating season.
- Raise their summer air conditioning temperature setpoint.
- Make a deliberate effort to keep windows and doors closed when air conditioning their home.
- Open their windows and use fans to cool their home as much as possible.
- Take shorter showers to save on hot water use.
- Remember to turn off lights and appliances whenever they are not being used.

They also implement these “low cost” changes to their lifestyle and habits:

- Install a programmable thermostat, so heat and AC are used minimally when their home is unoccupied.
- Replace the air filters in their heating and AC units every year.
- Have yearly, professional maintenance checks performed on their heating and AC systems.
- Seal cracks around windows and doors with caulk.
- Replace worn weather stripping on windows and door.
- Replace all incandescent light bulbs with energy efficient LED lamps.

These measures save an average of 8% on both their electricity and natural gas use.

9. Calculate this family’s five year savings for electricity. Your answers go in the boxes to the left. Show all of your math work to the right.

Answer	**Math Work**
9a. **[$ 609.20 saved]**	$\frac{\$\,\mathbf{1522.80}}{\cancel{\boldsymbol{year}}}\ \boldsymbol{x}\ \mathbf{0.05}\ \mathbf{5}\ \cancel{\boldsymbol{years}} =$
9b. **[3365.5 lbs. Coal saved]**	$\frac{\mathbf{8413.2}\ \boldsymbol{lbs}}{\cancel{\boldsymbol{year}}}\ \boldsymbol{x}\ \mathbf{0.08}\ \mathbf{5}\ \cancel{\boldsymbol{years}} =$
9c. **[6912.0 lbs. CO_2 eq. saved]**	$\frac{\mathbf{17,280}\ \boldsymbol{lbs}}{\cancel{\boldsymbol{year}}}\ \boldsymbol{x}\ \mathbf{0.08}\ \mathbf{5}\ \cancel{\boldsymbol{years}} =$

10. Calculate this family's five year savings for natural gas. Your answers go in the boxes to the left. Show all of your math work to the right.

Answers	Math Work
10a. [$ 223.78 saved]	$\frac{\$\,559.44}{\cancel{year}}\ x\ 0.08\ 5\ \cancel{years} =$
10b. [28,800 ft^3 of Natural Gas saved]	$\frac{72,000\ ft^3}{\cancel{year}}\ x\ 0.08\ 5\ \cancel{years} =$
10c. [3369.6 lbs. CO_2 eq. saved]	$\frac{8424\ lbs}{\cancel{year}}\ x\ 0.08\ 5\ \cancel{years} =$

11. Summarize this family's combined five year savings for electricity and natural gas. Your answers go in the boxes to the left.

5 year savings
11a. [$ 832.98 saved]
11b. (9b.) [3365.5 lbs. Coal saved]
11c. (10b.) [28,800 ft^3 of Natural Gas saved]
11d. [10,281.6 lbs. CO_2 eq. saved]

12. Candace and Patrick decide to place a solar PV array on their roof. The entire system is large enough to generate all of the electricity the family will need in any given month.

Determine money, resources, and CO_2 savings for electricity use for a year, for five years, and for a 25 year period (approximate working life of a solar PV system array).

1 year savings	5 year savings	25 year savings
12a. (9a.) [$ 1522.80]	12b. [$ 7614]	12c. [$ 38,070]
12d. (9b.) [8413.2 lbs. Coal]	12e. [42,066 lbs. Coal]	12f. [210,330 lbs. Coal]
12g. (9c.) [17,280 lbs. CO_2 eq.]	12h. [86,400 lbs. CO_2 eq.]	12i. [432,000 lbs. CO_2 eq.]

13. Recreate the chart above just a little differently. Your cost answers will remain the same. But divide all of the answers you expressed in pounds (lbs.) by 2000, which will convert them to tons (2000 lbs. = 1 ton). Post your new data in tons, below.

1 year savings	5 year savings	25 year savings
13a. [$ 1522.80]	13b. [$ 7614]	13c. [$ 38,070]
13d. [4.2 tons Coal]	13e. [21.0 tons Coal]	13f. [105 tons Coal]
13g. [8.6 tons CO_2 eq.]	13h. [43.2 tons CO_2 eq.]	13i. [216 tons CO_2 eq.]

Lesson Summary Questions

1. Candace and Patrick decide to install the solar PV array referred to earlier. It will generate all of the electricity the family will need in any given month. It costs them $18,000 to install. How many years will it take for them to pay back their investment of $18,000? Explain your answers with both words and math.

