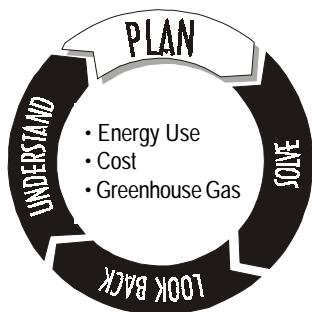
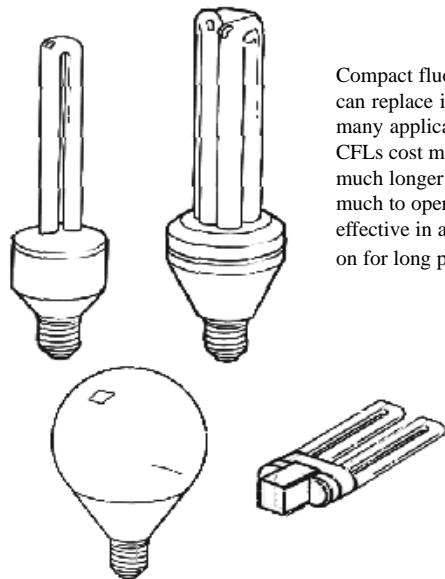


Determine the Feasibility of Installing Energy Efficient Lighting



In this part of the exercise, you will plan a new approach to lighting your school library. This new plan will use less energy, cost less, and result in less greenhouse gas. Your plan will also include bottom line calculations and decision factors such as: identifying the costs and payback for buying and installing new lighting

equipment and making a determination about whether or not the new, more efficient lighting will provide sufficient illumination to the library.



Compact fluorescent lamps (CFL) can replace incandescent lamps in many applications. Although the CFLs cost more initially, they last much longer and cost one fourth as much to operate. They are most effective in areas where the lights are on for long periods.

Replacing incandescent bulbs with compact fluorescent lamps

The savings result from increased efficiency: getting more light with less electricity. The efficiency of these fixtures can be measured in terms of lumens per Watt (lm / Watt), and the higher the lumens per Watt rating, the more efficient they are. Generally, fluorescent lamps are much more efficient than incandescent bulbs, producing as much as four times more light (and less heat) with the same electricity input. For example, a 27-Watt compact fluorescent lamp provides 1800 lumens, while a 100-Watt incandescent bulb produces 1750 lumens. The CFL produces almost four times the lumens per Watt of the incandescent bulb.

Replacing incandescent exit signs with those lit by light emitting diodes (LED)

Similar efficiencies can be obtained from exit signs using light emitting diodes (LED), also used in the display areas on a calculator. LEDs are very long lasting and require very little power. For this reason, they work very well in applications such as exit signs that must stay on all the time.

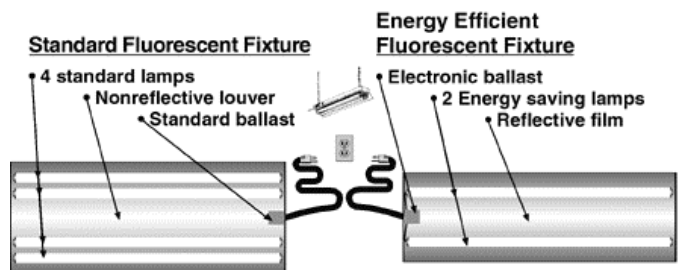
Replace F40 lamps and 34 watt energy saver lamps with T8 lamps and electronic ballasts (retrofit)

Replacing the existing 40w or 34w fluorescent lamps with the more efficient T8 lamp that is operated by an electronic ballast will provide excellent energy savings and also produce a superior quality of lighting which is important in a library environment. It is important that the existing fixtures be well cleaned before the new lighting is installed. Fixtures get dirty with age and are rarely cleaned. Up to 40% of a fixture's efficiency can be lost to dirt, so it is critical that all fixtures are well cleaned when being retrofitted. Replacing the old F40 lamps with the new efficient T8 lamps can save as much as 40% of the energy while providing equivalent or superior levels of illumination and a much better quality of lighting.

Background Information

The feasibility of replacing existing lighting with more efficient lighting depends on the cost of replacement versus the savings. The per year savings depend on the type of lighting and the number of hours per year the lights are on. Three types of efficient lighting will be examined here:

- replacing incandescent bulbs with compact fluorescent lamps
- replacing incandescent exit signs with those lit by light emitting diodes (LED)
- replacing the existing F40 lamps and 34 watt energy saver fluorescent fixtures with T8 lamps and electronic ballasts



New fluorescent fixtures with energy-saver tubes, reflective louvers, and electronic ballasts provide almost as much light as the old, 4-tube fixtures while using less than half the electricity.

