The Cost of Using Energy

Students calculate the cost of energy used by various products found in the home and at school.

Grade Level: 5–8 (9-12)

Subject Areas: English Language Arts, Family and Consumer Science, Mathematics, Science, Technology Education

Setting: Classroom

Time:
Preparation: 30-45 minutes
Activity: One to three 50-minute periods, depending on how many ***Life Cycle Cost Comparison*** sheets are to be completed.

Vocabulary: Life cycle cost, Lumen, LED (Light Emitting Diode) light bulb

Major Concept Areas:

- Quality of life
- Management of energy resource use

Getting Ready: You may want to gather specific energy cost information from a local utility or a service station.

Objectives

Students will be able to

- calculate the cost of energy used by various products; and
- compare the costs of buying and operating lights and appliances.

Rationale

Calculating energy costs and comparing the costs of buying and operating standard and energy-efficient products enables students to make informed choices when purchasing products that use energy.

Materials

- An incandescent light bulb (optional)
- A 10 to 12-watt LED light bulb with the same or similar light output as the incandescent light bulb (optional)
- Copies of one or more of the following ***Life Cycle Cost Comparison*** sheets, depending on your classroom needs:
  - ***Life Cycle Cost Comparison: Light Bulbs***
  - ***Life Cycle Cost Comparison: Refrigerators***
  - ***Life Cycle Cost Comparison: Cars***
- Find additional resources related to this activity on keepprogram.org > Curriculum & Resources

Background

Mr. Jones buys a 60-watt incandescent light bulb for 42 cents. Ms. Smith buys a 10.5-watt LED light bulb that puts out a similar amount of light for $4.00. The incandescent bulb Mr. Jones bought is obviously the better buy, Or is it?

Do we know how much it costs to operate the lights and appliances we have or to fuel the cars we drive? Will buying efficient lighting, appliances, and cars save money in the long run even though they may cost more than their less efficient counterparts? By answering questions like these, we can find ways to save money and use energy more efficiently.

Determining the cost of the energy we use begins with finding information on energy prices. Gasoline prices are available online or from a nearby service station. Electric and natural gas rates are printed on utility bills. If energy prices are not easily available, average Wisconsin electricity prices for 2017 are included in the ***Life Cycle Cost Comparison*** sheets that accompany this activity.

The next step is to calculate the total cost of energy that products use. A general formula that does this is:

Amount of energy used x energy price per unit of energy = total cost of energy

For example, suppose a car used 10 gallons of gasoline last week. If gasoline cost $2.50 per gallon, then the total cost for the gasoline used is:

10 gallons x $2.50 per gallon = $25.00 per week

This formula can also be used to calculate the total cost of energy used by lights, home appliances, or any other products that use energy. See the Life Cycle Cost Comparison Sheets that accompany this activity for more examples of calculations.

This method of calculating total energy costs can also be used to compare the total energy costs of similar models of products. Comparing items in terms of total energy costs can reveal the model with the lowest total energy costs over time. Choosing this model over others with higher total energy costs would save the buyer money. For example, suppose we compare the cost of fuel per year for two new cars. The purchase cost of the cars is the same, but the first car has an overall fuel efficiency of 25 miles per gallon (mpg) and the second car has an overall fuel efficiency of 30 mpg. Assume that both cars will be driven an average of 13,000 miles during the year, and the average price of gasoline will be $2.50 per gallon. The fuel costs per year for each car can be calculated using the following formula:

15,000 miles per year X $2.50 per gallon/vehicle mpg = fuel cost per year

The fuel cost per year of the first car is:

15,000 miles per year X $2.50 per gallon/25 mpg = $1,500.00 per year

The fuel cost per year of the second car is:

15,000 miles per year X $2.50 per gallon/30 mpg = $1,250.00 per year

The second car, with an overall fuel efficiency of 30 miles per gallon, has lower fuel costs per year than the first car. Buying the second car would save its owner $250 in fuel costs each year. In addition, fuel cost savings from driving the second car will increase if the price of gasoline increases beyond $2.50 per gallon. Therefore, based on this comparison, the second car is the better buy in terms of fuel costs.

Although choosing products that have lower energy costs is important, it is not the kind of cost information consumers usually look for when deciding which product to buy. Consumers are more likely to compare retail process between product types and will often choose the cheapest one. However, buying a product based only on the lowest retail price may not save money in the long run, because products with the lowest retail price often use more energy and have higher energy costs than similar, more energy-efficient products with higher retail prices. Cheaper, less efficient products may also have shorter useful lives than their more efficient counterparts, so they may need to be replaced more often. For example, an incandescent light bulb may last only 1,000 hours while an LED bulb may last 15,000 hours. Therefore, fifteen incandescent light bulbs would be needed to equal the useful life of one LED bulb.

Accounting for the retail price of a product and the total cost of energy it uses during its useful life is known as calculating the life cycle cost of the product. A simplified formula for calculating the life cycle cost is:

Retail price of product + ([energy cost/year] X [useful life in years]) = life cycle cost

Life cycle cost calculations can show consumers the total amount of money they will have to spend on the product over its useful life. When life cycle costs between products are compared, the one with the lowest life cycle cost turns out to be the better buy in the long run. These products are often the most energy efficient. (see ***Life Cycle Cost Comparison*** sheets to further investigate these calculations.)

A sound understanding of the relationship between energy costs and energy use has many benefits. Knowing how much money we spend on energy to run the products we use can lead to ways of using these products more wisely, thereby saving money as well as energy. Knowing how to compare energy costs of similar products can help us choose products that save energy costs over time. Fortunately, many products that save on energy costs are energy efficient and yield environmental benefits as well.

Additional Background

From "At Watt Rate?"

