IDAHO POWER
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Students For Energy Efficiency

Investigating Energy Efficiency
In Your School and Other Buildings

Idaho Power Training
2010

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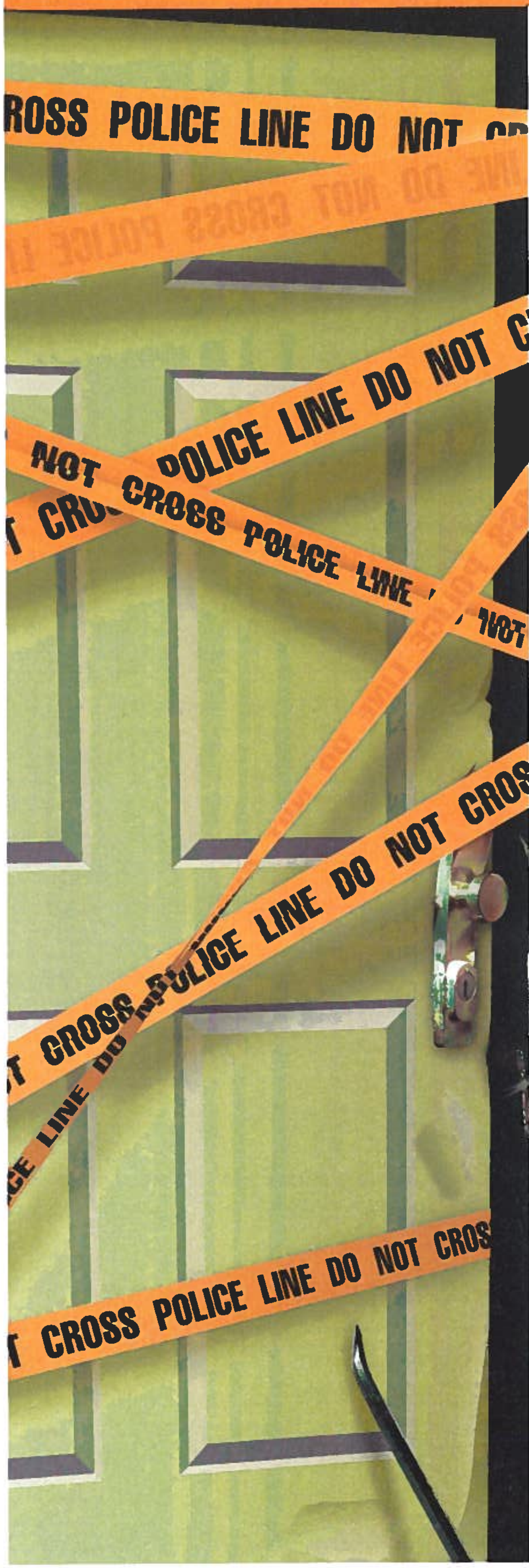

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Table of Contents

Introduction

Program Overview

Idaho Power is offering the *Students for Energy Efficiency* (SEE) program to Idaho high schools in an effort to educate students about energy used in schools and other buildings. The program is held in cooperation with the Idaho Office of Energy Resources (OER) and local school boards. This program is a hands-on learning lab that will allow students to build their knowledge of energy and apply it to recommend real-life energy efficiency improvements.

Targeted Educational Standards

This program addresses the following topics, which reinforce Idaho Department of Education content standards for science:

- What energy is
- How energy is used
- How energy is measured
- How energy can be used more efficiently

Definitions

Definitions of terms can be found in Appendix A. Definitions.

Purpose

This high school has a problem, a problem that affects not only the high school students, faculty, and administration, but also the surrounding communities. In fact, it's more than just a problem, it's a crime—this is the best way to describe the events continually occurring in the classrooms, auditorium, gymnasium, and hallways of *your* high school.

The crime is the waste of valuable energy resources used in your school.

Do you know what I am referring to? Are you aware of what's going on while you attend classes and eat lunch?

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What energy resources are being used in your school?

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What benefits does energy provide to your school?

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How is the energy transported to your school (e.g., electricity, natural gas [substitute propane, fuel oil, biomass, as appropriate])?

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How do we know how much energy is used by the school?

How would you measure the amount of energy used?

How do we determine how the energy could be used more efficiently?

Exercise: Energy Scene Investigation

The school assessment you are about to perform is an energy scene investigation (ESI). Similar to crime scene investigation (CSI) units featured in television programs, you will investigate where energy is being wasted in your school, using appropriate equipment and techniques, and report your findings to school administration.

Purpose

Why do we care about the efficient use of energy at your high school? Some possible reasons are:

- Comfort
- Safety

- Ability to work
- Costs:
  - To the school district
  - To residents of the surrounding communities
  - To the state
  - For future delivery
- Availability of adequate energy supplies for future students
- Environmental and social implications (e.g., transmission lines, dam breaching, future appearance of wind turbines on the landscape, competition with other entities for available energy resources, etc.)

Major Concept: Waste of Energy Resources

Energy wasted can be considered energy stolen from the people who paid for that energy. How do we determine the nature and extent of the energy being wasted and what tools and techniques would you use to measure the amount wasted?

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What do you do with your findings?

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Because your time is valuable, you'll want to make sure value is derived from your ESI. To help use your time effectively, you can focus your investigation on specific areas to determine the nature and extent of the energy being wasted. This is similar to law enforcement, which has many divisions that specialize in certain crimes (e.g., felonies, arson, and violence). You will focus on the following areas during your ESI:

- Building envelope
- Usage data
- Plug and phantom load
- Lighting

ESI Equipment

What are some tools used by CSI investigators (e.g., gloves, coveralls, bags, microscopes, gas chromatography, and special forensic equipment)?

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Your ESI will require the use of these specialized tools:

- Light level meters
- Magnetic/electronic ballast detector
- Kill A Watt™ meter
- Room occupancy/light sensor
- Room occupancy/temperature sensor
- Power strip
- Tape measure

ESI Report

Law enforcement officials prepare and present their cases in courts of law. In our investigation, you'll have the opportunity to present your findings to your fellow students, faculty, administration, and other members of your community. In your case, the judge and jury will be the school administration. Idaho Power will assist you and your school administration in determining what can be done to reduce the continued waste of valuable energy resources.

Preventing Future Energy Waste

There are several ways to prevent the future waste of energy at your school.

Educational/behavioral changes:

- Teaching students, faculty, and staff to change their behaviors

Replacement technologies:

- Installing more efficient lights, ballasts, and thermostats
- Installing occupancy sensors
- Changing the color of the school roof

Removals/corrections:

- Delamping and unplugging items that constantly use energy
- Adjusting thermostats

Others:

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Financial Resources Available to Schools and Businesses

The following are financial resources to assist schools and businesses in reducing wasted energy.

- **Idaho Power's *Easy Upgrades* and *Custom Efficiency* incentive programs.** These are proven, popular financial incentive programs that assist in funding the replacement and installation of equipment, resulting in improved energy efficiencies.
- **American Reinvestment and Recovery Act funding**. This is federal money (OER) available to assist schools throughout Idaho in reducing energy usage and operating costs.

School Budgets

In some cases, your school can use existing funds to implement energy efficiency measures and show a return on investment (ROI) within a single budget cycle or year.

Building Envelope

The building envelope, or building shell, is the part of the building that is exposed to the outdoors. The following are characteristics of building shells:

- They provide dry, clean space; safety; and comfort.
- Outer elements are the exterior doors, walls, windows, roof, and floor/ foundation and are barriers to moisture, wind, dust, heat, solar gain, and light.
- Roof types are built-up, membrane, shingles, or metal.
- Walls are concrete, masonry, or frame.
- Floors are slab-on-grade, frame-over-basement, or crawl space.
- Insulation is rated in R-value and U-value.
- Windows can have a greenhouse effect; have different glasses, frames, films, and coatings; and can be fixed or operable.
- Window treatments can be drapes or blinds.
- Window shading can be provided with landscaping, shades, and swings.
- Infiltration can occur through cracks, windows, doors, walls, and roofs.

Comfort, health, and safety must never be compromised—these are why we have buildings.

Savings Potential

Attitude and skill can save tremendous amounts of money. Figure 2-1 shows a school where one man made a difference of $35,000 annually.

Thermostat setback/setup (adjusting the thermostat setting to use less energy) is one of the easiest and most cost-effective improvements. However, take care during extreme weather conditions.

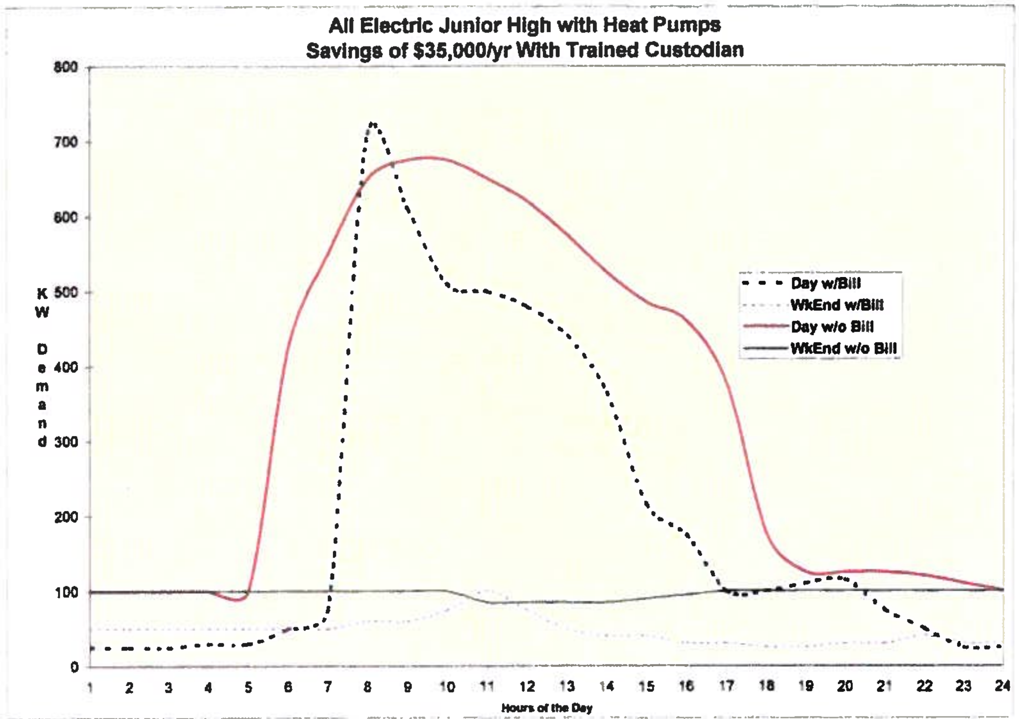


Figure 2-1. Potential for savings

Usage Data

Your school's energy providers compile usage data that is available to customers upon request. Your principal and teacher have already obtained usage data from your school's utility providers, including Idaho Power. Analyzing this data will reveal much about the amount of energy being used at your school and will help you determine where and when it is being wasted.

Utility providers use meters to monitor the amount of electricity, gas, and water being used, and so can you. If you want to determine what your school's daily usage is, or even time-of day usage, you can read the meter (see Figure 2-2) daily or several times a day. Be sure the meter you are reading is serving the area you are studying, as each school facility likely has several meters serving parking lot lighting, irrigation pumps, and new buildings.

Figure 2-2. Meter

Watts and Kilowatt-Hours

One watt of power is used when one ampere (amp) of current flows through a difference (pressure or force) of one volt, similar to water going through a hose: The water pressure is volts, the flow or size of the hose is amps, and how much water actually comes out of the hose when it's turned on is watts.
Let's work through the analogy. When your water valve is turned off, and even though no water is flowing out the end of the hose, the system stands ready to give water when you need it. When you open the valve, you can open it a little or you can open it all the way. With the right equipment, you can measure how much water comes out of the hose.

Your electrical system works in a similar way. It is ready to deliver as much power as you need when you open the valve (i.e., turn on the lights, plug in devices, or switch on appliances). When you turn on many things at once, it is like opening the valve all the way. Like measuring water coming out of a hose, your electrical meter measures the energy (watts) coming out of a valve.

n Electric bills are based on kilowatt-hours (kWh) used. A kWh equals 1,000 watts over one hour (e.g., If a 150-watt light bulb was left on for 10 hours, it would use 1,500 watts [1.5 kWh], and a 7-watt light bulb on for 10 hours would consume 70 watts [0.07 kWh]).

Demand

In the electric utility industry, demand refers to the amount of electricity being used and is measured in kilowatts (kW). Instantaneous demand is the amount of electricity used at a given moment in time and is tracked and averaged in 15-minute intervals. These averages help determine how much some customers pay for the electricity they use. Figure 2-3 shows instantaneous demand recorded over 45 minutes and the average demand of one, 15-minute interval. While the highest amount of electricity used during the 15-minute interval was 575 kW, the average amount of electricity used during that interval was 559 kW.

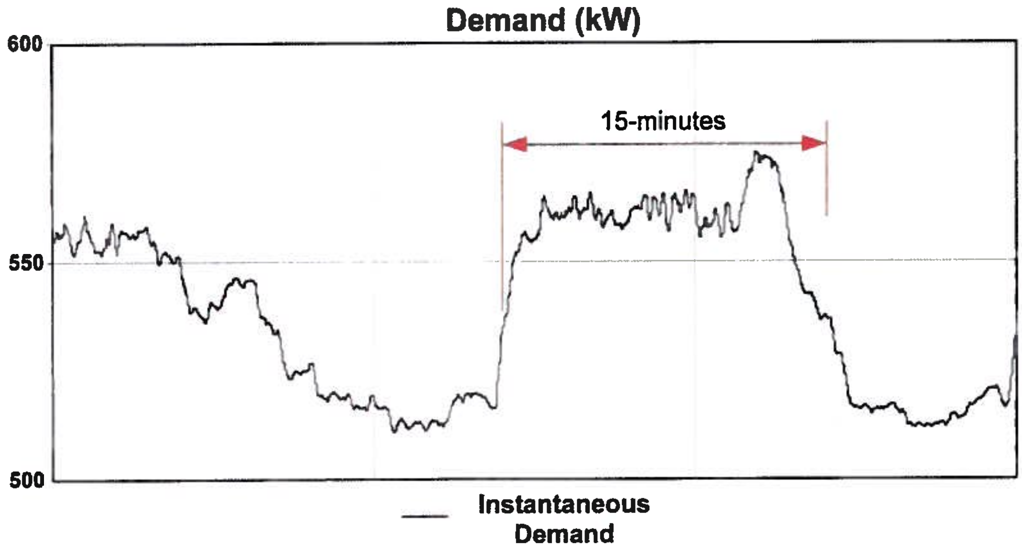


Figure 2-3. Demand

Peaks in Demand

Peaks in demand are when high amounts of electricity are required. A commercial customer's peak demand is the highest average kW required in a 15-minute interval during his/her billing cycle (see Figure 2-4). Each customer profile generally follows a pattern, and it is interesting to see and understand what is happening in a building when it peaks. As a whole, Idaho Power's electrical system often peaks during weekdays on the hottest summer afternoons because this is when businesses are open, irrigation pumps are running, and air conditioners are humming.

Customer Billing and Demand Charge

Because Idaho Power must be able to supply all the electricity every customer may require at any given moment, certain customers who generally require a lot of electricity pay a fee (demand charge) for having that amount of electricity ready and waiting. Irrigation, industrial, and commercial customers' electricity bills consist of two main components—energy charges and demand charges. Energy charges are for the total amount of energy (kWh) they use during a billing cycle, and demand charges are based on their peak demand (kW) during the billing cycle. Residential customers do not pay a demand charge.

Figure 2-4 shows the average demands of two, 15-minute intervals. The highest of these averages, the second 15-minute interval, is the peak demand for the 30 minutes.

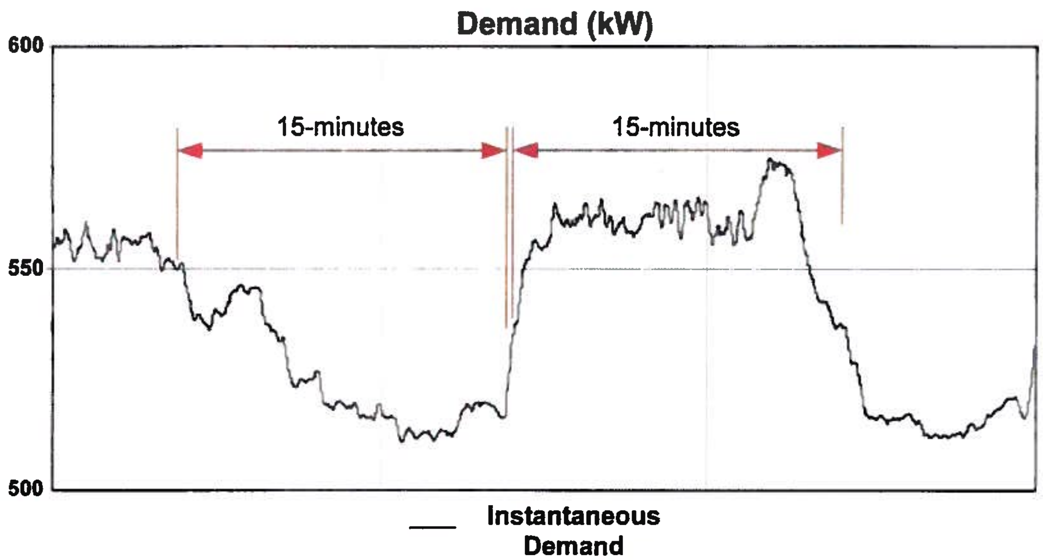


Figure 2-4. Peak demand

Table 2-1 shows two examples of energy and demand charges over one billing cycle (using rates of $0.07 per kWh and $3.50 per kW, respectively):

Table 2-1. Energy and demand charge examples

Customer One		Customer Two	
Customer one uses 500 kW for one hour. His/her charges are as follows:		Customer two uses 2,000 kW for 15 minutes and 0 kW for the next 45 minutes. His/her charges are as follows:	
Energy Charge		***Energy Charge***	
2,000 kWh x $0.07	= $140.00	2,000 kWh x $0.07	= $140.00
Demand Charge		***Demand Charge***	
500 kW x $3.50	= $1,750.00	2,000 kW x $3.50	= $7,000.00
Total Charge	= $1,890.00	***Total Charge***	= $7,140.00

Billing History Data

There are two types of meter history: 1) monthly billing data and 2) demand data from a digital meter, which reveals energy demand every 15 minutes. Both types of data can be translated to energy usage.

Monthly Data

Monthly data is available from your school's accounting department or utility provider. (**This is the information your teacher previously requested from Idaho Power.**) This data can be evaluated over any period of time: annually, monthly, daily, or hourly. To analyze and evaluate potential savings, it needs to be entered into a spreadsheet. We can look at seasonal changes and peak demand and evaluate the annual usage compared to similar facilities.

Demand Data

Demand data is extensive, with over 35,000 data points annually. It can be evaluated in two ways:

1. **Find the peak demand from the monthly bills** and determine where in the 15-minute readings it falls and why the peak was set. Often, this peak occurs in the morning when all systems are recovering from setback; or, if there has been a power outage, the peak is often the next reading. Microsoft Excel can be a very useful tool to evaluate this data.

2. **Determine what a typical day looks like and why.** This can be done by averaging several weeks worth of information at a time to represent activities. This data might be broken down into a typical weekday and typical weekend. See Figure 2-5 for an example.

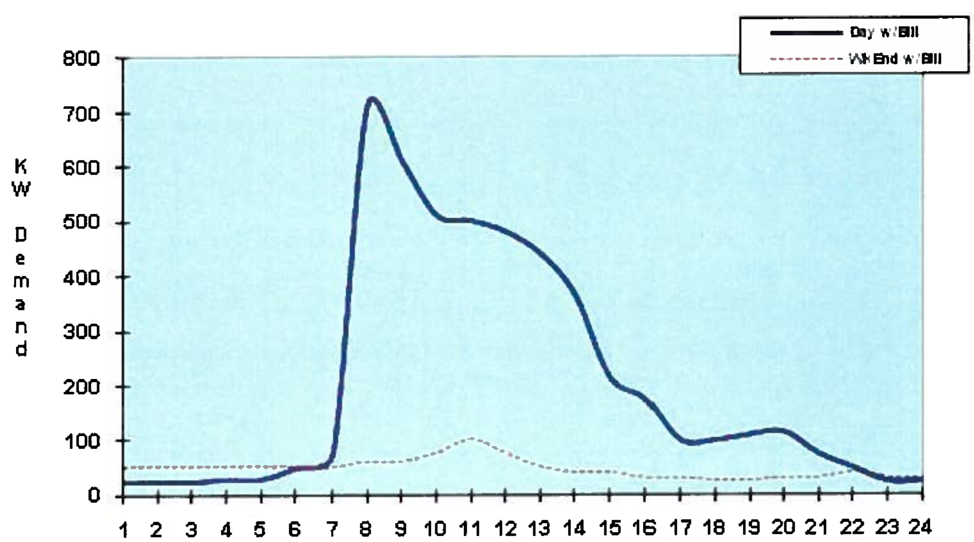


Figure 2-5. Junior high with heat pumps

Baseload

Baseload is the energy being used when the building is empty. It includes power appliances, such as refrigerators, freezers, emergency lights, fans, heaters, and everything that has to be on even though no one is in the building. However, many items are left turned on that can easily be turned off at night, reducing the baseload. Another area of energy usage is the routine morning start-up of heating, ventilation, and air-conditioning (HVAC) systems lights; pottery kilns (see Figure 2-6); etc. Check the data to determine if morning start-up occurs too early or if the settings are unreasonably high. Keep in mind that different schools will have different profiles. Elementary schools seldom have activities that go late in the evening, but high schools have many sports, concerts, and dances that run into the evening. However, these activities don't use the entire school, so most appliances can be shut down.

