STAFF ENERGY MANAGEMENT REFERENCE MANUAL

iSMART

ILLINOIS SMART METER AWARENESS RESEARCH AND TECHNOLOGY




EFFICIENT LIVING
Illinois PHA Energy Program

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ENERGY RESOURCES CENTER

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For more information on this project and our work, please see: www.ilpha.org

Contents

GENERAL ENERGY AND GRID EDUCATION

What is energy?

The energy used to power Public Housing Authority (PHA) facilities comes from two main sources, electricity and natural gas. Electric energy is measured by a unit called a kilowatt-hour (kWh). A kWh, like all forms of energy, is a function of power and time. Power and energy can be thought of akin to two familiar car gauges. The speedometer, which gives an instantaneous reading of car velocity (mph), is analogous to electrical power in kW, or simply put, the output of energy at a given moment in time. The odometer, which displays how far the car has traveled in miles, is analogous to electrical energy in kWh. Boilers, furnaces and other appliances operating via natural gas use the unit therms to quantify their energy use.

Power
kW / btuh

Energy
kWh / btu

The most common measurement of energy used in America is a British thermal unit. This unit is the amount of energy needed to cool or heat one pound of water by one degree Fahrenheit. Looking at the total energy a building consumes, it is sometimes useful to convert both electric (kWh) and natural gas (therms) consumption to Btus or the more practical kBtu (1000 Btus).[1] Use the table below to convert energy units as needed.

Table 1: Energy Conversion Table

Unit	kWh	therm	kBtu
1 kWh	1 kWh	0.034 therm	3.412 kBtu
1 therm	29.307 kWh	1 therm	100 kBtu
1kBtu	0.293 kWh	0.01 therm	1 kBtu

[1] See Benchmarking section for more on benchmarking a facility.

How does the grid work?

Electricity is generated in a variety of applications. In Illinois, the majority of electricity generated and sent to the grid is split, almost evenly, between nuclear and coal power generation. A smaller portion (roughly 10%) comes from renewable (wind, biomass, hydroelectric, solar) and natural gas sources. Coal-fired power plants, which make up roughly 40% of Illinois electric generation, are fueled by non-renewable fossil fuels. A range of technologies are applied to reduce emissions of sulfur dioxide, nitrogen oxides, particulates, and mercury from power plants (including coal cleaning, flue gas scrubbers, electrostatic precipitators, selective catalytic reduction, and activated carbon injection). Even with these controls, however, fossil fuels (including natural gas, not just coal) emit harmful carbon emissions into the atmosphere.[2] In other words, a large portion of energy consumed in Illinois has a direct environmental impact.[3]

The grid refers to the transmission and distribution of electricity from power plant to facilities. Transmission lines are those that take the high voltage, alternating current (AC), from the power plant across long distances to substations and step down transformers. From the substations, local distribution lines transport electricity to the end user where it is metered and charged to the customer.

Figure 1: Electric power industry generation by primary energy source, 2013[3]

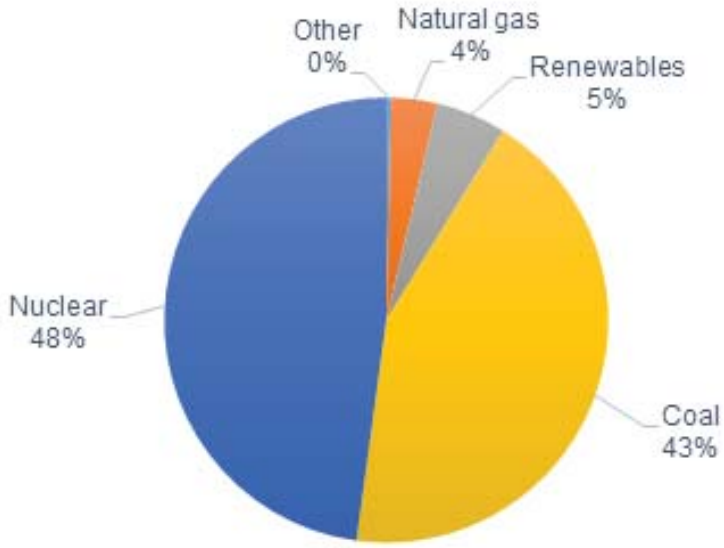
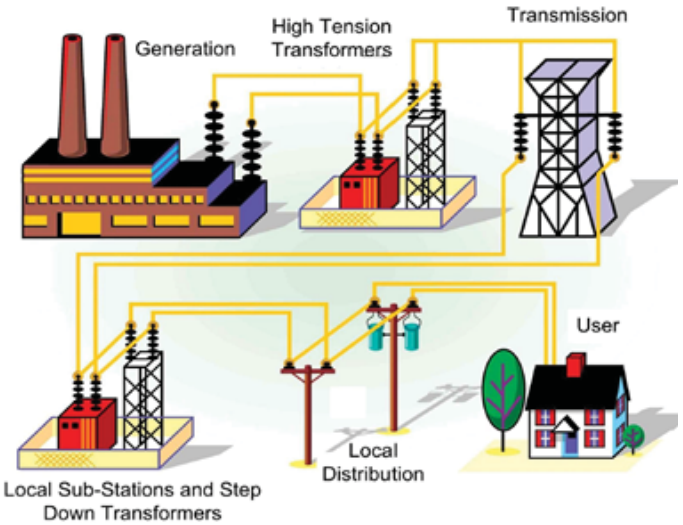