[The system cost $18,000 to install. We calculated their one year (annual) savings to be $1522.80. It will take 11.8 years to reach "payback."

$$\frac{\$18,000}{1}\ x\ \frac{1\ year}{\$1522.80} = 11.8\ years]$$

2. You decide to place a solar PV array at or on your home. At current electric rates it will take about 10 years for the cost savings to equal your investment in the array. What is likely to happen over the years to shorten your "payback time" even more?

[Electricity rates will probably go up during the ten year period. This would have the effect of increasing my annual savings, shortening my "payback time."]

3. You are considering the purchase of a solar PV system for your home. All of the installers you talk with stress this principle: Energy conservation comes first, even before renewable energy. Explain why this is such good advice to follow.

[It makes little sense to install a relatively expensive solar PV system where energy conservation hasn't occurred first.

1. **Good energy conservation measures are cheaper, and always save more energy than a PV system will save on an electric bill. Saving energy in the first place is always cheaper and better than producing energy to overcome energy being wasted.**

2. **The less energy being wasted in the home, the smaller the solar PV array has to be to supply the energy needed for the home. This saves money on the cost of the PV system. It also saves on the energy that would have been needed to manufacture a system larger than is really needed (saves "embedded energy").]**

4. Is the use of solar panels completely "green," or "waste-free," or "emissions-free?" Convincingly explain why it is or is not.

[The use of solar panels is not completely "green," or "waste-free," or "emissions-free." This is because it takes energy to manufacture the solar modules and energy to develop, refine, and transport the natural resources needed for their manufacture. This energy, which is significant, is called "embedded energy."]

5. Whenever you save or conserve energy, three things are saved at the same time. What are they?

[This should be easy for students to answer. It was a primary emphasis of this activity:

Money Resources Emissions / pollution / environmental wastes]

6. You employ many successful measures at home and work to save and conserve energy. How can it be said that you are environmental superstar?

[Whenever I save and conserve energy, I am saving money. But I am also saving resources from having to be wastefully developed and used, and saving pollution from having to be unnecessarily released into our environment.]

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

[Plainly this is a judgement question. Your lesson author would be especially pleased if your students write an answer that addresses any of these concepts:

1. **Energy savings not only result in cost savings, but resources and emissions savings. These three always go together.**
2. **Large quantities of resources and emissions are saved from the application of even small energy savings measures.**
3. **Very large quantities of resources and emissions are saved from the installation and use of even a relatively small solar PV system.]**

Instructions for filling in boxes 6g. – 6j.

Follow these instructions to obtain four pieces of information from the United States Environmental Protection Agency's Greenhouse Gas Equivalency Calculator.

The four pieces of information are:

- **lbs. of Coal Burned* / KWH of Electricity** used
- **lbs. of CO_2 Emissions Equivalent** / KWH of Electricity** used
- **Cubic Feet of Natural Gas / Therm of Natural Gas** used
- **lbs. of CO_2 Emissions Equivalent** / Therm of Natural Gas** use

Following are the definitions for the lbs. of CO_2 Equivalent and lbs. of Coal Burned we'll use in the lesson.

***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.

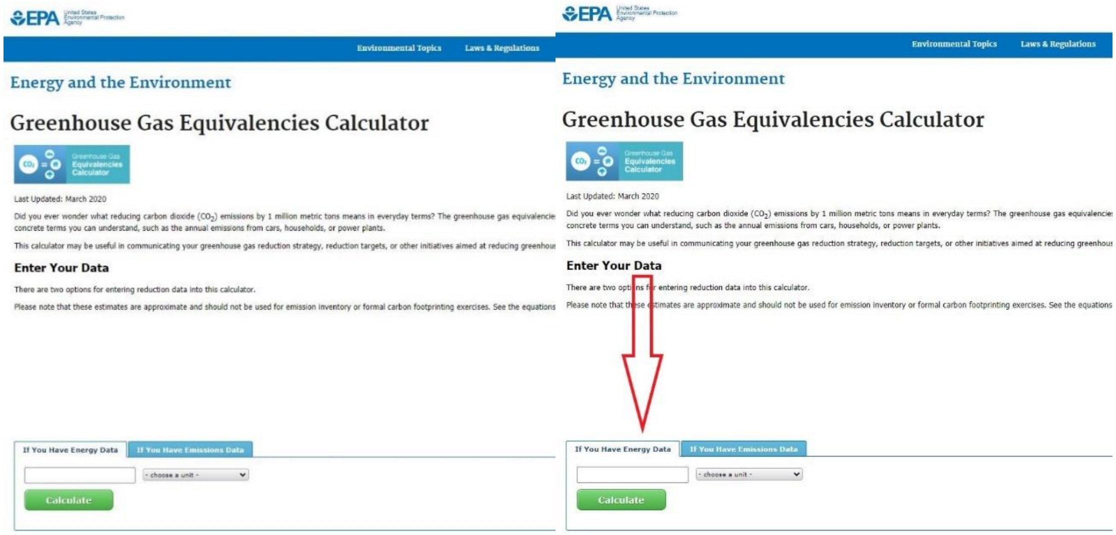
****Pounds of Carbon Dioxide Equivalent** defines the mass of CO_2 that would have the same warming potential as the mixture of emissions released during the use of a stated quantity of energy.

