Summary: Students conduct lighting surveys to calculate the cost to light their homes and compare that to the cost of lighting their classroom.

Light and Your Load

Objectives
By the end of this activity, students will be able to:
- calculate the cost of lighting the four most frequently used rooms in their house;
- calculate the cost of lighting their classroom;
- evaluate the efficiency of the lighting used both at home and at school;
- identify ways to educate students and staff about the cost of lighting.

Rationale
Calculating lighting costs, both at home and at school, will expose students to the energy expenses associated with today’s standard of living. Comparing efficient lighting options will hopefully lead students to make informed choices when purchasing lighting products.

Materials
- Copies of the Lighting Comparison Activity Sheet
- Calculator (optional)

Background
(Also see the Background for “Demanding School Electric Bills.”)

How would you feel if you had to grade homework by candlelight? How practical would it be to conduct science experiments in a lab without lights?

Lighting is required for nearly everything we do during our waking hours. Natural daylighting can be used for many things, but some artificial lights are needed when natural light is simply unavailable or inadequate.

At home, you may sit next to a window and have enough light to grade homework, but what happens when the sun goes down? Most teachers will flip on the light switch without thinking twice. In general, most people do not think about the energy used to light their homes.

Calculating the energy required to light your home can be done fairly easily. The number of fixtures can be determined by simply looking around each room. Determining the number of light bulbs and their wattage in each fixture may be somewhat more difficult, especially if the lamp(s) are enclosed, however, with a little help and possibly a ladder, you should be able to obtain that information. Once you have the number of lamps and their wattages, you may calculate the kilowatt-hours used by multiplying the number of lamps x wattage x hours used/day and divided by 1000 to convert to kilowatt-hours/day.

\[
\text{2 lamps} \times 100 \text{ watts/lamp} \times 4 \text{ hours on/day} = 0.8 \text{ kilowatt-hours (kWh)/day}
\]

If no one is home during the week, lights might only be used at night, but used more frequently during the weekends. However, if people are home during the week, lights may be used the same hours each day, weekday or weekend. To calculate the lighting costs for a month, multiply the kWh/day by 30 days. For a more accurate calculation, keep track of the actual hours the lights are on for a month.

Compact fluorescent light bulbs (CFL) last up to ten times longer and use approximately one quarter of the energy that a incandescent light bulb uses to produce the equivalent light output. Light emitting diode bulbs (LED) last twenty-five times longer than incandescent lighting and require less energy than CFLs. Refer to the chart on the next page for a quick comparison of wattage requirements for similar light outputs.

Note: Like all fluorescent lamps, CFLs do contain a small amount of mercury—an average of five milligrams (mg) per bulb. By comparison, some watch batteries contain 25 mg of mercury and many manual thermostats contain up to 3,000 mg.

In many schools, there are classrooms located on interior walls without windows...
Lighting costs can be calculated by multiplying the kWh used over a given time by the electric rate.

$$0.8 \text{ kWh/day} \times $0.10/\text{kWh} = $0.08/\text{day}$$

- OR -

$$285.12 \text{ kWh/month} \times $0.12/\text{kWh} = $34.21/\text{month}$$

In homes, lighting accounts for approximately 8% of electrical usage. By using efficient lighting options, such as LEDs/CFLs, people can cut their electric bills by a few percent.

Since lighting accounts for 10-15% of a school's electrical consumption, it is important to understand how conserving electricity in the classroom can add up to substantial savings for the school district. For example, if possible, turn off some of your overhead lights if they are not needed. If your lights are not wired in a way that allows you to turn some off, a simple way to save energy is to remove some of the bulbs in fixtures where the area is over lit. Be sure to consult your facilities manager before attempting any de-lamping projects on your own.
If you have identified areas in which the school district can save energy, have discussed them with the facilities manager, and are still in need of further assistance, contact the Focus on Energy Agriculture, Schools and Government Program. Search online for Focus on Energy Advisor Map to identify the Advisor in your area.

