



# Cost of Computers

## Objectives

By the end of this activity, students will be able to:

- explain that different types of computers use different amounts of electricity;
- compare and contrast computer mode settings and their electricity use; and
- identify ways to conserve electricity when using computers.

## Rationale

Calculating the cost of computers will help students realize potential energy savings both at school and at home.

## Materials

- Copies of **Calculating Computer Costs** activity sheet
- Calculator (optional)

## Background

How many hours do you use a computer each day? Each week? How many different computers do you use on a regular basis (at home, at school, at the library, etc.)? How much do you think it costs to operate the computer? Do you think all computers cost the same to run? What is the difference between putting your computer in sleep or standby mode and turning it off?

These days, computers are considered a common household appliance and an integral teaching tool in the classroom. People use computers all the time but rarely think about how much it costs to keep those computers running.

Although the amount of electricity generally wasted by an average classroom computer may be insignificant, typically around \$18 annually for each desktop computer, the sum of wasted electricity by computers throughout a school district can amount to hundreds or thousands of dollars.

There are many computer myths that have been dispelled over the years. One myth

is that screen-savers save energy. In fact, it takes the same amount of electricity to move that fish around your screen as it does to do any word processing.

Another myth is that it takes more energy to turn off and restart your computer than it does to just leave it on all the time. It is more likely that your computer will be outdated before it is worn out by turning it off and on. There are some school districts that require computers to be left on at night for software upgrades and network maintenance; these units are often automatically shutdown after the upgrades are complete. Although the computer will most likely be using some electricity because it is left plugged in, it may be the only alternative available in your school district.

Some people believe that turning off the monitor will save as much energy as turning off the whole computer. Although it will save some electricity, the Central Processing Unit (CPU) will still be operating as if the monitor is on, generally using approximately 74 watts. It is more energy efficient to put the computer into standby mode, which puts the computer in a low-power use mode. This recommended mode also allows the computer to be easily woken up when required. However, in computer lab settings with short breaks between classes, staff may be able to have the monitors plugged into an outlet that can be controlled by a toggle switch. This way, the teacher can turn off all of the monitors with one flip of the switch and they don't have to worry about rebooting all of the CPUs.

One more computer myth is that saving energy by powering down one computer won't make a difference. In fact, if all the computers in an entire school district are operated at their highest energy efficiency, electricity bills could be significantly lowered. Every little bit helps and this activity is designed to help reinforce that message.

**Summary: Students calculate and compare electrical costs of computers in various modes.**

**Grade Level:** 5–8

**Subject Areas:** English Language Arts, Mathematics, Science

**Setting:** Classroom

**Time:**

**Preparation:** 1 hour

**Activity:** Two 50-minute periods

**Vocabulary:** Blended rate, CPU, Electric rate, Kilowatt-hour, Sleep/standby mode, Watt, Watt meter

**Major Concept Areas:**

- Quality of life
- Management of energy resource use

**Getting Ready:**

A **Wattage Chart for Typical Computers & Monitors in Different Modes** is provided. Use a watt meter for a more accurate measurement of a computer's energy use in different modes (see **Using a Watt Meter to Determine Actual Energy Use**). Obtain a watt meter (Kill-A-Watt and Watts Up? are popular brands) from your local public library or contact KEEP to borrow one. It may be useful to purchase one for the classroom or school if this activity will be conducted year after year. Contact the facilities manager to request a copy of a typical electric bill for your school.

If the blended electric rate is not provided on the bill, calculate the rate as follows. Use the total cost due for electricity and divide by the total number of kWh used for the billing period found on your

*Continued on next page*

*Continued from previous page*

school's electric bill. Your blended rate will likely be in the \$0.09/kWh - \$0.14/kWh range, which will be higher than the on-peak and off-peak electric rates (if your school is charged, and most are) shown on your bill. The blended rate is higher because it takes into account the demand charges and other fees found on your school's electric bill. If you do not know your school's blended rate use \$0.12/kWh.

Talk to the district Information Technology department to find out approximately how many computers are in the district. Calculations made during this activity will be more accurate if you can find out how many of each kind of computer there are (LCD/LED screens, laptops and tablets).

Work through the **Classroom Computer Example** calculations to prepare for questions students may have when completing the **Calculating Computer Costs** activity sheet.