To get this information for in its most accurate and current form, navigate to the US EPA Greenhouse Gas Equivalency Calculator. Then place these values into **Table 6** back in Step 6 of your student lesson. Later, you will use these values as calculation conversions.

6-1. Follow the URL (just below) to the **United States Environmental Protection Agency's Greenhouse Gas Equivalency Calculator**:

https://www.epa.gov/energy/greenhouse-gas-equivalencies-calculator

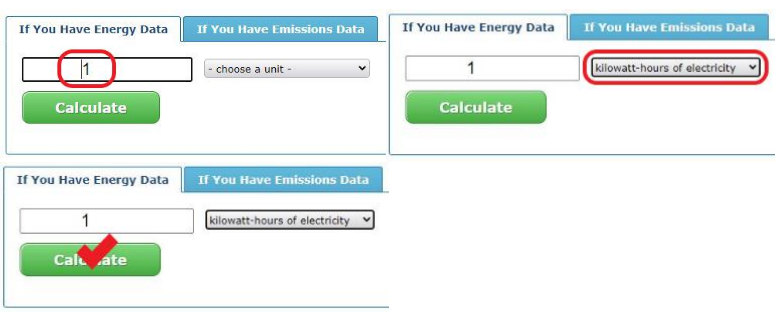
Their splash page will look like this. You will be entering data where indicated.

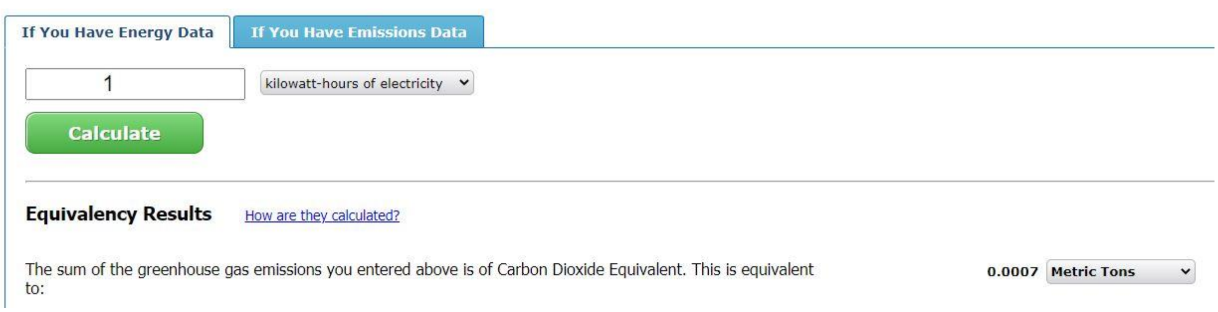


6-2. In the Energy Data section:

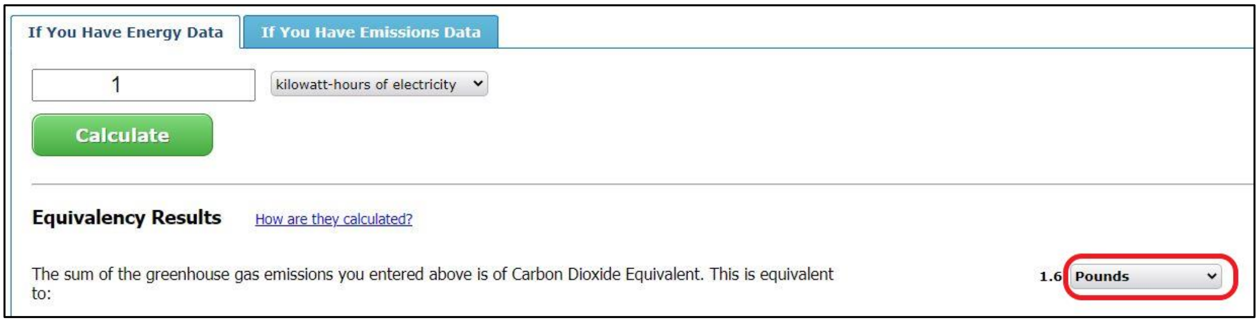
- Enter the number **1**
- Choose the unit of **kilowatt-hours of electricity**
- Click **Calculate**

After clicking, you'll arrive at a webpage displaying **Equivalency Results**.

