Name:\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
Date:\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ Mods: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ AP Environmental Science

“Watts” the Cost? Activity

**Background Information**

How much does it cost to watch television for an hour? How much energy does it take to cook a meal, heat a house or light a lamp? What does that energy cost? Does it take more energy to toast bread or to boil water? What are the major and minor energy users in your home? How much does it cost to use the various appliances per hour, day or year? Are they worth that amount? To answer these questions, we need to understand how we are charged for electricity.

Figure 1. The breakdown of the energy an average home uses.

When utility companies bill us for the electricity we use, they charge us according to how many kilowatt hour we have used.

A watt is a unit used to indicate how much electrical power has been used. A kilowatt equals 1,000 watts. An appliances “wattage” indicates the amount of watts an appliance uses in an hour.

If 1,000 watts (1 kilowatt) of power is used for one hour, that is a kilowatt-hour (kW). Thus, if an electrical appliance that uses 1,000 watts of power is used for 1 hour, 1 kilowatt-hour of power has been used. Ten 100-watt light bulbs left on for 1 hour would also equal 1 kilowatt-hour of power, as would one 100-watt light bulb left on for 10 hours.

A heater that uses 1,500 watts of power per hour uses 1.5 kilowatts of power per hour. If it were used for 2 hours, 3 kilowatt-hours of power would be used. Since 200 watt equals 0.2 kilowatts, a 200-watt television used for 1 hour would use 0.2kW of power.

Generally, converting electrical energy to heat energy takes a lot of electricity to obtain useable amounts of heat. Thus, appliances that are used to generate heat, such as stoves, water heaters, space (air) heaters, etc., use a lot of electricity. Some other electricity users such as radios and stereos use relatively little electricity in a given period of time. Even they, though, can add a lot to electricity bills when they are used a lot.

By knowing how much electricity costs per kilowatt-hour, we can get an idea of how much it would cost to operate an appliance for a period of time.

**In this activity**, you will determine how much power various appliance around your home use. Then you will calculate how much each cost you to use per month.

