

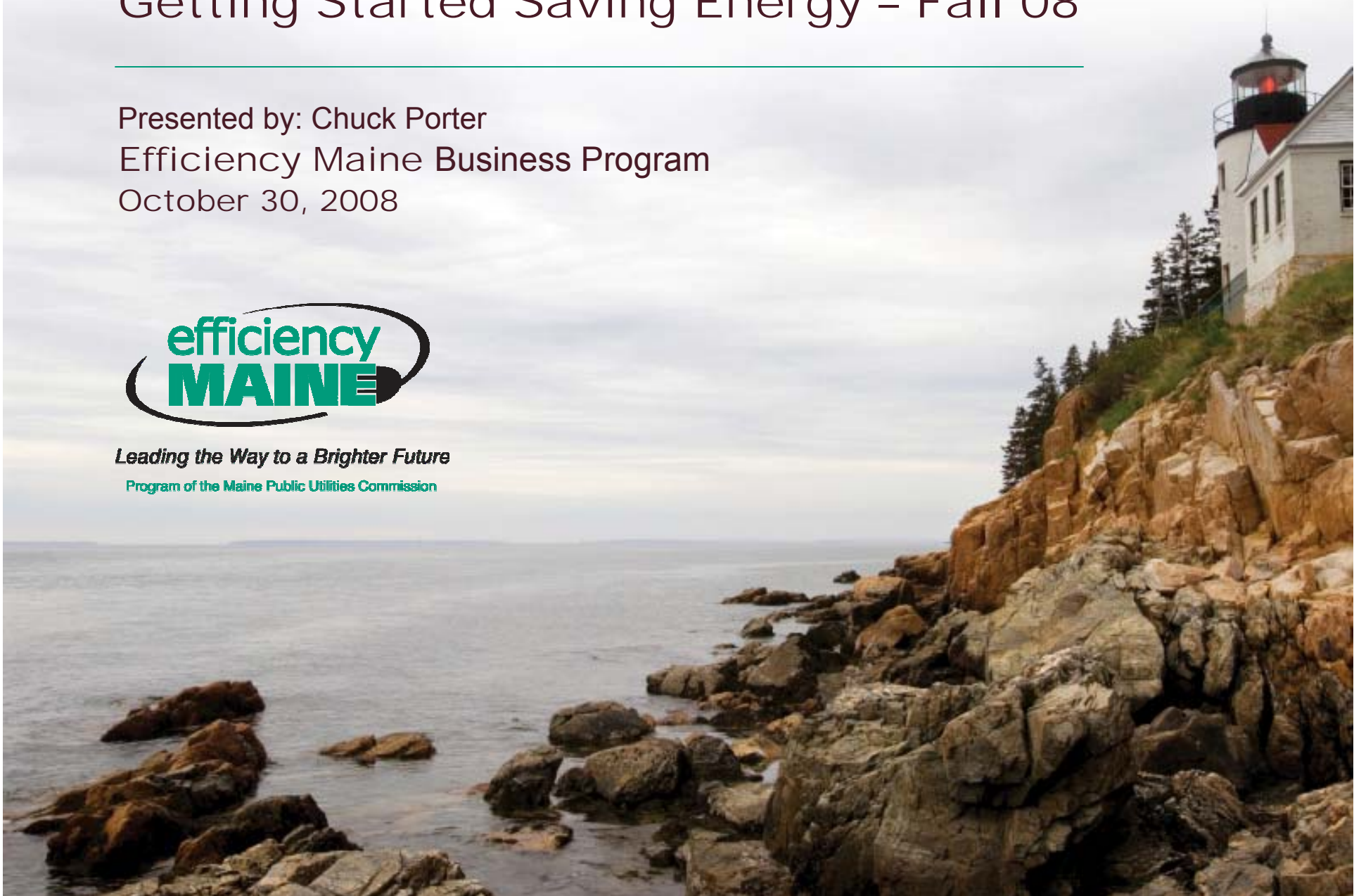
Getting Started Saving Energy – Fall 08

Presented by: Chuck Porter
Efficiency Maine Business Program
October 30, 2008



Leading the Way to a Brighter Future

Program of the Maine Public Utilities Commission





Introductions

- Who is in the Room
- What responsibilities do you have for energy costs in your facility?
- What do you hope to learn in today's session?
- Any burning questions before we get started?