### **Related KEEP Activities:**

"The Cost of Using Energy,"  
"Demanding School Electric Bills,"  
"Light and Your Load," "At Watt Rate?"

There are several variables to consider when calculating the cost of computers. Some of these include the energy efficiency of monitors and CPUs, mode in which the computer is in, electric rate, and hours of use, which are described in **Computer Variables**.

Conserving energy by operating computers efficiently is a great way to contribute to a school district's goal of reducing energy consumption and lowering utility bills. On average, computers make up seven to fourteen percent of a school's electricity consumption. Although computers are not the highest electrical consumers in a school, it is easier for individuals to manage computers efficiently than the heating and air conditioning systems. See the activity "Light and Your Load" for more ideas on how to conserve energy in your classroom.

## **Procedure**

### **Orientation**

Have students consider all the costs involved with buying and using a computer. Ask them if all computers cost the same. What makes one computer more expensive than another?

Help students understand that the energy used by a computer will continue to be a factor after it is bought and paid for. Ask students how they can reduce the energy cost of their computers.

### **Steps**

1. Inform students that a computer's energy use, like most appliances, is measured in watts. Remind students that a computer's energy consumption will be part of an overall electric bill that is recorded as kilowatt-hours (kWh). Review the definitions of kWh, watt, and other energy terms as needed.
2. Discuss different ways a computer can be shut down, identifying these as different computer modes (see **Computer Mode Definitions**).

3. Hand out the **Calculating Computer Costs** activity sheet. Review the (I.) Introduction and complete questions A through D of the (II.) Classroom Computer(s) section as a class. Provide the blended electric rate for the school (see **Getting Ready**).

4. Have students complete questions E through H of the (II.) Classroom Computer(s) section in class. A calculator may be used to assist with calculations. Be sure students show their math when doing calculations.

5. Assign students to complete the (III.) Home Computer(s) section of the activity sheet. Encourage students to have adult family members assist with the project. NOTE: It is advisable to secure parental permission prior to conducting surveys.

### **Closure**

After students complete the **Calculating Computer Costs** activity sheet, review the results as a class. Use the (IV.) Comparing Computer Costs at Home and at School questions to generate class discussion.

## **Assessment**

### **Formative**

- How well did students complete the **Calculating Computer Costs** activity sheet?
- Were students able to provide ways to lower the electricity costs of the classroom computer(s) or their home computer?
- Were students able to identify ways to educate other students and staff about the cost of computers?

### **Summative**

Have students calculate the cost savings if they were to operate the classroom computer(s) more efficiently. What are the savings/costs associated with upgrading the classroom computer with a more energy efficient CPU and monitor?

## Computer Variables

### Energy Efficiency of Monitors and CPUs

Standard LCD flat screen monitors are more energy efficient than the older, TV-like, CRT monitors (refer to the **Wattage Chart for Typical Computers & Monitors in Different Modes**). More and more school districts are using laptops and tablets instead of traditional desktop units. As mentioned earlier, many computers use power even when they are off, but still plugged in, or in standby mode (see **Using a Watt Meter to Determine Actual Energy Use**). Note: ENERGY STAR® monitors and CPUs are generally more energy efficient than older, traditional units.

### Mode

Many school computers are turned on Monday morning (or maybe at the beginning of the school year) and left on all week (or all year). Most computers will automatically go into a sleep mode after a certain amount of time has passed without use. Some computers can be put in standby or hibernation mode, but this is not usually automatic. There is a large range of how computers power down; it is important to observe the computer in your classroom and identify when it changes modes and what mode it is changing to (see **Computer Mode Definitions**).

### Electric Rate

Depending on where you live, electric rates can vary tremendously. Since most schools are billed a demand charge in addition to the actual electricity used charge, it is recommended to calculate the blended rate (see **Getting Ready**) to determine the true cost of using your computer. (Review the activity “Demanding School Electric Bills” for more information about demand charges.)

### Hours of Use

Some computers are used more than others. It is important to try to estimate the hours of use as accurately as possible to get a true idea of how much your computer costs. Use the **Classroom Computer Example** to help calculate the total number of hours your computer is used in the various modes.