Figure 2-6. Kilns

Natural Gas Bill

Natural gas utilities record usage in British thermal units (Btu) and therms:

Btu—The amount of heat required to raise one pound of water by one degree Fahrenheit. The higher the Btu rating, the more heating capacity of the equipment.

Therm—The equivalent of 100,000 Btu's of energy.

Gas meters seldom record the time of day, demand, or other specific information. Instead, they take measurements in cubic feet of gas, and these measurements are then converted into therms to determine the amount of energy the school is billed. Other items on the bill refer to the transportation charges, taxes, etc., but we will focus on the energy consumed, or therms, for the month.

Plug and Phantom Loads

Plug Load

Plug load is made up of the many appliances we have plugged into the wall. Often, only a few are turned on at any one time, so they are not all drawing electricity at the same time. Energy is wasted when these appliances are turned on but not used.

Phantom Load and Red Lights

Much of our electronic equipment stays on but, ideally, has a sleep mode that reduces the electricity it consumes while waiting for us to wake it up. Every time we have equipment set so it instantly starts, it is always on. This is sometimes called phantom load and refers to the load the equipment continues to draw even though it is turned off (see Figure 3-1). One way to reduce phantom load is to plug several devices into a power strip that you switch off at the end of the day. This simple step turns out all of those little red lights and reduces the waste of valuable energy resources.

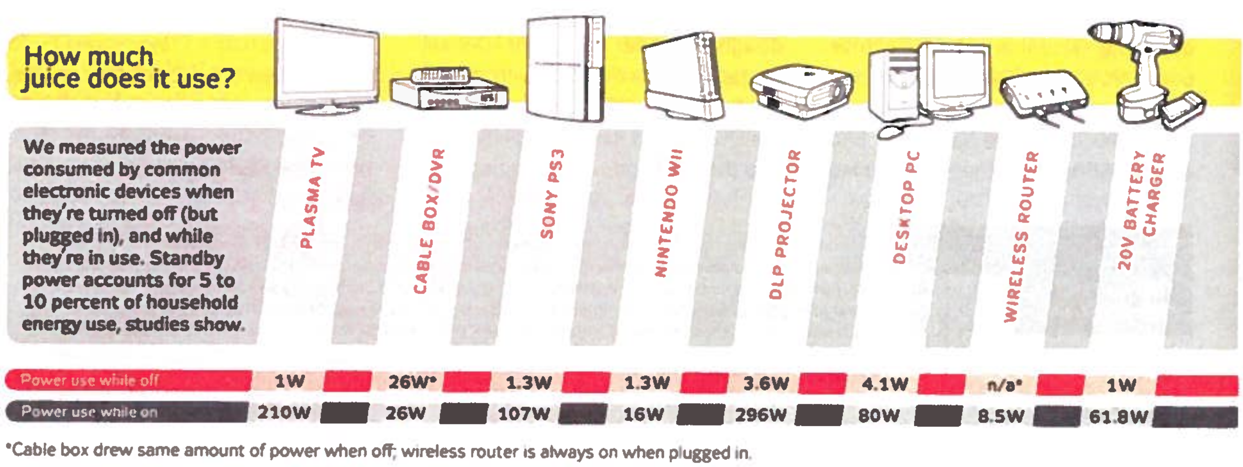


Figure 3-1. Phantom loads

Basic Calculations

Earlier we mentioned kilowatts (kW) and kilowatt-hours (kWh). Now we will use the information we gather to make some basic calculations.

Measured Watts

Assume we measured a refrigerator whose compressor runs about 15 minutes out of every hour. Since it is inside the building, outdoor temperatures do not affect its operation, so its operating hours are consistent.

Using an ampere (amp) meter, we measure the load on the refrigerator to be 3.63 amps. To determine the watts the refrigerator uses, we need to convert the amps. The conversion formula is:

$$\text{volts} \times \text{amps} = \text{watts}$$

A standard U.S. electric outlet has 110 volts, so the conversion to watts is:

$$110 \text{ volts} \times 3.63 \text{ amps} = 400 \text{ watts}$$

To determine the cost of operating the refrigerator annually, we need to convert 400 watts to kW:

$$400 \text{ watts} \times \frac{1 \text{ kilowatt}}{1{,}000 \text{ watts}} = 0.4 \text{ kW}$$

A year has 8,760 hours in it, so the refrigerator runs the following hours:

$$\frac{8{,}760 \text{ hours}}{1 \text{ year}} \times \frac{0.25 \text{ (15 minutes)}}{1 \text{ (60 minutes)}} = 2{,}190 \text{ hours per year}$$

The energy used per year is:

$$\frac{2{,}190 \text{ hours}}{1 \text{ year}} \times 0.4 \text{ kW} = 876 \text{ kWh per year}$$

The cost per year at $0.06 per kWh is:

$$\frac{876 \text{ kWh}}{1 \text{ year}} \times \frac{\$0.06}{1 \text{ kWh}} = \$52.56 \text{ per year}$$

Energy Scene Investigation Tool Kit

Idaho Power provides you with the following tools needed to conduct an energy scene investigation (ESI) of your school buildings:

- Light level meter
- Magnetic/electronic ballast detector
- Kill A Watt™ meter
- Room occupancy/light sensor (please return to Idaho Power)
- Room occupancy/temperature sensor (please return to Idaho Power)
- Power strip
- Tape measure

n A camera is not provided, but you are expected to include photos in your report. Ask your teacher for assistance if you do not have access to one. A cell phone camera is not to be used as the resolution is poor.

Lighting Basics

Visible light—the light we can see—is a small part of the electromagnetic spectrum (see Figure 5-1), which includes all energy from gamma rays to radio waves. In addition, white visible light is a combination of the colors of the rainbow. The heat portion of the spectrum is infrared and the damaging portion is ultraviolet.

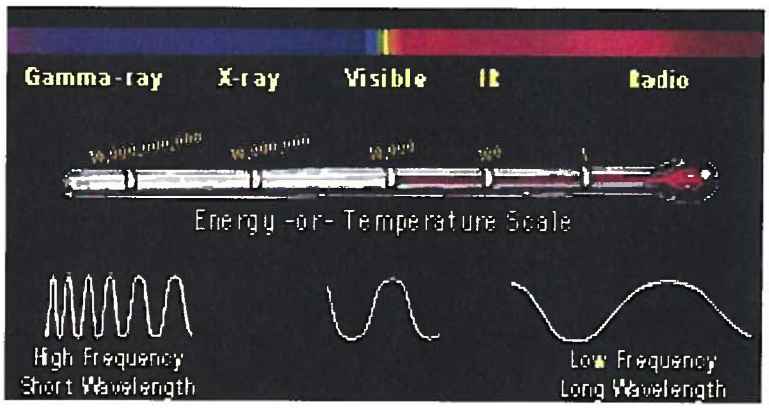


Figure 5-1. Electromagnetic spectrum

Measuring Light

To measure light, we use a light meter (see Figure 5-2). The light meter and the lighting industry use units of measurement called foot candles. A foot candle measures the intensity of light falling on a surface and was originally defined as a candle burning one foot from a given surface. How much light a lamp produces is given in lumens, so the conversion from foot candle to lumen is as follows:

1 foot candle = 1 lumen (perceived power of light) per square foot

n If a light is one foot from a surface and receives one lumen per square foot, then we move the light one foot farther away, the one lumen is then diluted over four square feet (¼ lumen per square foot). So, when we double the distance, we dilute the light by four times, demonstrating that the distance from the fixture is critical.

Figure 5-2. Light meter

To measure light, complete the following:

1. Close window blinds or take the reading at night to prevent natural light from interfering with the measurement.
2. Measure the light on the working surface (e.g., desk, table, or gym floor).
3. Take several readings, being careful not to influence the readings with your body (e.g., standing too close to the meter).
4. Average the readings together.

n Be careful with the light meter—keep it out of direct sunlight, and do not let it drop or get too hot.

n Nearly all lamp packages tell you how many lumens lamps produce.

Light Levels

The Illuminating Engineering Society (IES) has developed international standards. They suggest the following amounts of light are wanted:

Offices	30–50 foot candles
Class rooms	30–50 foot candles
Conference rooms	30–50 foot candles
Hallways	10–20 foot candles
Service and repairs	10–100 foot candles

These standards change according to technology and customer needs. The IES handbook is extensive and includes standards for nearly every conceivable space, including airports, cafeterias, kitchens, hotels, police stations, and sports stadiums. It can be obtained at http://www.iesna.org.

In addition, the amount of light needed depends on several other factors, including customer age, task duration, surroundings, and safety.

A Closer Look at Lamps

To the average homeowner, a lamp is a piece of furniture with a bulb. To a lighting professional, a lamp, or light bulb, is any device used to produce artificial light.

Lamp (Light Bulb) Light

Different lamps produce different amounts of light (see Figure 5-3), which are measured in lumens. Most lamp packages tell you how many lumens lamps produce.

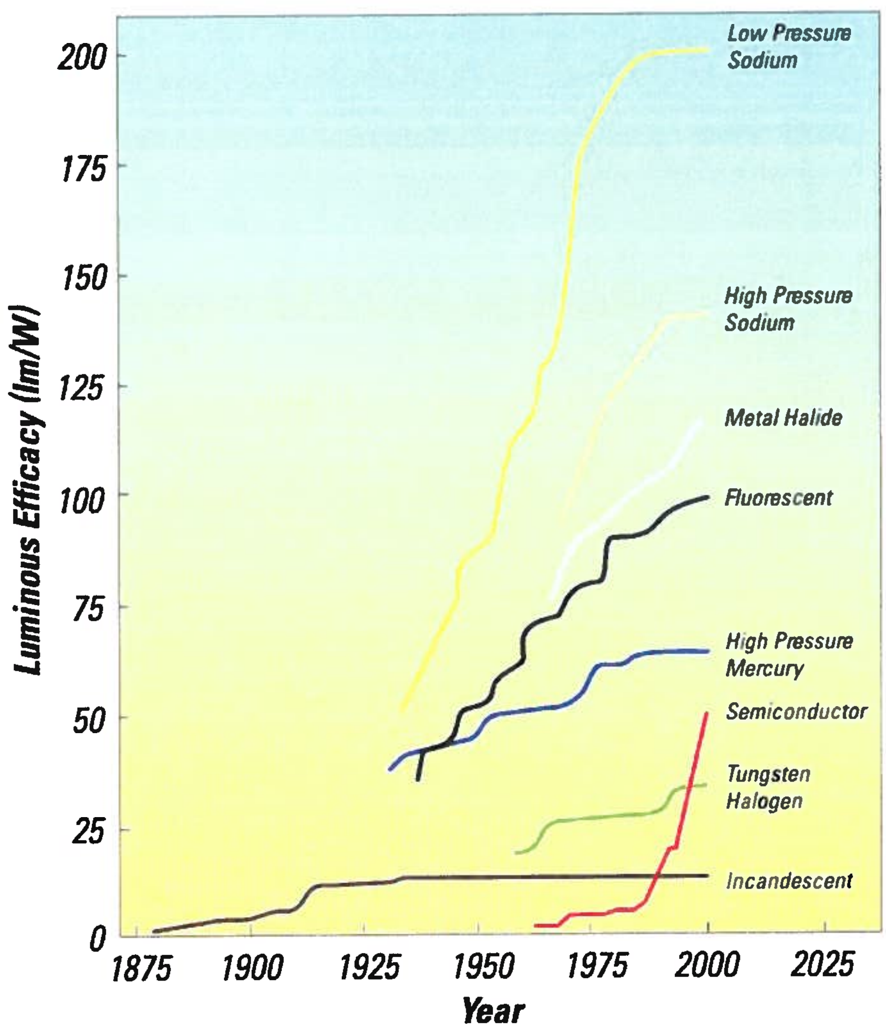


Figure 5-3. Lighting

Color Rendering Index

We measure colors against daylight and use a unit of measurement called the color rendering index (CRI). A CRI of 100 is as close to daylight as possible, and we consider it ideal for common functions. Most incandescent lamps have a CRI of 100. Other artificial light sources usually have a lower CRI.

Lamp Power

The power level associated with a particular lamp is measured in watts and this, along with lumens, is typically shown on lamp packages (see Figure 5-4).

This brings us to another term—efficacy—which is defined as lumens per watt.

$$\text{Efficacy} = \frac{\text{Lumens}}{\text{watts}}$$

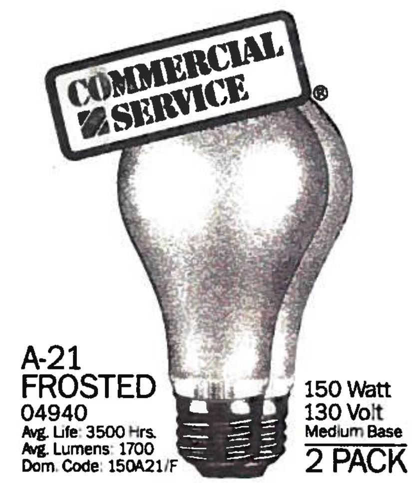


Figure 5-4. 150-watt light bulb

Lamp Life

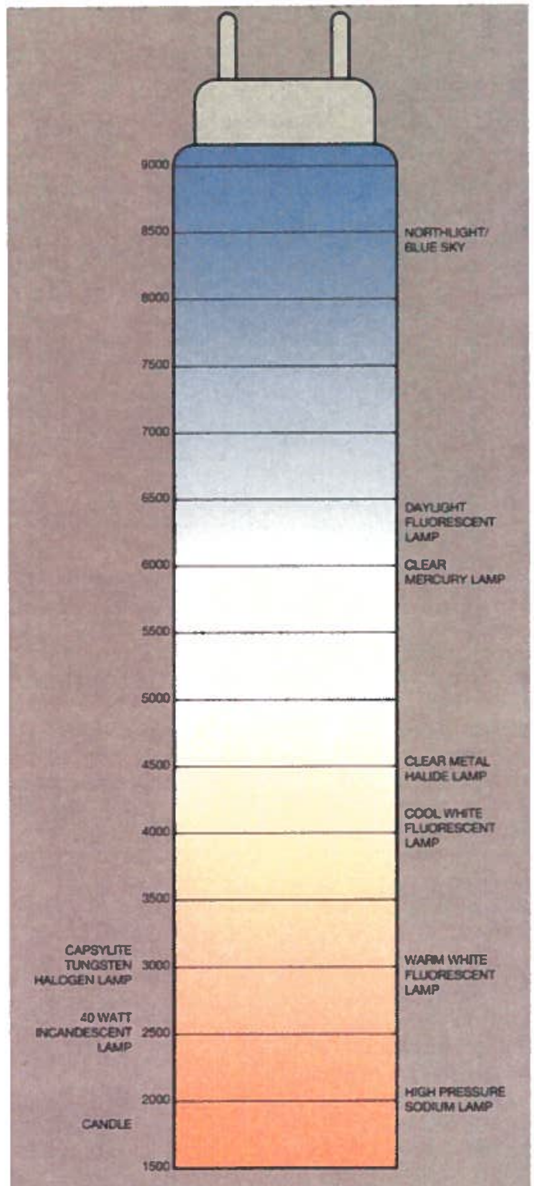
Standard lamp life depends on the lamp type. Expected lamp lives have been estimated based on a rigorous testing protocol. For example, most fluorescent lamps are rated at 20,000 hours, which means that, after being on for 20,000 hours (about 2 ½ years), half of the lamps will have failed.

Lamp Numbering

The American National Standards Institute (ANSI) has standardized how lamps are numbered using lamp size, type base size, and source to classify and name the various lamps.

Lamp Colors

In the past, lamp colors were identified as cool or warm. More recently, the temperature scale of Kelvin degrees (K) is becoming the standard—warm corresponds to 3,000 K and cool corresponds to 6,500 K (see Figure 5-5).



The color temperature scale assigns a numeric value to the color appearance of a light source ranging from orange/red ("warm" light) to blue/white ("cool" light).

Figure 5-5. Color temperature scale

Standard Lamp Types

The following are the common lamps types, each of which comes in a variety of sizes, types, and wattages for various uses.

- Incandescent
- Fluorescent
- High-intensity discharge (HID):
  - Mercury vapor
  - Metal halide
  - High-pressure sodium (HPS)
  - Low-pressure sodium
- Light-emitting diode (LED)

Recent Changes

Mercury vapor lamps were developed in the early 1900s and were the first energy-efficient lamps available. Metal halide and high-pressure sodium lamps replaced mercury vapor lamps in the 1960s. In the fluorescent category, energy-efficient ballasts were developed in the 1970s and T-8s and T-9s with electronic ballasts were developed in the 1980s.

T-8s displaced the T-9s and became the standard. Currently, T-5s and LEDs are becoming more common. However, the T-8 is now the most efficient light source used in standard situations.

Incandescent Lamps

How Incandescent Lamps Work

In incandescent lamps, electricity is sent through a filament (see Figure 5-6), causing it to heat white hot, which makes it very bright. The gas inside the bulb, along with the filament material and the wattage, will determine how much light is generated.

n An incandescent lamp works no matter which direction its base is pointed.

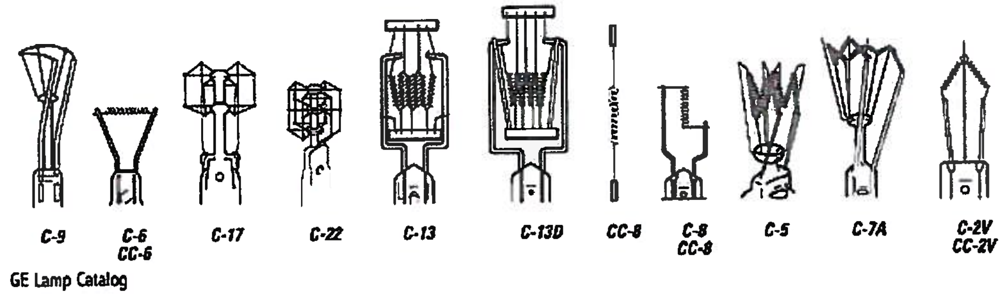


Figure 5-6. Incandescent filaments

Efficiency

Efficacies for incandescent lamps are normally 15 to 20 lumens per watt, slightly higher for energy-saving lamps, and usually lower for long-life lamps.

Life Span

The life span of an incandescent lamp is usually around 750 to 1,000 hours if it is used at its rated voltage. If the voltage is allowed to spike only once, their lives can be reduced by 25 to 50%.

Colors

The CRI of incandescent lamps is nearly always 99+, which indicates the color of light they put out is the same as the sun, our standard.

Other Incandescent Lamps

Tungsten halogen and quartz halogen lamps are both more efficient than the standard incandescent lamp and more expensive. The quartz halogen lamp is very common in outdoor lighting. The envelope of the quartz halogen lamp must be kept very clean and free of human touch—the oils from human fingers etch into quartz when it reaches very high operating temperatures, causing it to fail sooner. Very small spot lights are often quartz halogen and can be used in projectors and track lighting. Figure 5-7 and Figure 5-8 show halogen and other incandescent lamps.