Young children's awareness of where energy comes from and how it is used often reflects their everyday and immediate experiences. In their minds, the gasoline for cars simply comes from a service station. The electricity that runs the lights and appliances in homes and schools comes from flipping a switch or plugging an appliance in a wall outlet. The heat used to warm homes and schools is produced by a boiler or furnace that is usually located in the basement of the building. As children get older they are more likely to possess a greater awareness of where energy comes from and how it is used. Gasoline is made from crude oil. Electricity is produced by a power plant and transmitted by power lines. By middle school age, students have a better appreciation for the various energy sources, such as natural gas, fuel oil, electricity, propane, and wood that can be used to heat a home or school. They begin to recognize that our society needs large quantities of energy to keep going.

While we have some understanding about where energy comes from, a greater awareness of how we use energy (energy use patterns) can lead to better ways of managing energy use. We know that our homes use electricity, but we don't know how the electricity required for the lights in the kitchen compares to the amount used by the television in the den.

We use energy for lighting rooms, heating and cooling our homes, heating water, and refrigerating food as well as numerous other activities. Such energy uses can be categorized by devices, products, and systems that use energy for the same or for similar purposes. These categories are called energy end uses.

A typical house in Wisconsin uses several types of energy to power its various end uses. About two-thirds of Wisconsin homes use natural gas for space heating and the rest use fuel oil, liquid propane gas, electricity, or wood. More than half of Wisconsin homes use natural gas for water heating and most of the rest use electricity. Most homes also use electricity for cooling, refrigeration, and lighting.

One way to better understand our energy use patterns is to conduct an end use survey. Conducting energy end use surveys not only increases our awareness of how we use energy in our lives, but also helps us decide how to use energy more efficiently.

Calculating how much energy is used by the electrical appliances and equipment in our homes and schools makes us aware of which ones use large amounts of energy and which ones do not. This can lead us to adopt strategies for using appliances and equipment more efficiently and prompt us to buy new, more efficient appliances and equipment when older ones need to be replaced. Although improving the efficiency of all electrical appliances and equipment saves energy and lowers utility bills, focusing efficiency improvements on those that are large energy users should be the first priority.

Additional Background

From "So You Want to Heat Your Home?"

It is no surprise to Wisconsinites that most of the energy they use in their homes or apartments is for keeping warm during the winter. The amount of money spent on heating is also significant. The average homeowner may spend $485 to over $2,400 on energy per heating season, depending on the efficiency of the heating system and the type of energy. Given such a cost range, it makes sense for homeowners who wish to replace their old heating system to compare the efficiency and energy costs of new systems before buying one.

The majority of homes in Wisconsin use furnaces or boilers that burn natural gas, fuel oil, or propane (also called liquid petroleum gas, or LPG). Electric baseboard heat is used in some houses and apartments. Wood-burning stoves are especially popular in rural areas and in the northern part of the state, where wood supplies are plentiful and access to other fuels is restricted (see ***Information about Different Home Heating Systems***).

There are several important factors to consider when assessing a home heating system. The first factor is efficiency—the percentage of the energy that is converted into useful heat. For instance, a 15- to 20-year-old fuel oil or natural gas furnace may be 60 percent efficient, meaning that 60 percent of the energy from the oil or gas is transferred to the interior of the home. Most of the other 40 percent of the energy is lost when exhaust gases are vented up the chimney and outside, and the rest is lost warming up the furnace itself, or is used to restart the furnace after it has cycled off. The efficiency of new heating systems using natural gas, fuel oil, propane, and wood has improved considerably in recent years, and higher efficiency models are now widely available. Heating system efficiency does not vary much with the size of the system; the efficiency of a large-sized gas furnace used in a large house is not much different than that of a small-sized gas furnace used in a small house.

Energy cost is another important factor to consider when assessing a home heating system. Comparing energy costs requires thoughtful analysis because different energy types have different units of measurement and different price structures, as shown in the ***Heating Your Home with a New Heating System Data Table***. For example, the cost of fuel oil is set in dollars per gallon, while electricity is priced in cents per kilowatt-hour (kWh), and firewood is priced in dollars per cord.

In the United States, the commonly used unit of measure for space heating is the British Thermal Unit (Btu). One Btu is the amount of energy needed to raise the temperature of one pound of water by one degree Fahrenheit. A four-inch wooden kitchen match releases about one Btu of heat when it is burned. A typical Wisconsin home uses between 50 to 100 million Btu of heat each year (depending on the size of the home, quality of construction, and severity of winter weather). In order to compare different types of heating systems, it will be necessary to convert from Btu of heat into the units that are commonly used for sale of different energy sources.

A third important factor in assessing a home heating system is the cost of the system itself. High efficiency furnaces and boilers generally cost a few hundred dollars more than their less efficient counterparts. On the other hand, using a high-efficiency furnace or boiler often leads to noticeably lower energy bills during the course of Wisconsin's long heating season, and the savings in energy costs will often pay for the extra purchase cost of the high-efficiency systems after a few years. Electric baseboard systems are less expensive than furnaces or boilers, but high electricity costs offset this advantage. There is no direct relationship between the cost of a woodstove and its efficiency. Because heating system costs vary widely, the best sources for cost information are local heating contractors, utilities, or woodstove distributors.

Other factors to consider when assessing a home heating system are availability of the energy source in a given locale and, if needed, the cost of air ducts, pipes, fuel tanks (fuel oil and propane), and other auxiliary equipment.

The recent trend toward high-efficiency heating systems benefits homeowners and the environment. By choosing the right combination of an efficient heating system and low-cost energy source, the homeowner can save money in the long-term. High-efficiency heating systems also reduce energy use, which reduces air emissions and contributes to prolonging the supply of energy resources.