Introduction to Efficiency Maine



Established by the Maine Legislature:

The Efficiency Maine program is administered by the Maine Public Utilities Commission and funded by Maine electricity consumers

In order to:

- Provide education and financial incentives to help companies and residents become more energy efficient and reduce energy costs
- Take a leadership position in the statewide effort to promote efficient use of electricity and improve Maine's environment



Eligible Business Program Participants



All Non-Residential and Non-State owned facilities including:

- Public & Private Schools K-12
- Local & County Governments
- Commercial
- Industrial
- Institutional
- Nonprofits
- Farms
- Colleges
- Water & Wastewater Facilities





Our overall program includes the following programs:

- Business Program - Prescriptive & Custom (for small and large businesses)
- Residential Program (for residential lighting & Maine home performance)
- Renewable Energy (solar, biofuels, carbon free homes, clean energy Maine)
- Education & Training Program (Professional & K-12)
- Low Income Program (CFLs & appliance replacement)
- Maine High Performance Schools Program (New School Construction)

Benefits To Businesses



- Reduce electricity expenses which can strengthen the bottom line
- Reliable technologies that reduce risk
- Individual business can receive incentives up to \$100,000 per calendar year or \$200,000 over a two year period
- Resource for facility upgrades and personnel training
- Reduced facility maintenance
- Advice and information on purchasing energy efficient products
- Guidance regarding new technologies
- Assistance locating program allies (resources)
- Other resources including grant opportunities



Business Program Prescriptive Incentives



- Participants receive specified incentives for purchase of prequalified energy efficient equipment

- Prescriptive Incentives
 - Lighting
 - Motors
 - HVAC
 - Variable Frequency Drive for HVAC systems

- Project Pre-Approval **IS REQUIRED** for most prescriptive incentives
 - Lighting & Refrigeration in excess of \$1,000
 - HVAC & Variable Frequency Drives

- Project Pre-Approval **IS NOT REQUIRED** for:
 - Three-Phase Motors
 - Agricultural Measures



Business Program Custom Incentives



- Encourages Comprehensive & Innovative Energy Efficiency Measures
- Requires Engineering Assessment of Complex Projects
- Technical Analysis Can be Cost-Shared Under Specific Conditions
- Custom Incentives Include:
 - Lighting Systems w/Controls
 - Variable Frequency Drives
 - Compressed Air
 - HVAC
 - Other Non-Specified Energy Measures

In Summary: Anything That Produces Cost Efficient Electrical Savings!



Custom Incentive Submittals



- Incentives intended to cover a portion of the additional cost of premium efficiency equipment, compared to standard practice components
- Application must be supported by documentation of existing vs. proposed condition
- Labor & material costs
- Savings must support project cost
 - Simple payback = $\frac{1}{2}$ measure life
 - Benefit/cost ratio ≥ 1.0
- Incentives up to 75% of incremental measure cost for new installation
- Incentives up to 35% of installed cost for retrofit measures
- Will not exceed buy down to 1.5 year payback period



When homeowners are ready to tackle energy efficiency, this program makes the connection!

- Go beyond energy audits with investment-grade evaluations and home improvements
- Connects homeowners with qualified building contractors for energy efficient home improvement projects
- Uses a "whole house" approach to reduce high utility bills (looks at drafts and cold spots, ice dams, lights and appliances, furnaces and more!)
- Benefits include energy cost reduction, improve health and safety, increase personal comfort, extend longevity of your home and appliances, lower your carbon footprint, and increase the value of your home.



Residential Lighting Program

- Energy Star qualifying products
- Switching to CFL light bulbs
- Rebates on CFLs
- Options for new fixtures in remodeling and/or new home construction
- CFL recycling at participating retailers
- Savings calculator on the Efficiency Maine website

Quick Tip: Replace the 5 most often used bulbs in your home and see the difference immediately



Solar Energy Rebate Program



Note: Due to popular demand, all funds for 2008 have been allocated. Our solar rebate program offers cash incentives for making the switch.