Figure 5-7. Halogen lamps

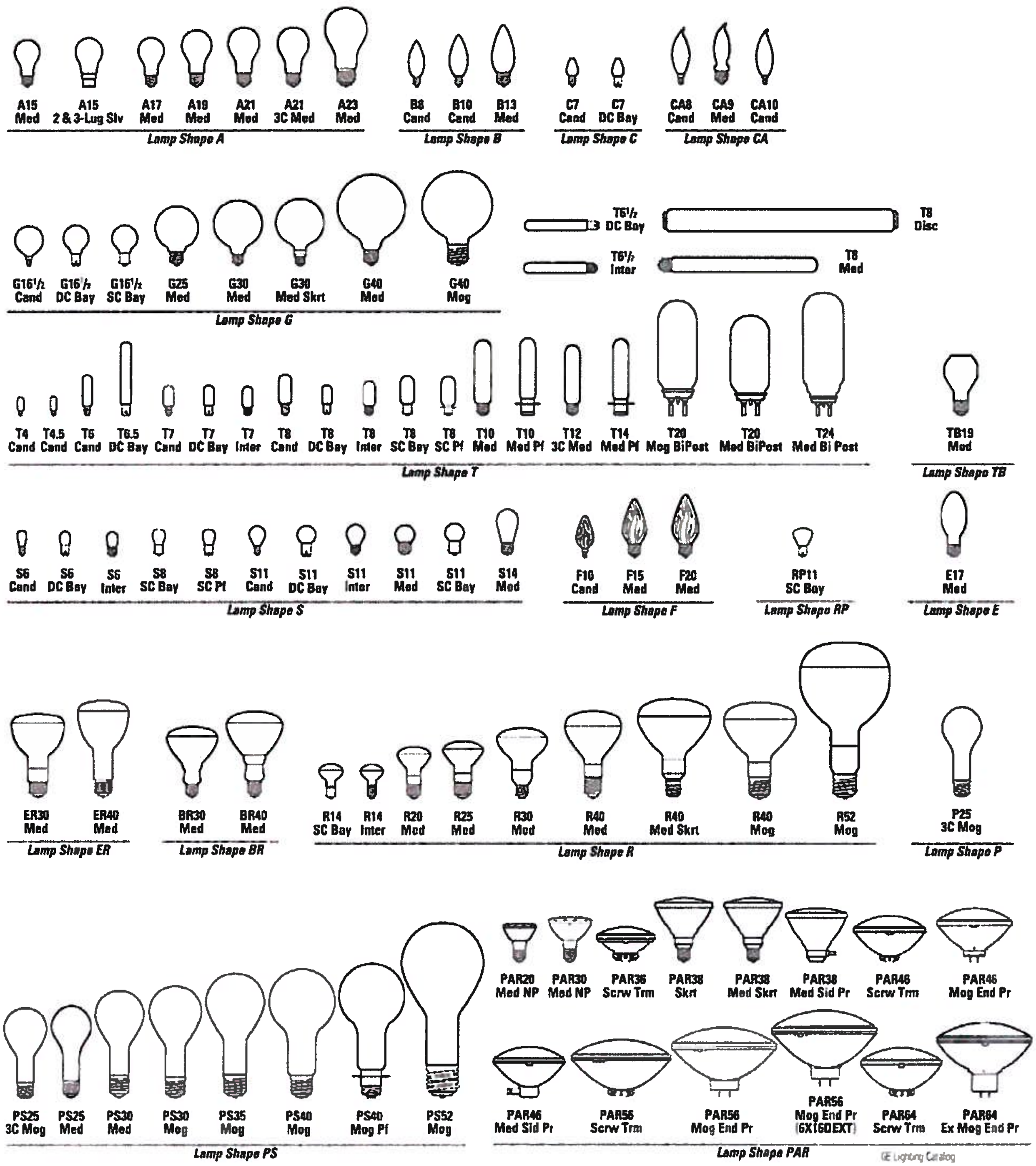
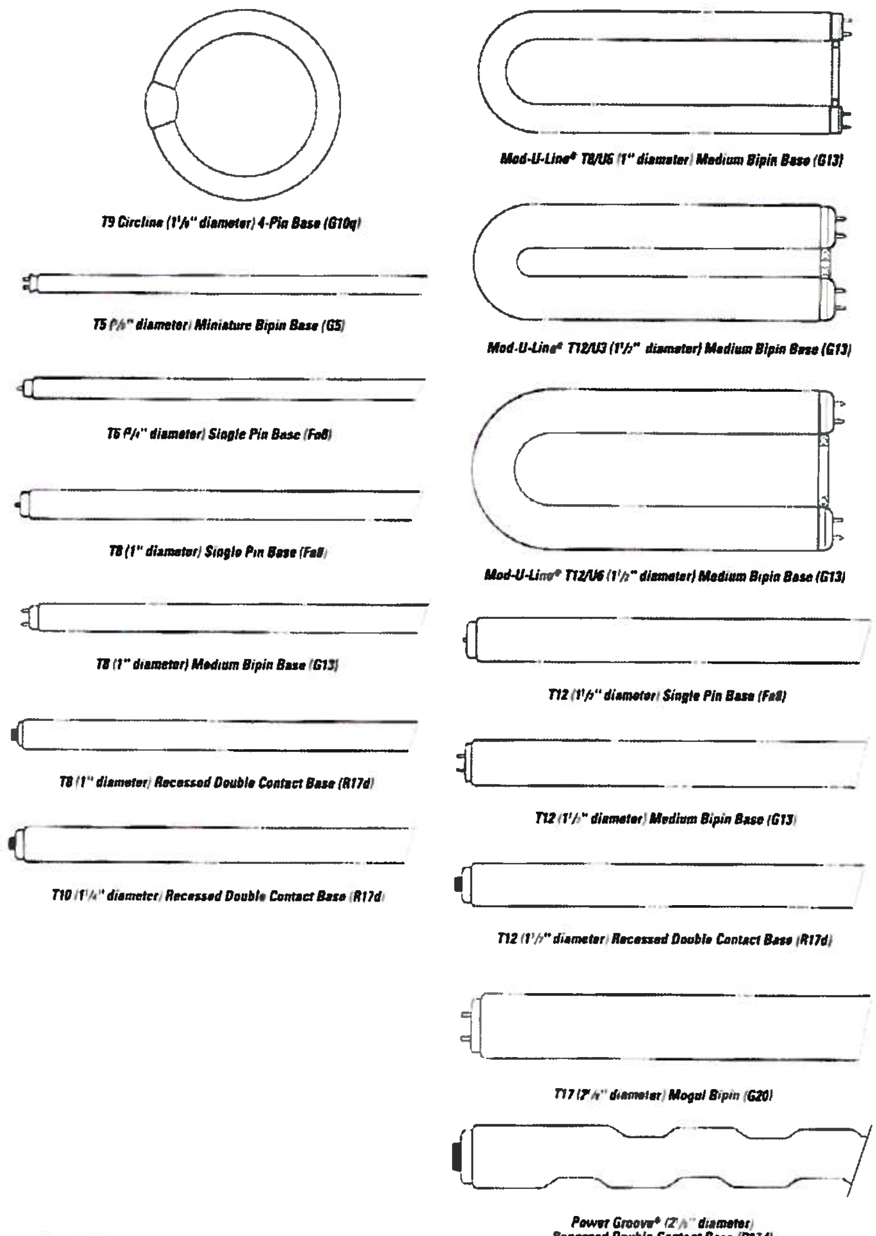


Figure 5-8. Incandescent lamps

Fluorescent Lamps

How Fluorescent Lamps Work

Fluorescent lamps use a bulb energized by a ballast (an electronic device for starting and regulating fluorescent and discharge lamps). The ballast generates an electric arc that spans the length of the lamp and travels through an inert gas and a very small amount of mercury. The electric arc generates an ultra-violet light that strikes the phosphor coating on the inside of the glass tube, causing the phosphors to glow and generate visible light. Figure 5-9 shows fluorescent lamp shapes.



GE Lamp Catalog

Figure 5-9. Fluorescent lamp shapes

Naming

Look at this example: F40T12CW

- **F** stands for fluorescent
- **40** are the watts it uses
- **T12** gives the diameter of the lamp in 1/8th of an inch, so 12/8 inch is 1 ½ inches in diameter
- **CW** tells us it generates a cool white color

Another example: F32T8

- **F** stands for fluorescent
- **32** are the watts it uses
- **T8** gives the diameter of the lamp—one inch

Length

Most fluorescent lamps are a nominal four feet long but, in reality, are shorter. They will fit in a 4-foot fixture, such as those for a 2 x 4 suspended tile ceiling. To fit other fixtures, they also come in a variety of lengths from a few inches to eight feet.

Compact Fluorescent Lamps

Compact fluorescent lamps (CFL) range from small 5- or 7-watt biaxial to 32- or 40-watt biaxial lamps. Biaxial means the tube is folded on itself to make it appear as two tubes. In addition, CFLs come in a variety of bases and sizes (see Figure 5-10).

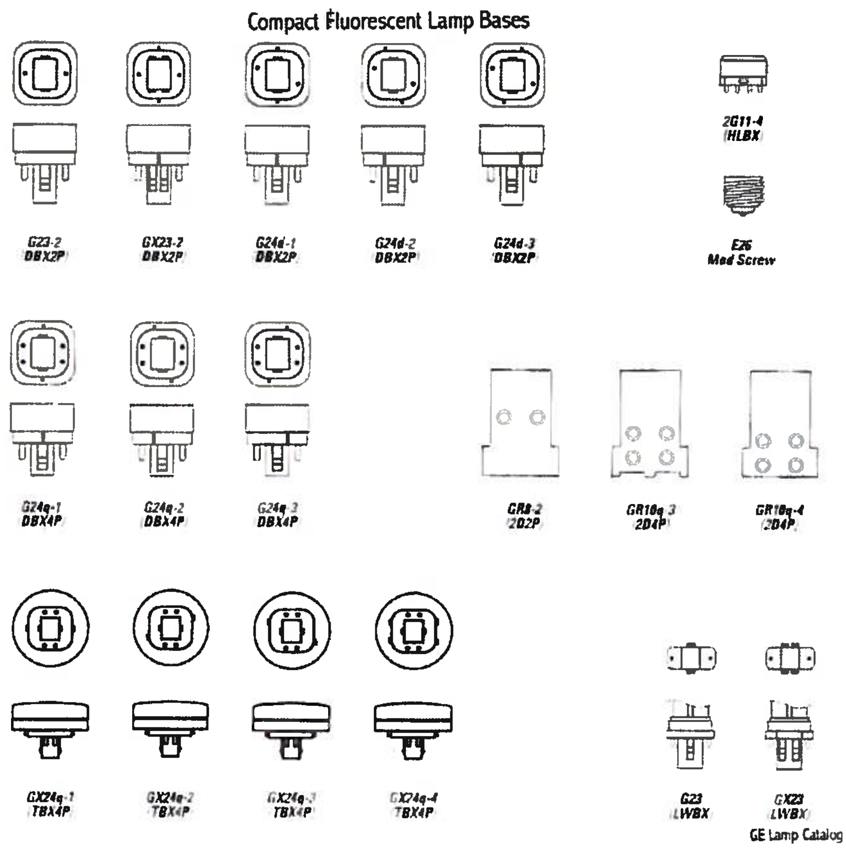


Figure 5-10. Compact fluorescent bases

Life Span

The rated life span of standard fluorescent lamps is normally 20,000 hours or more and 12,000 hours for CFLs. They are insensitive to voltage changes because the ballast, especially an electronic ballast, will level the voltage out if it fluctuates.

n To increase the life of a fluorescent lamp, leave it burning for at least 12 hours after it is first installed, allowing it to "burn in" and stabilize.

Recent Changes

The most recent addition to the family of fluorescent lamps are T-5s, which give more light per lamp and are especially useful for high bay fixtures, such as those you would find in a gym or workshop. They are a very bright light source: occupants require a substantial amount of distance from the lamps so they are not blinded. Figure 5-11 shows fluorescent lamps.

T-12s, the old standard, are being replaced by T-8s, which are comparable or better than T-5s in efficacy. (T-8s fit in the same fixture as T-12s with minor wiring changes and a ballast replacement, but T-5s require new fixtures.)

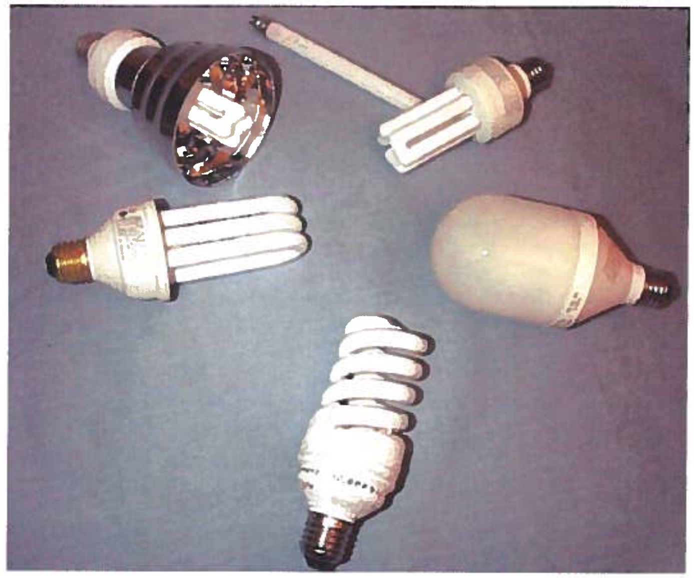


Figure 5-11. Fluorescent lamps

Colors

Fluorescent lamps generate a wide variety of colors from warm white (CRI of 50) to deluxe warm white (CRI of 89). The newer T-8 and T-5 lamps have been made with better phosphors and, as a result, have better color than standard lamps.

Ballasts

Ballasts generate very high voltages and limit the current to the lamp. Older, magnetic ballasts were, essentially, a transformer with a starter yet they consumed a high amount of energy, up to 15 to 20 watts for a two-lamp ballast. New, electronic ballasts (see Figure 5-12) are much more efficient, more versatile, and are expected to last longer. Additional advantages of electronic ballasts are as follows:

- Two, T-8 lamps on an electronic ballast are rated at 61 to 63 watts. In comparison, T-12 lamps on a magnetic ballast will use 96 to 114 watts.
- Electronic ballasts normally handle a variety of lamp sizes, numbers, and voltages, which eliminates much shelf stock.
- Due to the cooler operation of electronic ballasts, they are expected to last longer; some do, some don't. They are rated like lamps when half fail.

- Electronic ballasts operate at 20,000 to 40,000 Hertz (Hz), which means they do not flicker.

- Dimming ballasts can dim fluorescent lamps. Two-level ballasts allow light to be reduced to about 50%. The price of a dimming ballast is slightly more than a standard ballast.

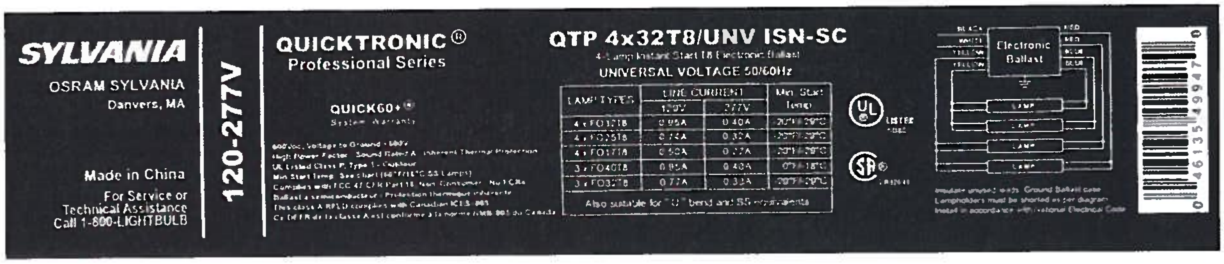


Figure 5-12. Electronic ballast label

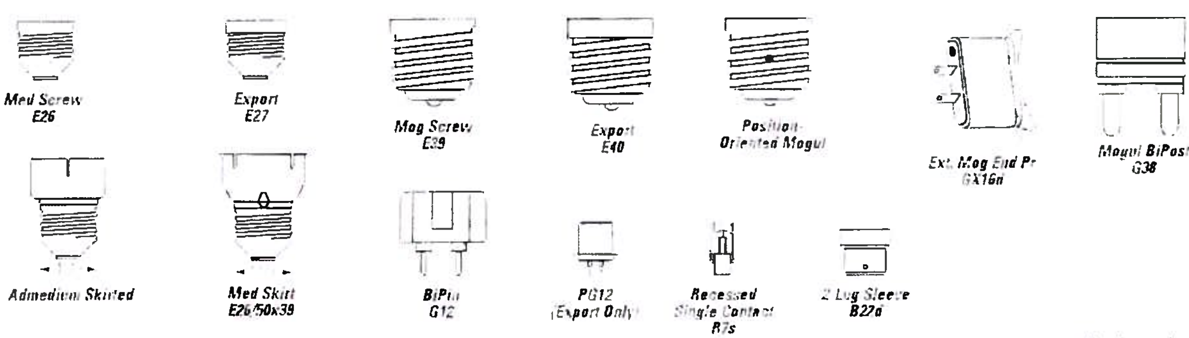
Ensure you are purchasing quality ballasts. The following are indicators of a quality ballast:

- **Total harmonic distortion factor.** This should be no less than 20% and should be noted on the ballast.

- **Sound rating.** Class A is the least noise and Class F is the loudest, which should only be used in areas of high background noise, such as boiler rooms and shops.

High-Intensity Discharge Lamps

HID lamps operate differently and have many different qualities than incandescent or fluorescent lamps. HIDs have a very bright and small arc generated inside a small envelope. In turn, the envelope is inside another glass bulb. There are four HID types—mercury vapor, metal halide, high-pressure sodium, and low-pressure sodium lamps—each with its own advantages and characteristics, including wattages, bases, and shapes (see Figure 5-13).



GE Lighting Catalog

Figure 5-13. HID bases

Mercury Vapor Lamps

Mercury vapor lamps, as their name implies, use a small amount of mercury inside the arc tube to help generate the arc. However, due to their poor efficacy, they are obsolete. Characteristics of mercury vapor lamps include the following:

- Color is a greenish blue and has a CRI of 25 to 50.
- Efficacy is 45 to 55 lumens per watt.
- Rated life is up to 24,000 hours, but they should be replaced much earlier due to lumen depreciation.
- Warm-up is commonly five minutes.
- Restrike or restart time after they have been turned off is about five minutes.
- When nearing the end of their lives, they dim or passively fade out.
- Require a specific ballast.
- Lamp ballast efficacy is 24 or higher.

Mercury vapor lamps can still be found in gymnasiums, workshops, and warehouses.

Metal Halide Lamps

Metal halide lamps (see Figure 5-14) were more recently developed and use a metal halide gas along with mercury and argon gases. Their color and efficacy are better than mercury vapor lamps, so they are commonly used where color is important, such as in retail stores and parking lots. They are available in wattages from 30 to 2,000. It is important they not be operated without a lens over them to protect people from ultraviolet light generated if the outer envelope is broken.

Figure 5-14. Metal halide lamp

Characteristics of metal halide lamps include the following:

- Color is crisp and bluish with a CRI of 70 to 80.
- Efficacy is 80 to 85 lumens per watt.
- Rated life is 7,500 to 15,000 hours.
- Warm-up time is five minutes.
- Restrike or restart time is up to 10 minutes or longer.
- When nearing the end of their lives, they dim and consume more energy.
- Require a specific ballast.
- Lamp ballast efficacy is 49 or higher.
- Burn position (base up or base down within 15 degrees) is important.

High-Pressure Sodium Lamps

HPS lamps are different from other HID lamps due to their ceramic arc tube, which is under high pressure and contains a xenon gas with coated tungsten electrodes. HPS lamps also come in a variety of sizes, shapes, and bases (see Figure 5-15).

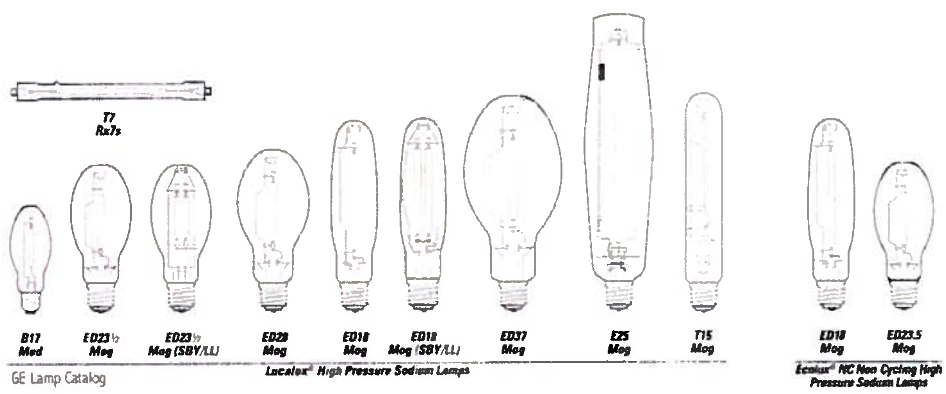


Figure 5-15. High-pressure sodium lamps

HPS lamps were developed and are used for street lighting and security lighting because of their high efficacy and life span. Because of their very yellow/gold color, they are used primarily where color is not critical. Where color is important, they can be paired with metal halide lamps, which will balance the color spectrum. However, with recent improvements in color, HPS lamps have been successfully installed in school gyms and shops. HPS lamps do not require a closed fixture and are made with two-arc tubes, which essentially eliminate the restrike time and double the life span—when one tube burns out, the other takes over.

Characteristics of HPS lamps include the following:

- Color is yellow/gold with a CRI of 20 to 65.
- Efficacy is 80 to 125 lumens per watt.
- Rated life is up to 24,000 hours.
- Warm-up time is three minutes.
- Restrike or restart time is about one minute.
- When nearing the end of their lives, they cycle off and on, which is very hard on the ballast.
- Require a matching ballast.
- Ballast lamp efficacy is 63 or higher.
- Burn position is unimportant.

Low-Pressure Sodium Lamps

Low-pressure sodium lamps (see Figure 5-16) are extremely efficient, with efficacies well over 100 lumens per watt. However, their color is monochromatic (very limited to the yellow range). They are used primarily where light pollution is a problem, such as around astronomical observatories. Their color range can be easily filtered out.

Figure 5-16. Low-pressure sodium lamps

Light-Emitting Diodes

LEDs are the latest light source on the scene and have the advantage of a very long life, projected to be in the range of 100,000 hours. However, tests are showing they have substantial lumen depreciation. Due to advances in technology and their long life, these tests are not yet conclusive. LEDs also require direct current (DC). They are being used in signs, exit lights, and other areas where long life is a major advantage. Efficacy is 20 to 40 lumens per watt and climbing.

Figure 5-17 shows a comparison of lighting efficiency.

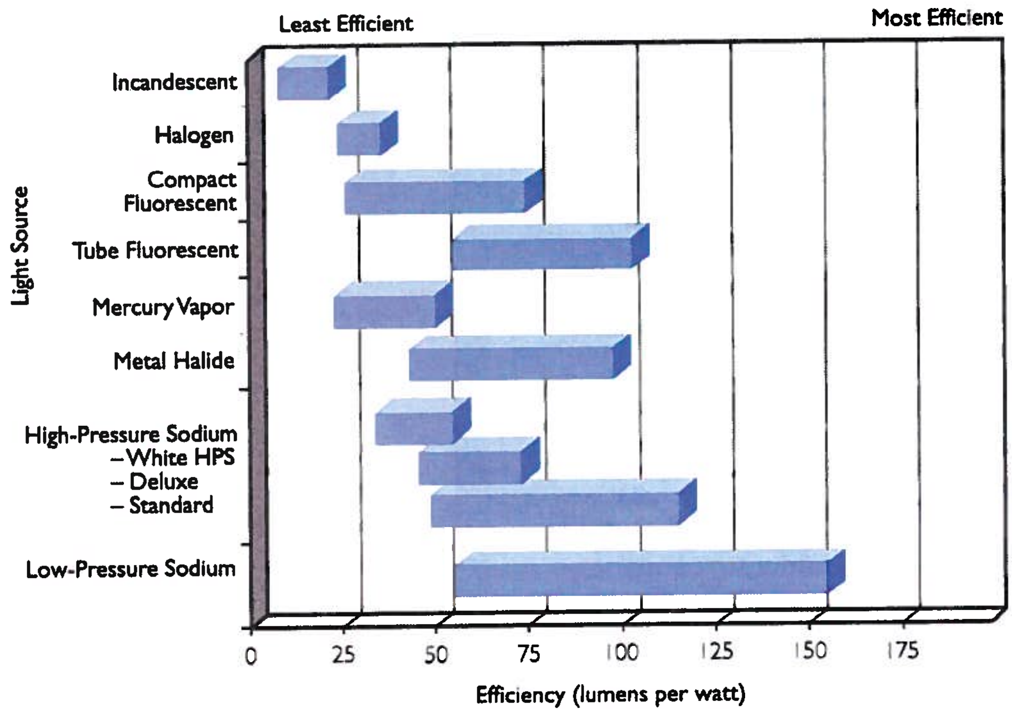


Figure 5-17. Comparison of lighting efficiency

Fixtures and Lighting Energy Management

Light Fixtures

Light fixtures, known as luminaires in the professional world, are the various housings, covers, containers, starters, ballasts, and wiring for the lamp types discussed in the Lighting Basics section on page 21. Light fixtures control, reflect, diffuse, and shield.