## Extensions

Involve students in a thorough computer survey of the entire building and meet with the Information Technology staff to determine the standard operating procedures and options to maximize efficiency of computer usage for the school.

If more efficient computer operating procedures are needed, have students report their findings to the superintendent or school board with recommendations.

# Classroom Computer Example

(Sample answers for **Calculating Computer Costs Activity Sheet**)

## Situation

A classroom has a desktop computer with a typical 22" LCD monitor. It is turned on Monday morning at 7:00 am and turned off Friday afternoon at 4:00 pm. It is not used over the weekends at all. Each school day the computer is used for 3 hours. When it is not in use, it goes into sleep mode but it is not set to go into standby or hibernate mode. The blended electric rate for the school is \$0.12/kWh.

**Calculate the total kWh for a week** using the values for the desktop computer and 22" LCD monitor from the **Wattage Chart for Typical Computers & Monitors in Different Modes**.

$$\text{In use: } 181 \text{ W (computer)} + 55 \text{ W (monitor)} = \frac{236 \text{ W} \times 15 \text{ hrs}}{1000 \text{ watts/kWh}} = 3.5 \text{ kWh}$$

$$\text{Sleep: } 83 \text{ W (computer)} + 8 \text{ W (monitor)} = \frac{91 \text{ W} \times 90 \text{ hrs}}{1000 \text{ watts/kWh}} = 8.2 \text{ kWh}$$

$$\text{Standby: } 9 \text{ W (computer)} + 4 \text{ W (monitor)} = \frac{13 \text{ W} \times 0 \text{ hrs}}{1000 \text{ watts/kWh}} = 0 \text{ kWh}$$

$$\text{Off/Shutdown: } 0 \text{ W (computer)} + 0 \text{ W (monitor)} = \frac{0 \text{ W} \times 63 \text{ hrs}}{1000 \text{ watts/kWh}} = 0 \text{ kWh}$$

$$\text{Total: } 3.5 \text{ kWh} + 8.2 \text{ kWh} + 0 \text{ kWh} + 0 \text{ kWh} = 11.7 \text{ kWh/week}$$

## Calculate the total kWh for a month

NOTE: This calculation uses 4 weeks in a month for simplicity. If you would like to determine the energy usage or cost for an entire school year, multiply the kWh/week by the total number of weeks your school is in session.

$$11.7 \text{ kWh/week} \times 4 \text{ weeks/month} = 46.8 \text{ kWh}$$

## Calculate the cost to operate your computer for a month

$$46.8 \text{ kWh} \times \$0.12/\text{kWh} = \$5.62/\text{month}$$

## Conclusion

Which mode costs the most in this example? Sleep. If the computer was put in standby mode for 90 hours each week, there could be a savings of 7.0 kWh each week (8.2 kWh currently used in sleep mode – 1.2 kWh if used in standby mode) which equals a savings of \$3.36/month (7.0 kWh/week x 4 weeks x \$0.12/kWh). This is over half the cost of operating the computer. That may not sound like much, but if there are 500 computers in the district that are operated the same way, that could be a savings of \$1,680/month for this example (\$3.36/month x 500 computers).

	In use (hours)	Sleep-time not in use, standby, or off (hours)	Standby (hours)	Off/Shutdown (hours)
Monday	3	24 – 3 – 7 = 14	0	midnight to 7:00 am = 7
Tuesday	3	24 – 3 = 21	0	0
Wednesday	3	24 – 3 = 21	0	0
Thursday	3	24 – 3 = 21	0	0
Friday	3	24 – 3 – 8 = 13	0	4:00 pm to midnight = 8
Saturday	0	0	0	24
Sunday	0	0	0	24
<b>Total (hours)</b>	<b>15</b>	<b>90</b>	<b>0</b>	<b>63</b>

# Using a Watt Meter to Determine Actual Energy Use



A watt meter is an electronic instrument that measures the power (watts) used by an appliance. When you plug the appliances into your meter, you can measure how much electricity your appliances are using and what they are costing you. The meter will display wattage, cumulative kilowatt hours and cumulative cost. There should be an instruction guide that accompanies the meter for details in using the various functions.

