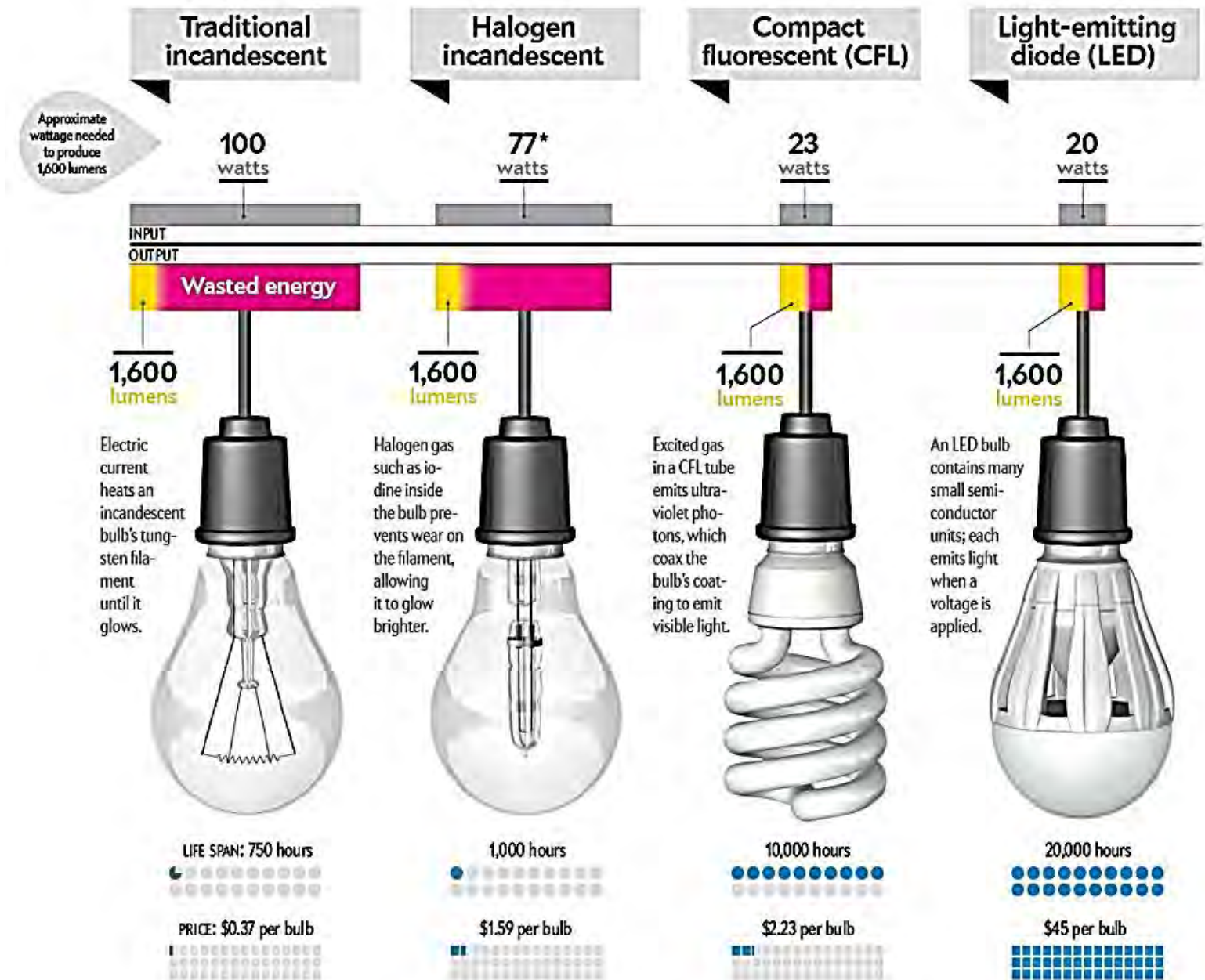


## ENERGY EFFICIENCY EXPERIMENT

The goal of energy efficiency is to accomplish the same tasks and functions as before while using less energy.

You may have heard that light bulbs are becoming more energy efficient to help you save energy, money, and protect the environment. In this experiment you will look at 4 different types of light bulbs and evaluate their energy efficiency.