Chart 1.

Light Output for Several Types of Energy-Efficient Lamps

Lamp Type	Cost *replace	Lamp Life (h)	Watts	Lumens	Lumens per Watt
Replace incandescent bulbs with compact fluorescent lamps					
Compact fluorescent lamp (CFL)	\$14	10,000	27	1800	67
Standard incandescent bulb	\$.50	1,000	100	1750	17.5
Replace F40 or 34 watt energy saver tubes with T8 lamps and electronic ballasts					
F40 or 34 watt fluorescent lamp	\$ 5 per tube	20,000	192	11,960	62
T8 lamp and electronic ballast	\$ 8.75 per tube	22,000+	106	10,620	
Replace incandescent exit signs with LED exit signs					
Incandescent exit signs		1,000	40		—
LED exit signs	\$ 90	20,000	2		—

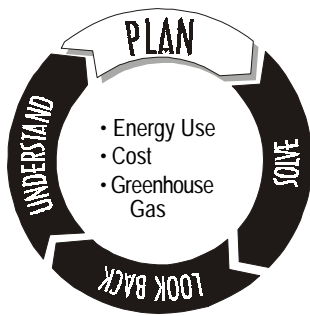
* Cost to replace fixtures in an existing building is higher than to install them in a new building because of higher labor costs to remove and replace fixtures. For example, costs for LED exit signs themselves are as low as \$10. The estimates in this chart include labor costs and may vary by 30% or more, depending on location.

PAY BACK

While commercial establishments require a 3-year payback or less for investing in lighting, schools and institutional facilities will generally accept a much longer payback period ranging up to six years. Some of the reasons these longer payback periods are acceptable include:

- The savings will continue many years after the initial investment is recovered since most schools are intended to be in use for 50 years or more
- Educators are concerned both with immediate savings from a new system and lighting quality

Occasionally, the first cost of a new, efficient system will require a simple return of investment that exceeds 5 years; however, the long-term benefits actually prove that the new, more efficient system with the higher first cost is the better investment. Steps 18-22 will provide you with first hand information about the economics for your school.



Plan a New Approach

Instructions: When energy auditors plan a new approach to lighting the library, they consider many factors, including when and how to use daylight, time controls on some lights and which energy-efficient light bulbs will deliver the same or better light but use less energy. In this activity we will concentrate on three common energy-efficient light replacement options. They are compact fluorescent lights, LED exit signs, T8 Fluorescents. In steps 10-14 you will recommend energy-efficient light bulb replacements, and then work to find the answer to the following variables about your new plan: the number of watts (**I**); the number of kilowatt-hours (**J**); its annual electricity cost (**K**); the carbon dioxide greenhouse gas created by the electricity produced (**L**); and the new lighting index (**M**). To begin, follow the directions to write and solve the equations below. Then complete the calculations and transfer the value of these variables to your key on page 10.

STEP 10

Refer to your library sketch and the equations you completed in step 5 to determine the number of inefficient light bulbs you could replace with the energy-efficient options you read about on your background sheet. Complete the

equations below. Then add up the answers to each equation and write this total in the variable key next to **I** on page 10.

_____	X 27 watts =	_____
Number of incandescent light bulbs replaced by compact fluorescent lights		
_____	X 2 watts =	_____
Number of exit signs with incandescent light bulbs replaced LED exit signs		
_____	X 34 watts =	_____
Number of fluorescent light tubes you can replace with T8		I = <input type="text"/>

STEP 11

Use the total watts you calculated in step 10 (**I**) and the total hours the lights are used in a year from step 2 (**B**) in the equation below to figure out how many kilowatt-hours are consumed by the new approach you planned. Write your answer in

the variable key next to **J** on page 10.

$$\frac{I \times B}{1000} = J \quad J = \text{$$

STEP 12

Refer to steps 4 and 11 for the value of the variables in the equation below. Then do the math to determine the current annual cost of operating the lights in your library. Write your answer in the variable key next to **K** on page 10.

$$J \times C = K \quad K = \text{$$

STEP 13

The amount of carbon dioxide greenhouse gas generated during electricity production ranges from 1.4lbs. to 2.8 lbs. per kilowatt-hour (depending on whether or not the electricity is produced from coal, nuclear power, or hydropower). Use the