Additional Background

From "Reading Utility Bills"

Once a month, local electric and natural gas utilities send out bills reminding consumers that the energy they use is not free. Customers respond by writing a check for the amount due or paying online. Beyond that, many

Heating Your Home with a New Heating System Data Table

Retail prices are Wisconsin averages for the winter of 2014-2015. Since prices vary regionally and change frequently, your teacher may provide updated data for your specific location.

Energy Source	New Heating System	Efficiency	Commonly Used Unit of Sale	Btu per Unit of Energy	Retail Price
Natural Gas	High Efficiency Gas Furnace	95%	therm	100,000 Btu per therm	$0.74 per therm
Fuel Oil	High Efficiency Oil Furnace	85%	gallon	138,690 Btu per gallon	$2.80 per gallon
Electricity	Baseboard Heaters	100%	kilowatt-hour	3,413 Btu per kilowatt-hour	$0.14 per kilowatt-hour
Propane (LPG)	High Efficiency Propane Furnace	95%	gallon	94,475 Btu per gallon	$1.79 per gallon
Wood (Dry Hardwood Delivered)	High Efficiency Woodstove	83%	cord	21,000,000 Btu per cord	$315 per cord

customers do not give their utility bills much thought. However, the utility bill contains a great deal of valuable information for the customer.

One important piece of information found on a utility bill is the amount of electricity or natural gas used. Electric and natural gas use is determined by reading a meter located at the customer's home or business. Electric meters directly measure electric energy use in units of kilowatt-hours (kWh). Natural gas meters, however, do not directly measure the amount of energy in the gas that is used. Instead, they measure the volume of the gas in units of hundred cubic feet (abbreviated as ccf, where the first "c" stands for the Roman numeral one hundred) or thousand cubic feet (abbreviated as mcf, where the "m" stands for the Roman numeral one thousand). Natural gas meters measure volume because different sources of natural gas contain slightly different amounts of energy per unit of volume. After the volume of natural gas is measured, the amount of natural gas energy used is calculated by multiplying the volume by natural gas energy units called therms. This calculation is shown on the bill.

Other important pieces of information found on a utility bill are electric and natural gas rates. The rate is the cost of the electricity or natural gas per unit of energy. Electric rates are expressed in dollars (or cents) per kilowatt-hour, and natural gas rates are expressed in dollars (or cents) per therm. Electric and gas rates are often made up of at least two separate rates—one rate covers the utility's cost of generating or purchasing and obtaining each unit of energy and the other rate covers the cost of handling these units of energy within the utility's service territory. Utilities determine these rates based on the costs they must pay to provide electric or natural gas service plus their profit margin. Rates change over time, and utilities may change the way they report their rates as well.

The total cost for electric and natural gas service is calculated using energy use and rate information. In addition, the utility often includes a monthly customer charge to cover the cost of providing and reading meters, maintaining electric and natural gas lines, and processing bills. Other billing information includes meter reading dates, bill payment due dates, the customer's account number, and heating or other weather-related information.

Billing information may be reported differently by different utilities; there is no standard format. Bills may also differ from customer to customer. Some customers may only use electricity, a few may only use natural gas, and others may have special rates or provisions associated with their service. Businesses and industries generally use much more energy than residential customers and as a result, usually purchase electricity and natural gas at lower rates.

Comparing a set of utility bills can reveal a great deal of information about how a consumer uses energy over the course of a year. For instance, billing information can show whether a natural gas customer uses this fuel to heat his or her home, or whether an electric customer uses air conditioning during the summer. Billing information can also show whether a customer has made improvements in energy efficiency. If a natural gas customer adds insulation to an attic or replaces an old natural gas furnace with an energy-efficient one, the results will show up on the bill as reduced natural gas use. Billing information can also show when a customer has increased his or her energy use, and may suggest actions that can be taken to avoid similar increases in the future.

Procedure

Orientation

Discuss the following scenario with students:

Mr. Jones buys a 60-watt incandescent light bulb for 42 cents. Ms. Smith buys a 10.5-watt LED bulb that puts out nearly the same amount of light for $4.00. Which light is the better buy?

Ask students if they think the cost of electricity used by the bulbs is important, and then ask which consumer will save money in the long run. Record answers on the board or elsewhere so they can be reviewed later. Have students explain the reasons for their answers.

Tell students that they will be learning how to answer questions like these by conducting life cycle cost comparisons for different products.

Steps

1. Depending on which ***Life Cycle Cost Comparison*** sheet students complete, you may want to review the definition of life cycle costs and sample calculations (see **Background**; see also examples of calculations found on the sheets).

2. Assign students to one of the three ***Life Cycle Cost Comparison*** sheets for light bulbs, refrigerators, and/or cars. You may have the class complete the same

sheet or break the class up into three groups and have them complete a sheet for each item. Be sure to review the information found at the beginning of the ***Life Cycle Cost Comparison*** sheets with the class so that they understand how to use the information to complete a life cycle cost analysis.

Closure

Have students discuss the answers to the questions on the ***Life Cycle Cost Comparison*** sheets. You may also want to review the scenario discussed in the **Orientation** and have students revise their answers based on the sheets they completed.

Discuss with students the connection between using energy-efficient products and the cost of using energy. Do students think that energy efficiency is cost-effective overall? What existing barriers might prevent people from buying more energy-efficient products?

Use the results from the ***Life Cycle Cost Comparison*** sheets and the Action Ideas: “Energy Efficiency Measures” from the Energy Sparks section to create an energy management plan.

Assessment

Formative

- How well did students complete the different ***Life Cycle Cost Comparison*** sheets?
- Were students able to give reasons why they would buy a particular product based on its energy and life cycle costs?

Summative

Students could perform life cycle cost analyses for products not covered in the ***Life Cycle Cost Comparison*** sheets, such as flat screen televisions, water heaters, home heating systems (see **Background** for life cycle cost information).

