POST-VISIT ACTIVITY: CHALLENGING VERSION

TEP BRIGHT STUDENTS: THE CONSERVATION GENERATION

Tucson Electric Power

Part A. Energy Savings Kit

Go through the contents of the Energy Savings Kit with students. Make sure that all students know **where** to install each device. Make sure students also remember the basic benefits of each device (e.g. the low-flow showerhead saves energy and water and, therefore, money). Consider a brief role-play in which students practice explaining the function and location of the devices in the Energy Savings Kits. Remind students that the aerator has an instruction card.

Part B. Home Efficiency Measures

Lead a classroom discussion with students about what different energy efficiency measures they can undertake at home, either alone or with the help of parents. See "Home Efficiency Measures" handout.

Optional: Have students pledge to do at least 5 energy efficiency measures. Ask students to write down their 5 (or more) choices and pledge together as a class to become more energy efficient.

Part C. Light Bulb Return on Investment (ROI) Activity

Students will do a basic ROI activity looking at the costs associated with purchasing and using energy efficient light bulbs. Note: this is a challenging activity recommended for students who have completed the standard-difficulty post-visit activity and who are capable of complex independent math and word problems.

Part D. On-Line Extensions

Explore some of the energy efficiency tips and strategies available at www.tep.com/tips. Consider promoting the following with your students:

- The Carbon Footprint Calculator (https://www.tep.com/efficiency/tools/carbon/)
- The Kilowatt Counters Charts (https://www.tep.com/efficiency/tools/kilowatt/)
- Other Energy Games and Tools (https://www.tep.com/efficiency/tools/world/)
- The TEP Home Energy Report – a comprehensive and interactive tool that TEP customers can use once they have logged into their accounts online. Available at (https://tep.opower.com/ei/app/dashboard)

Home Efficiency Measures

Home Energy Efficiency Measures can be thought of in two ways:

1. Using efficient devices that will automatically save anytime they are being used (e.g. CFL and LED light bulbs).
2. Changing behavior to become more efficient.

The lists below are differentiated by the two different ways to be efficient listed above. They are also ranked in terms of cost. That is, the items at the top of the list are the lowest cost while the items at the bottom of the list are highest cost. Use these lists as a tool when brainstorming ways to become more efficient with your students.
Note: These lists are comprehensive though by no means absolute. Feel free to add to them with your students!

Efficient Devices

- CFL light bulbs
- Weather stripping
- Pipe insulation
- Air filter whistle
- Metallic duct tape to seal ducts
- Faucet aerator
- Low-flow showerhead
- Caulk to seal gaps near windows
- Refrigerator and freezer thermometers or temperature cards
- LED night lights
- LED light bulbs
- Plant trees on the south and/or west side of your house
- Use smart power strips
- Note: The following devices are much higher cost and, obviously, fall to the discretion of parents. The benefits, however, are significant:
  - EnergyStar certified pool pump
  - EnergyStar certified refrigerator
  - EnergyStar certified dishwasher
  - EnergyStar certified clothes washer
  - EnergyStar certified clothes dryer
  - EnergyStar certified HVAC unit

Efficient Behavior

- Use ceiling fans
- Turn off lights when leaving the room
- Adjust hot water heater temperature to 120 degrees F
- Adjust air conditioner to 78 degrees F or higher in the summer
- Adjust heater to 68 degrees or lower in the winter
- Run the dishwasher only when full
- Run the washing machine only when full and only in cold water
- Clean the lint filter on the dryer before every use
- Hang dry clothes on a clothes line or clothes rack instead of using the dryer
- Clean refrigerator coils
- Use a home energy monitor
- Get a home energy audit from an energy professional

Student Worksheet:
Light Bulb Return on Investment Analysis

Name: _____ Class: _____ Date: _____

An important part of deciding which home energy efficiency options make the most sense is figuring out when a device will "pay for itself." That is, when will the amount of energy savings from the device equal (and then pass) the amount of money the device itself cost? Answer the following questions about a sample home to learn about the return on investment of CFL and LED light bulbs.