Proper Placement of Fixtures

Glare is always a problem with a bright light source, and light fixtures have an intensity curve that will be critical in determining proper placement. In an office, fixtures should be placed over either shoulder of the occupant so the light will reflect away from the individual. For general lighting, arrange the fixtures to complement each other by overlapping the light from one fixture with the light from its neighbor as it gets farther away and diluted.

Lighting Energy Management

Simplest Steps for Managing Lighting Energy

The easiest and most cost-effective lighting management practices include:

- Replacing incandescent lamps with compact fluorescent lamps.
- Replacing magnetic ballasts with electronic ballasts.
- Replacing T-12 lamps and magnetic ballasts with T-8s and electronic ballasts. This is the most common long-range change because a pair of T-12 lamps on one magnetic ballast uses about 96 watts, and a corresponding pair of T-8s on an electronic ballast will use about 61 to 64 watts. This will reduce connected load by one-third, slightly reduce light output, likely improve CRI, and reduce flickering common to other fluorescent lamps.

Location of Detailed Information

Light fixture, lamp, and ballast catalogs give a wealth of information we will need for our investiagtion. For example, the combination of a ballast and a lamp in a fluorescent fixture determines how much electrical energy is used and how many lumens of light they generate.

The Lighting Survey

What We Look For

What do we look for when completing our survey?

1. What is the function of the space you are evaluating?
2. Is the existing lighting system adequate? Does it meet the customer's needs?
3. Is the area over-lit?
4. What condition is the lighting system in?
5. How are the light fixtures controlled?
6. How can the system be improved?

Count the fixtures and enter the data on Table 6-1 on page 42. Your comments are also critical, so enter your impressions and suggestions.

Safety Concerns

Safety comes first—note any problems you see, and keep safe.

- Don't turn the customer's switches on or off.
- Don't reach into the electrical boxes or panels.
- Be careful in wet or winter weather.
- Be aware that some lamps, such as metal halide lamps, must be in an enclosed fixture to avoid ultraviolet radiation escaping.

More Information

You can find more information about energy management for schools and other buildings at the following online resources (also see Figure 6-1):

- *Idaho Power*—www.idahopower.com
- *Department of Energy Rebuild America*—www.rebuild.gov
- *ENERGY STAR® for Small Business*—www.energystar.gov
- *Department of Energy*—www.doe.gov

ONLINE RESOURCES

General Information

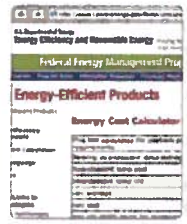
The Lighting Research Center's National Lighting Product Information Program provides facilities management and lighting professionals with information to help them specify, purchase, install, and operate efficient lighting equipment. Visit **(www.lrc.rpi.edu/programs/NLPIP/technologies.asp)** for a self-administered education in lamps, ballasts, luminaires, and controls.

Super T8 Specs

The Consortium for Energy Efficiency Inc. (CEE), a nonprofit corporation, promotes the manufacture and purchase of energy efficient products and services. The organization launched its High-Performance Commercial Lighting Systems initiative in November 2004. Review **(www.cee1.org/com/com-lt/com-lt-main.php3)** when specifying HPT8 or reduced-wattage T8 products. CEE's website provides detailed specification and application information.

State Recycling Mandates

LampRecycling.com offers users information on state regulations for fluorescent lamp disposal. Simply locate your state on the map, click, and review a comparison of state and EPA mandates. An explanation of regulations, along with reasons why mercury is hazardous, can also be found at **(www.lamprecycling.com/regulations)**.



CFL Retrofit Calculator

The U.S. Department of Energy's EERE office and its Federal Energy Management Program provide an online calculator to help you estimate the energy savings that result when retrofitting from incandescent to compact fluorescent lamps. Gather lamp cost, wattage, use, and labor data, and input the information at **(www1.eere.energy.gov/femp/procurement/eep fluorescent_lamps_calc.html)**.

List of Lamp Recyclers

This site, created by the National Electrical Manufacturers Association, is a one-stop source of information about spent fluorescent and high-intensity discharge (HID) lamp recycling. Of all the wonderful information presented, the most helpful might be its list of companies in the United States and Canada that claim to recycle or handle spent mercury containing lamps. To find a handler in your area, visit **(www.lamprecycle.org)**.

Building Magazine May 2008

Figure 6-1. Online resources

Table 6-1. Lighting inventory sheet

Area/ Room	Area Size (ft^2)	Ceiling Height (ft)	Lamp Type*	Lamp Size	Lamp Watts	Ballast Type	Lamps per Fixture	Light Level (fc)	Number of Fixtures	Usage Time (hr/wk)	% of Time on During Business Hours	Occupancy Sensors

Other observations (e.g., lamps clean, reflectivity, effective use of daylight, lighting on in unoccupied areas, ballasts disconnected in delamped fixtures):

*Type codes: Incandescent—I; Fluorescent—F; Mercury vapor—MV; High-pressure sodium—HPS; Low-pressure sodium—LPS; Metal Halide—MH

Note: Include recessed can fixtures, wall sconces, suspended fixtures, lamps and task lighting, accent light and track lighting, illuminated exit signs, and exterior lighting.

Project Timeline

The project timeline (see Table 7-1) was developed to assist you in planning and completing all *Students for Energy Efficiency* (SEE) projects. Idaho Power will assist you in this process.

Table 7-1. Timeline

Task	Date
Perform the school building assessment	
Identify appropriate locations and place HOBO lighting and temperature data loggers throughout building	
Download HOBO data logger data	
Input assessment data into the Easy Upgrades Lighting Savings/ Incentives Calculator (Lighting Calculator)	
Prepare your report outline	
Identify your report format:	
• PowerPoint presentation	
• Website	
• Word document	
Schedule report presentations (choose a minimum of two):	
• Internal (classroom/teachers)	
• PTO-PTA meetings*	
• School board*	
• Civic organizations* (Kiwanis, Rotary, etc.)	
Submit your draft of the Lighting Calculator (for review by an Idaho Power engineer)	
Submit your draft report	
Submit your final Lighting Calculator	
Submit your final report	
Present	

*Potential funding sources for your report recommendations.

Easy Upgrades Lighting Savings/ Incentives Calculator

The Idaho Power Easy Upgrades Lighting Savings/Incentives Calculator (Lighting Calculator) is an Excel-based tool to assess how much you can save by upgrading your lighting to more energy-efficient alternatives. The calculator estimates the incentives your school can earn, calculates the cost benefit of potential projects, and provides projected kilowatt (kW) and operational cost savings.

n In addition to the money-saving and incentive-earning estimates the calculator generates, there are other benefits to efficient lighting not included here (e.g., better lighting quality, reducing lighting maintenance costs, etc.).

Accessing the Calculator

The Lighting Calculator can be accessed in two manners:

1. Go directly to the following URL: http://www.idahopower.com/EnergyEfficiency/Business/Programs/EasyUpgrades/LightingCalculator.cfm
2. Click the **Lighting Savings/Incentives Calculator** link.

   ⇒ This will open an Excel file that requires macros to properly operate; you must enable the macros setting before inputting data into the spreadsheet.

   ⇒ This file opens in a read-only format. To save your project, save the file on your computer under a different name.

OR

1. Start at Idaho Power's website: www.idahopower.com
2. Move your cursor over the **Energy Efficiency** tab.
3. From the drop-down menu, click **Business**.
4. Under the **Programs** tab, click the **Easy Upgrades for Simple Retrofits** heading.

5. In the **Related Information** box, click the **Lighting Savings Calculator** heading.

6. Click the **Lighting Savings/Incentives Calculator** link.

   ⇒ This will open an Excel file that requires macros to properly operate; you must enable the macros setting before inputting data into the spreadsheet.

   ⇒ This file opens in a read-only format. To save your project, save the file on your computer under a different name.

n The calculator is intended as a tool for Idaho Power customers and lighting contractors to estimate the incentives and other financial benefits available for many typical lighting retrofits and control projects. While Idaho Power has made every attempt to ensure the accuracy of this calculator, savings may vary widely, and customers are responsible for verifying their actual savings.

Using the Calculator

As you review these instructions to create a lighting calculator for your school project, refer to the example calculations for Franklin High School (see foldouts in the Lighting Specifics section of the Report Template).

Lighting Retrofits Table Tab

1. Click the **Lighting Retrofits Table** tab at the bottom of the spreadsheet.

2. Fill in the **Project Information** box. Under **Building Type**, use the drop-down menu to choose the appropriate building type.

   ⇒ A message will display, indicating a default number of operating hours will be inserted into the table—accept this setting.

3. In the **Project Location** box, insert the name of your building and its address.

4. In the **Existing Equipment** box, complete the following according to the existing equipment in the building:

   4.1 In the **Location Area/Room** column, insert the data on each of the rooms you assessed.

   4.2 In the **Existing Equipment** column, use the drop-down menu to choose the appropriate descriptions for existing lighting.

n If you have assessed multiple classrooms with identical lighting data, list the data in one row and, in the **Notes** column, indicate the number of classrooms for future reference.

4.3 In the **Watts/Fixture** column, enter the average watts per fixture.

4.4 In the **Qty column**, enter the total number of fixtures.

Enter the total number of fixtures for all identically-lit rooms if you are entering their data on one row.

5. In the **Proposed Equipment** box, complete the following according to the replacement equipment you propose:

   5.1 In the **Equipment to be Installed** column, use the drop-down menu to choose the appropriate description for the replacement equipment you you propose to install.

   ⇒ Usually, once you enter the equipment to be installed, the calculator will automatically insert a figure in the **Watts/Fixture** column.

   5.2 In the **Qty** column, enter the total number of fixtures.

   ⇒ Once you enter the quantity, and based on your selection for building type in the **Project Information** box, the calculator will automatically populate a figure in the **Annual Operating Hours** column.

   5.3 Work with your facility's maintenance manager, custodian, or electrical contractor to obtain and enter data in the **Installed Cost (each)** column.

   ⇒ The calculator will automatically populate the remaining columns, providing useful data on the total cost, kW savings, and proposed incentives.

Lighting Controls Table Tab

When you have completed the **Lighting Retrofits** tab, complete the following tasks:

1. Click the **Lighting Controls Table** tab at the bottom of the spreadsheet.

   ⇒ The calculator automatically retrieves the information you inserted into the **Lighting Retrofits Table** tab.

2. In the **Controls–User Input** box, complete the following:

2.1 In the **Control Type** column, use the drop-down menu to choose the lighting control you are recommending be used on the lighting previously listed.

2.2 In the **Control Quantity (units)** column, indicate the quantity.

2.3 Work with your facility's maintenance manager, custodian, or electrical contractor to obtain and enter data in the **Installed Cost (each)** column.

⇒ The calculator will automatically populate the remaining columns, providing useful data on the total cost, kW savings, and proposed incentives.

⇒ The calculator will automatically incorporate the data from the **Lighting Controls Table** tab into the **Lighting Retrofits Table** tab, specifically into the **Combined Project Energy Savings–Retrofit Plus Controls** box.

Projected Annual Cost Savings–Lighting Retrofit Box

Based on the data you inserted in the **Lighting Retrofits Table** tab and the **Lighting Controls Table** tab, the **Projected Annual Cost Savings–Lighting Retrofit** box will automatically display the calculated kW savings, estimated annual cost savings, estimated payback in years, and return on investment (ROI) for the project. This information will be extremely useful when developing your report and presenting your findings and recommendations to potential funding sources, such as your school board or civic organizations.

HOBOware: Getting Started Guide

Please refer to the insert.

onset®

HOBOware

Getting Started Guide

HOBO®

onsetcomp.com

Contact Information

For support, please contact the company that you bought the products from: Onset Computer Corporation or an Onset Authorized Dealer.

Onset Computer Corporation
470 MacArthur Blvd.
Bourne, MA 02532

Mailing Address:
P.O. Box 3450
Pocasset, MA 02559-3450

Phone: 1-800-LOGGERS (1-800-564-4377) or 508-759-9500
Fax: 508-759-9100
Hours of Operation: 8 AM to 5 PM ET, Monday through Friday

E-mail: loggerhelp@onsetcomp.com
Main Onset Web site: http://www.onsetcomp.com

Part #: MAN-BHW-GS
Doc #: 12284-D

INTRODUCTION

This guide is intended to help a new user become familiar with the basic functionality of using HOBOware with HOBO data loggers, including:

- Installing HOBOware
- Connecting a Device
- Launching a Device
- Reading Out a Device
- Plotting and Analyzing Data

Onset suggests that you perform a trial setup at your desk to familiarize yourself with the procedures before you deploy your loggers.

This guide is for HOBOware Pro and HOBOware Lite, for Windows™ or Macintosh™. Any differences in functionality are noted.

For detailed information on all of the HOBOware features, use the online help or refer to the *HOBOware User's Guide*, which you can find on your installation CD, or on the Onset product manual web page: http://www.onsetcomp.com/support/manuals.

Notes

- This guide covers HOBO data loggers. If you are configuring HOBOnode Indoor Wireless Sensors, refer to the *HOBOnode Indoor Wireless Sensors Quick Start Guide.*
- Windows screen captures in this document are English versions. If you have a version of HOBOware in another language, see the software for the translated windows.

An Overview of HOBOware

HOBOware combines fast, easy logger launch and readout functions with powerful data plotting capabilities, making it easier than ever for you to analyze environmental conditions recorded with HOBO loggers.

The intuitive, graphical user interface allows you to select environmental parameters to display, format graphs, perform analysis, and save projects for future use.

HOBOware Lite

HOBOware Lite is Onset's entry-level software for HOBO USB loggers, offering easy logger launch, readout, and data plotting. HOBOware Lite does not support any of Onset's Data Assistants or data shuttles.

HOBOware Lite supports all HOBO U-Series loggers (except the HOBO U30 Station)

HOBOware Pro

In addition to the basic features in HOBOware Lite, HOBOware Pro offers the following:

- Valuable features such as scaling data to sensor units and saving graphs so they can be recalled and used in the future.
- Optional tools for real-time data readout, alarms, and post processing of data provide you with even greater insight into your data.
- Supported Devices
  - HOBO U-Series loggers
  - HOBO Weather Stations and HOBO Micro Stations
  - HOBO Energy Logger Systems
  - HOBO U-Shuttle and Waterproof Shuttle
  - HOBO FlexSmart Modules

SUMMARY OF TASKS

The following are the basic steps to use a HOBO data logger that are explained in this guide. Onset suggests that you perform a trial setup at your desk to familiarize yourself with the procedures before you deploy your loggers.

1. Installing HOBOware
2. Connecting Device(s)
3. Launching Logger
4. Checking Logger Status
5. Reading Out Logger
6. Plotting and Analyzing Data

INSTALLING HOBOWARE

Before You Begin

Refer to the README file on the Web site or the installation CD for detailed information about system requirements needed to run HOBOware. If you have additional questions, please call Onset Technical Support or check the HOBOware website at http://www.onsetcomp.com/support.

License Key

When you purchase HOBOware, your email receipt will include a license key. If you purchase HOBOware online, the license key is also displayed in the online receipt. After you install HOBOware and run it for the first time, you will be prompted to enter the license key in the License Key Manager dialog. You can also access the License Key Manager dialog by selecting Help > License Key.

If you are using a trial version of HOBOware, the License Key Manager dialog will indicate how much time you have remaining in your trial period. When the trial expires you will be prompted to enter a license key before you can continue using HOBOware.

NOTE: If you are updating an existing version of HOBOware you will not need to enter a license key.

Steps

Windows

1. Insert the CD in your computer's CD drive.

The installation program should start automatically. If it does not, navigate to the CD drive in My Computer or Windows Explorer and double-click HOBOware_Setup.exe to launch the HOBOware installer.

NOTE: HOBOware for Windows requires the Java™ 2 Runtime Environment. If the correct Java 2 Runtime Environment version is not already installed on your computer, the HOBOware Setup program will ask if you want to install it now. (You must be logged in as an administrator on your computer to install the Java 2 Runtime Environment.) Click **Yes** and follow the prompts. After the Java 2 Runtime Environment is installed, the HOBOware installation will continue.

2. Follow the prompts to install HOBOware.

HOBOware should open automatically when the installation is complete. If it does not open by itself, double-click the HOBOware icon on your desktop or Quick Launch menu. Or, from the Start menu, select Programs > Onset Applications > HOBOware.

Macintosh

1. Insert the CD in your computer's CD drive.
2. Double-click the CD icon in the Finder and double-click the HOBOware.pkg to launch the HOBOware installer.
3. When you reach the final screen of the installation program, click **Restart**.
4. After restarting, open HOBOware by double-clicking the HOBOware icon in your computer's Applications folder.

Using the HOBOware Setup Assistant (HOBOware Pro Only)

When you open HOBOware Pro for the first time, you are greeted by the HOBOware Setup Assistant, which allows you to change the key preferences. To run the Setup Assistant, click **Start** and follow the prompts.

NOTE: The Setup Assistant is optional. If you click **Cancel**, you will be able to use HOBOware with its default settings, listed below.

- Device Types - Default is USB

  If you enable Serial Devices (HOBOware Pro only) you can select the port to use.

- Unit System - Default is US units
- Data Assistants - Default is enable all installed data assistants

Other Preferences

To see all of the preferences you can configure in HOBOware, go to:

Windows: File > Preferences

Macintosh: HOBOware > Preferences

CONNECTING DEVICES

Connecting a USB Device

You can connect most devices to the USB port by using an Onset-supplied USB interface cable.

NOTE - HOBOware Pro: For instructions on connecting HOBOware shuttles, or using the HOBO Waterproof Shuttle as a base station, refer to the shuttle's user guide.

Steps

1. Open HOBOware.
2. Plug the large end of the USB interface cable into a USB port on the computer.
3. Plug the small end of the USB interface cable into the port on the device. Refer to the diagram and instructions that came with the device if you need help finding the port.

NOTE - Windows Only: If the device has never been connected to this computer before, it may take some time for the computer to detect the new hardware and report that it has connected successfully. One or more messages will appear, indicating that new hardware has been found. You may also hear a chime.

NOTE - Windows Only: Your computer may tell you to reboot before you can use the device. It is not necessary to reboot.

When the device is recognized by HOBOware, the right side of the status bar at the bottom of the HOBOware window will update to reflect the number of devices connected. At this point, you can access the device from HOBOware.

To disconnect the device, simply unplug it from the USB cable.

Using a Base Station/Coupler

Some loggers require an optic USB base station/coupler to connect to the computer. Consult the manual that came with your device for specific information about required base stations/couplers.

NOTE - Windows Only: If you are connecting a base station/coupler or logger that has never been connected to this computer before, it may take some time for the computer to detect the new hardware and report that it has connected successfully. One or more messages will appear, indicating that new hardware has been found. You may also hear a chime.

NOTE - Windows Only: You may be prompted to reboot you computer before you can use the logger. It is not necessary to reboot.

Steps

1. Open HOBOware.
2. Plug the base station/coupler cable into a USB port on the computer.

   Important: Make sure the base station/coupler is the correct model for the logger you want to use. Consult the manual that came with the logger if you are not sure.
3. Attach the logger to the base station/coupler as described in the documentation that came with your logger.

When the logger is recognized by HOBOware, the right side of the status bar at the bottom of the HOBOware window will update to reflect the number of loggers connected. At this point, you can access the device from HOBOware.

To disconnect a logger, simply unplug it from the base station/coupler. Wait for the status bar to update the number of devices before continuing.

To attach another logger via a base station/coupler, remove the logger, leaving the base station/coupler connected, and then connect the next logger.

To disconnect the base station/coupler, unplug it from the USB port.

Connecting a Device Using a Serial Cable (HOBOware Pro Only)

1. Open HOBOware Pro.
2. Plug the 9-pin end of the serial interface cable into a serial port on the computer or Keyspan™ adapter.
3. Plug the other end of the serial interface cable into the communications port on the device. Refer to the diagram and instructions that came with the device if you need help finding the port.
4. If you are using a serial port other than COM1 (PC) or Default (Macintosh), you will need to set up HOBOware to look at another port. To change the Serial Ports setting go to:

   Windows: File > Preferences > Communications

   Macintosh: HOBOware Pro > *Preferences* > *Communications*

   Note that checking multiple serial ports can take some time, even when no devices are attached.

The status bar at the bottom of the HOBOware Pro window will update to reflect that the device is connected and selected. At this point, you can begin using the device.

