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**Conscientious Energy Consumer**

Adapted by Alliance to Save Energy, December 2012

**Lesson 2: Calculating Appliance Costs**

It is recommended that “Conscientious Energy Consumer Lessons 1, 2 and 3 be taught together. Lessons 1 and 2 can be used as stand-alone lessons. Lesson 3 relies on Lesson 1 and should be done after completing Lesson 1, although it can be modified to become a stand-alone lesson.

**Grade Level:** 5-8

**Subject**: Science, Mathematics,

**Length**: one 45-minute class period

**Road Map:** Appliances

**Common Core Standards: TBD**

**National Science Standards: A, B, E, F\***

 \*will be updated when NGSS are finalized

**Vocabulary:**

power

 watt

 kilowatt

kilowatt hour

 wattage rate

**Lesson Objectives:**

During this lesson, students will:

* Calculate and compare operating energy costs of appliances.

**Lesson Overview**

Students calculate costs for common appliances, and evaluate criteria for selecting appliances.

**Essential Questions:**

* What criteria that should be used to select common household appliances?
* What role does the cost of using the appliance play in the selection?

**Materials Needed:**

Pencils, calculator, and the following:

 *Lesson Resources***:**

2-A – Appliance kWh and Cost page

*Student Worksheets***:**

#2-1 – Appliance Calculations (optional)

**Background**

**Appliances We Own**

A recent survey by the Department of Energy showed that over one-half of American households have some form of air conditioning, one-third have two or more television sets, over one-third have separate freezers and 13 percent have two or more refrigerators. How much electricity do these appliances consume and do we really need all the appliances we buy?

**Wattage Rate**

**Power** is the measure of the rate at which electricity is used, and it is measured in **watts**. A **kilowatt** is equal to 1,000 watts. **Wattage rate** is the rate at which an appliance uses electricity; i.e. the power that an appliance uses. The standard unit of measure for wattage rate is a watt.

Power (measured in watts) and time are multiplied to find the total amount of energy used or the **kilowatt hour** rating of an appliance (Energy = Power x Time). A kilowatt hour is used as the basis for determining the cost of electricity. One kilowatt hour is equal to 1,000 watts of electricity used for one hour. A small portable heater rated at 1,000 watts would use one kilowatt of electricity in one hour, as would ten, 100-watt light bulbs.

**Calculations for Yearly Appliance Costs**

The formula for determining the kilowatt hour cost for an appliance on a yearly basis is:

Yearly cost =

Wattage rate of appliance $X$ $ \frac{ 1 kW}{1000 W } (to convert to kw) X \frac{avg \# hours appliance is used }{year }$ X $\frac{cost}{kWh}$ .

For example: How much does it cost to use an air conditioner which has a wattage rating of 3,860 watts, operates an average of 60 hours per month, and the cost per kWh is 12 cents?

**Step 1:** Change the wattage rating of the air conditioner to kilowatts:

3860 watts $X \frac{ 1 kW}{1000 watts }$ = 3.86 kilowatt (kW)

**Step 2:**

Estimate the average number of hours the air conditioner may be used per year:

$$\frac{60 hours}{month} x \frac{12 months}{year}= \frac{720 hours}{year}$$

**Step 3:**

Calculate the kilowatt hours used per year

3.86 kW$ × \frac{720 hours}{year}$ = 2,779.2 $\frac{kWh}{yr}$ rounded to 2,779 $\frac{kWh}{yr}$ .

**Step 4:**

Determine the cost per year, using $0.12 as the price of one kilowatt hour:

$\frac{2,779 kWh}{yr}$ x $ \frac{\$ 0.12 }{kWh } $= $ \frac{\$33.48}{yr}$ .

**Informed Consumers**

It is up to the consumers to become well informed about electrical appliances they want to purchase. Initial cost, longevity, and operating expenses should be considered.

**Procedure**

**Preparation:**

1. Duplicate student worksheet 2-1.
2. Prepare Lesson Resource 2-A so that it can be seen by all students during discussion. (individual copies, computer projection, or chart, etc.)

**Engagement:** (Science, Math)

Ask students to identify electrical appliances used in their home. List these on the board. Have students estimate the number of hours they use each appliance and how much they think it might cost to run that appliance for a year. Continue the discussion with the following questions:

* Which appliances do you think are the most expensive to operate?
* Which do you think are the least expensive? *(Answers will be determined in the Activity.)*
* How can we calculate the cost of running appliances? *(See background information.)*
* What steps can we take to figure out the cost? *(See background information.)*
* What information do we need to know in order to do this? *(See background information.)*