Scenario: You and your family are considering upgrading the light bulbs in your kitchen, living room, and family room. You did a light bulb inventory and determined the following:

- Kitchen: 6 incandescent bulbs
- Living Room: 4 incandescent bulbs
- Family Room: 3 incandescent bulbs

You also did some research and determined that the average amount of time the light bulbs were on in each room is:

- Kitchen: 6 hours per day
- Living room: 5 hours per day
- Family Room: 4 hours per day

1. A typical incandescent light bulb for your home is 60W. Convert 60W to kW.
   (Hint: 1,000W = 1kW or .001kW = 1W)

_____W X _____ = _____kW

2. A typical CFL light bulb for your home is 13W. Convert 13W to kW.
   (Hint: 1,000W = 1kW or .001kW = 1W)

_____W X _____ = _____kW

Student Worksheet:
Light Bulb Return on Investment Analysis *(Continued)*

3. A typical LED light bulb for your home is 10W. Convert 10W to kW.
   (Hint: 1,000W = 1kW or .001kW = 1W)

_____W X _____ = _____kW

4a. Now that you know how many kW each type of bulb in your house uses, convert these units to kWh based on the length of time each bulb is used in each room for the incandescent light bulbs.
Example: A 60W incandescent bulb left on for 6 hours uses .36 kWh (.06 kW x 6 hours).

Kitchen Incandescent Light Bulb kWh Use per day_____

Living Room Incandescent Light Bulb kWh Use per day _____

Family Room Incandescent Light Bulb kWh Use per day _____

4b. Now that you know how many kW each type of bulb in your house uses, convert these units to kWh based on the length of time each bulb is used in each room if each bulb were a CFL.
Example: A 13W CFL bulb left on for 6 hours uses .078 kWh (.013 kW x 6 hours).

Kitchen CFL Bulb kWh Use per day _____

Living CFL Light Bulb kWh Use per day _____

Family Room CFL Bulb kWh Use per day _____

4c. Now that you know how many kW each type of bulb in your house uses, convert these units to kWh based on the length of time each bulb is used in each room if each bulb were a LED.
Example: A 10W LED bulb left on for 6 hours uses .06 kWh (.01 kW x 6 hours).

Student Worksheet:
Light Bulb Return on Investment Analysis *(Continued)*

Kitchen LED Bulb kWh Use per day _____

Living Room LED Bulb kWh Use per day _____

Family Room LED Bulb kWh Use per day _____

Helpful Hints: Once you know how much electricity a bulb uses in a day, you can figure out how much it uses in months and years as well. Consider the following questions:

- How many days are there in a month?
- How many months are there in a year?

Complete the tables below for the total electricity use for the bulbs in each of the three rooms. Use an extra piece of paper to show your work.

Note: When calculating costs, round to 2 decimal places.
Example 1: $.058 = $.06
Example 2: $1.242 = $1.24

5. The cost per kWh is $.11/kWh. Determine how much it costs to light each room:

Incandescent Light Bulb Costs			
	Per Day	Per Month	Per Year
All Kitchen Bulbs	$	$	$
All Living Room Bulbs	$	$	$
All Family Room Bulbs	$	$	$
All Bulbs Totals	$	$	$

Student Worksheet:
Light Bulb Return on Investment Analysis *(Continued)*

6. Determine how much it would cost to light each room if all bulbs were CFLs:

CFL Light Bulb Costs			
	Per Day	Per Month	Per Year
All Kitchen Bulbs	$	$	$
All Living Room Bulbs	$	$	$
All Family Room Bulbs	$	$	$
All Bulbs Totals	$	$	$

7. Determine how much it would cost to light each room if all bulbs were LEDs:

LED Light Bulb Costs			
	Per Day	Per Month	Per Year
All Kitchen Bulbs	$	$	$
All Living Room Bulbs	$	$	$
All Family Room Bulbs	$	$	$
All Bulbs Totals	$	$	$

8. Determine the monetary savings ($) per month if all the bulbs in the kitchen, living room, and family room were CFLs (hint: use the figures from total cost per month):

_____

9. Determine the monetary savings ($) per month if all the bulbs in the kitchen, living room, and family room were LEDs (hint: use the figures from total cost per month):

_____

Student Worksheet:
Light Bulb Return on Investment Analysis *(Continued)*

Scenario: You go to the store to purchase new light bulbs to replace the incandescent bulbs. You see the following costs:

- CFL bulbs: $1.00 each
- LED bulbs: $10.00 each

10. How much would it cost to purchase new CFLs to replace all the incandescent bulbs in the three rooms?

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11. How much would it cost to purchase new LEDs to replace all the incandescent bulbs in the three rooms?

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12. How long is the return on investment if the light bulbs in all three rooms are replaced with CFLs? (hint: compare the savings per month with the cost of purchasing new CFLs)

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13. How long is the return on investment if the light bulbs in all three rooms are replaced with LEDs? (hint: compare the savings per month with the cost of purchasing new LEDs)

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14. Bonus Question #1: How much money will the CFLs save after 5 years? The LEDs?