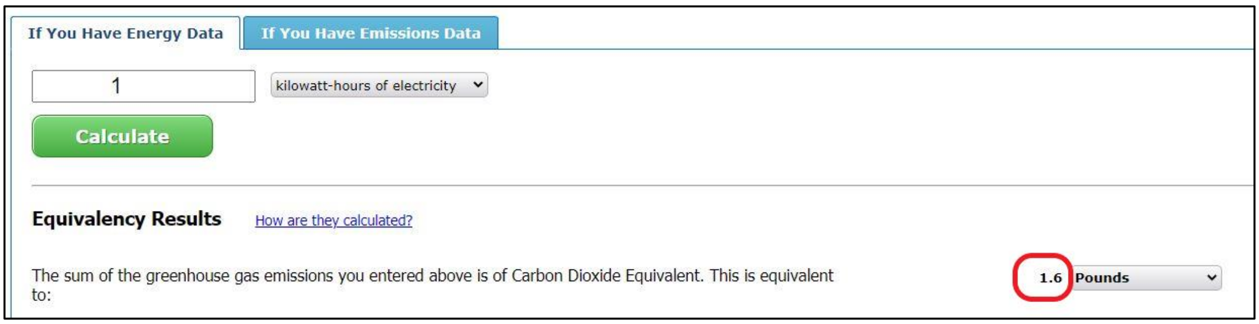




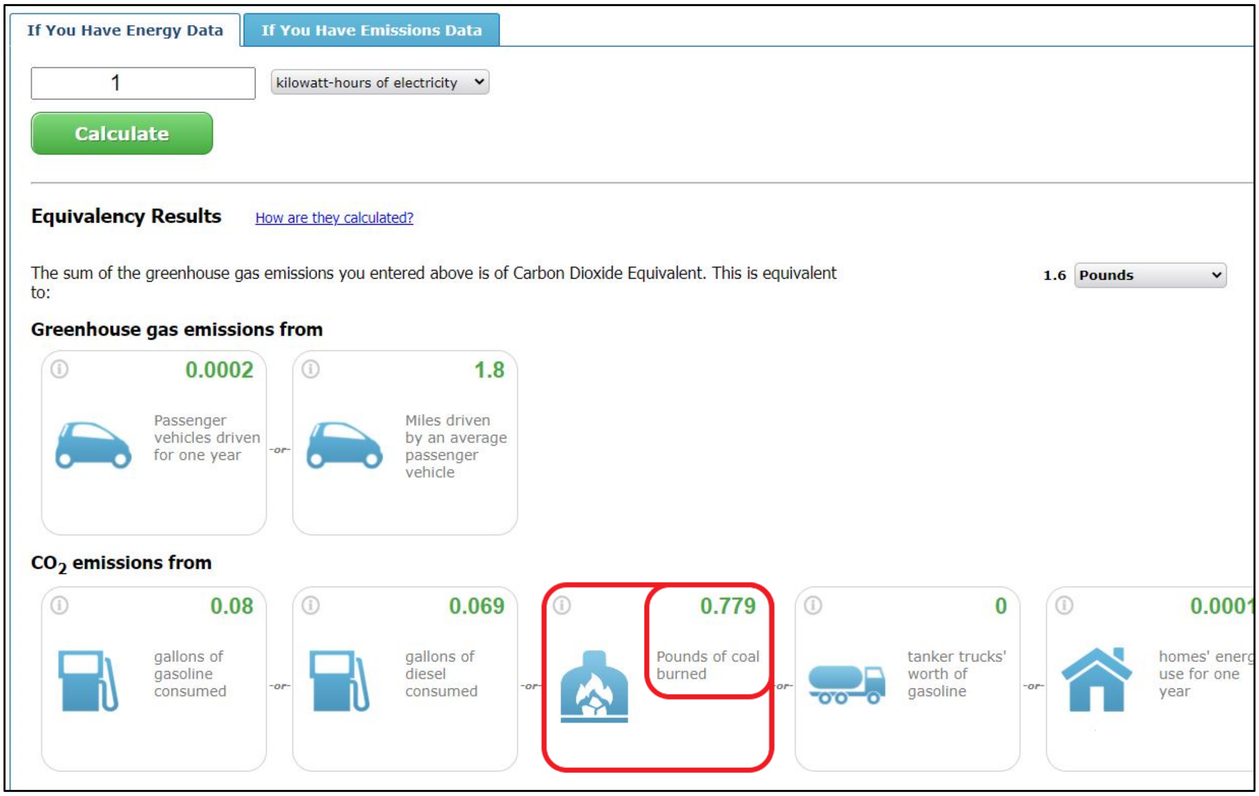
6-3. Where indicated, change the unit of **Metric Tons** to **Pounds**.