Students could also conduct research to see if there are cases where a more energy-efficient product is also cheaper to buy than its standard, less-efficient counterpart, or if there are energy and life cycle cost benefits to buying used versus new items (e.g. cars).

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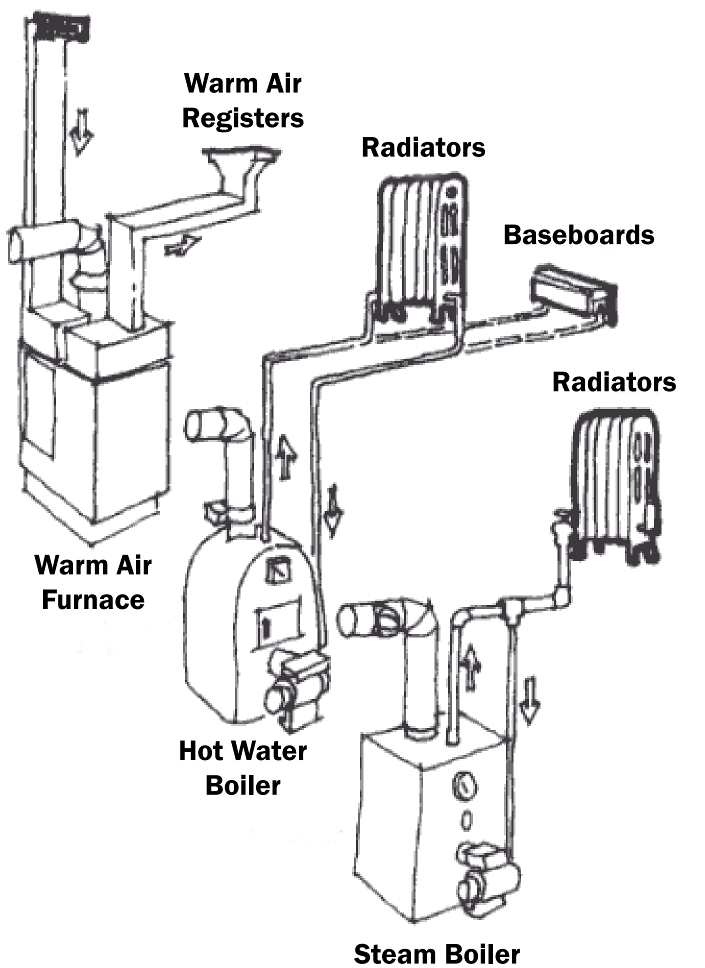
Information about Different Home Heating Systems

Natural gas and fuel oil are burned in furnaces or boilers. A furnace heats air, which is then distributed by air ducts throughout the house. A boiler may heat water to a high temperature or may turn it into steam. The hot water or steam is then piped to radiators located in different rooms of the house and piped back to the boiler after some of the heat is transferred to the rooms. The highest efficiency for natural gas furnaces is 96 percent, while high-efficiency oil furnaces and boilers, as well as natural gas boilers, achieve ratings of up to 86 percent.

Propane is often used to heat rural homes that do not have access to natural gas lines. Similar in composition to natural gas, propane is stored in liquid form in pressurized tanks and converted to a gas when released for burning. Propane furnaces and boilers generally have the same efficiencies as those burning natural gas (as listed above).

Electric heating systems use baseboard heaters made of wire elements that heat up when current passes through them, much like portable electric space heaters used to warm individual rooms. Baseboard heating is 100 percent efficient because all the electrical energy is converted into heat by the heating elements. On the other hand, when the efficiency of electric power plants and transmission lines are taken into account, electric heating is usually not as efficient as other heating systems. Because of its expense, electricity is not used as much for home heating. Very energy-efficient homes and apartments with small living areas use electric heat more often.

Furnaces heat air, while boilers heat water



Woodstoves are preferred over fireplaces for heating a home with wood. High quality woodstoves achieve efficiencies of 90 percent. Despite their appeal, fireplaces in most houses are only 10 to 15 percent efficient at best, and many lose more heat than they provide. Therefore, using a fireplace to heat a home is not recommended, unless it is custom designed and operated specifically for efficient heating. Wood used for home heating is sold in units called cords; a cord is a stack of wood 8 feet long by 4 feet wide by 4 feet high, or 128 cubic feet. Wood may also be sold in face cords, which is about one-third of a cord. Since a cord of hardwood may yield up to twice as much heat energy as a cord of softwood, burning hardwoods like oak and maple is more economical.

Life Cycle Cost Comparison: Light Bulbs

Compare the life cycle costs of using incandescent and LED light bulbs to find out which is the better buy.

1. Suppose you need a new bulb for a fixture that is lit for at least four hours per day. A 60-watt incandescent light bulb costs $0.42. A 10.5-watt LED bulb that provides nearly the same amount of light costs $4.00. Which bulb would you buy and why? Did you take into account the cost of the electricity used to light the bulb over its lifetime in addition to its purchase price?

2. Review the Lighting Information in the table below. You will use this information to calculate and compare the life cycle cost of each bulb.

Lighting Information

Information Listed on Packaging	Incandescent Bulb	LED Bulb
Light Output	855 Lumens	800 Lumens
Bulb Wattage	60 Watts	10.5 Watts
Bulb Life	1,000 Hours	15,000 Hours
Cost of each bulb (including tax)	$.42	$4.00

Source: Home Depot

3. Divide the bulb life of a LED by the bulb life of an incandescent bulb. Round your answer to the nearest whole number. The answer you get is equal to the number of incandescent bulbs that will need to be replaced to equal the bulb life of one LED bulb. Write your answer in the space below.

4. Use the following formula to determine the total electrical energy used by both bulbs over the bulb life of one LED bulb in kilowatt-hours.