**Experiment 1: Evaluating energy efficiency of different light bulbs.** You will use an AC Load Device containing 4 different types of light bulbs. Each bulb produces approximately 450 lumens of light (a lumen is a unit measure of “emitted light”). You will measure how many watts of power (a watt is a unit of measure of “rate of work”) it takes each bulb to produce the same amount of light. You will evaluate their energy efficiency.

**Part 1:** Incandescent Light Bulb

**Part 2:** Halogen Light Bulb

**Part 3:** Compact Fluorescent Light (CFL) Bulb

**Part 4:** Light Emitting Diode (LED) Bulb

**DIRECTIONS:** Make sure you read the instructions thoroughly as well as refer to any photos provided to ensure that your experiment is successful.

**MATERIALS:** Gather all the necessary materials onto a working table (refer to photo on the next page, and compare to the list below).

1. (1) extension cord
2. (1) AC Load Device
3. (1) “Watts Up” watt meter
4. 1 package of each for reference throughout experiment:
  - Incandescent light bulbs - PHILLIPS Soft White
  - Halogen light bulbs - PHILLIPS EcoVantage Soft White
  - CFL bulbs - ECOSMART Soft White
  - LED bulbs - CREE Warm White



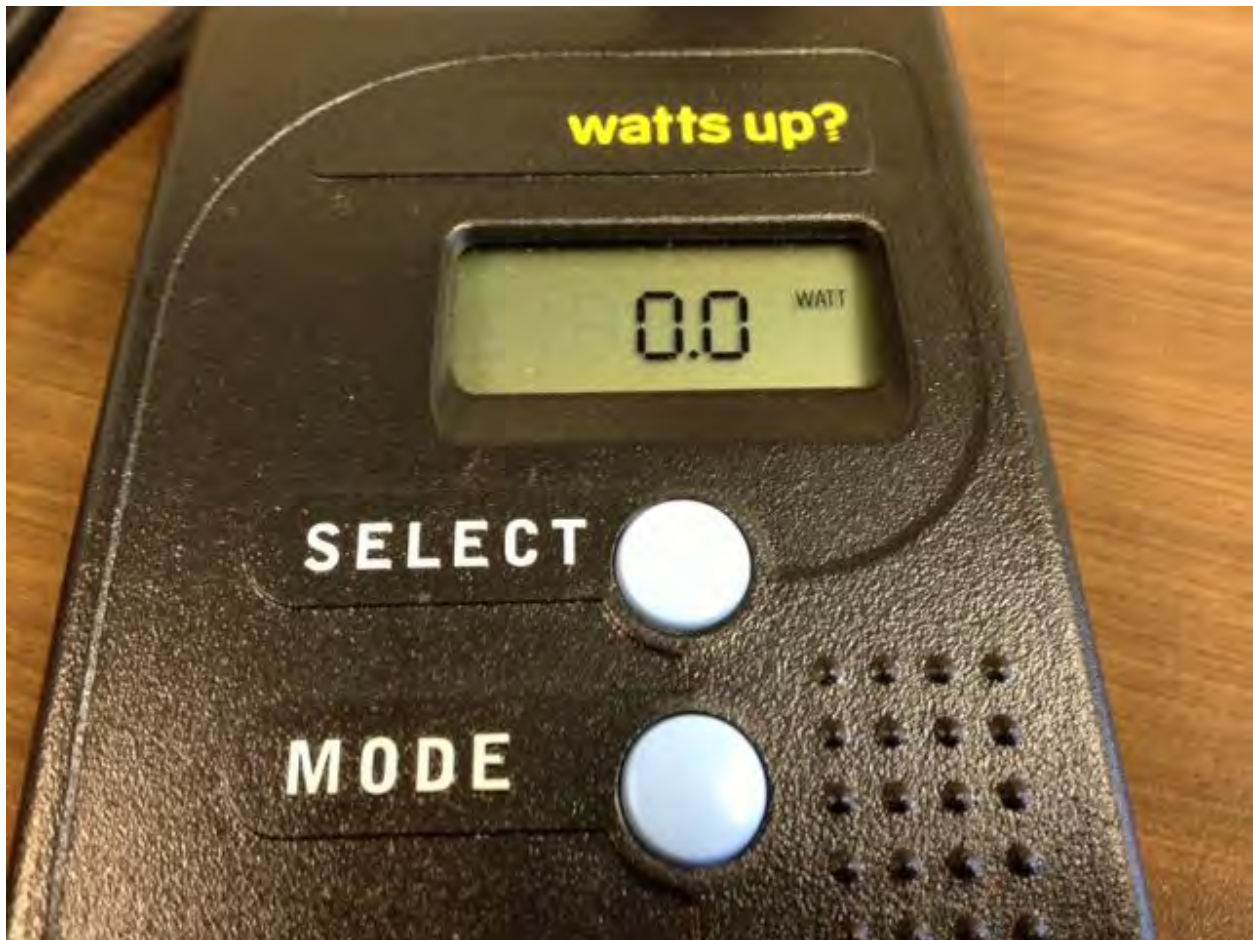
**Set-up:** Before plugging anything in, screw one of each type of light bulb into the sockets of the AC load device in the following order: an incandescent bulb in the Load 1 socket, a halogen bulb in the Load 2 socket, a CFL bulb in the Load 3 socket and a LED bulb in the Load 4 socket. Take the extension cord to a wall AC outlet and plug it in. Set the other end of the extension cord next to the watt meter on the table. Plug the watt meter into the extension cord (the watt meter will turn on). Now, make sure all switches on the AC load device are OFF. Then, plug the AC load device into the watt meter.

