Instructions for using the “Kill a Watt” device in the derivation of a personal carbon footprint.

Lesson 7

Objective: The goal of this activity is to make students aware of the cost (monetarily and environmentally) of electricity used to power the average home.

Time needed: 50 minute period

Materials: Kill A Watt devices (10), assorted household appliances (ex. hairdryer, toaster, IPod and charger, lamp with incandescent bulb, lamp with an EnergySmart bulb...)

Procedure: This lesson is to be used after completion of the stoichiometric calculations of the amount of CO\textsubscript{2} produced from the combustion of a gallon of gasoline and of CO\textsubscript{2} produced by burning 1 pound of coal at a coal burning electric plant.

1) Before using this lesson, there are a couple of numbers that need to be checked and modified as needed on the worksheet.

   For letter E, and for letter B in the homework assignment, find the current cost for a kWh in the students’ area. As an example, for Athens, AL, Google the phrase Athens AL electric department retail electric rates and adjust the worksheet to the current amount charged/kWh.

   For letter G and the text for number 4, check the listed EPA website and correct the multiplier to the current value.

2) Give each student a copy of the Electrical Consumption Worksheet. Divide students into groups of 2 or 3. Assign each group a different appliance and give each group access to a Kill A Watt device. (The device’s use is not complicated. The pink button on the right, labeled “KWH Hour”, is a toggle switch and toggles between the kWh used by the appliance and the amount of time the device was plugged in and powered on.)

3) Have each group plug in the Kill A Watt device then plug in their appliance to the device. Allow students to power their appliance until they have used at least 2 kWh of power. They will record this value of kWh and then toggle to find the number of minutes the device was turned on. (They will need to convert from the number of minutes to fraction of an hour for the worksheet.) If students make a mistake or need to start over, the Kill A Watt device is reset by just unplugging it.

4) Have students complete the worksheet individually. At the end of the period, pass out copies of the article titled, Estimating Appliance and Home Electronic Energy Use taken from the EnergySavers website showing approximate wattages of household appliances. Lead a discussion as to how this information might be valuable. (Answers can include finding ways for families to save money on their power bill, making wiser decisions about running appliances in the home such as hanging clothes to dry instead of using the dryer for a small load.)

5) Make the following homework assignment.

Assessment: As homework, have students complete the homework assignment listed on the last page.
### Electrical Consumption Worksheet

Name: ____________________________

Pick one item to investigate and complete the following table using a data from the Kill a Watt device and a calculator:

<table>
<thead>
<tr>
<th>Item Name:</th>
<th>Description</th>
<th>Unit(s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>Energy Consumption Reading (KWH) from Kill a Watt monitor</td>
<td>kWh</td>
</tr>
<tr>
<td>B</td>
<td>Elapsed Time Recorded by Kill a Watt (press KWH/Hour Key to get to clock)</td>
<td>Hours</td>
</tr>
<tr>
<td>C</td>
<td>Average Hourly Consumption (Divide Answer for A / Answer for B)</td>
<td>kWh/hr</td>
</tr>
<tr>
<td>D</td>
<td>Average Annual Energy Consumption (Answer for C x # hours used per day X 365)</td>
<td>kWh</td>
</tr>
<tr>
<td>E</td>
<td>Price of a Kilowatt Hour</td>
<td>$0.083/kWh</td>
</tr>
<tr>
<td>F</td>
<td>Annual Operating Cost (Answer for D x E)</td>
<td>$/year</td>
</tr>
</tbody>
</table>

### 3. Visit EPA’s Power Profiler at [http://www.epa.gov/cleanenergy/energy-and-you/how-clean.html](http://www.epa.gov/cleanenergy/energy-and-you/how-clean.html) and enter your zip code to determine what energy sources (“fuel mix”) are used for electricity generation by your energy provider. **Depending on your zip code, you may be asked to indicate your utility.** What two fuels are responsible for most of the electricity generated by your provider? _______ ( %) & _______ ( %)

### 4. You’ll see from the graph that coal provides 59% of the energy used to generate the electricity to run this item for one year. In the Southeastern US, approximately 1 pound of coal is required to generate 1 kWh of electricity*. Calculate the amount of coal required to power the item above for one year.

| G | Pounds of coal used (Answer for D from above x .59) | lbs coal/year |

### 5. Calculate the amount of emissions* that result from burning this coal by completing the table below.

| H | Pounds of CO\(_2\) emitted/year (Answer G from above x 1.4lb) | |
| I | Pounds of SO\(_2\) emitted (Answer G from above x 0.006lb) | lbs SO\(_2\)/year |
| J | Pounds of NO\(_x\) emitted (Answer G from above x 0.003lb) | lbs NO\(_x\)/year |

### 6. a. The second graph of EPA’s Power Profiler shows the air emissions associated with this fuel mix profile. What is the impact of CO\(_2\), SO\(_2\), and NO\(_x\) emissions from power plants on the environment and human health?

b. What other pollutants of concern are emitted from coal-burning power plants?

### 7. List any ways to reduce the amount electricity consumed by this item (e.g., only plug it in when you need it).
Estimating Appliance and Home Electronic Energy Use

http://www.energysavers.gov/your_home/appliances/index.cfm/mytopic=10040/

If you're trying to decide whether to invest in a more energy-efficient appliance or you'd like to determine your electricity loads, you may want to estimate appliance energy consumption.