Figure 2: Simplified Functional Structure



[2] http://www.epa.gov/airmarkets/progress/datatrends/summary.html#one

[3] http://www.eia.gov/state/?sid=IL

What is a smart meter?

A meter is a device that measures the amount of electric energy or natural gas consumed. This allows utilities to charge for the direct portion of services used. Meters should be viewed as an onsite tool used to measure the amount of energy utilities are suppling to their customers.

Standard electric meters measure demand in kW and consumption in kWh, for which the facility is charged. Peak periods refer to the periods in a given day where a relatively large amount of electricity is being used instantaneously causing a spike in demand consumption (kW). Such events happen when many appliances are turned on at the same time (tenants coming home from work at the same time and turning on their AC units), or significant energy hogs are switched on (activating a large chiller or heat pump). For example, a typical household may use 24 kWh in a day, for an average of 1 kW per hour in a 24 hour period, but also may use 2-3 kW per hour during the early evening when air conditioning and a range of appliances and lighting are in operation.

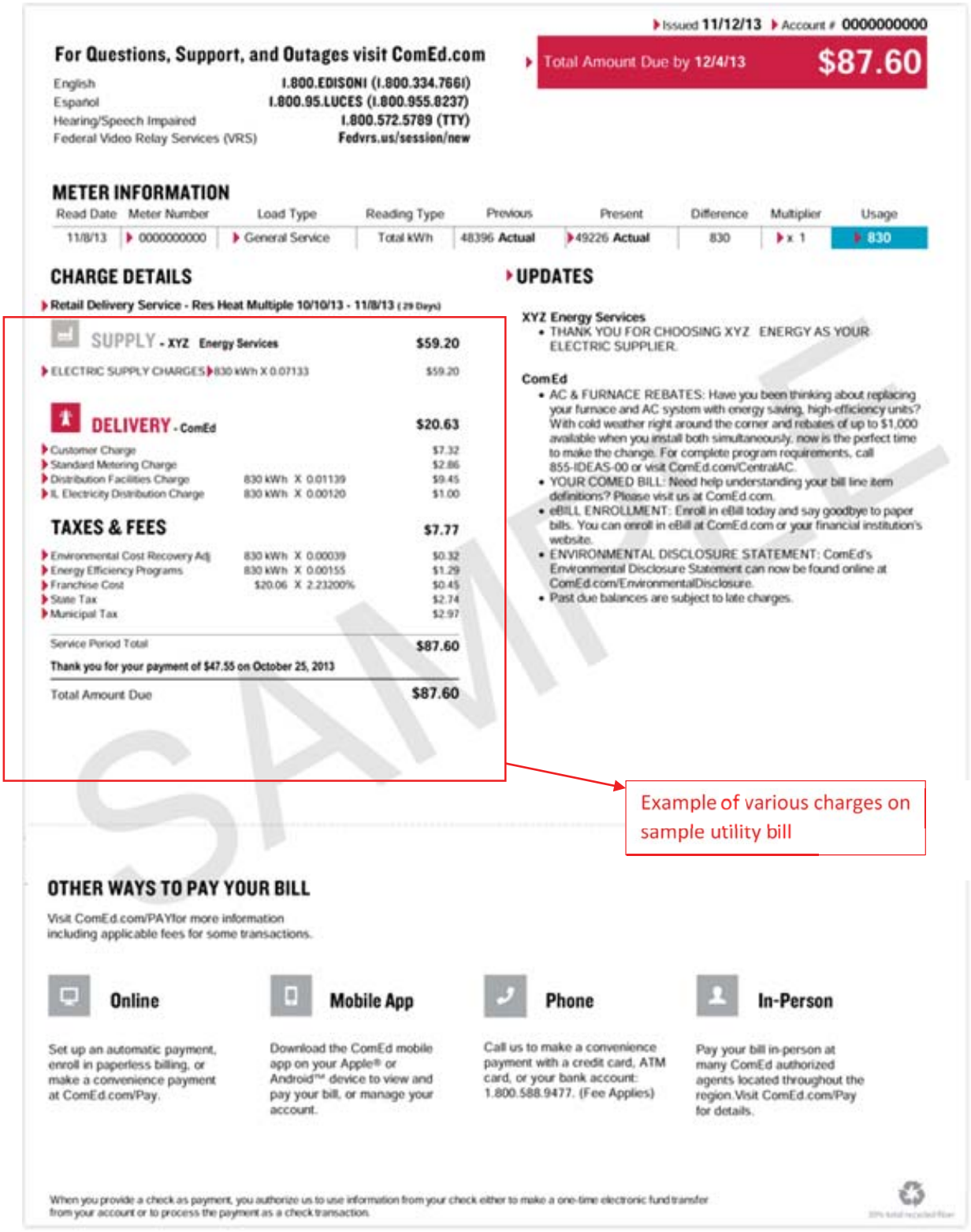
The demand portion of an electric bill can often be the most expensive service utilities charge. Typically, utilities will charge for the single highest demand event that occurred during that billing period, sometimes called a capacity charge, regardless of how often or little that event occurs. Electric consumption, measured in kWh, is a separate charge billed on a price per kWh basis. This highest demand event often determines the rate at which the customer purchases electricity, because the electric supplier must anticipate how much electricity to send to the grid at a given time and prepare for that. Other fees on a typical electric utility bill[4] may include a metering charge, an energy efficiency program charge, transmission and distribution charges, taxes and other miscellaneous fees.