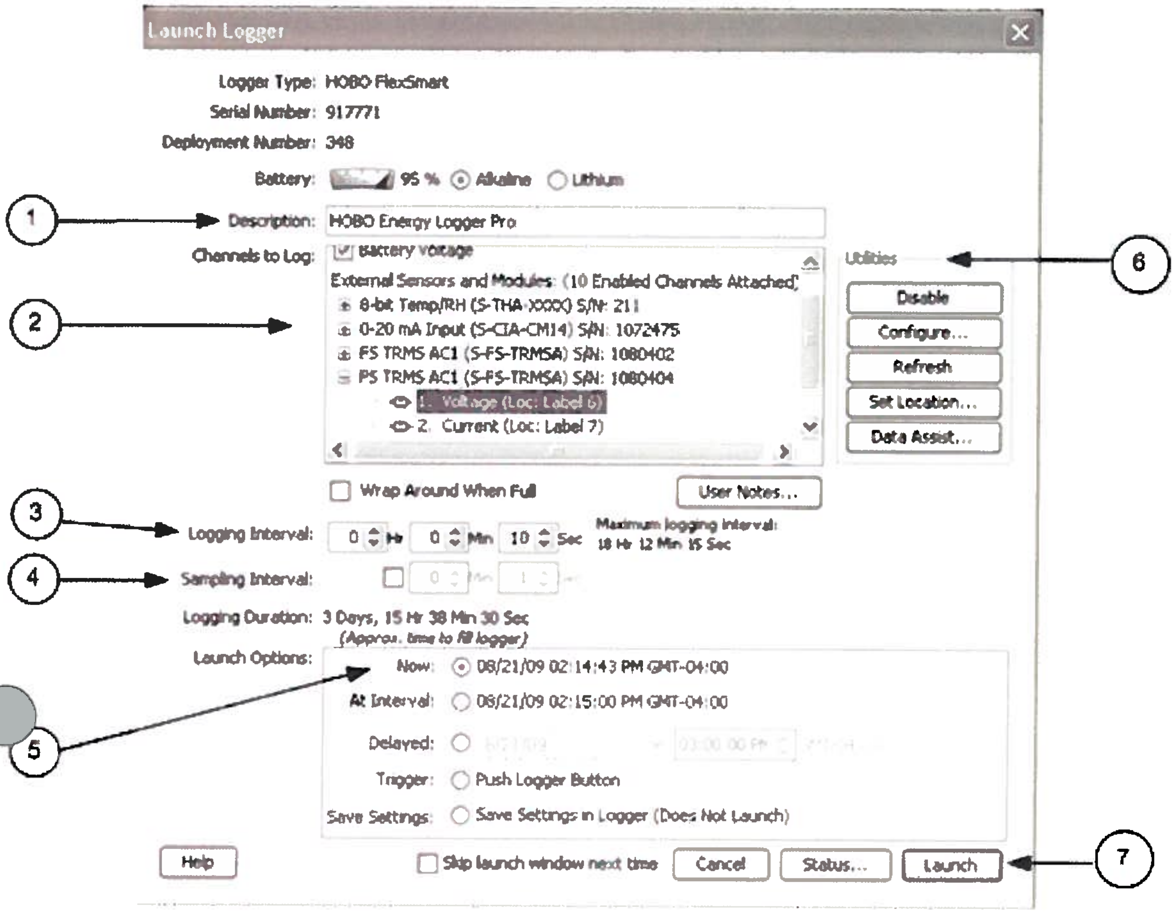
NOTE: To disconnect the device, simply unplug it from the serial cable.

LAUNCHING THE LOGGER

To launch the logger, click the Launch icon on the toolbar.

This displays the logger's Launch window.

The Launch window varies slightly for each type of logger, but most look similar to the following:



1. Description: Enter a description for the launch.
2. Channels to Log: Select the channels/sensors that you want to be logged.
3. Logging Interval: Set how often the logger will record data from the sensors. For this exercise, set a short Logging Interval (five seconds or less) so that you can get some readings quickly. When you actually deploy the logger, change this to your desired interval.
4. Sampling Interval - (Station Loggers only): Set how often you want measurements to be taken within a Logging Interval. They are then averaged together to create a single logged measurement.
5. Launch Options: Select when to launch the logger. For this exercise select *Now*. When you actually deploy the logger, change this to your desired option.
6. Utilities - (HOBOware Pro only):

   Depending on the logger and sensors connected, various utilities such as Scaling, Alarms, and Data Assistants are available. See the *HOBOware User's Guide* for details.
7. Launch Button: Click **Launch** to launch the device.

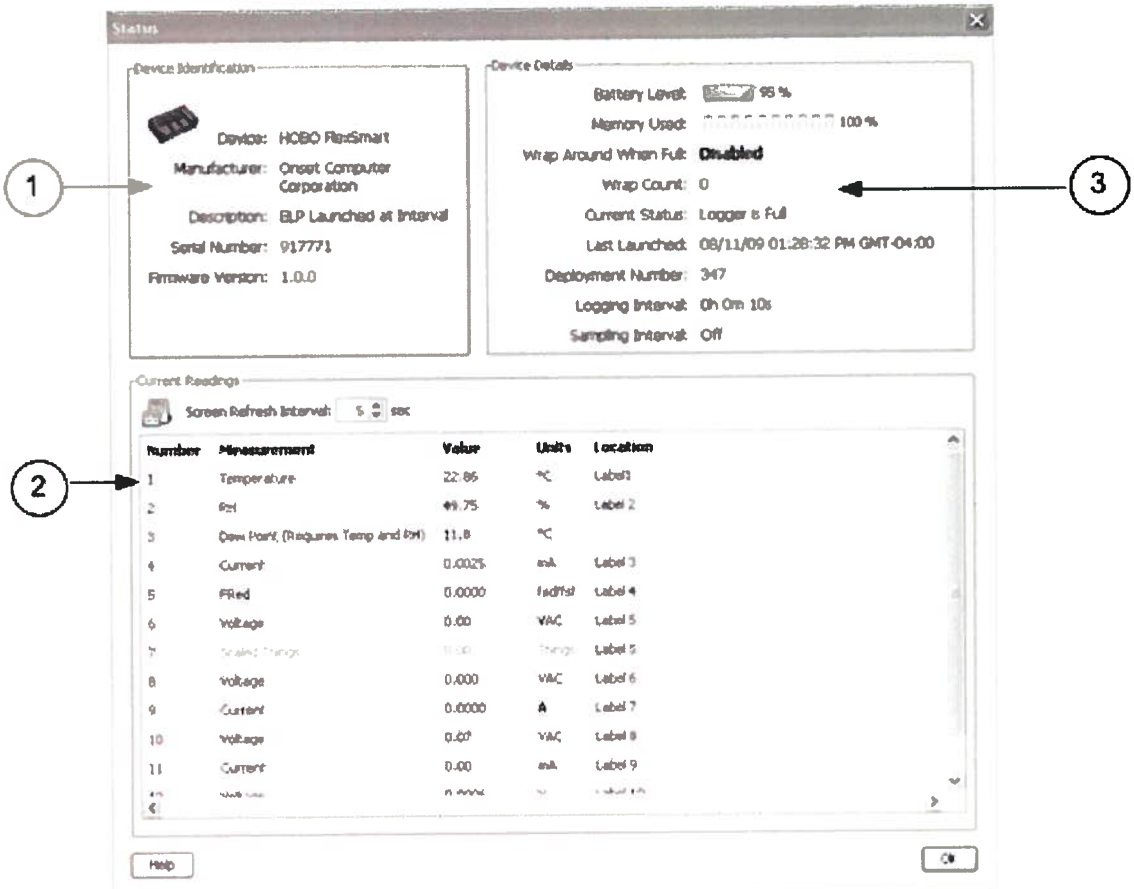
HOBOware displays the progress of the launch and warns you not to unplug the logger while it is being configured.

Normally, when the launch is finished, you will unplug the logger and deploy it. For this exercise, leave the logger plugged in so you can get familiar with reading it out and plotting data.

CHECKING LOGGER STATUS

To check the status, click the Status icon on the toolbar.

The Status window appears, displaying information about the device. Watch as the Current Readings update in real time.



1. Device Identification: Includes device type and serial number.
2. Current Readings: Shows current readings for attached sensors, including series output from Data Assistants defined in a previous launch.
3. Device Details: Includes Battery Level, Memory Used, Current Status, and Current State.

Testing the Logger and Sensors

To verify that your logger and sensors are working and recording data properly, perform the following tests. Later when you plot the data, you should see the results of these tests in the graph.

Change Current State

1. If you are using a U-Series logger that has a button, hold the button down for several seconds.
2. Watch the Current States field in the Status window change to *Button Down*.
3. Release the button.

Change Sensor Readings

1. If you are measuring temperature, change the temperature reading by holding the logger or sensor in your hands for a minute or two.
2. Watch the Current Readings in the Status window change as the conditions change.

When the tests are complete, close the Status window by clicking **OK**.

READING OUT THE LOGGER

To retrieve data recorded by a logger, you must read out the logger.

Reading out the logger copies data from the logger to your computer, allowing you to save the data in a datafile and view the plot.

During readout, the logger continues to record data unless you have stopped the logger or the logger is full.

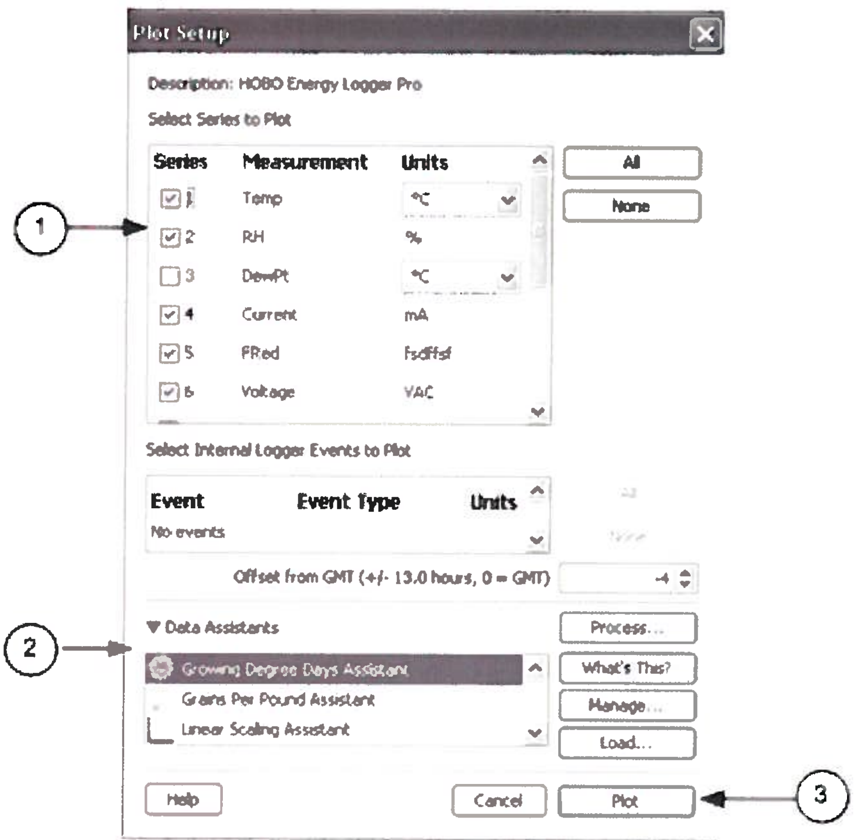
1. Click the Readout icon on the toolbar.
2. Click **Stop** when HOBOware asks if you want to stop the logger before reading out.

   After reading out the logger, HOBOware prompts you to save the datafile.
3. Enter a name and location for the file and click **Save**.

The Plot Setup window appears.

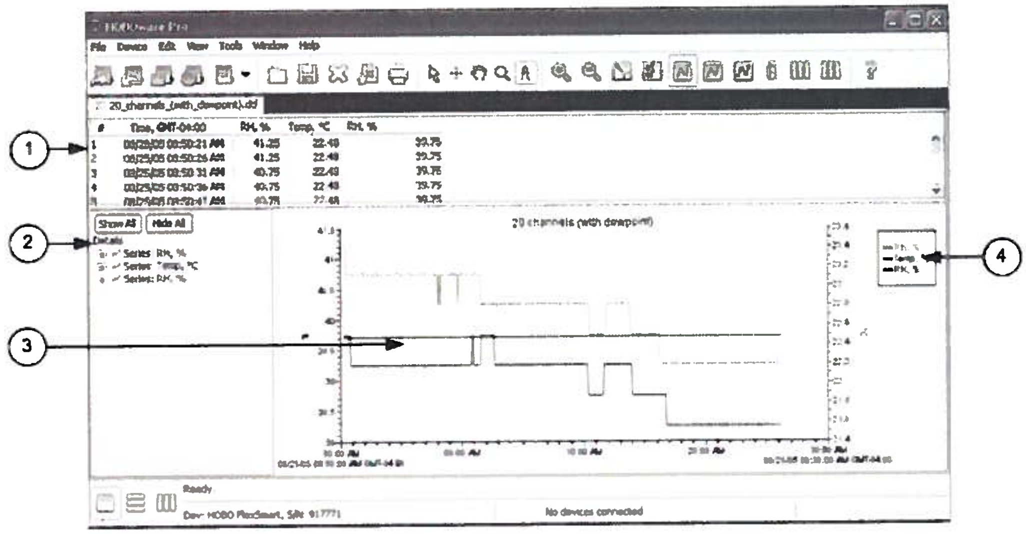
PLOTTING AND ANALYZING DATA

After you read out a logger and save the data file, the Plot Setup window appears. Even if you only intend to export the data to another format, you must plot the data first.



1. Select Series to Plot: Select the series you want to plot and the units, if applicable.
2. Data Assistant: HOBOware Pro Data Assistants let you create new data series by converting data recorded by the logger to other useful formats. For now, skip this step. See the *HOBOware User's Guide* for more information on using Data Assistants.
3. Plot Button: Click **Plot** to plot the selected sensor data on a graph.

After you click the **Plot** button, the data will appear in a graph along with other information.



1. Points Pane: Lists the data in table format.
2. Details Pane: Lists information about the launch and summarizes the deployment.
3. Graph: A plot of the data. You should be able to see the changes in sensor readings and state changes that you initiated in *Testing the Logger and Sensors* reflected in the graph.
4. Legend: Displays the keys for each sensor, state, and event series.

NOTE: To enable the Points Pane and the Details Pane in HOBOware Lite, go to Preferences > Plotting > Points Table and Details Pane.

Use the tools on the toolbar to experiment with the export, print, and many viewing and customization tools available within HOBOware. Pause the pointer over each icon on the toolbar for a description of each tool.

IMPORTANT: Make sure you change your Launch Settings to those you prefer before deploying the logger.

See the *HOBOware User's Guide* for more information and details on features and procedures.

Report Template

This report template for the *Students for Energy Efficiency* (SEE) program references a fictitious school with fictitious data. Students are encouraged to follow this report template but insert their own data where applicable.

In the interest of time, we are recommending students focus their report on electrical findings only. Recommendations involving heating, ventilation, and air conditioning (HVAC) and the use of fuels, such as natural gas, propane, or fuel oil are encouraged, but the emphasis of the report should be on the opportunity to reduce electrical energy throughout the building. Consequently, students can eliminate graphing and analysis of natural gas and other heating fuels from the report.

Students are encouraged to review and refer to the school building audit performed by professional engineers, under the direction of the governor's Office of Energy Resources (OER), for supporting recommendations on lighting and temperature setbacks. Idaho Power has requested copies of these professional energy audits from the OER for all schools participating in the SEE program. We will electronically forward the audits to participating teachers.

n The following text is a sample report. Students are encouraged to create their own.

Introduction

As students in Mrs. Troxell's science class at Franklin High School, we were excited to partner with Idaho Power and participate in the *Students for Energy Efficiency* (SEE) program. As citizens of Idaho, we have an obligation to use energy and natural resources in a wise and efficient manner. With that in mind, we performed an energy assessment of our high school building and present these findings and recommendations for consideration by our principal, superintendent, and school board in the hopes it will result in reduced energy usage and lower operating costs for Franklin High School.

General Information

This report details the findings and recommendations of our student team, which was sponsored by Mrs. Troxell, Franklin High School science teacher.

Team Members

Mrs. Troxell:	Science teacher and SEE sponsor
David Thornton:	10th grade teacher
John Bernardo:	11th grade teacher
Robb Akey:	12th grade teacher
Joe Paterno:	12th grade teacher

School Information

Name:	Franklin High School
Address:	1210 Victory Rd. Franklin, ID 88888
District:	Outskirts School District in southeastern Idaho
Contact:	Mrs. Katherine Troxell Science Teacher 1-208-555-1212

n Insert photos of your school.

Weekly School Occupancy Hours

Monday through Friday:	10 hours/day (7am–5pm)
Saturday through Sunday:	5 hours/day (varies)
Saturday through Sunday:	5 hours/day
Total:	60 hours/week

Yearly School Occupancy Hours

Hours/week:	60
Weeks/year:	37
Hours/year:	2,200
Summer and holiday hours/year:	225
Total hours/year:	2,245

n The Easy Upgrades Lighting Savings/Incentive Calculator (Lighting Calculator) (see Tab) requires inserting the building type in the **Project Information** box. We recommend selecting **School–Secondary** from the drop-down menu, which will automatically insert 2,500 hours into the **Ltg Operation** field. This corresponds to the occupancy hours (2,425) calculated above.

Building Details

Square footage:	54,500
Original construction year:	1968
Years since last remodel:	10
Electrical utility provider:	Idaho Power
Heating utility provider:	Intermountain Gas

n Insert photos of electric and gas meters.

Other

Number of Exit Signs:
0 Light-emitting diode (LED)
40 Incandescent
5 Fluorescent

n Insert photos of exit signs.

Lighting contractor: Benjamin Edison Electrical

Training Details

The students participated in a three-hour training session presented by Idaho Power trainers at Franklin High School on October 28. The training consisted of a PowerPoint presentation detailing the crime of wasting energy at our school and how we could look for opportunities to increase energy efficiency and reduce overall energy usage and operating costs for the school district.

Highlights of the presentation included the following:

- Introduction of the energy scene investigation (ESI) (similar to a crime scene investigation [CSI]) we were to perform at our school
- Energy concepts: how energy is generated, transmitted, used, and measured at the school

- Major areas of energy usage in the school:
  - Building envelope (shell)
  - Lighting
  - Plug and phantom loads
- Historical energy usage, including peak usage
- SEE equipment to determine energy usage:
  - Light level meters
  - Magnetic/electronic ballast detector
  - Kill A Watt™ meter
  - Room occupancy/light sensor
  - Room occupancy/temperature sensor
  - Power strip
  - Tape measure

n Insert photos of equipment and/or students using equipment.

After the presentation, we walked through the school with the Idaho Power trainers, becoming familiar with the proper use of the equipment and where to investigate energy efficiency opportunities.

Assessment Details

We performed a school-wide assessment of Franklin High School over seven weeks, from November 2 to December 18, 2009. Total student hours spent performing the energy assessment approximated 75 hours.

n Consider listing the date range during which the assessment was taken and the hours per student.

We split up and rotated duties so all students became familiar with the ESI equipment. We performed the following assessments:

- **Measurements**. To determine energy use per square foot in each room, we measured every room in square feet using the roll-up measuring tape, including hallways, the auditorium, the gymnasium, locker rooms, and the teacher lounge.

n Insert photos.

- **Lighting.** We detailed lamp types, the number of lamps, ballast types, wattages, lumen outputs, and hours of use. We then compared the total wattage per room with the room's square footage.

n Insert photos.

- **Plug and phantom loads.** In every room, we measured the wattage used when a plugged-in device was operating and the wattage used when the device was idle, yet plugged in.

n Insert photos.

- **Energy use per square foot.** In many cases, we saved time by determining energy use per square foot using data obtained from similar-sized rooms or rooms with similar lighting and plug load demands.
- **Monthly peak loads.** We analyzed past electrical and natural gas usage to determine if usage drops, as expected, during periods of lower school attendance, including holiday breaks and summer months. The electrical data was provided by Idaho Power and the natural gas data by Intermountain Gas.

n Consider inserting graphs, charts, or tables of the electrical- and gas-usage data.

- **Location and number of meters.** We identified meters that measure electrical and natural gas usage to assess usage on a monthly basis after recommendations are implemented.

n Insert photos.

- **Building envelope (shell).** We determined information about the shell by using the audit data provided by the OER, through conversations and tours with building custodial staff, and by reviewing building drawings.

n Insert photos of the building (e.g., windows, the roof, doors, etc.)

Existing Energy-Efficient Technologies, Signage, and Practices

We identified many existing technologies, signage, and practices that promote energy efficiency in our school. Among these are the following:

- Vendingmiser motion sensor devices are installed on two out of eight vending machines.
- T-8 lamps are used in two classrooms: rooms 124 and 126.
- Computers and monitors in the computer room are connected to multiple power outlet strips with toggle switches, and the computer teacher switches off the power strips at the end of the day.
- Signage reminding occupants to turn off lights is in two rest rooms and ten classrooms.
- Five out of forty-five exit signs use fluorescent lamps instead of incandescent lamps.

n Insert photos.

Findings

Building square footage:	54,500
Electrical energy usage for the past 18 months:	922,640 kilowatt-hours (kWh)
Electrical energy usage for the past 12 months:	608,942 kWh
Electrical energy usage/square foot for one year:	11.17 kWh

n The national average of electrical energy usage/square foot for one year for high school buildings is 11.00 kWh/square foot.