The actual electricity used is measured as a kilowatt hour, which is equal to one kilowatt (or 1000 watts) of electricity used steadily for one hour. For example, ten 100-watt light bulbs, left on for one hour, would use one kilowatt-hour (or 1000 watt-hours) of electricity.

## To use the watt meter on computers:

NOTE: If you only have one watt meter, you will need to first determine the wattages used by the CPU, then start from the beginning and determine the wattages used by the monitor). If you have two watt meters, you can run them simultaneously for quicker results. You will need to obtain more information to calculate your computers monthly electric usage and cost (hours of use and electric rate), but the following options will help you gather needed wattage/usage information. Directions reflect operation of a WattsUp? brand meter.

### Option 1

The data gathered from using this option will more closely resemble data used throughout this activity and in the **Calculating Computer Costs** activity sheet than the results from option 2. Gathering data this way is more hands-on, and should only take 30 minutes.

1. Make sure the computer has been shut down properly and is turned off.
2. Unplug the CPU (or monitor). Plug the watt meter cord into the same socket. The watt meter will switch on automatically.
3. Plug the CPU (or monitor) into the watt meter.
4. The watt meter will first show you the estimated cost of electricity being used. Push the MODE button once so it displays kilowatts (kW). This is the number of kilowatts being consumed by the CPU (or monitor).
5. The MODE button will switch readings from the kilowatts (kW) being consumed, to the length of time (HR) the unit has been running, to the total kilowatt-hours (kWh) of

electricity consumed. You will need all three measurements for an accurate calculation, so be sure you're comfortable finding the readings (in this option you will focus on the kW and HR readings).

6. After you've become familiar with the readings, unplug the meter cord and plug it back in so the time is reset to 0.00.
7. Start with the computer and monitor turned "off;" if the watt meter shows a reading for kW while the computer (or monitor) is off, the CPU (or monitor) uses standby power, and you should continue following these steps. If the kW reading is 0, then the CPU (or monitor) does not use standby power, and you should skip to Step #8b.
8. For CPUs (or monitors) that use standby power:
  - 8a. Keep the computer (or monitor) off and record the average amount of standby power used in terms of kilowatts (kW).
  - 8b. Unplug the meter to reset it and then plug it in and turn on the computer and monitor. Use the computer as you would normally for 10–20 minutes (i.e., active web browsing, word processing, email, upload photos or data) and record the range of kilowatts (kW) used. Divide your recorded kW by 1000 to obtain watts (W). Your results should fall within the range provided in the **Wattage Chart for Typical Computers & Monitors in Different Modes**. For calculation purposes, use the high end of your range of kW. You can use this information to determine the amount of electricity used when the computer is on and "in use."
  - 8c. Let the computer go into "sleep" mode, where the screen goes black but the computer is still on. Look at the watt meter and record the range of kilowatts (kW) used in this mode by the CPU (or monitor) for 5 minutes. Again, for calculation purposes use the high end of your range of kW. You can use this information to determine the electrical usage during "sleep" mode.
  - 8d. If you can easily set your computer to go into "standby" mode, do so and record the range of kilowatts (kW) used in this mode by the CPU (or monitor) for 5 minutes. Again, for calculation purposes use the high end of your range of kW. You can use this information to determine the electrical usage during "standby" mode. If you are unable to set your computer to go into "standby" mode, skip to Step #8e.
  - 8e. The total electric usage of the computer (or monitor) will be the amount it uses when it is turned off, in "standby" mode, in "sleep" mode, plus the amount it uses when it is on and "in use." This information can be used to calculate the total monthly electric usage or monthly cost of the computer (or monitor). Refer to the **Classroom Computer Example** for sample calculations.

# Using a Watt Meter to Determine Actual Energy Use

## Option 2

This option will provide a more accurate evaluation of the energy your computer and monitor uses; however, the results will not be determined in the same fashion as outlined in the rest of the activity and it takes a week to obtain the data. It may be interesting to determine your computer's energy usage by using data gathered in option 1 and data gathered in option 2 and compare the results.

1. Follow Steps #1–#6 outlined in Option 1.
2. Start with the computer and monitor turned “off;” then turn them on and use the computer as you would normally for one full week. Record the total kilowatt hours (kWh) used over the week. This information can be used to calculate the total monthly electric usage or monthly cost of the computer (or monitor).