Figure 3: Smart Meter

While standard electric meters operate continuously measuring instantaneous voltage and current, more advanced metering technology is being rolled out that offers additional functionality. Smart meters not only measure energy but communicate energy use information remotely with both the utility and end user. Smart meters are beneficial to utility companies because they help more closely match power consumption with generation. Some utility companies utilize smart meters to price rates based on time-of-day consumption and the season. Consumers can benefit from smart meters as well by taking advantage of greater awareness of consumption to better manage their energy use and reduce utility bills.

[4] https://www.comed.com/customer-service/billing-payment/understand-bill/Pages/residential-bill-front.aspx

Figure 4: Sample Utility Bill[5]



[5] https://www.comed.com/customer-service/billing-payment/understand-bill/Pages/residential-bill-back.aspx

BUILDING ENERGY MANAGEMENT

The primary objective of energy management is to improve energy efficiency and reduce energy use, thereby reducing cost. A successful energy management program maximizes profit and minimizes cost. It helps in creating a road map for continuous improvement in a buildings' future energy performance. The following tools can be used to facilitate successful energy management:

Benchmarking

Establishing a baseline serves as a metric for future energy usage. Benchmarking is the process of comparing a facility's energy performance to its performance from previous years. Alternatively, the energy performance of the facility can also be compared to similar facilities elsewhere.

Tracking theses metrics assists the consumers and decision-makers in identifying potential energy savings opportunities at their facility.

Benchmarking drives action.

Energy Metrics

As a first step, the energy profile of a facility can be best understood by utilizing the following metrics. Energy metrics are basic indicators of potential for savings or data points that quantify the amount of energy used by a property:

They provide a useful way to compare the facility's energy use with a trusted benchmark value. For example, if the annual electric use in the facility is 25% higher than the benchmark value, then a 25% savings in electric use maybe a reasonable goal.

Table 2: Sample Benchmarking Table

	Annual Consumption		Annual Costs		Average Unit Cost	
Electricity	449,630	kWh	$49,459	71%	$0.11	$/kWh
Natural Gas	24,097	therms	$19,759	29%	$0.82	$/therm
		Total	$69,219	100%		
Floor Area	60,000	sf				
Site Energy Use Intensity	66	kBtu/sf/yr	**Energy Cost Intensity**	$1.28	$/sf/yr	
Electricity Use Intensity	7.49	kWh/sf/yr	**Natural Gas Use Intensity**	0.40	therms/sf/yr	

A key metric: Energy Use Intensity (EUI), expresses a building's energy use as a function of its size or other characteristics.[6] It is calculated by dividing the annual energy consumed by the gross square footage of the building. For the purpose of this calculation, electricity and gas consumption is measured in kBtu (a unit of energy).