   Wattage of bulb (watts) × 1 kilowatt/1,000 watts × bulb life of a LED (hours) = total lifetime electrical energy used by the bulb (kWh)

   Incandescent ______________________ LED ______________________

Life Cycle Cost Comparison: Light Bulbs

5. Write down the electric rate in your area in dollars per kilowatt-hour ($/kWh). If you cannot find out what rate your family or school pays for electricity, use one of the average electric rates listed:

   Your electric rate: ______________________

   Home (residential rate): $0.11 per kilowatt-hour (kWh)

   School (commercial rate): $0.075 per kilowatt-hour (kWh)

6. Use the following formula to find the total cost of the electricity used by the bulbs over the bulb life of one LED bulb in dollars ($).

   Total energy used by bulb (kWh) (Step 4) X Electric rate ($/kWh) (Step 5) =
   Total cost of electricity used by bulb ($)

   Incandescent ______________________________ LED ______________________________

7. Calculate the total cost of purchasing the light bulbs. For the incandescent bulbs, multiply the bulb cost from the Lighting Information table by the number of incandescent bulbs needed to equal the life of one LED bulb (see your answer to Step 3).

   Cost of one incandescent bulb ($) X Number of incandescent bulbs equal to the life of one LED bulb

   Incandescent ______________________________ LED ______________________________

8. Find the life cycle cost (the cost of buying and using the bulbs) of each bulb. Add your answers from Step 6 to your answers from Step 7.

	Incandescent Bulb	LED Bulb
Total Energy Cost ($) (Step 6)		
+ Total Purchase Cost ($) (Step 7)		
= Life Cycle Cost ($)		

Life Cycle Cost Comparison: Refrigerators

Compare the life cycle costs of two refrigerators (with the freezers on top) to find out which is the better buy.

1. Suppose you need to buy a new refrigerator. You are considering two refrigerator models: A and B. Both refrigerators have similar features and have the freezer compartments located on top of the refrigerator (top freezer). The model A refrigerator has a lower purchase price but uses more energy than the model B refrigerator. Which refrigerator would you buy and why? Did you take into account the cost of the electricity used by the refrigerator over its lifetime in addition to its purchase price?

2. Review the Refrigerator Information in the table below. You will use this information to calculate and compare the life cycle cost of each refrigerator model.

Refrigerator Information		
Refrigerator Model	**Refrigerator A (Top Freezer)**	**Refrigerator B (Top Freezer)**
Retail Price (including tax)	$680	$750
Energy used per year (kWh/year)	550	420
Lifetime	15	15

Source: Based on Horie, Yuhta Allan. "Life Cycle Optimization of Household Refrigerator-Freezer Replacement." Report No. CSS04-13. University of Michigan. Center for Sustainable Systems. August 14, 2004.

3. Use the following formula and information from the Refrigerator Information table to determine the total energy used by both refrigerators over their lifetime in kilowatt-hours.

   Energy used per year (kWh/year) X Lifetime (years) =
   Total energy used by refrigerator over its lifetime (kWh)

   Refrigerator A ____________________ Refrigerator B ____________________

4. Write down the electric rate in your area in dollars per kilowatt-hour ($/kWh). If you cannot find out what rate your family or school pays for electricity, use one of the average electric rates listed:

   Your electric rate: ____________________

   Home (residential rate): $0.11 per kilowatt-hour (kWh)

   School (commercial rate): $0.075 per kilowatt-hour (kWh)

Life Cycle Cost Comparison: Refrigerators

5. Use the following formula to find the total cost of the electricity used by the refrigerators over their lifetime in dollars ($).

   Total electricity used by refrigerator (kWh) (Step 3) X Electric rate ($/kWh) (Step 4) =
   Total cost of electricity used by refrigerator over its lifetime ($)

   Refrigerator A ______________________ Refrigerator B ______________________

6. Find the retail cost of purchasing each refrigerator from the Refrigerator Information table, and write the cost in the spaces shown.

   Refrigerator A ______________________ Refrigerator B ______________________

7. Find the life cycle cost (the cost of buying and using the refrigerators) of each refrigerator model by adding your answers from Step 5 to your answers from Step 6.

	Refrigerator A	**Refrigerator B**
Total Electricity Cost ($) (Step 5)		
+ Purchase Cost ($) (Step 6)		
= Life Cycle Cost ($)		

8. Based on the calculations you completed, which refrigerator model (A or B) would you buy and why?

Life Cycle Cost Comparison: Cars

Compare the life cycle costs of two 4-cylinder sedans with different fuel economies to find out which is the better buy.

1. Suppose you want to buy a new compact and have narrowed down your choices to a Honda Accord and a Toyota Prius, both having similar engine sizes and features. Which car would you buy and why? Did you take into account the cost of the energy used to drive the car over its lifetime in addition to its purchase price?

2. Review the Car Information in the table below. You will use this information to calculate and compare the life cycle cost of each car.

Car Information

Make and Model of Car	Honda Accord 2017	Toyota Prius 2017
Engine and Transmission	2.4 Liter engine, Automatic	1.8 Liter Engine, Automatic
Suggested Retail Price (including tax)	$25,000	$28,000
Miles Driven each Year	15,000	15,000
Lifetime (years)	10	10
Fuel economy (miles per gallon)	30 mpg	52 mpg

3. Use the following formula and information from the Car Information table to determine the total number of miles driven by both cars over their lifetime in miles.

   Miles driven per year (miles/year) X Lifetime (years) =
   Total number of miles driven over car's lifetime (miles)

   Honda Accord ________________ Toyota Prius ________________

Life Cycle Cost Comparison: Cars

4. Use the following formula and information from the Car Information table to determine the total number of gallons of gasoline used by both cars over their lifetime in gallons.

