School Outdoor Lighting Audit Guide

Adapted with permission from the National Optical Astronomy Observatory.

Overview: You will conduct an audit of the types of outdoor lights on one building at your school to determine how those lights may be negatively impacting people and wildlife as well as how much energy those lights are using. With this information, you will then be able to recommend actions to reduce light pollution and improve energy efficiency at your school.

Materials: Pencil; graph paper; ruler/tape measure; copy of the "For Students" page titled *Types of Lighting Fixtures*; copy of this *School Outdoor Lighting Audit Guide;* camera or handheld device with camera

Time Requirement: one hour-long nighttime session

Group Size: Break into teams of 2-3 students

Part A. Data Gathering and Observation

Day Time

1. With your team and with your teacher or leader's approval, determine the building for which you will be conducting the lighting audit.
2. Measure the dimensions of the building and diagram the building and grounds using graph paper. Make your diagram to scale. Write in the building dimensions—length and width.
3. On your diagram, draw the location of the lights. Use lines and shading to show where you think the light will fall.
4. Take pictures of all of the light fixtures in order to be able to identify them later. You will eventually want to be able to determine the type of bulb used in the fixture and the type of shielding used to direct where light falls. To identify bulb type, see ***Figure 1: Types of Light Bulbs*** below. To determine shielding type, see the "For Students" page titled ***Types of Lighting Fixtures***.
5. Gather data on the amount of electricity used, as measured by watts, for each of the lightbulb types found on your site. Sources of information include labels on light bulb packaging or by interviewing facility staff that may have access to the specifications for light bulbs used on the site. If specific watts are unknown, use the table below as an estimate for wattage amounts.

Amount of Electricity Used by Various Types of Lightbulbs to Produce 800 Lumens

Type of Bulb	Typical Electricity Use (Watts)
Incandescent	60
Halogen	43
Mercury Vapor	25
High Pressure Sodium	15
Metal Halide	15
Compact Florescent	14
Light Emitting Diodes (LED)	13
Low Pressure Sodium	7

This table provides a rough comparison of the amount of watts used to produce a level of brightness equivalent to 800 lumens. These amounts are approximations and will vary depending on bulb manufacturer.

Night Time

Return to the site at night and confirm where the light falls for each fixture. On your building diagram, make notes of any observations about the light. Here are some questions that will help guide your observations:

- Is the area being illuminated too much or too little?
- Does the light fall where it is needed, or is it blocked by vegetation or some other structure?
- Are there overly bright or dark patches that make it difficult to see what is around you?
- What color is the lamp (i.e., yellow, orange, greenish-white, blueish-white…)?

Interview

1. Interview the buildings and grounds (facilities) staff at your school, facility, or at your school district office in order to learn more about the lighting. Consider the following questions to ask a facilities staff member:
   - What are the watts and lamp type for each of the lights?
   - Are the lights on timers or light sensors (dusk to dawn) or motion sensors?
   - If the lights are on timers, what are the approximate hours of operation?
   - Do you think the current outdoor lighting is adequate? What changes, if any, would you like to make?

2. Find out from the school district office what the school pays for electricity in dollars per kilowatt-hour. This number can be found on the monthly electrical bill.

Part B. Calculations

1. Use the formula below to estimate the number of hours per year that the building lights are on.

   (hours/week x weeks school is in session) + (hours/week x weeks school not in sessions) = total hours

2. For every different type of fixture with a particular lamp that has a particular wattage, calculate the amount of power used in a year using the following formula:

   # of lamps x wattage x hours/year = power (Watt-hours) used in a year

3. Add together the power used in a year for all of the different lamps of different wattages.
4. Divide this yearly power in Watt-hours by 1000 to change the units to kilowatt-hours.
5. Determine the current annual cost of operating the outdoor lights around your building:

   # of kilowatt-hours/year x dollars/kilowatt-hour = dollars spent on outdoor lights

6. The amount of carbon dioxide (a greenhouse gas) released into the atmosphere during electricity production is between 1.4 lbs. to 2.8 lbs. per kilowatt-hour, depending on what the source is (coal, nuclear power, or hydropower). Estimate the amount of carbon dioxide released when electricity is made to power the outdoor lights around your building:

   # of kilowatt-hours calculated x ~2 = weight of greenhouse gas released/year

Part C. Discussion

With your class, discuss what you learned. Consider the following questions:

- What types of lamps and fixtures were found?
- What is the range of wattages?
- Out of all of the fixtures around the building, how many were shielded?
- Are the light shieldings for the fixtures the type that contribute to glare and light trespass, or the type that help minimize glare and light trespass?
- At what angles or directions were the fixtures pointed (straight up, down, at an angle of 45°)?
- What were the colors of the lamps?
- Do the lamps and fixtures provide light where light is needed?