**Table 1. APPROXIMATE ENERGY USE FOR SOME APPLIANCES**

Note: These are **approximations**. Adjust them as seems appropriate for your family. For example, if you have a particularly powerful appliance, or a small model, you might adjust these wattages accordingly. Older appliances tend to use more watts then comparable newer models.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **APPLIANCE** | **Approx energy use (Watts/hr or /use)** |  | **APPLIANCE** | **Approx energy use (Watts/hr or /use)** |
| *Air conditioner (room)* |  | Iron (Hand/Steam) | 1000 |
|  Window/wall | 1500 |  | Jacuzzi/Spa Pump  | 1300 |
|  Central | 4500 |  | Microwave oven | 1000 |
|  Evaporative cooler | 500 |  | *Oven* |
|  Portable fan | 250 |  |  Rangetop burner | 1200/burner |
| Aquarium | 50-1210 |  |  Self-cleaning feature | 6000/use |
| Blender | 350 |  | Radio, portable | 20 |
| Broiler | 1500 |  | Refrigerator-freezer |
| Cell phone charger | 3 |  |  Manual defrost | 3000/day |
| Christmas lights  | 800 |  |  Auto, defrost, 16 cu. Ft | 3300/day |
| Clock | 2 |  |  Auto, defrost 22 cu. Ft. | 5000/day |
| Clock radio | 10 |  | *Stereo components (most need receiver too)* |
| Clothes dryer | 5000/load |  |  Cassette player (+ receiver) | 100 |
| Clothes washing machine | 250/load (+ water) |  |  CD player (+ receiver) | 14 |
| Coffee maker | 120/use |  |  Receiver/radio | 75 |
| *Computer* |  |  |  Turntable (+ receiver) | 10 |
|  Tower - awake / asleep  | 120 / 30  |  | Sewing machine | 75 |
|  Monitor - awake / asleep  | 150 / 30  |  | Shaver | 14 |
|  Laptop  | 50 |  | Straightening Iron (Hair) | 22.5 |
|  Printer (printing) | 600 |  | *Swimming pool* |
|  Router | 3.4 |  |  Sweep and filter pump | 1800 |
| Dehumidifier | 275 |  |  (+ increased water heating) |   |
| *Dishwasher***\*Lighting:** Check the wattage of the bulbs in the most frequently used lamps and estimate hours of use, or approximate 100,000 watt-hours (100 kW) per month.**\*Hot water:** This will vary greatly according to length and numbers of showers/baths, cloths and dish washing, whether you have a blanket on the heater, and the setting on the water heater. An average family might use about 350,000 watt-hours (350 kW) per month.  |  | Tablet Charger | 180 |
|  Normal cycle | 1000/load (+ water) |  | *Television* |
|  Energy saver cycle | 500/load (+ water) |  |  LCD 17" | 22 |
| Electric blanket (*single/double*) | 60 / 100 |  |  LCD 20" | 56 |
| *Fan* |  |  |  LCD 24" | 62 |
|  Attic | 370 |  |  LCD 40" | 94 |
|  Ceiling | 100 |  |  LCD 44" | 150 |
|  Circulating | 200 |  |  LCD 50" | 220 |
|  Portable | 250 |  |  LCD 55" | 280 |
| *Food Mixer*  |  |  |  LED 32" | 50 |
|  Hand-Held Mixer | 127 |  |  LED 46" | 90 |
|  KitchenAid Mixer | 214 |  |  LED 50" | 87 |
| *Freezer* |  |  LED 55 | 105 |
|  Auto, defrost, 20 cu. Ft. | 3800/day |  |  LED 60 | 120 |
|  Manual defrost, 22 cu. Ft | 2700/day |  |  LED 80 | 140 |
| Frying pan, electric | 1000 |  |  Plasma 50" | 400 |
| *Game Console (Active/Standby)* |  |  Plasma 65" | 420 |
|  Original Xbox | 172/2.2 |  |  VCR/DVD /Blu Ray | 19 / 23/ 32 |
|  Xbox 360 | 88/0.7 |  |  Home Theatre System  | 330 |
|  Nintendo Wii  | 16/1.9 |  | Toaster | 75/use |
|  Original PlayStation 3 | 189/1.1 |  | Toaster oven | 500/use |
|  PlayStation 3 Slim | 85/0.5 |  | Toothbrush | 7 |
| Garbage Disposal  | 445 |  | Vacuum cleaner | 750 |
| Hair dryer | 1300 |  | Waffle Iron  | 1200 |
| *Heater (space/air)* |  | Water bed (w/thermostat) | 280/day |
|  Baseboard (6’) | 3000 |  | Water heater *(40 gallon)* | 5000 |
|  Heat pump | 4000 |  | Water pump *(deep well)*  | 650 |
|  Portable | 1500 |  | Typewriter | 50 |
|  Wall furnace | 10,000 |  | Other : |   |

\***Note:** Many homes have gas water heaters, space heaters, ovens and stoves.

**Watts” the Cost? Instructions**

In this activity, you will first survey your home, listing the various electrical appliances you have in your home. Then you will estimate how many hours each is used per month. Finally, using an average rate (cost) per kilowatt-hour of electricity, you will compute how much money is spent on each appliance per month.

**To calculate your average rate per kilowatt-hour**, you will need to obtain one of your family’s electrical utility bills. Find the area that indicates kilowatt-hours of electricity used and how much money was charged for that electricity. Then divide the cost by the kW. This will give you your average rate per kW.

*For example*: If the cost of electricity was $86.88 and 724 kW were used, the average rate was $0.12 per kW.

**To determine the wattage of an appliance**, look for a label, plate or other marking that gives such information as model number, voltage, and wattage. The abbreviation for watt is “W,” or the wattage mark would look like “400 W.”

To **convert watts to kilowatt**, divide watts by 1,000.

 *2,500 watts = 2.5 kW 350 watts = 0.35 kW 25 watts = 0.025 kW*

To find **the cost of using an appliance per month**, multiply the following:

 **Days used X hours used/day X kilowatts X average rate/kW = cost/month**

(For some appliances, it makes more sense to calculate the kW per use or per day than per hour.)