Recommendations

Building Envelope (Shell)

In general, we defer to the HVAC recommendations found in the energy audit of Franklin High School conducted by McClure Engineering through the OER in December 2009. This includes recommendations for equipment maintenance, thermostat setbacks, and changes in air infiltration.

n The McClure Engineering report supports many of our recommendations regarding lighting improvements.

All schools participating in the SEE program will receive an electronic copy of the energy audit report funded through the OER. We will forward these to you as soon as we receive them from the OER. We encourage you to include a copy of the OER-sponsored audit report with your assessment report.

We recommend the following for the building envelope:

- Repairing the cracks in the walls and floors of the following rooms:
  - Wood shop east wall
  - Boys' locker room floor
  - Home economics kitchen north wall and floor
- Replacing three cracked windows in the cafeteria
- Adding weather-stripping to all external doors

Insert photos.

Lighting

We determined that lights are left on after normal operating hours in major spaces within the high school, including the gymnasium, auditorium, and hallways. As such, we recommend the following for lighting:

- Install wiring for separate light switches and light only part of the fixtures in the hallway (or two of the four lamps per fixture) to reduce hallway lighting during low-use hours and to promote safety.

Insert photos.

- Install motion sensors in the gymnasium, auditorium, teachers' lounge, offices, rest rooms, and custodial closets.

Insert photos.

- Purchase or have made by students in the Art department light switch signs for all classrooms reminding users to turn off lights when the room is vacant.
- Remove lamps from individual fixtures to reduce energy usage without compromising the teachers' ability to teach and students' ability to learn. This would reduce lighting in the following rooms, which are over-lit:

(The lumen output by existing lighting, as measured by the lumen light meter, exceeds the lighting levels recommended by the Illuminating Engineering Society [IES].)

n This information was provided by Idaho Power in its PowerPoint presentation and SEE curriculum binder.

- Biology and chemistry labs
- First floor conference room
- 20 classrooms

n Insert photos.

For example, we determined the current lighting and wattage for a single classroom and the potential savings if our recommendations are implemented. Since the lighting and square footage of the classroom is representative of 19 others in the high school, the potential energy and operational cost savings can be multiplied by 20. Our recommendations include reducing the lighting hours from 10 per day (7 a.m.–5 p.m.) to 9 per day (7 a.m.–4 p.m.) and reducing the lighting usage by 2 kW per room through delamping. Table 10-1 shows existing and recommended lighting.

Table 10-1. Existing and recommended lighting

Existing		Recommended	
10	hours per day average usage	9	hours per day average usage
12	kW	10	kW
× $0.06	per kWh	× $0.06	per kWh
× 10	hours per use per day	× 9	hours per use per day
× $7.20	per day per classroom	× $5.40	per day per classroom
$144	per day for 20 classrooms	$108	per day for 20 classrooms
$34,920	annually at 2,425 hours	$29,100	annually at 2,425 hours
$34,920 - $29,100 = **$5,820 savings per year**			

- Replace all T-12 fluorescent lighting with magnetic ballasts used in the older section of the building with T-8 lights and electronic ballasts.

n Insert photos.

- Where incandescent bulbs are still in use (e.g., custodial closets, locker rooms, desk lamps, etc.), replace them with compact fluorescent lamps (CFL).

n Insert photos.

- Replace all exit signs using incandescent or fluorescent lamps (45 in total) with LED lamps to reduce energy usage and the frequency of lamp replacement by custodial staff.

n Insert photos.

- Install Vendingmiser devices on all eight vending machines operating in the building; the total number of machines requiring devices is six. In the future, the school should require Vendingmiser devices on all new vending machines.

- Follow the IES's recommendations for various spaces (see Table 10-2).

Table 10-2. Space recommendations

Space	IES Recommended Lumen Level	Actual Lumen Level Measured	Inside or Outside of Range	Recommendation
Main Office	30–50	40	Inside	None
Hallways	10–20	50	Outside	Reduce lighting/ delamping
Main Floor Classrooms	30–50	35	Inside	None
Biology and Chemistry Labs	30–50	65	Outside	Reduce lighting/ delamping
First Floor Conference Room	30–50	60	Outside	Reduce lighting/ delamping
20 Same-Sized Classrooms	30–50	65	Outside	Delamp
Custodial Closets	10–100	8	Outside	Install CFLs, providing higher lumen output

Lighting Specifics

Table 10-3 lists the existing lamps and our recommended replacements.

Table 10-3. Existing and recommended lamps

Existing Lamps		Recommended Replacements	
500	4', 4-lamp T-12 fixtures	**250**	4', 2-lamp T-8 fixtures
		500	4', 2-lamp T-12 delamping
140	4', 2-lamp T-12 fixtures	**140**	4', 2-lamp T-8 fixtures
150	4', 4-lamp T-12 fixtures	**150**	4', 4-lamp T-8 fixtures
220	4', 2-lamp T-12 fixtures	**220**	4', 2-lamp T-8 fixtures
200	4', 3-lamp T-12 fixtures	**200**	4', 2-lamp T-8 fixtures
		200	4', 1-lamp T-12 delamping
90	400 watt metal halides	**90**	6-lamp T-8 fixtures
20	250 watt metal halides	**20**	4-lamp T-8 fixtures

n Insert photos.

The Lighting Retrofits and Lighting Controls foldouts show the calculations we obtained using the Lighting Calculator.

IDAHO POWER
An IDACORP Company

Easy Upgrades Lighting Savings/Incentives Calculator
Lighting Retrofits
Updated for 2010

October 15, 2010
Version 4.12 December 2009

PROJECT INFORMATION			
Customer:	Franklin High School	Project Location (State):	ID
Contact Person:	Mrs. Troxell	Bldg Name:	Franklin High School
Contact Phone:	208-867-5309	Bldg Address:	1210 Victory Road
Building Type:	School - Secondary	City, State, Zip:	Franklin, ID 88888
		Ltg Operation:	2500 hours per year

Page 1 - Lighting Retrofits	
Ann'l Savings =	$ 1,592.79
Incentive =	$ 2,654.00
Project ROI =	36.8%

Contractor Info:	
Contractor's Name	
Contractor's Company	
Phone No	
E-mail Address	

EXISTING EQUIPMENT					PROPOSED EQUIPMENT					PROJECT COST		SAVINGS AND INCENTIVES					
Location Area/Room	Existing Equipment *Describe fixture, lamp & ballast type*	Notes	Watts/ Fixture	Qty	Equipment to be Installed	Measure Number	Watts/ Fixture	Qty	Annual Oper Hours	Installed Cost (each)	Total Cost	KW Saved	KWH Before	KWH After	Proposed KWH Savings	Proposed Incentive (each)	Proposed Incentive Amount
Science Classroom	2-lamp 4' T12 fixture	Includes lab prep room	82	20	2-lamp 4' T8 fixture	L_1b	60	20	2500	$ 50.00	$ 1,000.00	0.44	4,100	3,000	1,100	$ 14.00	$ 280.00
History Classroom	2-lamp 4' T12 fixture		82	10	2-lamp 4' T8 fixture	L_1b	60	10	2500	$ 50.00	$ 500.00	0.22	2,050	1,500	550	$ 14.00	$ 140.00
Principal's Office	4-lamp 4' T12 fixture		164	4	2-lamp 4' T8 fixture	L_1b	60	4	2500	$ 50.00	$ 200.00	0.42	1,640	600	1,040	$ 14.00	$ 56.00
Gymnasium	250W Metal Halide		295	30	4-lamp 4' T8 High Bay fixture	L_6	110	20	2500	$ 200.00	$ 4,000.00	6.65	22,125	5,500	16,625	$ 80.00	$ 1,600.00
Locker Rooms	INCANDESCENT	M & W	100	16	CFL or LED lamps, up to 25W	L29	23	16	2500	$ 5.00	$ 80.00	1.23	4,000	920	3,080	$ 2.00	$ 32.00
Exit Doorways	INCANDESCENT EXIT SIGN		40	30	LED or equivalent exit sign	L32	4	30	8760	$ 40.00	$ 1,200.00	1.08	10,512	1,051	9,461	$ 15.00	$ 450.00
					Delamping fixtures	L17		8								$12.00	$96.00
			Existing Fixture Quantity	110		Proposed Fixture Quantity		100		Retrofit Totals	$ 6,980.00	10.04	44,427	12,571	31,856		$ 2,654.00
			Existing FL Lamp Count	76		Proposed FL Lamp Count		68		Controls Totals	$ 250.00	0.00	9,100	6,825	2,275		$ 200.00
			Eligible for Delamping Bonus	8						Combined Project Totals	$ 7,230.00	10.04	53,527	19,396	34,131		$ 2,854.00
			Additional Delamping														
			Quantity	0													
			Cost each														

COMBINED PROJECT ENERGY SAVINGS - RETROFIT PLUS CONTROLS	Before	After	Savings	% Savings
Lighting Retrofits	44,427	12,571	31,856	72%
Lighting Controls	9,100	6,825	2,275	25%
TOTAL	44,427	19,396	34,131	77%

See "Controls Calculator" tab for energy savings and incentives from occupancy sensors and other controls.

BUSINESS ENERGY TAX CREDIT (BETC)	Standard	Actual	YES/NO
CHECK - IS THE PROPOSED PROJECT IN OREGON:	OR	ID	NO
CHECK - ARE ENERGY SAVINGS GREATER THAN 25%:	25%	64%	YES
CHECK - ARE PROJECT COSTS MORE THAN $1,000:	$1,000	6,980	YES
CHECK - IS SIMPLE PAYBACK AT LEAST ONE YEAR:	1	4.5	YES
CHECK - IS MAXIMUM PAYBACK LESS THAN 15 YEARS:	15	4.5	YES

PROJECTED ANNUAL COST SAVINGS - LIGHTING RETROFIT

Facility Information:			
Location	Rate	$/kWh	$/kW
ID	UNK	0.050	-

Monthly Demand Charge ($/kW):	-
kW Demand Reduction:	10.04
Cost Savings from kW Reduction: $	-
kWh Energy Savings:	31,856
Cost Savings from kWh Energy Savings: $	1,592.79
Estimated Annual Cost Savings: $	1,592.79
Estimated Payback in Years (After Incentive):	2.72
Simple ROI (Return on Investment) After Incentive:	36.8%

BETC Tax Credit (est.) =

Visit the Oregon Department of Energy's website at http://egov.oregon.gov/ENERGY/CONS/BUS/BETC.shtml
or contact them at 1-800-221-8035 for more details

Easy Upgrades Lighting Savings/Incentives Calculator
Lighting Controls
Updated for 2010

IDAHO POWER® An IDACORP Company

October 15, 2010
Version 4.12 December 2009

PROJECT INFORMATION		Project Location (State): ID	
Customer:	Franklin High School	Bldg Name:	Franklin High School
Contact Person:	Mrs. Troxell	Bldg Address:	1210 Victory Road
Contact Phone:	208-867-5309	City, State, Zip:	Franklin, ID 88888
Building Type:	School - Secondary	Ltg Operation:	2500 hours per year

Page 2 - Lighting Controls		
Annual Savings =	$	113.75
Incentive =	$	200.00
Project ROI =		227.5%

Data From Lighting Retrofit Page					Controls - User Input						Controls - Calculator Output						
Location Area/Room	Fixture type controlled	Number of Fixtures	Watts/ Fixture	Baseline Operating Hours	Control Type	Measure No	Control Quantity (units)	Installed Cost (each)	Total Cost	Fixture Watts Controlled	Percent Savings	Annual kWh Before	Annual kWh After	Proposed kWh Savings	Cost Avoidance	Proposed Incentive (each)	Proposed Total Incentive Amount
Science Classroom	2-lamp 4' T8 fixture	20	60	2500	Occupancy Sensor	L24	1	$ 50.00	$ 50.00	1200	25%	3,000	2,250	750	$ 37.50	$ 40.00	$ 40.00
History Classroom	2-lamp 4' T8 fixture	10	60	2500	Occupancy Sensor	L24	1	$ 50.00	$ 50.00	600	25%	1,500	1,125	375	$ 18.75	$ 40.00	$ 40.00
Principal's Office	2-lamp 4' T8 fixture	4	60	2500	Occupancy Sensor	L24	1	$ 50.00	$ 50.00	240	25%	600	450	150	$ 7.50	$ 40.00	$ 40.00
Gymnasium	4-lamp 4' T8 High Bay fixture	20	110	2500	Central Lighting Control System	L26	2	$ 200.00	$ 400.00	2200	15%	5,500	4,675	825	$ 41.25	$ 0.10	$ 0.20
Locker Rooms	INCANDESCENT	16	100	2500	Occupancy Sensor	L24	2	$ 50.00	$ 100.00	1600	25%	4,000	3,000	1,000	$ 50.00	$ 40.00	$ 80.00
Exit Doorways	LED or equivalent exit sign	30	4	8760					$ -								
									$ -								
									$ -								
									$ -								
									$ -								
									$ -								
									$ -								
									$ -								
									$ -								
									$ -								
									$ -								
TOTALS							5		$ 250.00	3,640 728		9,100	6,825	2,275	$ 113.75	$ 160.00	$ 200.00

= Fields pulled over from the lighting retrofit page
= Fields that require user input

COMBINED PROJECT ENERGY SAVINGS - RETROFIT PLUS CONTROLS	Before	After	Savings	% Savings
Lighting Retrofits	44,427	12,571	31,856	72%
Lighting Controls	9,100	6,825	2,275	25%
TOTAL	53,527	19,396	34,131	64%

Potential BETC Tax Credit (est.) =
See the bottom of the "Lighting Retrofit" page (below the print section) for more details

PROJECTED ANNUAL COST SAVINGS - LIGHTING CONTROLS

Facility Information:

Location	Rate	$/kWh	$/kW
ID	UNK	0.050	-

kWh Energy Savings from Controls:		2,275
Percent Energy Savings from Controls:		25%
Estimated Annual Cost Avoidance:	$	113.75
Estimated Payback in Years (After Incentive):		0.44
Simple ROI (Return on Investment) After Incentive:		227.5%

Plug and Phantom Loads

Due to infrequent use, we recommend unplugging all classroom TVs. The average phantom load measured from TVs plugged in, but not turned on, equals 15 watts per day. Using the basic calculations discussed on page 19, we determined that, at 24 hours per day, multiplied by 30 TVs in the school, the usage equals 3,942 kWh annually. At an average rate of $0.06/kWh, the potential savings equals $236.52 annually.

n Insert photos.

We recommend plugging computer towers and monitors into single power strips with on/off toggle switches to be turned off by the principal user at the day's end. Multiple computers and monitors in the computer lab should continue to be placed on larger power strips to reduce the time involved in powering off the power strips. Computer towers and monitors left plugged in, but not turned on, use an average of 25 watts per day. Using the basic calculations discussed on page 19, we determined that, at 118 hours per week, multiplied by 70 computer systems, the usage equals 9,086 kWh annually. At an average rate of $0.06/kWh, the potential savings equals $545.16 annually.

n Insert photos.

n Students are encouraged to add additional recommendations.

Building Temperature

Using the HOBO temperature data logger, we determined the school is kept at a temperature of 71°F day and night. We strongly recommend installing programmable thermostats, which can reduce the temperature setting for typical non-use hours, including weekends and nights (see Figure 10-1). Even reducing the heating load by three degrees for eight hours per day could result in substantial energy savings and reduced operating costs.

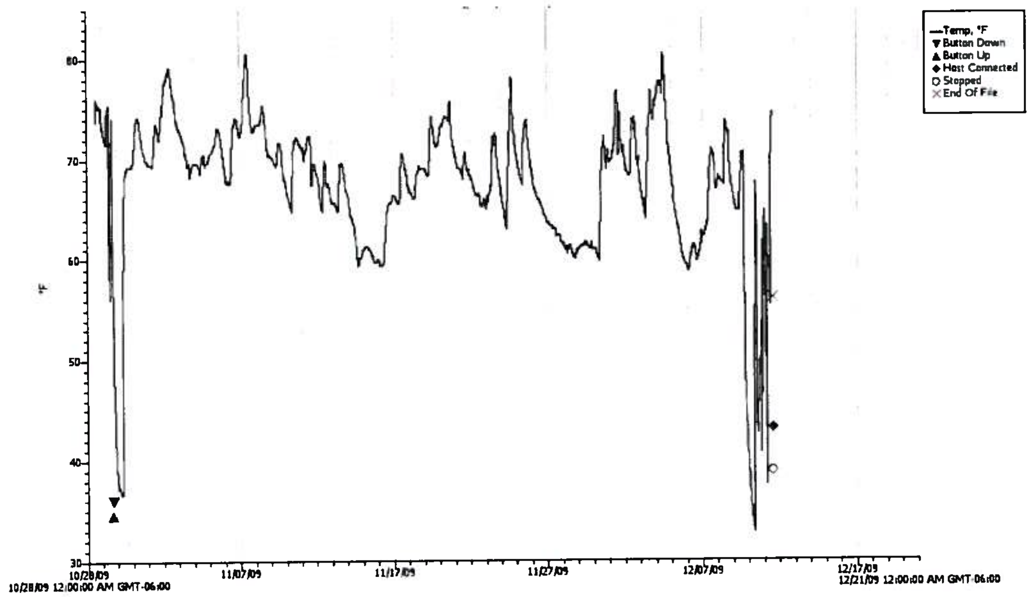


Figure 10-1. Franklin High School gym temperature

Energy Usage and Peak Load

We graphed the historical electrical usage data provided by Idaho Power to visually determine monthly peak usage (see Figure 10-2). As expected, we noted an increase in electrical energy usage during the summer months and late December. Based on our analysis, it appears the school could reduce electrical usage by increasing the thermostat settings, keeping lights off in unused rooms, and ensuring plug loads and phantom loads are reduced where possible.

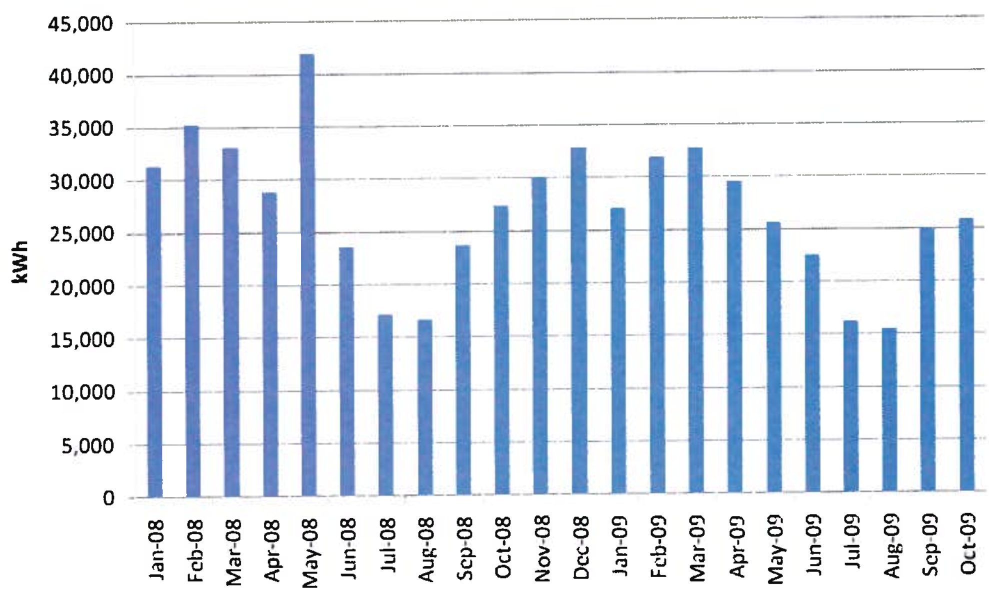


Figure 10-2. Electrical usage

We recommended compiling and analyzing daily and hourly electrical usage to determine daily and weekly peak demand and identify additional opportunities to reduce energy and costs.

Conclusion

As students of Franklin High School, we enjoyed the opportunity to perform this energy assessment of our school and put to practical use many of the math and science skills we learned. We hope the administration will seriously consider our recommendations to lower operating costs and promote energy and resource conservation for our school and surrounding community.

Review

The following section includes Idaho Power's recommendations and is not an example review.

The review should summarize your recommendations for energy savings. It should be brief and succinct so you can use it when soliciting funding from the school board, civic organizations, PTO associations, etc. For instance, create one to two PowerPoint slides to capture the relevance of your SEE report and print these slides to provide as a handout when presenting.

Include the following information:

- Recommendations
- Costs to purchase and install the equipment you are recommending
- Projected energy savings*
- Projected cost savings*
- Potential incentive money available from Idaho Power*
- Expected return on investment (ROI) for the project*
- Appendix—the appendix could include the following items, among others determined by the students:
    - Copy of the OER-sponsored audit report performed in 2009 or 2010
    - Copies of the Lighting Calculator spreadsheets showing the kWh savings related to replacing lamps, delamping, installing motion sensors, etc.

- Copy of the electrical usage data
- Graphs of the energy usage data
- Lighting assessment sheet
- Plug and phantom loads assessment sheet
- Building envelope assessment sheet
- HOBO lighting data logger findings
- HOBO temperature data logger findings

*As determined from the Lighting Calculator

Targeted Presentations

n The following section includes Idaho Power's recommendations and is not an example targeted presentation.

We strongly recommend students make a minimum of one and a maximum of three presentations to share their findings and recommendations with decision makers and other interested parties. Suggested audiences include the following:

- Principal, superintendent, and school board members at a school board meeting
- PTA/PTO members
- Fellow students and faculty
- Local service organizations

We highly recommend inviting the local Idaho Power regional customer representative to one of your student presentations so he/she is aware of your recommendations and can support your initiatives. Idaho Power can assist you in making these arrangements.