- Do any fixtures provide light where little or no light is needed?
- How does your vision respond to a fixture that is unshielded versus shielded?
- Did your team have differences in calculations as compared to other teams?
- If different buildings were audited, what differences in the buildings might support the differences in the calculated results?

Part D. Action Plan Research

Using information gathered in Parts 1, 2, and 3, create a lighting re-design action plan.

While looking at your diagram, consider how different areas around the building and on the school grounds may need different amounts of light. Make notes on your diagram that provide answers to the following questions:

- For each area around the building, what are the benefits of lighting? Is the light necessary? Why?
- Are there times of the day or night, days of the week, or weeks of the year when lighting is necessary? Are there times when lighting is unnecessary?
- How much light is needed?
- What kind of light do you want to use? Why?
  - Which type of lamp is appropriate?
  - What color of light is needed?

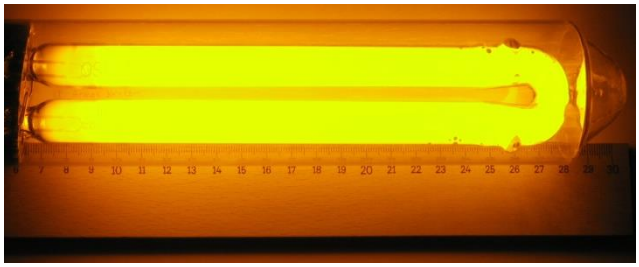
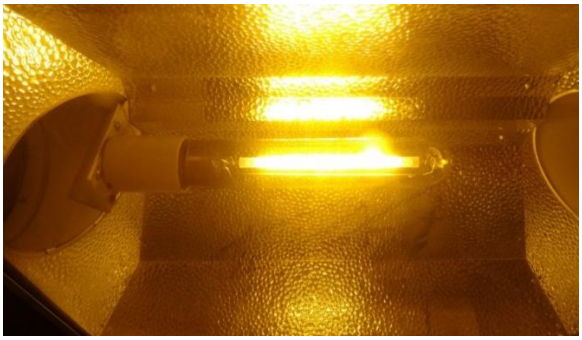
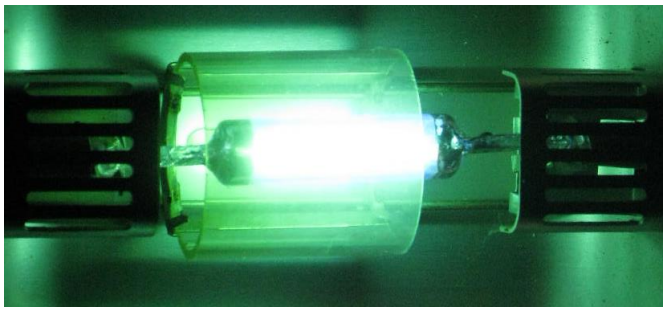
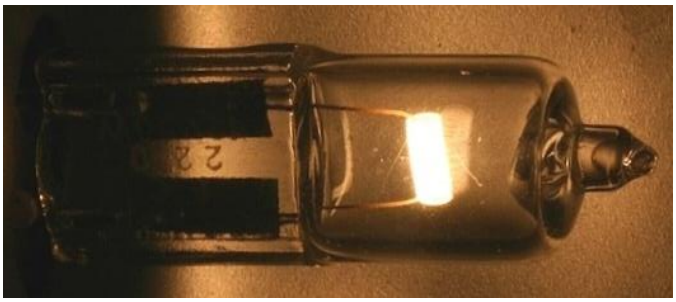
Part E. Action Plan Proposal

Using your answers to questions in Part IV, create and present an action plan that recommends changes to the current lighting at your school. This plan can be provided in different forms, including a paper, a poster, a PowerPoint presentation, a video, an audio recording, or a speech. Before your team starts working on plan, discuss with your teacher which format your team will use and when your team will present the plan. Be sure to include answers to the following questions in your plan:

1. Why is reducing excessive amounts of light from light fixtures helpful to people?
2. Why is reducing excessive amounts of light from light fixtures helpful to wildlife?
3. What are the current lighting conditions at your school?
4. What steps can be taken to improve lighting at your school or study site?
5. What materials will you need for your plan?
6. What is the estimated cost of your plan?
7. How many hours of work will be needed, and from whom?
8. How much power can be saved with your plan?
9. How much money can be saved with your plan?
10. What species of wildlife do you think will benefit from your action plan?

Figure 1. Types of Light Bulbs

Images courtesy of National Optical Astronomy Observatory

Low-Pressure Sodium (LPS) – yellowish	**High Pressure Sodium (HPS)** – orange
	
Mercury Vapor lamp – greenish	**Incandescent lamp** – white
	
Halogen lamp – blue-ish white	**Metal Halide lamp** – blue-ish white
	
Compact Fluorescent lamp – white	**Fluorescent lamp** – white