Procedure
Orientation
Ask students what they think their parents/guardians pay for electricity each month. What percent of a typical family’s electrical consumption is used for lighting? How much does it cost for all of the electricity used at school each month? How much does it cost to light their classroom for a month?

Steps
1. Hand out the **Lighting Comparison Activity Sheet**. Review the Introduction and At Home section as a class.

2. Assign students to complete the At Home section of the lighting survey. A calculator may be used to assist with calculations (optional). Encourage students to have adult family members assist with the project. NOTE: It is advisable to secure parental permission prior to conducting surveys.

3. Provide the type and number of lamps in each overhead fixture in your classroom along with the blended electric rate for the school. Have students complete the At School section of the lighting survey in class.

Closure
After the At Home section is completed, review the worksheet as a class. Focus on the four comparison questions on the second page to generate class discussion.

Assessment
Formative
- How well did students complete the **Lighting Comparison Activity Sheet**?
- Were students able to determine if the school currently uses the most energy efficient lighting options?
- Were students able to identify ways to educate other students and staff about the cost of lighting?

Summative
Have students calculate the cost of lighting their classroom with a more or less efficient lighting option. What are the savings/costs associated with the ‘new’ lighting option.

Extension
Ask the facilities manager to speak to the students about the lighting in the school. They could explain any updates that have been made at the school and discuss how much money was actually saved. They could also provide suggestions for how students could save energy in other ways in the school.

Involve students in a thorough lighting survey of the entire building. Meet with the Facilities Manager to determine the percent of electricity used on lighting for the school. Using a light meter, record interior light levels of classrooms and common areas to determine which spaces are over lit. (See **Recommended Interior Light Levels in Schools** chart.)

If lighting upgrades are needed, have students report their findings to the superintendent or school board with recommendations.
Lighting Comparison Activity Sheet

Introduction
How much does it cost to provide electricity for lighting? Are some types of lighting more cost effective than others? To answer these questions, you will calculate electricity costs for some of the lights you use in your home and school.

At Home
Use the table below to calculate the cost of lighting the four most frequently used rooms in your home. An example of the calculations needed has been provided on the first row.

Before you do the calculations, find out how much a kilowatt-hour (kWh) of electricity costs in your area. This information can be found on your utility bill. Write your answer below.

A. ________________  (If you can not determine your electric rate, use $0.10/kWh)

<table>
<thead>
<tr>
<th>Name of Room</th>
<th>B. Fixtures # and watts per bulb**</th>
<th>C. Watts # watts used when on</th>
<th>D. Hours on/day Average # of hours/day that light bulb is on</th>
<th>E. Watt-hours used per day watts (C) × hrs (D)</th>
</tr>
</thead>
</table>

** If you have fluorescent tube lighting, use table on next page to determine typical wattages

F. Total watt-hours per day for four rooms. Add together totals from (E) for all rows

G. Calculate the watt-hours used in one month. Total watt-hours per day (F) × 30 days

Example: (960 × 30 = 28,800 watt-hours)

H. Calculate the total kilowatt-hours (kWh) for one month. Watt-hours (G) divided by 1,000 watts

Example: (28,800 / 1,000 = 28.8 kWh)

I. Calculate the cost of lighting four rooms for one month. Total kilowatt-hours for one month (H) × cost of electricity (A)

Example: (28.8 × 0.10 = $2.88)

J. Calculate the lighting cost for one year. Cost of lighting four rooms for one month (I) × 12 months

Example: ($2.88 × 12 = $34.56)
At School

Use the table below to calculate the cost of lighting a typical classroom in your school. An example of the calculations needed has been provided on the first row.

Before you do the calculations, find out how much the blended rate for a kilowatt-hour (kWh) of electricity costs at your school. This information can be found by taking the total amount due on your school’s electric bill and divide by the total kWh used (on-peak and off-peak). Write your answer below.