Formula for Estimating Energy Consumption

You can use this formula to estimate an appliance's energy use:

\[(\text{Wattage} \times \text{Hours Used Per Day}) \div 1000 = \text{Daily Kilowatt-hour (kWh) consumption}\]

1 kilowatt (kW) = 1,000 Watts

Multiply this by the number of days you use the appliance during the year for the annual consumption. You can then calculate the annual cost to run an appliance by multiplying the kWh per year by your local utility's rate per kWh consumed.

Note: To estimate the number of hours that a refrigerator actually operates at its maximum wattage, divide the total time the refrigerator is plugged in by three. Refrigerators, although turned "on" all the time, actually cycle on and off as needed to maintain interior temperatures.

Examples:

*Window fan:*

\[(200 \text{ Watts} \times 4 \text{ hours/day} \times 120 \text{ days/year}) \div 1000 = 96 \text{ kWh} \times 8.5 \text{ cents/kWh} = $8.16/\text{year}\]

*Personal Computer and Monitor:*

\[\frac{[(120 \text{ Watts} + 150 \text{ Watts}) \times 4 \text{ hours/day} \times 365 \text{ days/year}] \div 1000}{\text{394 kWh} \times 8.5 \text{ cents/kWh} = $33.51/\text{year}}\]

Wattage

You can usually find the wattage of most appliances stamped on the bottom or back of the appliance, or on its nameplate. The wattage listed is the maximum power drawn by the appliance. Since many appliances have a range of settings (for example, the volume on a radio), the actual amount of power consumed depends on the setting used at any one time.

If the wattage is not listed on the appliance, you can still estimate it by finding the current draw (in amperes) and multiplying that by the voltage used by the appliance. Most appliances in the United States use 120 volts. Larger appliances, such as clothes dryers and electric cooktops, use 240 volts. The amperes might be stamped...
on the unit in place of the wattage. If not, find a clamp-on ammeter—an electrician's tool that clamps around one of the two wires on the appliance—to measure the current flowing through it. You can obtain this type of ammeter in stores that sell electrical and electronic equipment. Take a reading while the device is running; this is the actual amount of current being used at that instant.

When measuring the current drawn by a motor, note that the meter will show about three times more current in the first second that the motor starts than when it is running smoothly.

Many appliances continue to draw a small amount of power when they are switched "off." These "phantom loads" occur in most appliances that use electricity, such as VCRs, televisions, stereos, computers, and kitchen appliances. Most phantom loads will increase the appliance's energy consumption a few watt-hours. These loads can be avoided by unplugging the appliance or using a power strip and using the switch on the power strip to cut all power to the appliance.

**Typical Wattages of Various Appliances**

Here are some examples of the range of nameplate wattages for various household appliances:

- Aquarium = 50–1210 Watts
- Clock radio = 10
- Coffee maker = 900–1200
- Clothes washer = 350–500
- Clothes dryer = 1800–5000
- Dishwasher = 1200–2400 (using the drying feature greatly increases energy consumption)
- Dehumidifier = 785
- Electric blanket- Single/Double = 60 / 100
- Fans
  - Ceiling = 65–175
  - Window = 55–250
  - Whole house = 240–750
- Hair dryer = 1200–1875
- Heater (portable) = 750–1500
- Clothes iron = 1000–1800
- Microwave oven = 750–1100
- Personal computer
  - CPU - awake / asleep = 120 / 30 or less
  - Monitor - awake / asleep = 150 / 30 or less
  - Laptop = 50
- Radio (stereo) = 70–400
- Refrigerator (frost-free, 16 cubic feet) = 725
- Televisions (color)
  - 27" = 113
  - 36" = 133
  - 53"-61" Projection = 170
  - Flat screen = 120
- Toaster = 800–1400
- Toaster oven = 1225
- VCR/DVD = 17–21 / 20–25
- Vacuum cleaner = 1000–1440
- Water heater (40 gallon) = 4500–5500
Water pump (deep well) = 250–1100
Water bed (with heater, no cover) = 120–380

**Homework Assignment:** Now you will apply what you learned in class. Ask the person who pays your bills for the amount of your family’s average monthly electricity bill. If water is included on the same bill then subtract that portion from the total bill. Enter this amount as the first value in A.

A) __________ x 12 = ________________  This represents your approximate yearly amount of money used for electricity. Enter the answer from this question as the first value in B.

B) __________ ÷ 0.083 = ________________  This represents the total kWh used by your family in one year. Enter the answer from this question as the first value in C.

C) __________ x .58 = ________________  This represents the kWh used by your family that was generated by burning coal. Enter the answer from this question as the first value in D.

D) __________ x 1.4 = ________________  This is the approximate number of pounds of CO\(_2\) produced by your family in one year from the burning of coal to power your household.

After completing this exercise, on a separate sheet of paper, write a complete paragraph that answers the following questions.

1) Were you surprised by the amount of your family’s budget used for electricity?
2) Were you surprised by the amount of CO\(_2\) generated by your family’s usage?
3) What simple measures could you and your family take to reduce your family’s utility bill?
4) What might be some reasons to reduce electricity usage besides saving money?
5) What might be some reasons to not change electricity usage behavior around the house?

These websites might help you develop some electricity saving strategies for your family:


Idea: If you implement strategies in your household and are able to show a substantial financial savings to your family’s energy bill, maybe you could receive 10% of the savings as a bonus. Instead of paying that money to TVA, your family could pay you and this could help to grow your college fund. Just an idea. 😊