**Activity: *Energy Use*** (Science, Math)

1. Ask students to find the wattage rating of at least 5 appliances in their home and record them on Student Worksheet #2-1. The wattage rate is usually indicated on a data plate on the back or bottom of the appliance. If it is not in plain view, students should unplug the appliance before continuing to search for the rate. (Students could volunteer to gather data for specific appliances so that the wattage of all listed appliances can be surveyed.)
2. Have students estimate the number of hours per month the appliance is used.
3. Review instructions on the student worksheet to show students how to perform the calculations to determine the kilowatt hours used per year.
4. Finally, have students calculate the cost per year of the appliance.
5. After appliance wattage data has been gathered and calculations have been made, record the wattage rates on Resource 2-A, Column A and the calculations in Column C, E, and G. If different wattages for a similar appliance were discovered, have students calculate the average wattage. Compare student figures in Column A to Column B figures derived from the Edison Electric Institute Publication. The figures in Columns A and B may differ because certain brands of appliances are more energy efficient.
6. Review Column C and D for estimated average hours used for each appliance. Note that these are averages and that heating and cooling hours can vary greatly based on the climate of an area, as well as the structure, design, size, and age of a home. Compare Columns E and F, as well as G and H. Discuss with students:
* Which appliances are the most expensive to use yearly? *(High wattage / high use appliances, which can be seen by looking at the list on handout, Resource 2-A.)*
* Which appliances use the most energy per hour, yet do not use a lot of energy each year? *(High wattage appliances which are not used very much.)*
* How does the students’ ranking of the appliances (Lesson 1) compare with their costs? Which appliances are worth their cost per year? Which are not? *(Answers will vary.)*
* Identify appliances whose operational costs could be lowered through use of conservation measures. *(Answers will vary. Refer to handout Resource 2-A.)*

**Closure and Informal Assessment:** *(Answers will vary.)*

1. If you could only use 9,500 kWh of energy a year, which appliances would you choose? Are these appliances considered to be essential? Are they “needs” or “wants”?
2. Which 5 appliances would you now consider essential? Why? Which 5 are now unnecessary? Why? How do your answers differ from the ones on Worksheet #1-1?
3. What is the major reason a person might purchase a particular brand of appliance? *(Brand recognition, purchase price, operating cost, energy efficiency, appearance are some possible answers.)*
4. Is considering energy cost of an appliance important? *(Yes.)* Why? *(Energy cost of an appliance can affect the total household budget.)* Will it be more important in the future? Why? *(Answers will vary.)*

**Assessment**

1. Give students the data (wattage rating and estimated average hours used) for an appliance not listed on Resource 2-A, and ask them to calculate kWh used per year and cost per year to run that appliance.
2. Ask students to write a persuasive letter to an audience of their choice to convince the audience not to use or buy a specific appliance or to use a specific appliance less. (This assessment can be done following any of the three Conscientious Energy Consumer lessons, although will be most effective following all three lessons.)

**Extensions:**

(These extensions can be completed after lesson 1 or following the completion of both lessons.)

1. Compare features of appliances identified in this lesson to criteria used for evaluation in consumer publications (e.g., Consumer Reports).
2. Ask the class to invent the world’s most useless appliance (e.g., a watermelon seeder or an electric nail clipper). They may want to spend some time embellishing their designs.

**Additional Resources:**

Estimating Appliance and Home Electronic Energy Use, *U.S. Department of Energy*

<http://energy.gov/energysaver/articles/estimating-appliance-and-home-electronic-energy-use>

Consumer Reports appliance comparison: <http://www.consumerreports.org/cro/appliances/index.htm>

Good Housekeeping appliance comparison: <http://www.goodhousekeeping.com/product-reviews/appliances/>

**Credits:**

Lesson by Alliance to Save Energy, December 2012.

Resource 2-A

APPLIANCE kWh AND COST

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | (A)Class Wattage Rating Figures | (B)Average Wattage | (C)Class Estimate of Average Hours Used | (D)Average Hours per year | (E)Class Estimate of kWh Used per year | (F)kWh Used per year | (G)Class Estimate of Cost per year | (H)Average Cost per year ($0.15 per kWh) |
| Air Conditioner |  | 3,750 |  | 1,000 |  | 3,750.0 |  | $375.00 |
| Fan, Window |  | 200 |  | 850 |  | 170.0 |  | $17.00 |
| Blender |  | 386 |  | 39 |  | 15.1 |  | $1.51 |
| Coffee Maker |  | 894 |  | 119 |  | 106.4 |  | $10.64 |
| Deep Fryer |  | 1,448 |  | 57 |  | 82.5 |  | $8.25 |
| Dishwasher |  | 1,201 |  | 302 |  | 362.7 |  | $36.27 |
| Microwave Oven |  | 1,450 |  | 131 |  | 190.0 |  | $19.00 |
| Mixer |  | 127 |  | 102 |  | 13.0 |  | $1.30 |
| Range with Oven |  | 12,200 |  | 96 |  | 1,171.2 |  | $117.12 |
| Toaster |  | 1,146 |  | 34 |  | 39.0 |  | $3.90 |
| Waffle Iron |  | 1,116 |  | 20 |  | 22.3 |  | $2.23 |
| Refrigerator-freezer, 14 cu ft |  | 326 |  | 3,488 |  | 1,137.1 |  | $113.71 |
| Refrigerator-freezer, 14 cu ft frostless |  | 615 |  | 2,974 |  | 1,829.0 |  | $182.90 |
| Curling Iron |  | 40 |  | 50 |  | 2.0 |  | $0.20 |
| Hair Dryer |  | 750 |  | 51 |  | 38.3 |  | $3.83 |
| Shaver |  | 14 |  | 129 |  | 1.8 |  | $0.18 |
| Toothbrush  |  | 7 |  | 71 |  | 0.5 |  | $0.05 |
| DVD Player |  | -- |  | 1hr/day |  | -- |  | -- |
| Radio |  | 71 |  | 1,211 |  | 86.0 |  | $8.60 |
| Television (color) |  | -- |  | 4hr/day |  | -- |  | -- |
| Television |  | -- |  | 4hr/day |  | -- |  | -- |
| Video Games |  | -- |  | 1hr/day |  | -- |  | -- |
| Clock |  | 2 |  | 8,760 |  | 17.5 |  | $1.75 |
| Garage Door Opener |  | 350 |  | 30 |  | 10.5 |  | $1.05 |
| Vacuum Cleaner |  | 630 |  | 73 |  | 46.0 |  | $4.60 |
| Clothes Dryer |  | 4,856 |  | 205 |  | 995.5 |  | $99.55 |
| Washing machine (automatic) |  | 512 |  | 208 |  | 106.5 |  | $10.65 |
| Water Heater |  | 4,474 |  | 1,075 |  | 4,809.6 |  | $480.96 |