Student Worksheet:
Light Bulb Return on Investment Analysis *(Continued)*

15. Bonus Question #2: How much money will the LEDs save after 10 years?

_____

16. Bonus Question #3: What is another important consideration with light bulbs when considering which one to purchase that was not discussed here?

_____

Student Worksheet:
Light Bulb Return on Investment Analysis – Answer Key

Name: _____ Class: _____ Date: _____

An important part of deciding which home energy efficiency options make the most sense is figuring out when a device will "pay for itself." That is, when will the amount of energy savings from the device equal (and then pass) the amount of money the device itself cost? Answer the following questions about a sample home to learn about the return on investment of CFL and LED light bulbs.

Scenario: You and your family are considering upgrading the light bulbs in your kitchen, living room, and family room. You did a light bulb inventory and determined the following:

- Kitchen: 6 incandescent bulbs
- Living Room: 4 incandescent bulbs
- Family Room: 3 incandescent bulbs

You also did some research and determined that the average amount of time the light bulbs were on in each room is:

- Kitchen: 6 hours per day
- Living room: 5 hours per day
- Family Room: 4 hours per day

1. A typical incandescent light bulb for your home is 60W. Convert 60W to kW.
   (Hint: 1,000W = 1kW or .001kW = 1W)

_____60_____W X _____.001_____ = _____.06_____kW

2. A typical CFL light bulb for your home is 13W. Convert 13W to kW.
   (Hint: 1,000W = 1kW or .001kW = 1W)

_____13_____W X _____.001_____ = _____.013_____kW

Student Worksheet:
Light Bulb Return on Investment Analysis *(Continued)*

3. A typical LED light bulb for your home is 10W. Convert 10W to kW.
(Hint: 1,000W = 1kW or .001kW = 1W)

10 W X .001 = .01 kW

4a. Now that you know how many kW each type of bulb in your house uses, convert these units to kWh based on the length of time each bulb is used in each room for the incandescent light bulbs.

Example: A 60W incandescent bulb left on for 6 hours uses .36 kWh (.06 kW x 6 hours).

Kitchen Incandescent Light Bulb kWh Use per day .06 kW x 6 hours = .36 kWh per bulb

Living Room Incandescent Light Bulb kWh Use per day .06 kW x 5 hours = .30 kWh per bulb

Family Room Incandescent Light Bulb kWh Use per day .06 kW x 4 hours = .24 kWh per bulb

4b. Now that you know how many kW each type of bulb in your house uses, convert these units to kWh based on the length of time each bulb is used in each room if each bulb were a CFL.

Example: A 13W CFL bulb left on for 6 hours uses .078 kWh (.013 kW x 6 hours).

Kitchen CFL Bulb kWh Use per day .013 kW x 6 hours = .078 kWh per bulb

Living CFL Light Bulb kWh Use per day .013 kW x 5 hours = .065 kWh per bulb

Family Room CFL Bulb kWh Use per day .013 kW x 4 hours = .052 kWh per bulb

4c. Now that you know how many kW each type of bulb in your house uses, convert these units to kWh based on the length of time each bulb is used in each room if each bulb were a LED.

Example: A 10W LED bulb left on for 6 hours uses .06 kWh (.01 kW x 6 hours).

Student Worksheet:
Light Bulb Return on Investment Analysis *(Continued)*

Kitchen LED Bulb kWh Use per day .01 kW x 6 hours = .06 kWh per bulb

Living Room LED Bulb kWh Use per day .01 kW x 5 hours = .05 kWh per bulb

Family Room LED Bulb kWh Use per day .01 kW x 4 hours = .04 kWh per bulb

Helpful Hints: Once you know how much electricity a bulb uses in a day, you can figure out how much it uses in months and years as well. Consider the following questions:

- How many days are there in a month?
- How many months are there in a year?

Complete the tables below for the total electricity use for the bulbs in each of the three rooms. Use an extra piece of paper to show your work.

Note: When calculating costs, round to 2 decimal places.
Example 1: $.058 = $.06
Example 2: $1.242 = $1.24

5. The cost per kWh is $.11/kWh. Determine how much it costs to light each room:

Incandescent Light Bulb Costs			
	Per Day	Per Month	Per Year
All Kitchen Bulbs	.36 kWh x 6 bulbs x $.11/kWh = $.24	$.24 x 30 days/month = $7.20	$7.20 x 12 months/year = $86.40
All Living Room Bulbs	.30 kWh x 4 bulbs x $.11/kWh = $.13	$.13 x 30 days/month = $3.90	$3.90 x 12 months/year = $46.80
All Family Room Bulbs	.24 kWh x 3 bulbs x $.11/kWh = $.08	$.08 x 30 days/month = $2.40	$2.40 x 12 months/year = $28.80
All Bulbs Totals	$.24 + $.13 + $.08 = $.45	$7.20 + $3.90 + $2.40 = $13.50	$86.40 + $46.80 + $28.80 = $162.00