## Computer Mode Definitions

Some modes outlined below may have different definitions on different machines. Investigate your computer to identify its individual power saving modes, what each mode is named and how it's defined.

**In Use** means the computer is plugged in or turned on at power strip and in use through active web browsing, word processing, email, etc.

**Sleep** mode has many different definitions depending on the computer and operating software. For this activity, sleep is the mode your computer automatically goes into after a certain period of inactivity. The screen will generally go black, but the computer is operating and running as usual. When needed, the computer and monitor automatically return to the active mode.

**Standby** is a state in which your monitor and hard disks turns off, so that your computer uses less energy. When you want to use the computer again, it comes out of standby quickly, and your desktop is restored exactly as you left it. Use standby to save power when you will be away from the computer for a short time while working. Because standby does not save your desktop state to disk, a power failure while on standby can cause you to lose unsaved information. Most computers can be put in standby by selecting the feature on the power option menu; then they must be turned on manually. NOTE: standby wattages found in the **Wattage Chart for Typical Computers & Monitors in Different Modes** are to be used if your computer is in hibernation or shutdown.

**Hibernation** is a state in which your computer shuts down to save power but first saves everything in memory on your hard disk. When you restart the computer, your desktop is restored exactly as you left it. Use hibernation to save power when you will be away from the computer for an extended time while working. Note: It may take your computer longer to come out of hibernation than standby.

**Shutdown** is when you turn your computer off, but it is still plugged in. In this mode, it will still usually draw electricity, similar to Standby or Hibernation modes.

**Off – Unplugged or Turned Off** at Power Strip is the only way to ensure that your computer is not drawing any electricity.

# Calculating Computer Costs

Name \_\_\_\_\_

Date \_\_\_\_\_

## I. Introduction

How many hours do you spend on a computer each day? What are the electrical costs to operate a computer? Do all computers cost the same and does it matter if they are in sleep or standby mode? To answer these questions, you will calculate electricity costs for your classroom computer and your computer at home. Either use the **Wattage Chart for Typical Computers & Monitors in Different Modes** provided or a watt meter to determine the actual wattages for calculations.

NOTE: Use the highest value listed if a range is provided and you are uncertain what the exact wattage is. Do NOT include monitor wattages when calculating laptop and tablet costs.

**Wattage Chart for Typical Computers & Monitors in Different Modes**

Mode	Wattage (W) of Desktop Computer (CPU)	Wattage (W) of 22" LCD/LED monitor	Wattage (W) of laptop/notebook/netbook	Wattage (W) of tablet
<b>In use</b>	28–181	2–55	15–73	3–7
<b>Sleep</b> (black screen, computer still on)	1–83	0–8	0–55	1–5
<b>Standby</b> (low power state, computer still on)	0–9	0–4	0–50	0–1
<b>Off</b> (unplugged)	0	0	0	0

**Wattage Chart Determined by Using a Watt Meter**

If your class uses a watt meter to determine actual wattages for the computer in different modes, fill in the following information.

Mode	Wattage (W) of Desktop Computer (CPU)	Wattage (W) of monitor	Wattage (W) of laptop/notebook/netbook	Wattage (W) of tablet
<b>In use</b>				
<b>Sleep</b> (black screen, computer still on)				
<b>Standby</b> (low power state, computer still on)				
<b>Off</b> (unplugged)				

## II. Classroom Computer(s)

- A. **What type of computer does your classroom have?** Circle one Desktop Laptop Tablet
- B. **Complete the following chart by entering the number of hours the computer is running in each of the four modes (in use, sleep, standby, and off) for each day of the week. Add up each column and enter total number of hours for each mode on bottom line.** Write partial hours in decimals (e.g., 15 minutes = 0.25 hours, 30 minutes = 0.5 hours, 45 minutes = 0.75 hours)

Weekly Computer Use in Different Modes					
	Example: In use (hours)	In use (hours)	Sleep (hours)	Standby (hours)	Off (hours)
Monday	3				
Tuesday	3				
Wednesday	3				
Thursday	3				
Friday	3				
Saturday	0				
Sunday	0				
<b>Total (Hours)</b>	15				

- B. **What is the blended electric rate for electricity at your school (teacher will provide this)?** \$\_\_\_\_ /kWh  
If you can not determine your school's blended electric rate, use \$0.12/kWh)

**Please show math for all calculations.**

- C. **Calculate the total watts your classroom computer and monitor (or laptop) uses in the four different modes.** (Use the wattages from the chart provided or your own measurements).

