



## WEATHERIZATION

### TOPIC OF STUDY

Energy Efficiency



90 MINUTES

### KEY TERMS

Light emitting diode bulbs (LEDs)

Incandescent bulbs

Compact fluorescent lamps (CFLs)

Kill-a Watt™: audit device used to measure electric use of lighting and appliances

Lumens: a unit of light given out equally in all directions; brightness

## LESSON

Lighting Efficiency

## OBJECTIVES

Students will:

- Compare the cost of incandescent, CFLs and LEDs over time to determine which is most cost effective
- Use a Kill-a-Watt to determine the energy use of the three types of bulbs
- Compare results when the cost of the bulbs over an extended period is included

## BIG IDEA(S)

Energy efficiency refers to the renovations and retrofits we do to a building to reduce the energy usage and the cost to the home or property owner.

## TASK LIST SUBCATEGORY

- 102 Describe how energy is fundamental to our everyday lives
- 207 Perform operations in context involving fractions, decimals and percentages
- 805 Perform energy audit procedures
- 809 Apply math concepts to energy efficiency
- 810 Use energy efficiency industry vocabulary

## OVERVIEW

This lesson is a follow-up to Lesson Energy Efficiency Strategies for Appliances and provides additional practice on calculating energy use of lighting, providing a template for determining yearly cost of the three main types of bulbs.

## STANDARDS

### PA/SDP

**3.4.10.B1.** Compare and contrast how the use of **technology** involves weighing the trade-offs between the positive and negative effects.

**3.4.10.E7.** Evaluate structure design as related to function, considering such factors as style, convenience, safety, and efficiency.

### NGSS

**HS-ETS1-2.** Design a solution to a complex real-world problem by breaking it down into smaller, more manageable problems that can be solved through engineering.

**CL** Analyze data using tools, technologies, and/or models in order to make valid and reliable scientific claims or determine an optimal design solution.

**CN** Apply concepts of statistics and probability to scientific and engineering questions and problems, using digital tools when feasible.





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## INSTRUCTIONAL

### TEXT/REFERENCES

*Energy Conservation Handbook*, pp. 145-147

### MATERIALS NEEDED

#### MATERIALS

- 3 kinds light bulbs
- Lamp
- Kill-a-Watt
- Other tools listed on p.145 of the *Energy Conservation Handbook*

**Technology:** Computers or phones to research on whether LEDs are the most cost effective bulbs.

**Note:** It may be a good idea to measure each bulb for electricity use with the Kill-A-Watt with the students in prior classes so that the measurements are available for the calculations required. If done in class the time measured will be much shorter.

## IMPLEMENTATION (LESSON PLAN)

1. Review the 3 kinds of bulbs. Tell students: *An older energy textbook says that "LEDs are currently too expensive to be worth the cost." The text was written in 2012. Use computer or phone to find out whether that has changed. Are LEDs currently more cost effective?* Have students present their research and evaluate how results are supported by facts.
2. Establish the cost of electricity per kilowatt hour: The average price a residential customer in the U.S. pays for electricity as of September 2020 is 13.3 cents per kWh. (Exploring the kinds of generation of electricity and note differences in cost vs. environmental/sustainability factor would be another possible lesson).
3. Review Lumens and Watt comparison for the 3 types:  
Compare Lumens (Brightness) to Watts (Energy Used)

LUMENS	LED WATTS	CFL WATTS	INCANDESCENT WATTS
400 - 500	6 - 7W	8 - 12W	40W
650 - 850	7 - 10W	13 - 18W	60W
1000 - 1400	12 - 13W	18 - 22W	75W
1450 - 1700+	14 - 20W	23 - 30W	100W
2700+	25 - 28W	30 - 55W	150W

4. Procedure: choose CFL, LED, and incandescent bulbs that produce the same amount of light (lumens). Test with the Kill-A-Watt for the same amount of time for each bulb. If done ahead, use a longer time like one hour. If measured for less than an hour, convert kWh used to one hour of time usage in order to calculate yearly cost in the worksheet appended. Procedure for Kill-A-Watt on p 146. Video procedure in resources.
5. Student use the appended chart to tabulate results from the light comparison activity eventually comparing the yearly cost of the bulbs.





## IMPLEMENTATION (LESSON PLAN) - CONTINUED

- Have students share their findings and compare answers in pairs. Debrief with the whole class to clarify answers.
- For comparison, use the following chart which also includes the manufacturer's projection of the life-span of the bulb. This creates another variable for determining cost effectiveness which is not considered in the procedures. Here's how much each type of bulb would cost to purchase and operate over a 25,000-hour lifespan (about 23 years at three hours per day) based on 12 cents per kilowatt hour (2013):

	INCANDESCENT	CFL	LED
Watts used	60W	14W	7W
Average cost per bulb	\$1	\$2	\$4 or less
Average lifespan	1,200 hours	8,000 hours	25,000 hours
Bulbs needed for 25,000 hours	21	3	1
Total purchase price of bulbs over 20 years	\$21	\$6	\$4
Cost of electricity (25,000 hours @ \$0.15kWh)	\$169	\$52	\$30
<b>Total estimated cost over 20 years</b>	<b>\$211</b>	<b>\$54</b>	<b>\$34</b>



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## RESOURCES/LINKS

Procedure for using a Kill-a-Watt

<https://www.youtube.com/watch?v=7K2uBZKLOEg>

LED Savings Calculator

<https://www.viribright.com/led-savings-calculator/>