Your materials should look like the photo below:



### Experiment 1: Comparing energy efficiency between light bulbs

Use the SELECT button on the watt meter to get to the “WATT” screen display (the word “WATT” will show in the right hand corner above the 0.0 reading – if the reading is not 0.0 WATT, unplug the watt meter and then plug it back in to reset it).



All incandescent light bulbs are rated at the level of power they consume in order to produce light. The one you will use is rated at 40 watts. Each of the “alternative” 3 light bulbs you will use on the AC Load Device is rated as a 40 watts “equivalent”. This is because they produce the equivalent amount of light as the incandescent light bulb they are meant to replace. A bit later, as we turn on each light bulb, the watt meter will give us the amount of power (in watts) that each light bulb needs to produce light. In theory, since each bulb is rated at 40 watts, the watt meter should read 40 watts for each light bulb, right? Let’s see.

**Part 1: Incandescent Light Bulb:** Starting on the left hand side of the AC load device turn ON the first light bulb – Load 1. This is an incandescent light bulb – look at the package. Incandescent light bulbs were commercially manufactured for the first time in 1880. It was Thomas Edison who was able to perfect the technology that allowed for this. Look at the watt meter. What is the reading? The incandescent light bulb actually uses 40 watts to produce light. There is also something else this bulb produces. Without actually touching the bulb, because it gets very hot, feel around it. What do you feel? Along with light, the bulb produces heat which is very inefficient. Now, turn OFF the bulb.

**Part 2: Halogen Light Bulb:** Turn ON the second bulb –Load 2. This is a halogen light bulb – look at the package. Look at the watt meter. What is the reading? The halogen bulb only uses 29 watts to produce light which is 28% more energy efficient than the incandescent bulb, and on the package it states exactly that. If you think in terms of an incandescent light bulb costing \$100.00 per year to produce light, a halogen bulb would only cost about \$72.00 per year (a 28% savings). Feel the bulb. Does it feel cooler than the previous one? Now, turn OFF the bulb.

**Part 3: Compact Fluorescent Light Bulb (CFL):** Turn ON the third bulb – Load 3. This is a CFL bulb – look at the package. It is not as bright right away because this CFL has a warm-up time, but after about 30 to 60 seconds it is just as bright. Fluorescent lights use cathodes to heat a special gas or mix of gases to create UV light. The UV light is then filtered through phosphors to create white or colored light. To do this however, the cathodes have to warm up. Look at the watt meter. What is the reading? The CFL bulb only uses 9.5 watts to produce light. It is more efficient than the halogen bulb. When compared to the incandescent bulb it is 75% more energy efficient! Let's look at the dollar amount difference. If the incandescent bulb costs \$100.00 per year to produce light, the CFL would only cost \$25.00 per year (a 75% savings!). Feel the bulb. Does it feel cooler than the previous one? Now, turn OFF the bulb.