\*\*\*Number of hours used varies widely.

**WORKSHEET #1-1: Appliance Survey**

1 = Essential (You can’t live without it)

2 = Convenient (It makes life easier)

3 = Unnecessary (You can really live without it!)

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| --- | --- | --- | --- |
| **ELECTRIC APPLIANCE** | Student Ranking | Adult 1 Ranking | Adult 2 Ranking |
| Air conditioner |  |  |  |
| Blender |  |  |  |
| Cell Phone Charger |  |  |  |
| Clothes Dryer |  |  |  |
| Coffee Maker |  |  |  |
| Computer |  |  |  |
| Dishwasher |  |  |  |
| DVD Player |  |  |  |
| Electric Blanket |  |  |  |
| Fan |  |  |  |
| Hair Dryer |  |  |  |
| Iron |  |  |  |
| Microwave |  |  |  |
| Mixer |  |  |  |
| MP3 Player |  |  |  |
| Radio |  |  |  |
| Refrigerator/Freezer |  |  |  |
| Stereo |  |  |  |
| Stove / Oven  |  |  |  |
| TV |  |  |  |
| Toaster |  |  |  |
| Video game console |  |  |  |
| Washing Machine |  |  |  |
| Water Heater |  |  |  |

**WORKSHEET #2-1: Appliance Calculations**

List 5 appliances that you have at home and record their wattage rating. To find this rating, check the back or underneath the appliance. (If it is not in plain view, unplug the appliance before you continue to search for the rating.)

**CALCULATIONS**

**Power** is the measure of the rate at which electricity is used, and it is measured in **watts**. A **kilowatt** is equal to 1,000 watts. **Wattage rate** is the rate at which an appliance uses electricity; i.e. the power that an appliance uses. The standard unit of measure for wattage rate is a watt. Wattage rate is converted to kilowatts by multiplying by the conversion factor $\frac{1 kW}{1000 W}$ and then multiplied by the amount of time the appliance was on (in hours) to find the kilowatt hour rating for each appliance. A kilowatt hour is equivalent to 1,000 watts used for 1 hour.

The formula for determining the kilowatt hour cost per year is:

Wattage rate of appliance $X$ $ \frac{ 1 kW}{1000 W } (to convert to kw) X \frac{avg \# hours appliance is used }{year }$ X $\frac{cost}{kWh}$ .

For example:

1. Suppose that an air conditioner has a wattage rating of 3,860. This can be expressed in kilowatt(s) by converting watts to kilowatts using this formula:

3860 watts $X \frac{ 1 kW}{1000 watts }$ = 3.86 kilowatt (kW).

2. Next, estimate the average number of hours that this air conditioner was used in one year. Determine this by estimating the number of hours it might have been used per month. If this air conditioner was used 60 hours a month for 12 months, the total would be

$$\frac{60 hours}{month} x \frac{12 months}{year}= \frac{720 hours}{year}.$$

3. Then, calculate the kilowatt hours used per year. Multiply the kilowatts by the average hours the air conditioner was used in one year:

3.86 kW$ × \frac{720 hours}{year}$ = 2,779.2 $\frac{kWh}{yr}$ rounded to 2,779 $\frac{kWh}{yr}$ .

4. Finally, determine the cost per year to operate the appliance. Multiply the kilowatt hours used per year by the cost of one kilowatt which is about $0.12;

$\frac{2,779 kWh}{yr}$ x $ \frac{\$ 0.12 }{kWh } $= $ \frac{\$33.48}{yr}$ .

The estimated cost per year for the air conditioner in the example is $333.48 per year.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| APPLIANCE | WATTAGE RATING (W) | KILOWATT(S) | AVERAGE HOURS USED PER YEAR | kWh USED PER YEARKilowatts X Avg Hours | COST PER YEARkWh used X $.12 |
| Air Conditioner |  3,860 | 3,860/1000 = 3.86 | 720 |  2,779 |  $333.48 |
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