Student Worksheet: Light Bulb Return on Investment Analysis *(Continued)*

6. Determine how much it would cost to light each room if all bulbs were CFLs:

CFL Light Bulb Costs			
	Per Day	Per Month	Per Year
All Kitchen Bulbs	.078 kWh x 6 bulbs x $.11/kWh = $.05	$.05 x 30 days/month = $1.50	$1.50 x 12 months/year = $18.00
All Living Room Bulbs	.065 kWh x 4 bulbs x $.11/kWh = $.03	$.03 x 30 days/month = $.90	$.90 x 12 months/year = $10.80
All Family Room Bulbs	.052 kWh x 3 bulbs x $.11/kWh = $.02	$.02 x 30 days/month = $.60	$.60 x 12 months/year = $7.20
All Bulbs Totals	$.05+ $.03 + $.02 = $.10	$1.50 + $.90 + $.60 = $3.00	$18.00 + $10.80 + $7.20 = $36.00

7. Determine how much it would cost to light each room if all bulbs were LEDs:

LED Light Bulb Costs			
	Per Day	Per Month	Per Year
All Kitchen Bulbs	.06 kWh x 6 bulbs x $.11/kWh = $.04	$.04 x 30 days/month = $1.20	$1.20 x 12 months/year = $14.40
All Living Room Bulbs	.05 kWh x 4 bulbs x $.11/kWh = $.02	$.02 x 30 days/month = $.60	$.60 x 12 months/year = $7.20
All Family Room Bulbs	.04 kWh x 3 bulbs x $.11/kWh = $.01	$.01 x 30 days/month = $.30	$.30 x 12 months/year = $3.60
All Bulbs Totals	$.04 + $.02 + $.01 = $.07	$1.20 + $.60 + $.30 = $2.10	$14.40 + $7.20 + $3.60 = $25.20

8. Determine the monetary savings ($) per month if all the bulbs in the kitchen, living room, and family room were CFLs (hint: use the figures from total cost per month):

$13.50 - $3.00 = $10.50 savings per month

9. Determine the monetary savings ($) per month if all the bulbs in the kitchen, living room, and family room were LEDs (hint: use the figures from total cost per month):

$13.50 - $2.10 = $11.40 savings per month

Student Worksheet:
Light Bulb Return on Investment Analysis *(Continued)*

Scenario: You go to the store to purchase new light bulbs to replace the incandescent bulbs. You see the following costs:

- CFL bulbs: $1.00 each
- LED bulbs: $10.00 each

10. How much would it cost to purchase new CFLs to replace all the incandescent bulbs in the three rooms?

13 bulbs total x $1.00 per bulb = $13.00

11. How much would it cost to purchase new LEDs to replace all the incandescent bulbs in the three rooms?

13 bulbs total x $10.00 per bulb = $130.00

12. How long is the return on investment if the light bulbs in all three rooms are replaced with CFLs? (hint: compare the savings per month with the cost of purchasing new CFLs)

Less than two months. After two months, the savings will = $10.50 x 2 = $21.00 while the cost of replacing the bulbs will = $13.00 (mathematically: $13.00/$10.50 savings per month = 1 month with a remainder, therefore between 1 and 2 months)

13. How long is the return on investment if the light bulbs in all three rooms are replaced with LEDs? (hint: compare the savings per month with the cost of purchasing new LEDs)

Less than one year. After 12 months, the savings will = $11.40 x 12 = $136.80, while the cost of replacing the bulbs will = $130.00 (mathematically: $130.00/$11.40 savings per month = 11 months with a remainder, therefore between 11 and 12 months)

14. Bonus Question #1: How much money will the CFLs save after 5 years? The LEDs?

CFLs = $10.50 savings per month x 12 months x 5 years = $630.00.
LEDs = $11.40 savings per month x 12 months x 5 years = $684.00

Student Worksheet:
Light Bulb Return on Investment Analysis *(Continued)*

15. Bonus Question #2: How much money will the LEDs save after 10 years?

LEDs = $11.40 savings per month x 12 months x 10 years = $1,368.00

16. Bonus Question #3: What is another important consideration with light bulbs when considering which one to purchase that was not discussed here?

There are actually two things to consider: 1) the lifespan of the bulbs and the subsequent cost to replace bulbs after they burn out (LEDs last much longer than CFLs) and 2) the likelihood that the cost of electricity will rise over time.