$$EUI = \frac{\text{Building's Energy Use (kBtu)}}{\text{Building Size (sq. ft.)}}$$

A low EUI, generally indicates that the building is a good performer. However, EUI is dependent on the property type. Some facilities will always use more energy than others. Average EUI for a multifamily housing building, with five or more units located in the Midwest is 66 kBtu/sqft/yr.[7]

Portfolio Manager

Another form of benchmarking uses the ENERGY STAR® Portfolio Manager ™ program. Portfolio Manager compares actual usage data to a database of buildings of similar type in the same region and calculates an ENERGY STAR score on a scale of 1-100. For an ENERGY STAR certification, a building would have to be a top performer, having received a score of 75 or more. The basic steps for using the Portfolio Manager are listed below. For a detailed guide visit Portfolio Manager® Quick Start Guide.[8] [9]

Step 1: Add a property

Step 2: Enter Energy & Water Data

Step 3: View Results & Progress

Bill spreadsheet tracking

Setting up a spreadsheet with headings like the electric and gas account pictured below will help one understand their monthly energy use profiles. Patterns or abnormalities in the profile highlight possible energy saving opportunities.

After the spreadsheet is set up for tracking your data, enter the most recent information from a paper bill or grab the data from ComEd's website.[10]

Figure 5: Utility Bill Tracking Template

Month	Electricity			Gas Consumption		
	Monthly kWh Usage	Total Cost ($)	$/kWh	Monthly therm usage	Total Cost ($)	$/therm
Sep-13						
Oct-13						
Nov-13						
Dec-13						
Jan-14						
Feb-14						
Mar-14						
Apr-14						
May-14						
Jun-14						
Jul-14						
Aug-14						
Sep-14						
Oct-14						
Nov-14						
Dec-14						
Jan-15						
Feb-15						
Mar-15						
Apr-15						
May-15						
Jun-15						
Jul-15						
Aug-15						

[6] http://www.energystar.gov/buildings/facility-owners-and-managers/existing-buildings/use-portfolio-manager/understand-metrics/what-energy

[7] RECS 2009

[8] https://www.energystar.gov/buildings/tools-and-resources/portfolio-manager-quick-start-guide

[9] https://www.energystar.gov/ia/business/multifam_housing/QRG_Multifamily_Housing.pdf

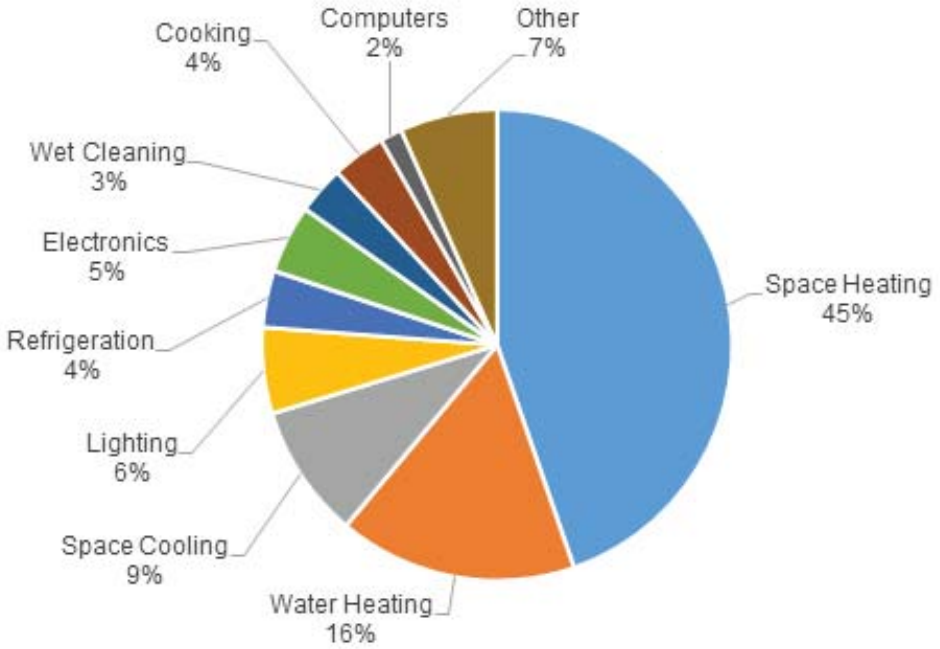
[10] https://www.comed.com/_layouts/comedsp/login

Energy use breakdown

Understanding how energy is used throughout a facility helps prioritize energy improvement efforts. When prioritizing investments, the larger categories typically offer the greatest savings potential.