   Total number of miles driven over car's lifetime (miles) / fuel economy of car (miles per gallon) = Total number of gallons of gasoline used over car's lifetime (gallons)

   Honda Accord ______________________ Toyota Prius ______________________

5. Write down the cost of gasoline in your area in dollars per gallon ($/gallon). If you do not know the cost of gasoline in your area, use $2.50 per gallon for the cost.

   Cost of gasoline: ______________________

6. Use the following formula to find the total cost of the gasoline used by the cars over their lifetime in dollars ($).

   Total number of gallons of gasoline used over car's lifetime (gallons) (step 4) X Cost of gasoline per gallon ($/gallon) (step 5) = Total cost of gasoline used by car over its lifetime ($)

   Honda Accord ______________________ Toyota Prius ______________________

7. Find the retail cost of purchasing each car from the Car Information table, and write the cost in the spaces shown.

   Honda Accord ______________________ Toyota Prius ______________________

8. Find the life cycle cost (the cost of buying and driving the car) of each car by adding your answers from Step 6 to your answers from Step 7.

	Honda Accord 2017	Toyota Prius 2017
Total Gasoline Cost ($) (Step 6)		
+ Purchase Cost ($) (Step 7)		
= Life Cycle Cost ($)		

9. Based on the calculations you completed, which car (Honda Accord or Toyota Prius) would you buy and why?

Action Ideas: Energy Efficiency Measures

Below is a list of action ideas that can improve energy efficiency at home, at school, and in the community. Students can perform many of these measures themselves, or they can work with their peers, family, school personnel, and community members to improve energy efficiency.

Energy efficiency measures that correspond to the ***Appliance Survey*** from "At Watt Rate?" (available at keepprogram.org) are listed under each end use category. Teachers may want to have students do these surveys first. If students discover other energy efficiency measures not listed here, they should be encouraged to undertake them if possible.

The cost of implementing energy efficiency measures varies widely. Measures listed under Basic Action Ideas for each end use are free. Many other measures only cost a few dollars. A few require a major investment, such as purchasing a large appliance, buying a new vehicle, or adding insulation as part of a home improvement project. Each energy efficiency measure is ranked from the least costly to the most costly within a specific energy end use category. The rankings are symbolized as follows:

No cost: Ø
Low cost: ¢ - $ (less than $1 to $25)
Medium cost: $ - $$ ($25 to $200)
High cost: $$$ (Greater than $200)

Broader cost ranges are shown using two cost symbols separated by a dash. For example, a cost range shown as "Ø - $" means that the cost to implement this measure ranges from no cost to a low cost. All costs are initial investment costs that save energy (and money) over time. Even those that cost little or no money may yield noticeable energy savings. The energy efficiency measures listed here represent only some of the many possible measures that can be taken.

Lighting

Implement Basic Action Ideas Ø

- Remember to turn off lights that are not in use.
- Do not turn on more lights than you need for specific tasks such as reading or writing.
- Clean light bulbs and fixtures by removing dust and dirt that have accumulated on them. **Caution: Never use water to clean light bulbs while they are turned on. The water's cooling effect could shatter hot bulbs.**

Delamp and Relamp Fixtures

- Reduce light levels that are too bright by removing unnecessary bulbs from fixtures (delamping). Ø
- Replace high wattage bulbs with lower wattage bulbs of the same type (relamping). ¢ - $
- Combine delamping and relamping to get the desired amount of light from a fixture. For example, replacing two 60-watt incandescent bulbs (120 watts and 1,730 lumens total) with one 100-watt, 1,710 lumen incandescent bulb will save 20 watts and provide the same amount of light. NOTE: Be sure to delamp and relamp first those fixtures that are used most often (4 hours or more per day).

Action Ideas: Energy Efficiency Measures

Replace Incandescent Light Bulbs with More Efficient Bulbs

- Replace incandescent bulbs with light emitting diodes (LEDs) or compact fluorescent lamps (CFLs). Be sure to install LEDs/CFLs first in fixtures that are used most often (4 hours or more per day). $ - $$ (depending on the number of bulbs being replaced)

Use Daylight

- Rearrange living and work spaces to take advantage of daylight. Ø
- Open curtains and blinds during the day to reduce the use of indoor lighting. Ø
- Consider repainting walls and ceilings with light colors to reflect more light. $ - $$
- Consider investing in skylights or extra windows to allow more daylight to enter the room. $$$

Use Other Lighting Energy Efficiency Measures

- Connect a timer or a light sensor to outdoor lights so that they automatically turn off during the daytime and turn on at night. $ - $$

Insulation and Air Infiltration

Implement Basic Action Ideas—Air Infiltration Ø

- Close drapes and window shades during the winter and the summer.
- Close doors when going in and out.
- Make sure that all interior windows and storm windows are closed during the heating season.
- If your home has a fireplace, make sure that the damper is tightly closed when you don’t have a fire burning.

Add Insulation

- Add insulation to the attic, walls, and basement as needed. Contact a building supply dealer, a home builder, an energy professional, the Wisconsin Energy Bureau, or the Wisconsin Department of Industry, Labor, and Human Relations (the state agency that oversees building codes) to find out recommended R-values for the areas where insulation is to be added. $$ - $$$

Reduce Air Infiltration in Windows

- Place clear plastic barriers over windows during the heating season to prevent drafts. Many department and hardware stores sell window plastic kits for this purpose. ¢ - $
- Replace cracked and broken windowpanes. ¢ - $
- Caulk and weatherstrip air leaks around the exterior and interior of window frames. ¢ - $
- Install new storm windows or repair old ones. $ - $$

Action Ideas: Energy Efficiency Measures

Add Window Coverings

- Install drapes, shades, or insulating coverings that can be rolled down and closed into place. $ - $$$ (depending on the type of window coverings installed and the number of windows covered)