**SAMPLE CALCULATIONS**

For a 200 W color television watched 3 hr/day with a rate of $0.12/kW:

 **30 days X 3 hr/day X 0.2 kW X $0.12/kWh = $2.16/month**

For a 1,500 W heater used 5 hr/day with a rate of $0.12/kW:

 **30 days X 5 hr/day X 1.5 kW X $0.12/kWh = $27.00/month**

For a 700 W refrigerator that comes on intermittently so that it uses 5 kW/day:

 **30 days X 5 kW/day X $0.12/kWh = $18.00/month**

For a clothes dryer that uses 4kW/load and is used for 9 loads/month:

 **9 loads X 4 kW/load X $0.12/kWh = $4.32/month**

Name:\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
Date:\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ Mods: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ AP Environmental Science

“Watts” the Cost? Data

Type of home: ( ) single family home ( ) apartment or condominium ( ) other:\_\_\_\_\_\_\_\_\_\_\_\_\_

Number of people living in the home: \_\_\_\_\_\_ Rate based on bill for the month of: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Other pertinent information: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
 **Rate calculation:**

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Hourly Use Appliances** | **Days used per month** | **X** | **Hrs. per day** | **X** | **kW per hr.** | **X** | **Average rate per kW** | **=** | **Cost per month** |
| Air conditioner |  | X |  | X |  | X | $ | = | $ |
| Blanket, electric |  | X |  | X |  | X | $ | = | $ |
| Christmas lights |  | X |  | X |  | X | $ | = | $ |
| Cell phone charger |  | X |  | X |  | X | $ | = | $ |
| Clock/clock radio |  | X |  | X |  | X | $ | = | $ |
| Coffee maker |  | X |  | X |  | X | $ | = | $ |
| Computer (type: \_\_\_\_\_\_\_\_\_\_\_\_\_) |  | X |  | X |  | X | $ | = | $ |
| DVD/VCR |  | X |  | X |  | X | $ | = | $ |
| Fan |  | X |  | X |  | X | $ | = | $ |
| Hair dryer |  | X |  | X |  | X | $ | = | $ |
| Heater (space/air) |  | X |  | X |  | X | $ | = | $ |
| Iron, steam |  | X |  | X |  | X | $ | = | $ |
| Microwave oven |  | X |  | X |  | X | $ | = | $ |
| Oven |  | X |  | X |  | X | $ | = | $ |
| Rangetop burner (stove)(per burner) |  | X |  | X |  | X | $ | = | $ |
| Stereo (all components) |  | X |  | X |  | X | $ | = | $ |
| Swimming pool filter pump & sweep |  | X |  | X |  | X | $ | = | $ |
| Tablet Charger |  | X |  | X |  | X | $ | = | $ |
| Television (size: \_\_\_\_\_\_\_\_\_\_\_\_\_\_) |  | X |  | X |  | X | $ | = | $ |
| Toaster |  | X |  | X |  | X | $ | = | $ |
| Toaster Oven |  | X |  | X |  | X | $ | = | $ |
| Vacuum cleaner |  | X |  | X |  | X | $ | = | $ |
| Other: |  | X |  | X |  | X | $ | = | $ |
| Other: |  | X |  | X |  | X | $ | = | $ |
| Other: |  | X |  | X |  | X | $ | = | $ |
| Other: |  | X |  | X |  | X | $ | = | $ |
| Other: |  | X |  | X |  | X | $ | = | $ |
| Other: |  | X |  | X |  | X | $ | = | $ |

***\*Note****: Many homes have GAS heaters, clothes dryers, stoves and ovens, rather than electric.*

\*\*Please make sure to include any others that might be applicable.