The U.S. Energy Information Administration (EIA) disseminates results from the Residential Buildings Energy Consumption Survey[11] for energy end-use consumption based on property type, size, and fuel types. These tables can be utilized to create a typical energy use breakdown chart for a facility. A sample energy breakdown of a multi-family housing building located in Chicago is illustrated below.

Figure 6: Sample Energy Use Breakdown by percentage



Building Automation system

A building automation system (BAS) is used to monitor and optimize control over occupant comfort while minimizing energy use. The systems usually controlled by the BAS include heating, cooling, ventilation and lighting.

In order to realize the energy savings potential of a BAS system however, all the following elements must be included and fully integrated:

- Equipment design and installation.
- Controls sequence planning and programming.
- Development of an intuitive, internet accessible, graphic user interface.
- Enhanced facility operator training.[12]
- Ongoing BAS maintenance (including periodic equipment and software upgrades).

If this is not done, it is possible that an improperly functioning BAS system can result in higher than the predicted energy consumption of the baseline building design.

[11] http://www.eia.gov/consumption/residential/data/2009/index.cfm?view=consumption

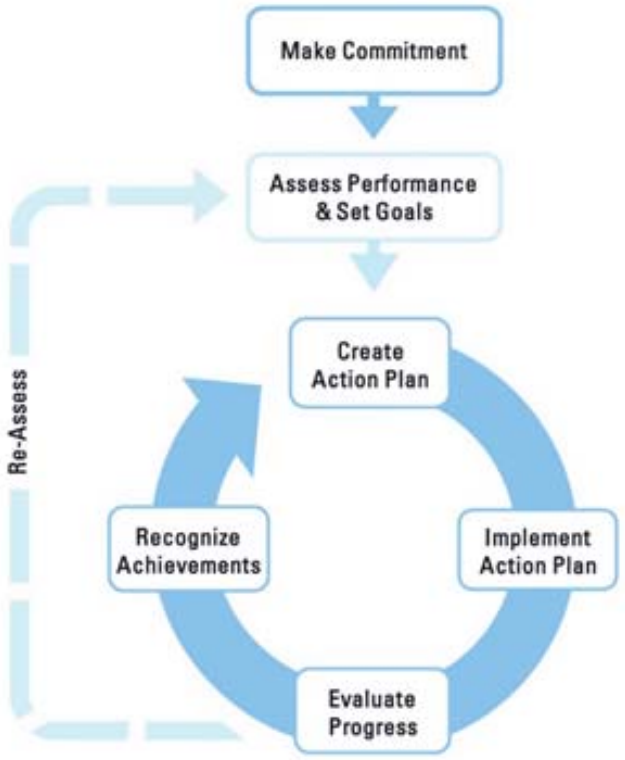
[12] Enhanced operator training for the primary facility operators is highly recommended. This will help to prepare the staff to be able to troubleshoot, and adjust system schedules, as needed, to adapt to changing conditions and schedules.

Energy Management Plan

An Energy Management Plan (EMP) is a set of steps or a procedure for driving implementation of energy efficient measures. A well-developed EMP will encourage continuous improvement of building systems in order to realize energy savings. The EMP includes appointing an Energy Management Team, identifying specific steps to drive implementation, and verifying savings of the energy efficiency projects that are implemented.

Assigning staff members to an energy management team will motivate employees to drive positive changes in the building with regard to energy efficiency. To be effective, the energy management team should be comprised of staff members directly involved in the day to day operation of the building. Energy management team members in combination, should have a good understanding of the buildings mechanical system, have access to the buildings utility bills and have the ability to make economic decisions for timely implementation of energy efficiency projects.

Figure 7: Building an Energy Management Plan[13]



The key member of an energy management team is the building operator or maintenance person. This member should have the ability to recognize when mechanical systems are underperforming, have a good idea where improvements need to be made in the building, and be able to communicate it to other members of the energy management team in order to drive action. The staff energy kit will provide the building operators with some of the tools necessary to assess the building systems equipment and their operation.

Other key members of the team should include a person trained to analyze utility bills and someone with the capability to raise capital for energy efficiency projects. By analyzing the utility bills a person can identify trends, recognize rising energy use, and work with the building operator to spot issues in the building systems performance. The team should be able to present a case for energy efficiency measures to the person with a role in funding to help ensure actions that cost money have an opportunity to be implemented.