Beyond Schools: Assistance to Businesses

Introduction

For those of you who have previously performed an energy assessment on your school building and presented a report detailing your findings and recommendations, you may want to consider performing a similar energy assessment on a local business for several reasons, such as the following:

1. Use the skills you learned, including the energy scene investigation (ESI) equipment.
2. Encourage local business owners and their employees to recognize opportunities to reduce energy usage and operating costs.
3. Perform more work on behalf of your community.
4. Add another line to your resume for school and job applications.
5. Make a difference.

Potential Businesses to Target

After speaking with your teacher and, perhaps, your principal, follow these steps to identify and contact potential businesses to perform an energy assessment of their buildings:

1. Consider small businesses that are locally owned and operated—it's easier to get their permission and support.
2. Talk with your teacher and principal to determine whether any small business owners are actively involved in your school—this would be a good way for the school to return the favor.
3. Consider businesses where you could easily assess the lighting and plug and phantom loads.
4. Make sure the business is not too far from your school to minimize transportation and time issues.

Energy Assessment Assistance

Based on the training you received and the assessment you performed at your school, you should be ready to use the ESI equipment to perform the following energy assessments:

- Lighting
- Plug and phantom loads
- Thermostat settings

Lighting

1. Identify the types and quantities of lamps and ballasts in use at the business.
2. Recommend more efficient replacements to the lamps and ballasts.
3. Determine operating hours and the potential for reduced lighting hours.
4. Consider whether occupancy sensors would be appropriate. If so, determine where and how many.
5. Use the HOBO lighting data logger to determine lighting efficiency opportunities.

ESI Equipment

- Ballast discriminator
- Lumen light level meter
- HOBO lighting data logger

Plug and Phantom Loads

1. Identify what appliances, devices, etc. are continuously plugged into electrical outlets.
2. Consider whether power outlet switches (single or multiple outlet strips) could reduce phantom load.
3. Determine whether unnecessary/seldom-used devices could be unplugged until needed.
4. Determine whether computer and monitors are programmed for sleep mode and if they are powered off at the end of the work day.

ESI Equipment

- Kill A Watt™ meter
- Multiple outlet power strip

Thermostat Settings

1. Determine whether the business uses a programmable thermostat.
2. Discuss whether the thermostat can be adjusted to settings that use less energy during non-work hours.
3. Determine whether window shading or use of natural light could be enhanced to reduce energy usage.
4. Use the HOBO temperature data logger to determine heating/cooling efficiency opportunities.

ESI Equipment

- HOBO temperature data logger

Idaho Power Assistance

After your initial assessment, you may want to talk with the business owner about inviting the local Idaho Power regional customer representative to perform a site visit to confirm your findings and identify additional opportunities.

Initial Contact with the Business Owner

1. Make sure you have identified the potential business with the input and approval of your teacher and principal—their awareness and support are crucial to your success and will go a long way in building an open and collaborative relationship with the business owner.
2. Make an outline of the topics you will discuss when initiating contact. You can use this outline again when you first sit down with the business owner at his/her business prior to conducting the assessment.

   2.1 Introduce yourself and your team members.

   2.2 Identify your school and the names of your teacher and principal.

   2.3 Briefly describe the energy assessment you performed on your school. Mention the assistance and guidance from Idaho Power.

   2.4 Offer to perform a similar assessment on the owner's business at no charge or obligation.

   2.5 Briefly talk about the areas you would assess: lighting, plug and phantom load, and thermostat settings

   2.6 Assure the business owner the assessment will not require inspection of monthly electric bills or heating, ventilating, and air conditioning

(HVAC) equipment; that all items to be assessed are easily accessible; and that no financial information need be revealed or shared.

2.7 Ask if you can schedule a time to visit with the owner at his/her place of business. If possible, combine the initial visit with the initial assessment.

n Not all business site assessments will require more than one assessment. You will need to determine this with the assistance of your teacher.

Compensation

If the business owner expresses an interest in providing compensation or giving back to the school for your efforts, we recommend suggesting a donation to your school to promote some of the energy recommendations you included in your school's report (e.g., a donation to cover the purchase and installation costs of occupancy sensors to reduce lighting usage in classrooms and hallways).

Beyond Schools: Assistance to Residences

Please refer to the insert.

SIMPLE WAYS

To Save Energy

MINI HOME ASSESSMENT

Dear Idaho Power Customer,

We all want the lights to come on with the flip of a switch. However, as the demand for energy grows, it's important that we use energy wisely today to ensure our energy future.

Idaho Power has a diverse portfolio of energy resources to provide a fair-priced, reliable and adequate supply of electricity to our customers. It includes hydroelectricity, fossil fuels, alternative resources like wind and geothermal, and…energy efficiency.

By making simple changes in the way we use energy, we can help slow down the increasing need for more power. And that helps ensure good stewardship of our natural resources. Whether it's purchasing energy efficient products, building more energy efficient homes or using less electricity during those times when demand is highest, Idaho Power is here to partner with you now to prepare for tomorrow.

This Mini Home Assessment will help your family examine your efforts to save energy, as well as provide simple ways to use energy more efficiently in your home and potentially cut costs. You have the power to make a difference.

Thank you for using energy wisely!

Theresa Drake, Customer Relations & Energy Efficiency Manager

To learn more, visit www.idahopower.com/energyefficiency

IDAHO POWER
An IDACORP Company

Simple Ways to Save Energy

MINI HOME ASSESSMENT

Circle the number that best matches your response to each statement. For each section, add up the numbers you circled in each column. Then add the totals from each category.

Energy efficiency means getting the most from every energy dollar. Energy efficiency is the least expensive, cleanest way to reduce energy use, energy prices, and pollution and extend our nation's energy supplies.

Be part of the solution.

Lights

	ALWAYS	SOMETIMES	NEVER
Replace incandescent bulbs with ENERGY STAR® qualified compact fluorescent light bulbs.	2	1	0
Turn off lights when not in use.	2	1	0
Turn off the TV when no one is watching.	2	1	0
Keep light bulbs clean and free of dust.	2	1	0
Use the natural daylight coming into your home.	2	1	0

___ + ___ + ___ = ___

Cooking

	ALWAYS	SOMETIMES	NEVER
Keep refrigerator and freezer doors closed tightly.	2	1	0
Let warm foods cool off before placing in the refrigerator.	2	1	0
Defrost foods in refrigerator before cooking them.	2	1	0
Use the smallest pan and burner possible.	2	1	0
Cover pots with lids to keep heat from escaping.	2	1	0
Use timer or meat thermometer.	2	1	0
Turn off the oven a few minutes before your food is ready.	2	1	0
Use glass or ceramic pans to lower oven temperature by 25 degrees.	2	1	0
Use a toaster oven, microwave or grill instead of your oven.	2	1	0

___ + ___ + ___ = ___

Washing

	ALWAYS	SOMETIMES	NEVER
Wash full loads of clothes in cold water.	2	1	0
Use the timed dry or sensor on your dryer.	2	1	0
Keep the dryer lint filter clean.	2	1	0
Repair dripping faucets.	2	1	0
Use a sink stopper when washing dishes by hand.	2	1	0
Wash full loads of dishes in the dishwasher.	2	1	0
Take 5-minute showers.	2	1	0
Use low-flow shower heads.	2	1	0
Fill the bathtub with only as much water as you need.	2	1	0

___ + ___ + ___ = ___

IDAHO POWER
An IDACORP Company

Cooling Your Home in the Summer

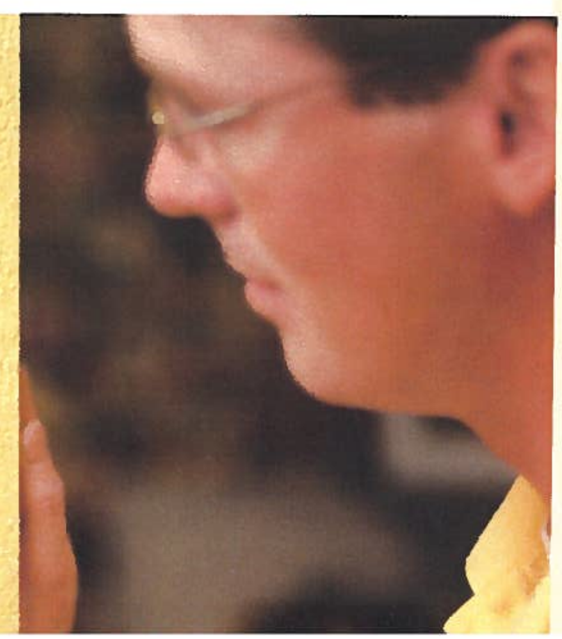
	ALWAYS	SOMETIMES	NEVER
Set your thermostat at 78 degrees during the cooling season.	2	1	0
Close the blinds before the sun heats up your home.	2	1	0
Schedule heat-producing tasks before 3 p.m. or after 8 p.m.	2	1	0
Use a fan to move cooled air around your home.	2	1	0
Schedule an annual check-up of your A/C unit.	2	1	0
Participate in A/C Cool Credit program.	2	1	0

☐ + ☐ + ☐ = ☐

Heating Your Home in the Winter

	ALWAYS	SOMETIMES	NEVER
Keep thermostats set at 66–72 degrees during heating season.	2	1	0
Give your furnace a regular tune-up.	2	1	0
Seal air leaks around windows and doors.	2	1	0
Replace or clean furnace filters once a month.	2	1	0
Put on a sweater instead of turning up the heat.	2	1	0
Open your blinds during the day to let the sun heat your home.	2	1	0

☐ + ☐ + ☐ = ☐



See how energy efficient you are by comparing your grand total to the scale below.

	TOTALS
Lights	______
Cooking	______
Washing	______
Cooling	______
Heating	______
GRAND TOTAL	☐

60-70 Congratulations! You are using energy in your home very efficiently.

25-59 Good job, but there's some room for improvement.

0-24 OOPS! Your home needs some help in saving energy. By following the suggestions listed in this survey more consistently, you can reduce the bottom line on your electricity bill, and conserve energy resources for everyone! Take a look at the tips on the next page.

Discover energy tools to help you manage your energy use and energy costs. Check out our programs and get a jump start on improving the efficiency of your home.

www.idahopower.com/energyefficiency

- If just one light bulb in every American home was replaced with an ENERGY STAR® qualified compact fluorescent light (CFL) bulb, we would save enough energy to light more than three million homes for a year.

An ENERGY STAR qualified CFL bulb uses about 75 percent less energy than standard incandescent bulbs and lasts up to 10 times longer.

- For each load of laundry your family washes in cold water instead of hot water, enough energy can be saved to power your television for 34 hours.

An energy-smart clothes washer can save more water in one year than one person drinks in an entire lifetime!

- If just one in 10 homes used ENERGY STAR qualified appliances, the change would be like planting 1.7 million new acres of trees.

Always look for the ENERGY STAR label. Qualified appliances incorporate technologies that use 10–50 percent less energy and water than standard models.

- Across America, refrigerators use the electricity of 25 large power plants every year.

- You always save energy when you turn off your computer. Enable the "sleep" function when not in use.

- A hot bath can use up to twice the amount of hot water and energy you need for a 5-minute shower.

Compact fluorescent light bulbs (CFL's) use 75 percent less energy and last longer than standard bulbs.

DID YOU KNOW?

Simple actions can make a big difference.

Energy efficiency matters—for you, your family and our future.

- On average, for every degree you set back your thermostat, you can save 3 percent on your energy bill.

We recommend 68° F during winter months and 78° F in the summer—and even deeper setbacks at night and when you are away from home.

- Trees shade your home from the sun on hot days and trees planted in a row farther from your home on the windward side will protect it on chilly days.

Carefully positioned trees can save up to 25 percent of a household's energy consumption for heating and cooling.

- Up to 50 percent of the energy you use in your home goes to heating it in the winter and cooling it in the summer. And an HVAC or A/C can waste up to 50 percent of the energy it uses if it's not operating efficiently.

One of the most important things you can do to save energy is to regularly tune up your furnace and A/C unit. You also can sign up for A/C Cool Credit and earn $21 in bill credits during the summer months.

Idaho Power—working to provide you with reliable, responsible, fair-priced energy services, today and tomorrow.

IDAHO POWER®
An IDACORP Company

www.idahopower.com

208-388-2323 from the Treasure Valley area or 1-800-488-6151

CID# 20908A/30/12-09

Appendices

Appendix A. Definitions

A

Ampere (amp)–The number of electrons in an electric current flowing past a point in one second; one amp = 6.28 x 1,018 electrons flowing per second.

B

Ballast–A magnetic or electronic device used to control the start and operation of discharge lamps, including fluorescent lamps.

Baseload–Most commonly referred to as baseload demand, this is the minimum amount of power a utility or distribution company must make available to its customers, or the amount of power required to meet minimum demands based on reasonable expectations of customer requirements. Baseload values typically vary from hour to hour in most commercial and industrial areas.

British Thermal Unit (Btu)–The amount of heat required to raise one pound of water by one degree Fahrenheit. The higher the Btu rating, the more heating capacity the equipment has.

Building Envelope–The interface between the interior of the building and the outdoor environment, including the walls, roof, and foundation. The building envelope serves as a thermal barrier and plays an important role in determining the amount of energy necessary to maintain a comfortable indoor environment relative to the outside environment.

C

Color Rendering Index (CRI)–A measurement of the amount of color-shift objects undergo when under a light source. CRI values generally range from 0 to 100.

D

Demand–A measure of the rate at which energy is used, measured in kilowatts (kW).

E

Efficacy–The amount of light (luminous flux) produced by a lamp (a light bulb or other light source), usually measured in lumens, as a ratio of the amount of power consumed to produce it, usually measured in watts.

Energy Efficiency–Energy used wisely and efficiently to get the maximum benefit.

F

Foot Candle–A standard measurement of illuminance, representing the amount of illuminance on a one-foot square surface on which there is a uniformly distributed flux of one lumen.

L

Lamp–An electrically energized light source, commonly called a bulb or tube.

Light-Emitting Diode (LED)–A semiconductor that emits light under certain circumstances; the color of the emitted light is dependant upon the semiconductor material used.

Lumen–A measurement of the perceived power of light. Lighting a larger area to the same level of lux requires a greater number of lumens.

Luminaire–One complete lighting unit, consisting of a lamp or lamps with the components required to distribute the light, position the lamps, and connect the lamps to a power supply. Often referred to as a fixture.

Lux–A measurement of the perceived intensity of light (see Lumen). One lux is equal to one lumen per square meter.

P

Peak Load–The maximum demand for electricity in a 24-hour period.

Phantom Load–Also known as standby power, vampire power, or vampire draw. The electric power consumed by electronic appliances while they are switched off or in standby mode. Phantom loads occur in most appliances that use electricity, such as VCRs, televisions, stereos, computers, and kitchen appliances. In the average home, 75% of the electricity used to power home electronics is consumed while the products are turned off. This can be avoided by unplugging the appliance or using a power strip and turning the power strip off when not needed.

Plug Load–The electrical load from devices constantly plugged into electrical circuitry (e.g., DVD players, music systems, computers, doorbells, alarm systems, toasters, coffee makers, hair dryers, garage door openers, and rechargeable tools).

T

Therm–100,000 Btu's.

V

Volt–A unit of electric potential or electromotive force. A potential of one volt occurs across a resistance of one ohm with a current flow of one ampere.

W

Watt–A standard unit of power (energy per unit time) equivalent to one joule per second.

Definition Sources

Customer Care: Understanding Demand Charge and Demand Meters by Austin Energy

Electro-Optics Handbook: http://www.burle.com/cgi-bin/byteserver.pl/pdf/Electro_Optics.pdf

encyclopedia.thefreedictionary.com

Energy Vortex.com

Green Building Advisor: http://www.greenbuildingadvisor.com/blogs/dept/musings/tackling-plug-loadproblem

Lighting Design Lab of Seattle: http://www.lightingdesignlab.com/library/glossary.htm

Ohno, Yoshi (2004), "Color Rendering and Luminous Efficacy of White LED Spectra", Proc. of SPIE (Fourth International Conference on Solid State Lighting), 5530, SPIE, Bellingham, WA, pp. 88, doi:10.1117/12.565757, http://physics.nist.gov/Divisions/Div844/facilities/photo/Publications/OhnoSPIE2004.pdf

Pew Center on Global Climate Change: http://www.pewclimate.org/technology/factsheet/BuildingEnvelope

SearchCIO-midmarket.com

Understanding Demand and Demand Charge by The Energy Cooperative

Understanding Electric Demand by National Grid

Understanding the Demanc Charge Idaho Power information sheet

US Department of Energy, "Home Office and Home Electronics," 15 Jan 2008.

Whatis.com

wordiq.com

Appendix B. Conversion Factors

Table B-1. Conversion factors

General			Oil		
Decca (D)	=	10	Residual	=	No. 6 oil
M sometimes	=	m	Light diesel (winter)	=	No. 1 oil
M always	=	1,000	Diesel (summer)	=	No. 2 oil
MM	=	1,000,000	1 gal No. 5 oil	=	148,500 Btu
Giga (G)	=	1,000,000,000	1 bbl No. 5 oil	=	6.237 MMBtu
1 quad	=	1,015 Btu	1 gal No. 2 oil	=	138,700 Btu
1 Btu	=	1,055 Joules	1 bbl No. 2 oil	=	5.825 MMBtu
		1 Stick Match	1 gal gasoline	=	127,000 Btu
1 kWh	=	3,412.8 Btu	**Other Gases**		
1 Btu	=	energy to raise 1 lb of water 1°F	1 gal propane	=	91,300 Btu
1 barrel (bbl)	=	42 gallons (gal)	1 bbl propane	=	3.836 MMBtu
1 foot candle	=	1 lumen	1 gal Butane	=	103,000 Btu
1 hogshead (hghd)	=	63 gal	1 bbl butane	=	4.326 MMBtu
1 ton (long)	=	2,240 lbs	1 cf manufactured gas	=	500 to 700 Btu
1 ton (short)	=	2,000 lbs	*Solid fuels*		
1 ton (short)	=	7 bbl crude	1 lb bituminous coal	=	14,000 Btu (PA)
1 metric ton	=	2,204.62 lbs	1 lb anthracite coal	=	12,700 Btu (PA)
1 foot head water	=	0.43 lbs per square inch (psi)	1 lb subbituminous	=	10,600 Btu (WY)
1 cubic foot (cf)	=	7.48 gal	1 lb lignite coal	=	7,000 Btu (ND)
1 gal water	=	8.34 lbs	1 lb uranium	=	250 MMBtu available
1 boiler horsepower	=	33,475 Btu/hr			
1 ton of cooling	=	12,000 Btu/hr			

Table B-1. Conversion factors (Continued)

Natural Gas		
Natural gas	=	95% methane, 3% ethane, and 1% propane & butane
1 cf = 1 feet ^{3}	=	1,027 Btu at standard conditions
1 Therm	=	100,000 Btu
Dth = Decca Therm	=	10 therms
1 MM Btu	=	1 million Btu
MMBtu gas	=	1.054615 gigajoules (GJ)
Cubic cf	=	100 ft^3
Mcf	=	1,000 ft^3
MMcf	=	1,000,000 ft^3
1 Btu dry gas		0.965 Btu wet gas
1 Mcf dry	=	1,000 cf dry
1 Mcf dry	=	1.027 MMBtu
103 m^3 =1000 m^3	=	35.315 Mcf
Gas standard cond.	=	14.7 psi absolute, 60 °F

Appendix C. Compact Fluorescent Replacement for Existing Incandescent Lamps

Table C-1. Incandescent lamps

Wattage	Lumens	Lumens/Watt
Frosted Standard Incandescent		
40	495	12
50	490	10
60	850	14
75	1,500	20
90	1,450	16
100	1,710	17
150	2,800	19
Long-Life Incandescent		
40	355	9
50	480	10
60	650	11
75	825	11
90	960	11
100	1,150	12
150	1,925	13
Compact Fluorescent with Ballast		
9	425	47
11	555	50
13	635	49
15	700	47
18	850	47
20	1,020	51
24	1,290	54
25	1,290	52

Table C-1. Incandescent lamps (Continued)

Wattage	Lumens	Lumens/Watt
26	1,350	52
28	1,485	53

n Use the compact fluorescent lamp (CFL) that generates at least as many lumens as the existing incandescent lamp, unless the current lighting level is more than what is needed.