Reduce Air Infiltration in Doors

- Install door sweeps or make fabric “snakes” and place them at the bottom of doors to prevent drafts. ¢ - $
- Caulk and weatherstrip air leaks around doors. ¢ - $
- Repair door closing mechanisms so that doors close automatically. ¢ - $
- Install storm doors on exterior doors if none are present. $ - $$

Reduce Air Infiltration in Walls, Foundations, and Other Openings

- Install foam rubber gaskets behind electrical outlet cover plates. ¢ - $
  Caution: Make sure that the electricity to the outlet is turned off before removing a cover plate.
- Caulk or seal cracks in the foundation and gaps or openings where wires and vents enter exterior walls of homes and buildings. ¢ - $$
- If your fireplace damper doesn’t work, either have it repaired, install a chimney-top damper, or install a door on the fireplace. $ - $$

Space Heating, Water Heating, and Air Conditioning

Implement Basic Action Ideas—Space Heating Ø

- During the heating season, set your thermostat to 68 degrees F (20°C) during the day (or when you are home) and to 58-60 degrees F (13 °C) when you go to bed (or when you are away).
- Close heating vents, radiators, etc. in rooms and other interior spaces that do not need to be heated. Also, clean the dust and cobwebs from heating vents (registers).
- Bleed the air out of hot water radiators.
- Close off rooms that do not need to be heated.

Implement Basic Action Ideas—Water Heating Ø

- Turn down the water heater thermostat to 120 degrees F (49 °C). Turn it down even further when your family goes on vacation. Some water heaters have a vacation setting specifically for this purpose.
- Do not let the water run while washing your hands, brushing your teeth, shaving, or washing dishes.
- Do not let the shower run for more than a few seconds before stepping into it.

Action Ideas: Energy Efficiency Measures

Implement Basic Action Ideas—Air Conditioning Ø

- During the cooling season, set the air conditioner at 78 degrees F (26 °C). Set it higher if your home has ceiling fans.
- Turn off the air conditioner if you leave your home for more than an hour.
- Close off rooms that do not need to be cooled.

Implement Space Heating Energy Efficiency Measures

- Clean or change the air filter of your furnace monthly. ¢ - $
- Build reflectors out of aluminum foil and place them between the radiator and the wall. This will help reflect heat from the radiators into a room. ¢ - $
- Install a programmable thermostat. $ - $$
- Have your boiler or furnace serviced every one or two years. $ - $$
- Seal and insulate warm-air heating ducts that come out of your furnace. $ - $$
- Consider installing a high-efficiency furnace or boiler if replacing an old furnace or boiler. $$$

Implement Water Heating Energy Efficiency Measures

- Install a low-flow shower head in your shower. ¢ - $
- Install water-efficient faucet aerators (faucet heads) in your kitchen and bathroom sinks. ¢ - $
- Fix leaky faucets. ¢ - $
- Install an insulating blanket around your water heater. ¢ - $
  Caution: Do not cover thermostats, burners, water heater controls, or air inlets of water heaters with insulating blankets. Do not cover the tops of natural gas water heaters. Make sure that blankets are taped securely to water heaters to prevent them from slipping down. Ask an adult for help when adding blankets to water heaters. Note that installing insulating blankets on certain high-efficiency water heaters may reduce efficiency. Follow directions and manufacturer's recommendations.
- Insulate the first three feet (90 cm) of the hot water pipe coming out of the water heater. ¢ - $
- Insulate all hot water pipes in unheated basements and crawlspaces. $ - $$
  Caution: Do not replace or cover older pipe insulation on your own. It may contain asbestos and should not be touched or disturbed except by a professional.
- Consider installing a high-efficiency water heater, if replacing an old water heater. $$$

Implement Air Conditioning Energy Efficiency Measures

- Place window air conditioners on the shaded sides of the house. Ø - $, depending on whether you have to buy mounting brackets
- Clean or change your air conditioner is air filter every one or two months. ¢ - $
- Build an awning over the air conditioner so that it is not exposed to the sun. $$ - $$$
- Consider installing a high-efficiency air conditioner, if replacing an old air conditioner. $$$.

Action Ideas: Energy Efficiency Measures

Major Home Appliances

Implement Basic Action Ideas—Refrigerators and Freezers Ø

- Set your refrigerator's temperature between 38 and 42 degrees F (3 and 6°C), and your freezer between 10 and 15 degrees F (-12 and -9 °C). Use a thermometer to check these temperatures, since refrigerator or freezer dials usually do not show temperatures.
- Do not open the refrigerator or freezer door longer than necessary.
- Decide what you want to get from the refrigerator or freezer before you open the door.
- Stock your refrigerator with food and fill any remaining large spaces with jugs of water. However, do not overfill your refrigerator to the point where you reduce air circulation and cooling effectiveness.
- Clean the coils behind your refrigerator and freezer at least once a year.
- Make sure the refrigerator door seal is tight when closed.
- Move refrigerators and freezers away from direct sunlight, stoves, dishwashers, and other heat sources.
- Make sure that the refrigerator is not pushed tightly against the wall; air must circulate through the coils.
- Use energy-saving settings on your refrigerator and freezer if they have them.

Implement Basic Action Ideas—Clothes Washers, Clothes Dryers, and Dishwashers Ø

- Use energy-saving settings on your clothes washer, clothes dryer, and dishwasher if they have them.
- Run clothes washers, clothes dryers, and dishwashers with full loads when possible.
- Wash clothes in cold or warm water when possible.
- Hang washed clothes on a clothesline to dry.
- Wash dishes by hand, especially if there aren't enough to fill a dishwasher. Use water-conserving habits (for example, don't let the water run unnecessarily) when washing.
- If your dishwasher doesn't have a no-heat air dry feature, turn off the dishwasher after the final rinse cycle and open its door to let dishes air dry.