It is very important that the PHAs have a specific set of steps or a procedure for implementing energy efficiency measures is in place. Installing energy efficient equipment to replace outdated or underperforming equipment is typically held off until the equipment breaks down instead of when it is economically viable to replace. Creating a standard procedure provides guidelines for when changes should be implemented and provides staff with a plan to drive changes in the building.

[13] https://www.energystar.gov/buildings/about-us/how-can-we-help-you/build-energy-program/guidelines

STAFF ENERGY EDUCATION KIT

REED® Light Meter

A light meter is a device used to measure the lighting output of light fixtures. Lighting levels can be measured using the REED LM-81LX light meter to confirm that it meets desired standards, or to identify over lit areas. A measurement can be obtained by placing the light meter directly under a light fixture until the display reading stabilizes (preferably at a work-surface height). Additional measurements, not directly under the light fixtures are recommended to be taken for understanding average light levels within a space.

The REED light meter has the capability of measuring light levels in both foot-candles and lux. Foot-candles and lux are units that indicate the density of light that falls on a surface. A foot-candle is equal to one lumen per square foot. A lux is the metric measure of a foot-candle and is defined as a lumen per square foot. A foot-candle is 10.76 lux. The recommended level for corridors, common areas, and office space range from 5 to 50 foot candles.[14] Please see table below for IESNA and ASHRAE 90.1 recommendations:

Figure 8: REED® Light Meter

IESNA Recommended Horizontal Illuminances and ASHRAE/IESNA 90.1 LPD Recommendations		
Space Type	**Illuminance (fc)**	**LPD (W/ft^2)**
Open Offices	30 to 50 (5 to 10 with task lighting)	1.1
Private Offices	50	1.1
Conference Rooms	30	1.3
Corridors	5	0.5
Restrooms	10	0.9
Lobby	10	1.3
Copy Rooms	10	
Classrooms	30	1.4
Gymnasiums	100	1.1
Dining Areas	10	0.9
Kitchen	50	1.2
Labs	50	1.4
Libraries	30	1.2 (reading area), 1.7 (stacks)
VDT Areas	3	
Museums (display areas)	30	1
General Warehousing/Storage	10	0.8
Inactive Storage	5	0.3
General Manufacturing	30	1.2 (low bay), 1.7 (high bay)
Residences (General)	5	
Parking Areas (uncovered)	0.2	0.15

Source: ASHRAE and Illuminating Engineering Society of North America

There are different ways to achieve the desired lighting output. Please see list below to identify which is more applicable for your building:

- Delamping lighting fixtures
- Retrofit T12 to T8 lighting lamps
- Reduce lighting wattage from 32W T8 to 28W
- Replace incandescent lamps to CFLs
- Install occupancy sensors in spaces that are used sporadically

Please note that any lighting changes will result in a different lighting intensity and lighting guidelines should be adhered to. The Reed light can be used to verity that lighting guidelines are properly satisfied.

Note that the most important aspect of lighting is visual quality. While making lighting changes for energy conservation, one must do it with an understanding of the factors that contribute to visual quality. Not only is lighting intensity important, the age of the viewer must also be taken into consideration. By age 60, visual sensitivity starts to decline significantly. In these cases, the key to energy efficiency is supplementary lighting. For example, a library area can be provided with task lights (with CFL lamps) instead of illuminating the entire space at a higher than recommended light level.

[14] http://www.nrel.gov/docs/fy11osti/50125.pdf

Kill-A-Watt®

Plug loads refer to any electrical equipment that plugs into the building's electrical system. A phantom load is any device plugged into an outlet that consumes electricity even when turned off. Managing these types of loads can lead to a significant amount of savings. Kill-A-Watt is an electricity usage monitor that can be utilized for this purpose.

Electrical consumption of individual pieces of equipment can be determined by plugging them into the Kill-A-Watt which is then plugged into an outlet. The equipment's daily, weekly, monthly or annual electrical consumption can be tracked. The device can project how much electricity each equipment is using after 24hrs to a week depending on the size of the equipment. The Kill-A-Watt displays voltage, frequency, current, volt amps, watts, power factor, kilowatt hours, and lapsed time. This device can help identify equipment with higher consumptions facilitating effective plug load management. The Kill-A-Watt can also help identify any and all phantom loads. A phantom load is the amount of energy a device uses when it is turned off but still plugged in.