### For example

**In use:** a desktop computer uses 181 watts (W) in use + a LCD monitor uses 55 W = 236 W

**Sleep:** The same computer and monitor uses 83 W + 8 W = 91 W

**Standby:** The same computer and monitor uses 9 W + 4 W = 13 W

**Off:** The same computer and monitor uses 0 W + 0 W = 0 W

**In use:**

**Sleep:**

**Standby:**

**Off:**



D. **Calculate the total kWh in each mode for a week.** Multiply total hours from the bottom line from the Weekly Computer Use in Different Modes table on the previous page by answers from D for each mode and divide by 1000 watts/kWh.

For example, In use:  $\frac{15 \text{ hours} \times 236 \text{ W}}{1000 \text{ watts/kWh}} = 3.5 \text{ kWh}$

**In use:**

**Sleep:**

**Standby:**

**Off:**

E. **Calculate the total kWh used by your classroom computer in a week.** Add the answers from E.

F. **Calculate the total kWh used by your classroom computer in a month.** Multiply F by four (four weeks in a month).

G. **Calculate the cost to operate your classroom computer for a month.** Multiply G by C (blended electric rate).

### III. Home Computer(s)

H. **What type of computer do you have at home?** *Circle one* Desktop Laptop Tablet

I. **Complete the following chart by entering the number of hours the computer is in each of the four modes (in use, sleep, standby, and off) for each day of the week. Add up each column and enter total number of hours for each mode on bottom line.** Write partial hours in decimals (e.g., 15 minutes = 0.25 hours, 30 minutes = 0.5 hours, 45 minutes = 0.75 hours)

Weekly Computer Use in Different Modes					
	Example: In use (hours)	In use (hours)	Sleep (hours)	Standby (hours)	Off (hours)
Monday	3				
Tuesday	3				
Wednesday	3				
Thursday	3				
Friday	3				
Saturday	0				
Sunday	0				
<b>Total (Hours)</b>	15				

- J. **What is the electric rate for electricity at your home (ask your parents to find the rate on an electric bill or look it up on your local utilities' web site)?** \$ \_\_\_\_ /kWh (If you can not determine your electric rate at home, use \$0.10/kWh)

**Please show math for all calculations.**

- K. **Calculate the total watts your home computer and monitor (or laptop) uses in the four different modes.** (Use the wattages from the chart provided or your own measurements).

**In use:**

**Sleep:**

**Standby:**

**Off:**

- L. **Calculate the total kWh in each mode for a week.** Multiply total hours from the *Weekly Computer Use in Different Modes* table by answers from L for each mode and divide by 1000 watts/kWh.

**In use:**

**Sleep:**

**Standby:**

**Off:**

- M. **Calculate the total kWh used by your home computer in a week.** Add the answers from L.

- N. **Calculate the total kWh used by your home computer in a month.** Multiply M by 4 (4 weeks in a month).

- O. **Calculate the cost to operate your home computer for a month.** Multiply N by O (electric rate from above).

## **IV. Comparing Computer Costs at Home and at School**

**1. Which has higher monthly electricity costs—your computer at home or your classroom computer?**

**2. What are the monthly electricity costs to operate all the computers in your school (estimate total # of computers in your school)? In your whole school district (estimate total # of computers in your whole school district)?**

**School:**

**District:**

**3. Which mode is your computer at home most often in? Your classroom computer? Why?**

**4. What can you do to lower the electricity costs of your computer at home or your classroom computer?**

**5. If you are unable to turn your computer off, what is the next best alternative? Why?**

**6. How can you educate the staff and students in your school about the cost of computers? Your family members?**

**Excerpt from**  
***Energy & Your School Activity Guide***  
**at [keepprogram.org](http://keepprogram.org)**

© 2019 Wisconsin Center for Environmental Education

The Wisconsin K-12 Energy Education Program is supported through funding from



Wisconsin K-12 Energy Education Program (KEEP)  
College of Natural Resources  
**University of Wisconsin - Stevens Point**