Appendix D. Energy Cost Comparisons

Table D-1. Energy costs comparisons

	Basic Energy Cost					Delivered Energy Cost at Stated Efficiency													
$/ Million Btu	Electricity $/kWh	#2 Oil $/gal	#5 Oil $/gal	Propane $/gal	Nat Gas $/therm	#2 Oil $/gal	#5 Oil $/gal	Propane $/gal	Nat Gas $/therm	#2 Oil $/gal	#5 Oil $/gal	Propane $/gal	Nat Gas $/therm	#2 Oil $/gal	#5 Oil $/gal	Propane $/gal	Nat Gas $/therm	$/ Million Btu	Coal $$/Ton
	100%	100%	100%	100%	100%	80%	80%	80%	80%	70%	70%	70%	70%	60%	60%	60%	60%		100%
15.00	$ 0.051	$ 2.07	$ 2.23	$ 1.38	$ 1.50	$ 1.66	$ 1.78	$ 1.10	$ 1.20	$ 2.98	$ 1.56	$ 0.97	$ 1.05	$ 1.24	$ 1.34	$ 0.83	$ 0.90	15.00	$ 300.00
15.50	$ 0.053	$ 2.14	$ 2.30	$ 1.43	$ 1.55	$ 1.71	$ 1.84	$ 1.14	$ 1.24	$ 1.50	$ 1.61	$ 1.00	$ 1.09	$ 1.28	$ 1.38	$ 0.86	$ 0.93	15.50	$ 310.00
16.00	$ 0.055	$ 2.21	$ 2.38	$ 1.47	$ 1.60	$ 1.77	$ 1.90	$ 1.18	$ 1.28	$ 1.55	$ 1.66	$ 1.03	$ 1.12	$ 1.32	$ 1.43	$ 0.88	$ 0.96	16.00	$ 320.00
16.50	$ 0.056	$ 2.28	$ 2.45	$ 1.52	$ 1.65	$ 1.82	$ 1.96	$ 1.21	$ 1.32	$ 1.59	$ 1.72	$ 1.06	$ 1.16	$ 1.37	$ 1.47	$ 0.91	$ 0.99	16.50	$ 330.00
17.00	$ 0.058	$ 2.35	$ 2.53	$ 1.56	$ 1.70	$ 1.88	$ 2.02	$ 1.25	$ 1.36	$ 1.64	$ 1.77	$ 1.09	$ 1.19	$ 1.41	$ 1.52	$ 0.94	$ 1.02	17.00	$ 340.00
17.50	$ 0.060	$ 2.42	$ 2.60	$ 1.61	$ 1.75	$ 1.93	$ 2.08	$ 1.29	$ 1.40	$ 1.69	$ 1.82	$ 1.13	$ 1.23	$ 1.45	$ 1.56	$ 0.97	$ 1.05	17.50	$ 350.00
18.00	$ 0.061	$ 2.48	$ 2.67	$ 1.66	$ 1.80	$ 1.99	$ 2.14	$ 1.32	$ 1.44	$ 1.74	$ 1.87	$ 1.16	$ 1.26	$ 1.49	$ 1.60	$ 0.99	$ 1.08	18.00	$ 360.00
18.50	$ 0.063	$ 2.55	$ 2.75	$ 1.70	$ 1.85	$ 2.04	$ 2.20	$ 1.36	$ 1.48	$ 1.79	$ 1.92	$ 1.19	$ 1.30	$ 1.53	$ 1.65	$ 1.02	$ 1.11	18.50	$ 370.00
19.00	$ 0.065	$ 2.62	$ 2.82	$ 1.75	$ 1.90	$ 2.10	$ 2.26	$ 1.40	$ 1.52	$ 1.84	$ 1.98	$ 1.22	$ 1.33	$ 1.57	$ 1.69	$ 1.05	$ 1.14	19.00	$ 380.00
19.50	$ 0.067	$ 2.69	$ 2.90	$ 1.79	$ 1.95	$ 2.15	$ 2.32	$ 1.44	$ 1.56	$ 1.88	$ 2.03	$ 1.26	$ 1.37	$ 1.61	$ 1.74	$ 1.08	$ 1.17	19.50	$ 390.00
20.00	$ 0.068	$ 2.76	$ 2.97	$ 1.84	$ 2.00	$ 2.21	$ 2.38	$ 1.47	$ 1.60	$ 1.93	$ 2.08	$ 1.29	$ 1.40	$ 1.66	$ 1.78	$ 1.10	$ 1.20	20.00	$ 400.00
20.50	$ 0.070	$ 2.83	$ 3.05	$ 1.89	$ 2.05	$ 2.26	$ 2.44	$ 1.51	$ 1.64	$ 1.98	$ 2.13	$ 1.32	$ 1.44	$ 1.70	$ 1.83	$ 1.13	$ 1.23	20.50	$ 410.00
21.00	$ 0.072	$ 2.90	$ 3.12	$ 1.93	$ 2.10	$ 2.32	$ 2.50	$ 1.55	$ 1.68	$ 2.03	$ 2.18	$ 1.35	$ 1.47	$ 1.74	$ 1.87	$ 1.16	$ 1.26	21.00	$ 420.00
21.50	$ 0.073	$ 2.97	$ 3.19	$ 1.98	$ 2.15	$ 2.37	$ 2.56	$ 1.58	$ 1.72	$ 2.08	$ 2.24	$ 1.38	$ 1.51	$ 1.78	$ 1.92	$ 1.19	$ 1.29	21.50	$ 430.00
22.00	$ 0.075	$ 3.04	$ 3.27	$ 2.02	$ 2.20	$ 2.43	$ 2.62	$ 1.62	$ 1.76	$ 2.13	$ 2.29	$ 1.42	$ 1.54	$ 1.82	$ 1.96	$ 1.21	$ 1.32	22.00	$ 440.00
22.50	$ 0.077	$ 3.11	$ 3.34	$ 2.07	$ 2.25	$ 2.48	$ 2.67	$ 1.66	$ 1.80	$ 2.17	$ 2.34	$ 1.45	$ 1.58	$ 1.86	$ 2.01	$ 1.24	$ 1.35	22.50	$ 450.00
23.00	$ 0.078	$ 3.17	$ 3.42	$ 2.12	$ 2.30	$ 2.54	$ 2.73	$ 1.69	$ 1.84	$ 2.22	$ 2.39	$ 1.48	$ 1.61	$ 1.90	$ 2.05	$ 1.27	$ 1.38	23.00	$ 460.00
23.50	$ 0.080	$ 3.24	$ 3.49	$ 2.16	$ 2.35	$ 2.59	$ 2.79	$ 1.73	$ 1.88	$ 2.27	$ 2.44	$ 1.51	$ 1.65	$ 1.95	$ 2.10	$ 1.30	$ 1.41	23.50	$ 470.00
24.00	$ 0.082	$ 3.31	$ 3.57	$ 2.21	$ 2.40	$ 2.65	$ 2.85	$ 1.77	$ 1.92	$ 2.32	$ 2.50	$ 1.55	$ 1.68	$ 1.99	$ 2.14	$ 1.32	$ 1.44	24.00	$ 480.00
24.50	$ 0.084	$ 3.38	$ 3.64	$ 2.25	$ 2.45	$ 2.70	$ 2.91	$ 1.80	$ 1.96	$ 2.37	$ 2.55	$ 1.58	$ 1.72	$ 2.03	$ 2.18	$ 1.35	$ 1.47	24.50	$ 490.00
25.00	$ 0.085	$ 3.45	$ 3.72	$ 2.30	$ 2.50	$ 2.76	$ 2.97	$ 1.84	$ 2.00	$ 2.42	$ 2.60	$ 1.61	$ 1.75	$ 2.07	$ 2.23	$ 1.38	$ 1.50	25.00	$ 500.00
25.50	$ 0.087	$ 3.52	$ 3.79	$ 2.35	$ 2.55	$ 2.82	$ 3.03	$ 1.88	$ 2.04	$ 2.46	$ 2.65	$ 1.64	$ 1.79	$ 2.11	$ 2.27	$ 1.41	$ 1.53	25.50	$ 510.00
26.00	$ 0.089	$ 3.59	$ 3.86	$ 2.39	$ 2.60	$ 2.87	$ 3.09	$ 1.91	$ 2.08	$ 2.51	$ 2.70	$ 1.67	$ 1.82	$ 2.15	$ 2.32	$ 1.44	$ 1.56	26.00	$ 520.00
26.50	$ 0.090	$ 3.66	$ 3.94	$ 2.44	$ 2.65	$ 2.93	$ 3.15	$ 1.95	$ 2.12	$ 2.56	$ 2.76	$ 1.71	$ 1.86	$ 2.19	$ 2.36	$ 1.46	$ 1.59	26.50	$ 530.00
27.00	$ 0.092	$ 3.73	$ 4.01	$ 2.48	$ 2.70	$ 2.98	$ 3.21	$ 1.99	$ 2.16	$ 2.61	$ 2.81	$ 1.74	$ 1.89	$ 2.24	$ 2.41	$ 1.49	$ 1.62	27.00	$ 540.00
27.50	$ 0.094	$ 3.80	$ 4.09	$ 2.53	$ 2.75	$ 3.04	$ 3.27	$ 2.02	$ 2.20	$ 2.66	$ 2.86	$ 1.77	$ 1.93	$ 2.28	$ 2.45	$ 1.52	$ 1.65	27.50	$ 550.00
28.00	$ 0.096	$ 3.86	$ 4.16	$ 2.58	$ 2.80	$ 3.09	$ 3.33	$ 2.06	$ 2.24	$ 2.70	$ 2.91	$ 1.80	$ 1.96	$ 2.32	$ 2.50	$ 1.55	$ 1.68	28.00	$ 560.00
28.50	$ 0.097	$ 3.93	$ 4.24	$ 2.62	$ 2.85	$ 3.15	$ 3.39	$ 2.10	$ 2.28	$ 2.75	$ 2.96	$ 1.84	$ 2.00	$ 2.36	$ 2.54	$ 1.57	$ 1.71	28.50	$ 570.00
29.00	$ 0.099	$ 4.00	$ 4.31	$ 2.67	$ 2.90	$ 3.20	$ 3.45	$ 2.13	$ 2.32	$ 2.80	$ 3.02	$ 1.87	$ 2.03	$ 2.40	$ 2.59	$ 1.60	$ 1.74	29.00	$ 580.00
29.50	$ 0.101	$ 4.07	$ 4.38	$ 2.71	$ 2.95	$ 3.26	$ 3.51	$ 2.17	$ 2.36	$ 2.85	$ 3.07	$ 1.90	$ 2.07	$ 2.44	$ 2.63	$ 1.63	$ 1.77	29.50	$ 590.00
30.00	$ 0.102	$ 4.14	$ 4.46	$ 2.76	$ 3.00	$ 3.31	$ 3.57	$ 2.21	$ 2.40	$ 2.90	$ 3.12	$ 1.93	$ 2.10	$ 2.48	$ 2.67	$ 1.66	$ 1.80	30.00	$ 600.00
30.50	$ 0.104	$ 4.21	$ 4.53	$ 2.81	$ 3.05	$ 3.37	$ 3.63	$ 2.24	$ 2.44	$ 2.95	$ 3.17	$ 1.96	$ 2.14	$ 2.53	$ 2.72	$ 1.68	$ 1.83	30.50	$ 610.00
31.00	$ 0.106	$ 4.28	$ 4.61	$ 2.85	$ 3.10	$ 3.42	$ 3.69	$ 2.28	$ 2.48	$ 2.99	$ 3.22	$ 2.00	$ 2.17	$ 2.57	$ 2.76	$ 1.71	$ 1.86	31.00	$ 620.00
31.50	$ 0.108	$ 4.35	$ 4.68	$ 2.90	$ 3.15	$ 3.48	$ 3.74	$ 2.32	$ 2.52	$ 3.04	$ 3.28	$ 2.03	$ 2.21	$ 2.61	$ 2.81	$ 1.74	$ 1.89	31.50	$ 630.00
32.00	$ 0.109	$ 4.42	$ 4.76	$ 2.94	$ 3.20	$ 3.53	$ 3.80	$ 2.36	$ 2.56	$ 3.09	$ 3.33	$ 2.06	$ 2.24	$ 2.65	$ 2.85	$ 1.77	$ 1.92	32.00	$ 640.00
32.50	$ 0.111	$ 4.49	$ 4.83	$ 2.99	$ 3.25	$ 3.59	$ 3.86	$ 2.39	$ 2.60	$ 3.14	$ 3.38	$ 2.09	$ 2.28	$ 2.69	$ 2.90	$ 1.79	$ 1.95	32.50	$ 650.00
33.00	$ 0.113	$ 4.55	$ 4.90	$ 3.04	$ 3.30	$ 3.64	$ 3.92	$ 2.43	$ 2.64	$ 3.19	$ 3.43	$ 2.13	$ 2.31	$ 2.73	$ 2.94	$ 1.82	$ 1.98	33.00	$ 660.00
33.50	$ 0.114	$ 4.62	$ 4.98	$ 3.08	$ 3.35	$ 3.70	$ 3.98	$ 2.47	$ 2.68	$ 3.24	$ 3.48	$ 2.16	$ 2.35	$ 2.77	$ 2.99	$ 1.85	$ 2.01	33.50	$ 670.00
34.00	$ 0.116	$ 4.69	$ 5.05	$ 3.13	$ 3.40	$ 3.75	$ 4.04	$ 2.50	$ 2.72	$ 3.28	$ 3.54	$ 2.19	$ 2.38	$ 2.82	$ 3.03	$ 1.88	$ 2.04	34.00	$ 680.00
34.50	$ 0.118	$ 4.76	$ 5.13	$ 3.17	$ 3.45	$ 3.81	$ 4.10	$ 2.54	$ 2.76	$ 3.33	$ 3.59	$ 2.22	$ 2.42	$ 2.86	$ 3.08	$ 1.90	$ 2.07	34.50	$ 690.00

Conversion Factors					
		Coal	10,000	Btu/lb	
Electricity	3,413 Btu/kWh	#2 Oil	138,000	Btu/gal	
#5 Oil	148,600 Btu/gal	Propane	92,000	Btu/gal	
Nat Gas	100,000 Btu/therm				

Appendix E. Natural Gas Quality Analysis

Table E-1. Natural gas quality analysis

Fri Mar 2 10:15:35 2007
Gas Quality Information for: Mar 1 2007

NWP GAS QUALITY VALUES @ 14.73 DRY

STATION	StrmId	GRAV	BTU	CO2	N2	TOTAL Inerts	C1	C2	C3	IC4	NC4	IC5	NC5	C6	C7	C8	C9	HDP	TOTAL
34-0 24" SPOKANE LAT NO CHR1	LEWLT1	0.580	1018	0.902	0.747	1.649	95.824	2.380	0.110	0.014	0.016	0.003	0.001	0.003				-114.9	100
34-0 SPOKANE LAT SO CHR3	LEWLT3	0.580	1019	0.902	0.748	1.649	95.807	2.400	0.108	0.013	0.016	0.003	0.001	0.003				-115.2	100
PGT STREAM #1	PLRMS1	0.577	1016	0.758	0.877	1.635	96.158	2.086	0.101	0.008	0.008	0.001	0.000	0.003				-121.0	100
PGT COMBINATION STREAM #2	PLRMS2	0.580	1019	0.898	0.754	1.652	95.811	2.387	0.113	0.013	0.016	0.003	0.001	0.003				-114.8	100
STANFIELD MS PGT/NWP CHR	STNMS1	0.580	1018	0.898	0.787	1.684	95.790	2.361	0.120	0.015	0.018	0.004	0.002	0.006				-106.7	100
STANFIELD MS 22" SO	STNMS2	0.596	1051	0.715	0.535	1.250	94.080	3.390	0.872	0.151	0.150	0.044	0.029	0.035				-22.8	100
STANFIELD MS 22" NO	STNMS3	0.585	1029	0.840	0.708	1.548	95.239	2.692	0.360	0.059	0.060	0.017	0.011	0.015				-69.6	100
STANFIELD MS 30" LL	STNMS4	0.596	1051	0.711	0.533	1.244	94.111	3.373	0.865	0.149	0.151	0.044	0.029	0.035				-22.9	100
CALDWELL CO 22" ML SO CHR1	CALCS1	0.597	1056	0.722	0.441	1.163	93.841	3.639	0.926	0.161	0.161	0.045	0.029	0.036				-20.5	100
CALDWELL CS 22" ML NO CHR2	CALCS2	0.597	1056	0.722	0.440	1.162	93.841	3.640	0.926	0.161	0.160	0.045	0.029	0.036				-20.4	100
CALDWELL CS 24" LOOP CHR3	CALCS3	0.597	1055	0.719	0.442	1.161	93.850	3.636	0.924	0.160	0.160	0.045	0.029	0.036				-20.6	100
MTN HOME CS 22" ML SO CHR1	MTHCS1	0.599	1056	0.734	0.491	1.225	93.638	3.742	0.950	0.166	0.165	0.047	0.031	0.036				-19.5	100
MTN HOME CS 22" ML NO CHR2	MTHCS2	0.599	1056	0.734	0.492	1.226	93.641	3.740	0.949	0.166	0.165	0.047	0.031	0.035				-19.6	100
MTN HOME CS 22" RENO LAT CHR3	MTHCS3	0.599	1056	0.734	0.489	1.223	93.644	3.740	0.949	0.166	0.165	0.047	0.031	0.035				-19.6	100
MTN HOME CS 24" LL NO CHR4	MTHCS4	0.599	1056	0.735	0.490	1.225	93.633	3.746	0.951	0.166	0.167	0.047	0.031	0.036				-19.4	100
LITTLE VALLEY CS	LTVCS1	0.598	1056	0.724	0.445	1.169	93.764	3.688	0.940	0.164	0.164	0.045	0.029	0.038				-18.5	100
POCATELLO CS 22" ML CHR	POCCS1	0.599	1057	0.718	0.505	1.223	93.672	3.678	0.962	0.170	0.165	0.051	0.034	0.045				-11.5	100
KEMMERER CS 22" CHR1	KEMCS1	0.599	1056	0.710	0.540	1.249	93.673	3.676	0.946	0.168	0.165	0.049	0.032	0.042				-14.5	100
OPAL PLANT TO NWP	OPLMS1	0.582	1037	0.543	0.354	0.897	95.915	2.541	0.448	0.073	0.063	0.022	0.015	0.026				-50.1	100
OPAL-SHUTE CREEK TO NWP	SHUMS1	0.567	988	0.007	2.686	2.694	97.213	0.077	0.010	0.003	0.002	0.000	0.000	0.001				-160.8	100
FRONTIER TO NWP	FRTMS1	0.614	1087	0.630	0.210	0.840	91.917	4.856	1.540	0.343	0.322	0.104	0.065	0.013				-13.6	100
QUESTAR CLEAR CREEK CHR1																			
EAST PAINTER OUT(AMOCO NRU)																			
NW MUDDY CREEK	1-4002	0.599	1056	0.712	0.537	1.249	93.707	3.635	0.949	0.169	0.165	0.050	0.033	0.043				-13.4	100
MFS X16 QUESTAR TO NWP	X16MS1	0.615	1079	0.915	0.350	1.265	91.599	5.039	1.438	0.244	0.253	0.070	0.045	0.026	0.016	0.007	0.001	10.4(a)	100
GREEN RIVER GATHERING LAT	GRGMS1	0.595	1057	0.693	0.187	0.881	94.290	3.584	0.785	0.168	0.150	0.054	0.029	0.060				-3.9	100
GREEN RIVER GATHERING NO	GRGMS2	0.608	1072	0.868	0.245	1.113	92.554	4.492	1.237	0.223	0.226	0.065	0.035	0.056				2.0	100
GREEN RIVER GATHERING SO	GRGMS3	0.618	1083	1.004	0.289	1.292	91.221	5.193	1.581	0.266	0.284	0.073	0.040	0.049				4.4	100
GREEN RIVER GATHERING BLEND	GRGMS4	0.610	1073	0.888	0.251	1.139	92.369	4.590	1.285	0.229	0.233	0.066	0.036	0.053				1.5	100
GREEN RIVER NORTH ST#1	GRNCS1	0.618	1083	0.994	0.331	1.325	91.198	5.197	1.561	0.264	0.276	0.073	0.050	0.057				8.4	100
GREEN RIVER SO ST#2	GRNCS2	0.618	1083	0.994	0.331	1.325	91.199	5.198	1.560	0.264	0.276	0.073	0.050	0.056				8.1	100

Footnotes: (a) indicates HDP calculated with actual values to C9.
(b) indicates HDP calculated with estimated C6+ values.

Page: 2

Appendix F. Simple, Sure Energy Savers

This is a condensed list of tips to save energy from *Energy Efficiency Pays—A Guide for the Small Business Owner* by the American Public Power Association and the Association of Small Business Development Centers.

Lighting

- Turn off lights and equipment when not in use.
- Adjust lighting to your actual needs.
- Use daylight to your advantage.
- Control direct sunlight through windows.
- Install occupancy sensors where appropriate.
- Install a programmable thermostat to automate your heating, ventilating, and air conditioning (HVAC).
- Keep lights clean.
- Replace incandescent light bulbs with compact fluorescent lamps (CFL) wherever appropriate.
- Install light-emitting diode (LED) exit signs.
- Convert T-12 lamps to T-8 lamps with electronic ballasts.

Heating, Ventilating, and Air Conditioning

- Fill cracks or leaks with weather stripping and caulking.
- Change air filters at least quarterly.
- Use ceiling fans to increase air movement and comfort levels.
- Tune up your HVAC.
- Use the auto setting on the thermostat rather than the on setting to reduce fan energy.
- Turn the thermostat down in the winter and up in the summer.
- Turn the system off or down when the facility is empty.

- Use cool morning air to purge the building in the summer.
- Calibrate the thermostat.
- Use economizer cycles to cool.
- Benchmark your building against similar buildings with ENERGY STAR®.

Office Equipment

- Use computers, monitors, and printers efficiently.
- Turn off equipment when not needed.
- Use sleep mode on equipment; be patient.
- Use a double-sided option when printing and copying.
- Use draft mode for your printer for normal use.
- Run copies in batches and let the copier sleep.
- Buy the smallest copier that will be appropriate.

Refrigerators and Freezers

- Keep doors shut.
- Check temperature settings and make sure they are appropriate.
- Properly load the refrigerator and freezer.
- Keep refrigerators and freezers away from stoves.
- Ventilate/clean properly.
- Make sure the door seals are effective with a piece of paper.
- Turn off vending machine lights when no one is around.

Hot Water

- Reduce the hot water you use.
- Reduce the temperature of the hot water and tank to 120 °F.
- Fix leaking faucets, toilets, and shower heads.

- Use low-flow shower heads and faucets.
- Insulate water pipes.
- Turn off water pipe heat taps when not needed or put them on a thermostat.

Appendix G. Program Funding

Funding for the *Students for Energy Efficiency* (SEE) program is the result of Idaho Public Utilities Commission (IPUC) Order No. 30760, dated March 27, 2009. The order directed the appropriate disposition of the proceeds from the sale of Idaho Power's sulfur dioxide (SO_2) emission allowances in calendar year 2007 to the development and implementation of an energy education program in Idaho Power's service area.