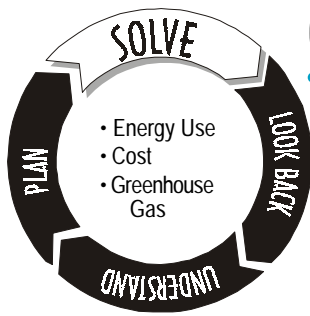
equation below to estimate the amount of carbon dioxide greenhouse gas created when the electricity is made to power the lights in your library with your new approach. Write your answer in the variable key next to **L** on page 10.

$$J \times 2 = L \quad L = \text{$$

STEP 14

Use the following equation to calculate an overall lighting index for the library. This index is the watts consumed per square feet. Write your answer in the variable key next to **M** on page 10.

$$\frac{I}{A} = M \quad M = \text{$$



Compare Your New Approach with the Current Situation

Instructions: Finally, the energy auditor must compare the current approach and the new plan. If you have not transferred the values of the variables you calculated from the previous pages onto the variable key on page 10, go back and do it now. Then write the equations with the values concerning your school library and do the math.



This exercise is designed to help you identify the payback possible from your proposed lighting changes. Simple payback is defined as the initial cost divided by the first-year dollar savings. To determine the simple payback that would occur if your school adopted your proposed lighting changes, use the equation below. Note: Financial decision-makers usually use a 3-year payback.



Calculate the energy savings between the current lights in your library and the new lights you recommended in your plan.

$$N = \boxed{} \quad E - J = N$$

Where N = the energy saved in a year



Calculate the energy cost savings between the current lights in your library and the new lights you recommended.

$$P = \boxed{} \quad F - K = P$$

Where P = the money saved in a year



Calculate the greenhouse gas emissions prevented by replacing your current lights in your library and the new lights you recommended.

$$Q = \boxed{} \quad G - L = Q$$

Where Q = lbs. of carbon dioxide prevented in a year

$$\frac{(R \times S) + (T \times U) + (V \times W)}{P} = \underline{\hspace{2cm}} = y \text{ year payback}$$

Where:

P = the money saved in a year

R = Initial cost of the compact fluorescent lights
(See Chart 1, page 6)

S = Number compact fluorescent lights you propose

T = Initial cost of the (LED) exit signs

U = Number of (LED) you propose

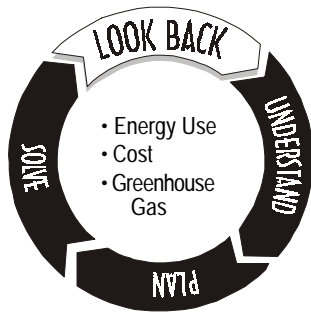
V = Initial cost of the electronic ballast T-8 fluorescent tubes

W = Number electronic ballast T-8 fluorescent tubes you propose



Now compare the index between your current situation, your proposed new lighting plan and the 1.3 w/ft² standard used by auditors to determine the probability of energy savings. Plot the values for H and M below.





What's The Bottom Line?

Instructions: Use your variable key on page 10 to fill in the chart below. Then consider proposing that the school accept your plan for a more energy-efficient, cost-effective, environmentally friendly library. Use the table in step 20 and the results of your work in steps 21-22 in your proposal.

	Energy	Cost	Greenhouse Gas
Current lights in the Library (variables E,F,G)			
Proposed new plan for the lights in your library (variables J,K,L)			
Savings from your proposal (variables N,P,Q)			



What difference can this make in your school?

If you get the total square footage of your school and complete the equations below you will have a good idea about the impact you can make on your school.



$$\frac{N}{A} \times \text{sq. footage of school} = \text{estimated energy saved by applying your plan to the whole school}$$

$$\frac{P}{A} \times \text{sq. footage of school} = \text{estimated money saved by applying your plan to the whole school}$$

$$\frac{Q}{A} \times \text{sq. footage of school} = \text{estimated CO}_2 \text{ greenhouse gas prevented by applying your plan to the whole school}$$

Make an Energy Smart Schools presentation.



Discuss your idea and findings with your classmates and teachers and make one combined proposal to your school board and administration team. Research the Energy Smart Schools program offered by the U.S. Department of Energy (www.eren.doe.gov/energysmartschools) and include the many benefits of this program and your findings from this activity as support for making your school or library more energy-efficient.