6-4. Write the **lbs. of CO_2 Equivalent** to produce **1 kilowatt-hour of electricity** into **Table 6 (number 6g.)** of your student lesson.

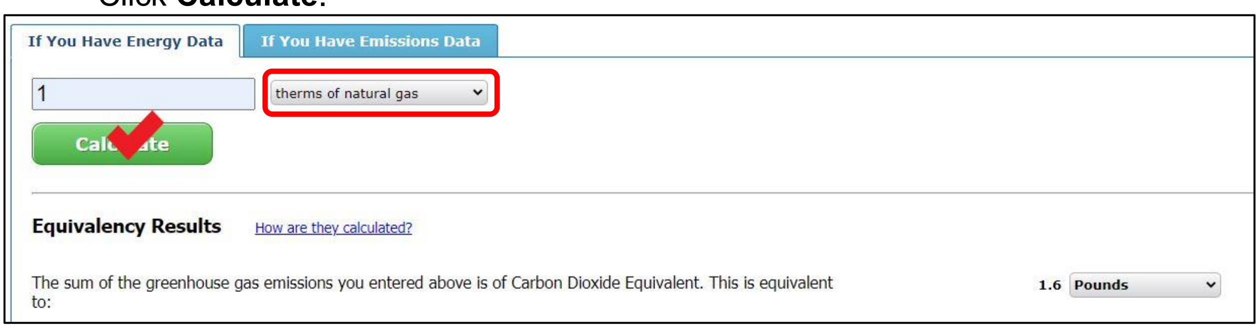


6-5. Write the **lbs. of Coal Burned** to produce **1 kilowatt-hour of electricity** into **Table 6 (number 6i.)** of your student lesson.

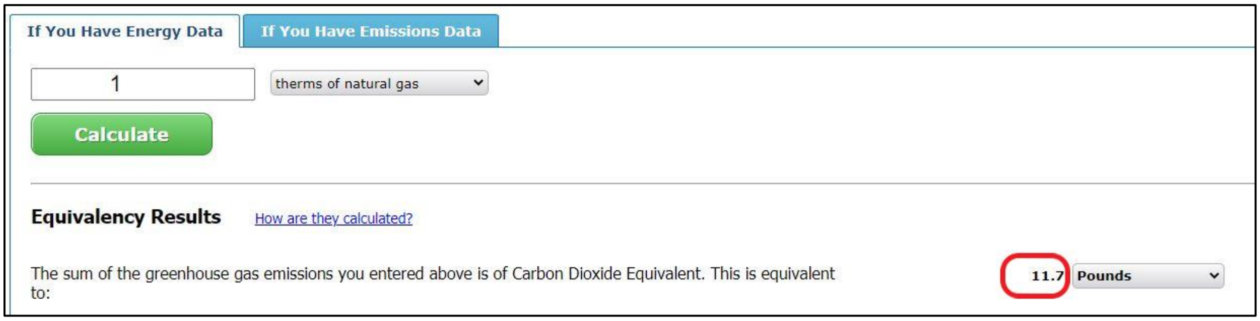


6-6. Change the unit of **kilowatt-hours of electricity** to **therms of natural gas**.

Click **Calculate**.



6-7. Write the **lbs. of CO_2 Equivalent** to produce **1 therm of natural gas** into **Table 6 (number 6j.)** of your student lesson.



6-8. Write the **cubic feet of natural gas** that defines **1 therm of natural gas** into **Table 6 (number 6h.)** of your student lesson. [the volume of 1 therm of natural gas varies, but it is approximately equal to 100 ft^3 of natural gas.]