 **TOTAL FROM THIS SIDE**: $\_\_\_\_\_\_\_\_\_\_\_\_\_

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Lighting: approximately 100 kWh per month (*adjust?*) \_\_\_\_\_\_\_\_\_\_\_\_\_ | X | $ | = | $ |
| Water heater\*: approximately 350 kWh per month (*adjust?*) \_\_\_\_\_\_\_\_ | X | $ | = | $ |
| Refrigerator/freezer: approx. 125 kWh per month (*adjust?*) \_\_\_\_\_\_\_\_ | X | $ | = | $ |
| Freezer: approximately 100 kWh per month (*adjust?*) \_\_\_\_\_\_\_\_ | X | $ | = | $ |
| Clothes washer: \_\_\_\_\_ loads per month X .25 kWh per load | X | $ | = | $ |
| Clothes dryer\*: \_\_\_\_\_ loads per month X 5 kWh per load | X | $ | = | $ |
| Dishwasher (normal cycle) \_\_\_\_\_ loads per month X 1 kWh per load | X | $ | = | $ |
| Dishwasher(energy saver cycle) \_\_\_\_\_ loads per month X .5 kWh per load | X | $ | = | $ |
| Self-cleaning oven\*: \_\_\_\_\_ cleanings per month X 6 kWh per cleaning | X | $ | = | $ |
| Other : | X | $ | = | $ |
| Other: | X | $ | = | $ |
| Other: | X | $ | = | $ |

\***NOTE**: *Many homes have GAS water heaters, stoves, ovens and clothes dryers.*

 TOTAL FROM THIS SIDE: $\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

 TOTAL FROM OTHER SIDE: $\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

 **TOTAL FROM BOTH SIDES**: $\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

**Electrical portion of your utility bill**: $\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

**How close did you calculated total come to your actual electric bill?** How do you explain any significant difference (over 10%) difference?

*Percent difference* =

*Explanation*

**Use the following equivalences in calculating answers to Exercises 1-5.** Be sure to show the steps of your work, including set-ups and proper units, as well as final answers.

1 kWh = 3.41 x 103 BTU (British Thermal Units)

1 BTU = 2.93 X 10-4 kWh

1 BTU = 1,055 J (joules)

12,000 BTU = 3.52 kWh = 1.27 X 107 J

1 pound bituminous coal = 12,000 BTU

1 barrel oil = 5.6 X 106 BTU = 5.91 X 109 J

1 ft3 natural gas = 1,030 BTU = 1.09 x 106 J

1. g 235U = 4.0 X 107 BTU = 4.22 X 1010 J
2. Calculate your **yearly energy** use:
3. How much electrical energy do you consume each day, on average?
4. How much would that be each year?

2. Suppose the electricity in your region was supplied by the burning of **natural gas**. *Use your yearly estimate.*

1. How many cubic feet of natural gas is needed to support your energy lifestyle?
2. 1,000 ft3 of natural gas contains about 20.2 kg of methane and when burned completely produces 122 lb of carbon dioxide. How much methane would you consume in one year?
3. How many pounds of carbon dioxide would you produce?

3. Suppose **coal** were used in the generators instead of natural gas. *Use your yearly estimate.*

1. How much coal would be burned to provide your energy?
2. When coal is burned, about 2.3 lb of CO2 is produced for every kilowatt of electrical energy consumed. How much carbon dioxide would be produced by your yearly electrical use?

4. Suppose electrical power was produced by **nuclear power**. How much uranium would be needed to support your yearly consumption? *Use your yearly estimate.*

5. **Calculate comparative costs**.

1. The cost for U3O8, the primary nuclear reactor fuel, is $66.36 per pound, or about $0.146 per gram. What would be the cost of the uranium needed to generate your electricity?
2. Coal costs about $71.25 per ton. Calculate the cost of this fuel to produce your yearly electricity.
3. The cost of natural gas for electric utilities is on the average $12.00 per 1,000 cubic feet. Calculate the cost of this fuel to produce your yearly electricity.

6. **Compare the pros and cons** of using these fuels to produce electricity on a large scale.

1. Is the cheapest fuel necessarily the best choice? Explain your reasoning in economic, social and environmental terms.

1. Discuss in some detail extraction, processing, transportation, burning, waste products, and health and safety aspects of the problem.

1. Outline 5 ways to reduce the use of electrical power in your everyday life.