Having the knowledge of current loads can help address plug load energy use, identify energy-saving priorities, and create an energy reduction strategy for continuing plug load management. For instance, there can be an appliance that is running 24hrs a day, but it is only needed for a few hours. This can help save a significant amount of energy throughout the building. Below are some tips to help address plug loads:

- Create inventory of equipment as done in the table below, and focus on the devices that use the most energy.
- Eliminate or unplug unnecessary devices by using smart strips.
- If phantom loads are identified, unplug equipment when not in use.
- Turn off or power down any equipment when not in use.
- Educate staff as to the reasons and appropriate instances when to power down appliances.
- Install a power strip that can be manually turned off when the equipment is not in use.
- Install a smart strip that automatically turns off when the equipment plugged into it is not in use for a certain amount of time.

	Base Watts	Daily	Weekly	Monthy	Yearly
Television	236				
Radio or Music Player	5				
Space Heater	1500				
Microwave	1100				
Mini Fridge	90				
Desktop Computer	245				
Portable Fan	100				
Cable or Satellite Receiver Box	45				
Laptop Computer	45				
Single lamp bulb	90				
Vacum Cleaner	50				
Toaster	1100				
Coffee Pot	900				

Figure 9: Kill-A-Watt® meter

Another way to help reduce the electric consumption of plug loads is to purchase ENERGY STAR® appliances and electronics as older equipment is phased out. Since appliances are estimated to have less of an impact on the annual energy use of a building when compared to lighting and computer equipment, it is recommended that they be replaced with efficient ENERGY STAR appliances only as appliances fail (Replacing old refrigerators is advisable because of the significant savings, even if the units have not failed). Numerous cost savings calculators are provided by ENERGY STAR website to show the impact of investing in energy efficient equipment.[15]

[15] http://www.energystar.gov/index.cfm?c=bulk_purchasing.bus_purchasing

HOBO® Datalogger

The HOBO® UX100-003 is an electronic instrument that records temperatures and relative humidity levels at set intervals over a period of time. The stand-alone USB data logger is recommend to be used to verify that temperature settings and setbacks in the building are working as intended. This should be done at the beginning of each cooling and heating season for a period of one to two weeks to have accurate readings. In addition, it can be utilized to monitor the temperatures in areas that are reported to be uncomfortable. This process can be start by placing the data logger in common rooms with large volumes and work your way down to smaller rooms throughout the building.

To access the measurements from the data logger, download and install a free software available on the HOBO® Data Logger website:

http://www.onsetcomp.com/products/software/hoboware.

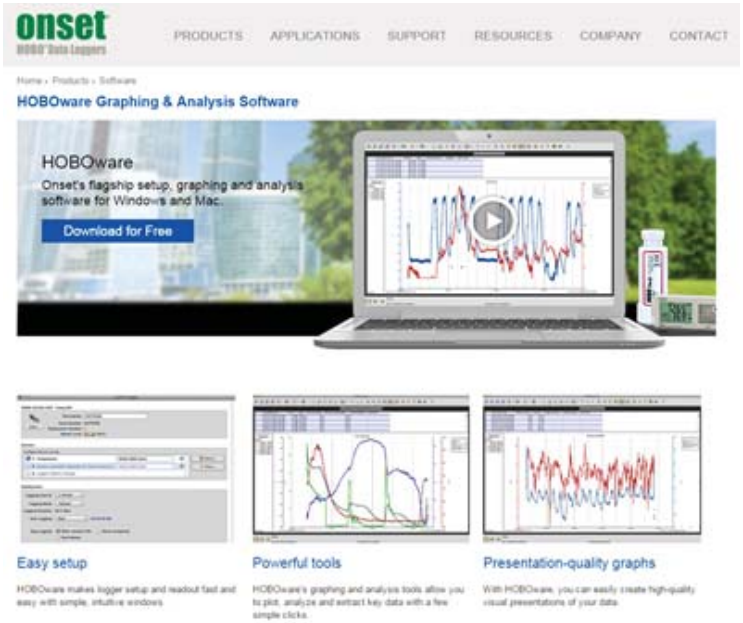


Figure 10: HOBO® Datalogger

Once the software is installed on a computer, you can download the information using a micro-USB cable. Please note that the micro-USB cable has to be purchased separately. The data can also be accessed using the HOBOmobile® application for HOBO MX Data Loggers. The data logger is capable of recording and storing up to 84,000 measurements in the device's memory. Once the memory is full, the device can be set to store new data by replacing the oldest measurements. To deploy the logger in the desired location, place it on a magnetic surface or utilize the mounting tabs.