Implement Basic Action Ideas—Stoves (Ranges) Ø

- Use microwave ovens and toaster ovens in place of electric ranges and ovens when possible.
- Cover pots when cooking food or boiling water, except when cooking food that may boil over (like pasta).
- Place small pots or pans on small burners when cooking.
- Make sure that the metal reflectors under burners are kept clean so they can reflect heat to pots and pans during cooking.
- Avoid opening the oven to look at food while it is cooking. Turn on the oven light and look through the window instead.
- Reduce cooking time by defrosting foods in the refrigerator before cooking.

Action Ideas: Energy Efficiency Measures

Implement Refrigerator and Freezer Energy Efficiency Measures

- Consider purchasing a high-efficiency refrigerator if replacing an old refrigerator. $$$

Small- and Medium-Sized Electrical Appliances & Equipment

Implement Basic Action Ideas Ø

- Turn off appliances and equipment if they are not being used.
- Substitute manual effort (labor) for using an appliance when possible. Think of it as a way of getting exercise.

Implement Electrical Appliance and Equipment Energy Efficiency Measures

- Buy energy-efficient appliances and equipment whenever possible. ¢ - $$$

Transportation

Use Transportation Alternatives

- Walk or bike to destinations whenever possible. Ø
- Start or join a carpool to commute to school or work. Ø - $ (depending on how the cost of carpooling compares to the cost of using your own vehicle)
- Use mass transit (buses, trains) for commuting purposes, when possible. Ø - $$ (depending on how the cost of using mass transit compares to the cost of using your own vehicle)

Maintain Vehicles for Greater Fuel Efficiency

- Keep the tires of your vehicle inflated to the manufacturer's recommended maximum pressure. Ø
- Change engine oil and the oil filter according to the manufacturer's recommended schedule. ¢ - $
- Have your vehicle's engine tuned up regularly. $ - $$
- Have the wheels of your vehicle aligned regularly. $ - $$

Practice Driving Habits That Increase Fuel Efficiency Ø

- Combine several errands into one trip.
- Reduce any unnecessary weight carried by the vehicle. Extra weight reduces fuel efficiency.
- If you stop for more than one minute, it is more efficient to turn off the engine than to let it idle.
- Avoid revving up the engine.

Action Ideas: Energy Efficiency Measures

- Avoid rapid acceleration and braking. Drive smoothly and anticipate traffic stops.
- Obey speed limits. Most vehicles reach their optimum fuel efficiency at speeds between 40 and 55 miles per hour (mph) (64.4 and 88.5 km/hr). As speed increases over 55 mph (88.5 km/hr), fuel efficiency drops quickly. Speeds of 65 mph (104.6 km/hr) use from 10 to 15 percent more fuel than 55 mph (88.5 km/hr). Losses at 75 mph (120.7 km/hr) compared to 65 mph (104.6 km/hr) are even greater.
- Use cruise control when driving on level highway roads.

Consider Buying a More Fuel Efficient Vehicle $$$

- If you or a member of your family plans to buy a new or used vehicle, consider choosing one with the highest possible fuel efficiency (miles per gallon, or mpg) rating. Small vehicles with four-cylinder engines and manual transmissions generally have the highest fuel efficiency ratings. However, fuel efficiency ratings also vary for different classes of vehicles (cars, minivans, station wagons, light trucks, etc.), so make sure to consider the most efficient vehicle within a certain class.

Trip Planning

- Design a travel brochure of Wisconsin that identifies energy-efficient ways of getting to various destinations and points of interest within the state.

Energy Efficient Landscaping

Plant Trees

- It's much cooler to sit under a densely leafed, spreading tree that blocks the sun's rays than under one that only filters rays. The Arbor Day Foundation suggests planting trees with round or horizontal-oval crowns. Trees rated highest for shade are maple, horse chestnut, beech, green ash, walnut, poplar, and sycamore.
- Consider the plant's adaptability and hardiness. For the north side of a building, choose a shade-tolerant plant that's extremely winter hardy. For the south and west sides, use plants that are adaptable to drought, excessive sun, and hot winds.
- To prevent foundation damage, a tree planted within 10 feet (300 cm) of a building should be selected from those species that have a taproot instead of a lateral root system.
- Plant trees with strong wood. However, for quick shade, interplant fast-growing weaker trees such as willows. When the slower, stronger trees reach a desirable height, remove the weaker ones.
- When deciding where to plant your trees, observe summer shadows on your property and plant trees where they will shade hot spots during the hottest days of summer. Locate large deciduous shade trees on the south, southwest, and west sides of the building about 15 to 25 feet (45-75 m) apart and 10 to 15 feet (30-45 m) from the building. Deciduous trees block the summer sun but let winter's warming rays filter through after the leaves fall. Plant trees with strong wood, such as oaks, lindens, or ashes. (Weaker trees can cause damage if branches break off during high winds.)

Action Ideas: Energy Efficiency Measures

Plant Dwarf Shrubs near Building Foundations

- Dwarf shrubs are suitable for energy-efficient landscaping because they remain small at maturity (2 to 3 feet high [60-90 cm]) and can be planted near buildings. Also, since they stay small, they require little maintenance. Small plantings near your building can save energy year-round. In the winter, dwarf shrubs, especially evergreens, can block the force of cold winter winds against the foundation. This reduces both heat loss through the walls and cold air leaks. In the summer, dwarf shrubs can cool the air near your building by a process called transpiration. As plants give off moisture to the air, the air cools, similar to the way perspiring cools humans. The air temperature can be as much as 10 degrees cooler by shrubs. Evergreen dwarf shrubs are especially effective for cutting heat loss in the winter. Many of the conifers (needle types) are very hardy and form an effective foundation wind barrier year-round. Locate these shrubs on the north and northwest sides of your building.