**Part 4: Light Emitting Diode (LED):** Turn ON the fourth bulb – Load 4. This is a LED bulb – look at the package. Look at the watt meter. What is the reading? The LED bulb only uses 6 watts to produce light. It is even more efficient than the CFL bulb. When compared to the incandescent bulb it is 85% more energy efficient! Let's look at the dollar amount difference. If the incandescent bulb costs \$100.00 per year to produce light, the LED would only cost \$15.00 per year (an 85% savings!). Consider the cost of all the light bulbs used in an entire home. Let's say it costs \$1000.00 a year. If you switched all of the light bulbs from incandescent to LED bulbs you would save 85% of \$1000.00 – that is a savings of \$850.00! What could you do with an extra \$850.00? Feel the bulb. Does it feel cooler than the previous one? Now, turn OFF the bulb.

So, which bulb is the most energy efficient? The LED and the CFL bulbs are both very energy efficient. Why do you think many people choose to purchase CFL bulbs?

CFL bulbs are cheaper to buy up front (first cost). If a CFL bulb costs you \$5.00 up front and a LED bulb costs you \$10.00 up front, many people will choose the CFL bulb because it is just about as energy efficient as the LED. The CFL package says that the bulb will last 8,000 hours. The LED package says that the bulb will last 25,000 hours. That is a little over 3 times longer. Let's do some math.

One CFL bulb costs \$5.00 but you would need 2 more of them to last as long as one LED bulb lasts. That's an additional replacement cost of  $\$5 \times 2 \text{ bulbs} = \$10.00$ . The energy consumption cost over 25,000 hours is \$22.50 making the operational cost \$32.50. That means the total life cycle cost of the CFL option is \$37.50. The LED first cost is \$10.00 and the operational cost over 25,000 hours is \$15.00. That means the total life cycle cost of the LED option is \$25.00. A 33% savings compared to the CFL.

**First cost** should be only one consideration when purchasing something. It is also necessary to consider the **operational cost**. Because the **total life cycle cost** (first cost and operational costs combined) is the best indicator when making any type of purchase.

First, carefully unplug all cords. Only after that, unscrew the bulbs from the AC load device and carefully place back in the packages. Lastly, return all materials to the storage box.

## Watts Going On?

To meet new efficiency standards, stores and manufacturers are rolling out alternatives to the familiar pear-shaped incandescent light bulb. Below, a comparison of technologies that can substitute in brightness and color for a warm or soft white 60-watt (800 lumen) incandescent bulb.



### Traditional incandescent

**Price per bulb:** 25-50 cents

**Lifespan:** 750-1,000 hours

**Energy used:** 60 watts

**Annual operating cost\*** \$4.80

**Comment:** Highly inefficient: 90% of energy used is wasted as heat. To be phased out by 2014. Upgrading 15 of these bulbs could save \$50 a year.



### Halogen-incandescent

**Average Price:** \$1.50-\$2

**Lifespan:** 1,000-3,000 hours

**Energy used:** 43 watts

**Annual operating cost:** \$3.50

**Comment:** Just like incandescent bulbs but with a halogen-gas filled capsule to increase efficiency by about 25%. Dimmable.



### CFL

**Price per bulb:** \$1.99-\$4.99

**Lifespan:** 8,000-10,000 hours

**Energy used:** 13-14 watts

**Annual operating cost:** \$1.20

**Comment:** Dubbed the 'squigly' light, many now have spiral hidden inside traditional-shaped outer bulb. Upside: about 75% more efficient and available in range of light tones. Downside: Bulbs contain trace amounts of mercury and generally aren't dimmable.



### LED

**Price:\*\*** \$20-\$55

**Lifespan:** 25,000 hours

**Energy used:** 13-14 watts

**Annual operating cost:** \$1

**Comment:** Considered lighting's Holy Grail, semiconductor light-emitting diodes (LEDs) are super efficient, safe and long lasting. Most today are dimmable and come in warm hues and cooler tones; prices expected to drop steeply over next few years.

\*Annual operating cost from Department of Energy based on two hours of operation a day at 11-cents per kilowatt hour.  
\*\*\$20 model available from Switch Bulb Co. Inc. this fall.  
Sources: General Electric Co., Royal Philips Electronics, Osram Sylvania, Home Depot Inc., Switch Bulb Co. Inc. and DOE.