It is recommended that an occupied temperatures of 68°F during the heating season and 78°F during the cooling season.[16] The temperature setpoints can be setback when the building is unoccupied. Setbacks should be scheduled one hour before regular occupancy. As a rule of thumb, 1% energy savings can be found per 1°F temperature reduction over a period of eight hours.[17] Understanding general occupancy schedules of common areas and optimizing the temperature settings as recommended can lead to significant energy savings.

[16] http://energy.gov/energysaver/thermostats
[17] http://energy.gov/energysaver/articles/thermostats

Fluke® Infrared Thermometer

FLUKE infrared thermometers (infrared gun) can determine the surface temperature of any object by measuring the amount of infrared energy radiated from it. By knowing exact temperatures of equipment and objects at specified locations, one can identify energy saving opportunities and establish equipment functionality.

To use the infrared gun, first aim it at the chosen object. The Fluke gun provided has a beam angle of 1:10, which means that if the gun is pointed at an object 10 feet away a temperature reading of one square foot area will be taken. To activate laser (for a more accurate aim), toggle through the selection options, press the SEL button till the laser option is displayed. Toggling through the same selection options, one can switch from °C to °F and choose from a myriad of other options.

Figure 11: Fluke® Infrared Thermometer

An area where facilities can benefit from using an infrared gun is in water heater savings. One can minimize energy losses by keeping the water temperature as low as practical. While most domestic water heaters are designed to produce water up to 180 °F, most lavatory application require water no hotter than 110 °F. In general, it is recommend to set hot water temperatures to no more than 120 °F. In some instances, certain appliances may require additional heat from the water heater such as dishwashers without booster heaters. The infrared gun can be used to accurately check the outlet temperature of the water or compare gun readings to the outlet thermometer on the water heater if one is provided.

RESIDENT ENERGY EDUCATION KIT

The resident energy education kits are provided to PHA residents to help them understand and reduce their energy use. The resident energy kits are designed to educate residents to be aware of their water usage, manage their plug loads, make use of daylight when available and provide general energy saving tips.

Shower Timer

The shower timer is a five minute timer with a suction cup designed to be attached to a wall in the shower. The shower timer can be secured to a smooth vertical surface in the bathroom and should be rotated 180 degrees to begin the timer at the start of the resident's shower. The resident does not pay natural gas and water bills directly so driving a behavioral change for savings is more difficult. Nonetheless, the timer will make residents think about how long they shower, and is intended to promote awareness of natural gas and water consumption.

Figure 12: Shower Timer

LED Nightlight

The LED nightlight is an LED plug lamp with a photocell control. The photocell will prevent the nightlight from turning on unless there is insufficient light in the space it is in. The LED nightlight is intended to educate the PHA residents about daylight harvesting, which is the practice of using natural light before turning on their lamps. The nightlight should also promote residents to think about when they need to turn on their lights, and when they can open the blinds instead. The LED nightlight should be plugged in an area with windows to make use of the photocell. Daylight harvesting is a good practice because it can result in peak demand reduction, which in turn will lower demand costs on the electricity bill. Peak demand awareness is one of the major areas of focus in this study because the residents are commonly at home during peak demand hours (11 am- 7 pm).

Figure 13: LED Nightlight

Figure 14: Power Strip

Figure 15: Water Conservation Tips

Figure 16: Energy Wheel

Power Strip

The power strip is intended to help residents manage their plug loads and phantom energy use. In our educational session we will teach the residents about phantom energy use and encourage them to connect any plug loads that they intermittently use throughout the day. Through education of phantom loads and which devices have large phantom loads, residents can make an informed decision on what plug loads should be controlled by their power strip. All of the plug loads chosen by the resident can then be turned off by turning off the power strip. By turning off the power strip residents can prevent phantom loads of their devices.

Water Conservation Tips

The water conservation tips wheel provides residents with tips on how to reduce daily water consumption. On the front face of the wheel there is a benchmark for a typical family's daily water use. It also provides a breakdown of what percentage of that total water is used for different daily activities. The other side of the water conservation wheel details the water savings in gallons that can be achieved by using low flow fixtures to replace standard fixtures. In addition, the savings tips on the wheel provide recommendations for drinking water, food preparation, washing dishes, laundry, cleaning and using bathroom fixtures. The water conservation tips wheel is meant to raise awareness of residents' water use.

Energy Wheel

Similar to the water conservation wheel, the energy wheel provides information on how much electricity common devices consume. The energy wheel also includes some basic information about power and energy and their relation. Included in the energy wheel are recommendations for maintenance and operation of appliances in their home to save energy.