A. ________________________ (If you can not determine your school’s blended electric rate, use $0.12/kWh)

<table>
<thead>
<tr>
<th>Classroom Name/Number</th>
<th>B. # of Fixtures for the entire classroom</th>
<th>C. # of Lamps per fixture* usually 2, 3, or 4</th>
<th>D. Type of Lamp T-5 or T-8 or LED</th>
<th>E. Watts per fixture* see table below for general wattages</th>
<th>F. Hours on/ day Average # of hours/day fixtures are on</th>
<th>G. Watt-hours used per day fixtures (B) × watts/fixture (E) × hrs (F)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Example: KEEP Office</td>
<td>4</td>
<td>3</td>
<td>T-8</td>
<td>88</td>
<td>8</td>
<td>4 × 88 × 8 = 2,816 watt-hrs</td>
</tr>
</tbody>
</table>

* If you don’t know the #, wattage, or type of lamp, use 126 watts/fixture

H. Calculate the watt-hours used in one month.
Total watt-hours per day (G) x 22 days (M-F only)
Example: (2,816 watt-hrs × 22 days = 61,952 watt-hrs)

I. Calculate the total kilowatt-hours (kWh) for one month.
Watt-hours (H) divided by 1,000 watts
Example: (61,952 watt-hrs / 1000 = 61.9528 kWh)

J. Calculate the cost of lighting a classroom for one month. Total kilowatt-hours for one month (I) × cost of electricity (A)
Example: (61.952 × 0.12 = $7.43)

K. Calculate the lighting cost for one school year. Cost of lighting classroom for one month (J) × 10 months
Example: ($7.43 × 10 = $74.34)

Comparing Lighting at Home and at School
1. Does it cost more to light the four most frequently used rooms in your home or your classroom?

2. How much would it cost to light all the classrooms in your school for a school year? In your school district (estimate total # of classrooms)?

3. Does your school currently use the most energy efficient lamps and fixtures?

4. How could you educate the staff and students in your school about the cost of lighting?
## Recommended Interior Light Levels in Schools

Involves students in a thorough lighting survey of the entire building. Using a light meter, record interior light levels of classrooms and common areas to determine which spaces are over lit. Be sure to take three measurements in each room under typical lighting conditions. Compare the room average to the chart below. Meet with the facilities manager or principal to share your results and recommend changes.

<table>
<thead>
<tr>
<th>Application</th>
<th>Foot-candles</th>
</tr>
</thead>
<tbody>
<tr>
<td>Administrative Offices</td>
<td>50</td>
</tr>
<tr>
<td>Auditorium</td>
<td></td>
</tr>
<tr>
<td>Assembly</td>
<td>10</td>
</tr>
<tr>
<td>Social activities</td>
<td>5</td>
</tr>
<tr>
<td>Reading</td>
<td>30-50</td>
</tr>
<tr>
<td>Bathrooms</td>
<td></td>
</tr>
<tr>
<td>Grooming</td>
<td>30</td>
</tr>
<tr>
<td>Lavatory</td>
<td>15</td>
</tr>
<tr>
<td>Cafeteria</td>
<td></td>
</tr>
<tr>
<td>Dining area</td>
<td>30</td>
</tr>
<tr>
<td>Kitchen</td>
<td>50</td>
</tr>
<tr>
<td>Classrooms</td>
<td>50</td>
</tr>
<tr>
<td>Computer Lab</td>
<td></td>
</tr>
<tr>
<td>Keyboards</td>
<td>30</td>
</tr>
<tr>
<td>Monitors</td>
<td>3</td>
</tr>
<tr>
<td>Reading printed material</td>
<td>50</td>
</tr>
<tr>
<td>Drafting Room</td>
<td>75</td>
</tr>
<tr>
<td>Gymnasium</td>
<td></td>
</tr>
<tr>
<td>General exercising and recreation</td>
<td>30</td>
</tr>
<tr>
<td>Basketball/Other games</td>
<td>50</td>
</tr>
<tr>
<td>Hallway</td>
<td>30</td>
</tr>
<tr>
<td>Library</td>
<td></td>
</tr>
<tr>
<td>Stack, audiovisual, checkout areas</td>
<td>30</td>
</tr>
<tr>
<td>Open study areas</td>
<td>50</td>
</tr>
<tr>
<td>Shop Areas</td>
<td>30-75</td>
</tr>
</tbody>
</table>

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