- First Come-First Serve Basis
- Residential & Commercial
- Solar Thermal & Solar Electric Systems



Solar Energy Rebate Program



➤ **Solar Thermal:**

- Heating of water & air
- 30% of system installed cost, or \$2,500.00, whichever is less
- Energy Star and Maine Performance Homes are 35% of the installed cost or \$3,000.00, whichever is less
- The commercial incentive is 35% of system installed cost or \$10,500.00, whichever is less
- Solar hot water systems must be installed by licensed & Maine PUC certified plumber or working for someone qualified by the Maine PUC
- View E-Maine website for list of certified installers or to become one, take two-day workshop and pass exam.
- Certification must be renewed every two years for a \$35 fee
- Must provide documentation of at least one install over that period or retake the two day course, pass the test, and pay the \$35 fee



➤ **Solar Electrical Systems:**

- Solar PV systems qualify for rebates of \$2.00/watt for the first 1,000 watts, capped at \$2,000.00
- Effective January 1, 2008, all applications must include a copy of the home energy audit signed by the auditor
- Up to 25% of the designated solar fund can be spent on solar electric system rebates.
- For solar electric systems installed after January 1, 2007, the system must be installed by a master electrician who is North American Board of Certified Energy Practitioners (NABCEP) certified or by a master electrician working with someone who is NABCEP certified
- View E-Maine website for list of NABCEP certified solar electric installers





Application Procedure

- Limited to Maine residents only
- Application form & reservation number must be done before starting project. Otherwise, application will be denied.
- 120 days to complete project or apply for 120-day extension
- Submit installer license & certification
- System cost & labor invoices

NOTE: Solar electric systems must be installed on homes or businesses connected to the utility grid





We provide a full range of training and education programs to keep industry professionals on the cutting edge

- The Building Operator Certification Program — an intensive multi-day certification program for building/facility managers and plant engineers
- A variety of single and multi-day workshops on lighting, pump systems, motors, compressed air and more.





We offer support for students and teachers in their efforts to educate future generations about the importance of energy efficiency

- Education and training for teachers in grades 4-8
- Classroom curriculum (grades 4-8) for electricity production, energy awareness, energy conservation at home and school, plus more!
- Additional classroom offerings for grades 9-12



Small Business Energy Audit Program



Purpose: To perform free walk-through energy audits for small to medium sized commercial, non-profit, and manufacturing facilities resulting in possible energy savings, with accompanying cost and waste reductions.

Selection Criteria:

- Limited to ≤ 50 employees or sales \leq \$5 million
- No in-house engineering staff
- Must provide Efficiency Maine with a copy of one year's worth of utility & heating bills prior to receiving audit
- Must provide Efficiency Maine with Federal Tax ID#
- Must agree to participate in audit follow-up in 6 months to a year

Schools, hospitals, nursing homes, private residences, or business with residential components such as apartment houses, camps or condominiums are not eligible for participation in this program.



Procedure:

- Considered a “walk-through” audit – NOT an engineering analysis
- Assessment is made based on information gathered
- Written audit report delivered to company within reasonable time frame
- Report contains information & recommendation for potential energy savings as well as information on financial options which may be available to help pay for suggested energy improvements



Small Business Low Interest Loans



These rules establish the criteria for a loan program providing loans up to \$35,000.00 currently at 3% interest to small businesses to fund MPUC approved energy conservation measures.

Loan processing costs will be paid by the applicant and may be added to the project cost.

Because of limited resources, schools, hospitals, and facilities with residential components, such as apartment buildings, condominiums, or private residences are not eligible for participation in this program.





Eligibility Criteria & Approval Process:

- Prior to loan application, an energy audit of the small business must have been conducted by Efficiency Maine-approved auditor. Energy audits provided by Efficiency Maine staff to the small business are free
- We must have recommended the energy conservation measure for which funds are requested
- Clients will be required to provide before and after pictures of project in electronic format
- Applicants are required to provide three estimates for the cost of all equipment and work which is to be paid for with loan funds



Eligibility Criteria & Approval Process Continued:

- The project may not be contracted for or undertaken prior to Efficiency Maine loan approval
- Requires collateral to secure the loan
- Decisions regarding creditworthiness will be based on a credit report
- Loan terms vary
- The Commission may deny a loan to any applicant that restricts membership, sales, or services on the basis of race, color, creed, religion, sexual orientation, national origin or gender





Biofuels for Maine: Biofuel products & technology are changing rapidly. This is driven in part by the critical need to reduce fossil fuel use, improve air quality, & mitigate global climate change.

Biofuels – What are they?: We define biofuels as liquid fuels produced from biomass (renewable organic matter), which are often blended with or used to replace petroleum.

Biofuels include biodiesel, ethanol, & second generation biofuels.





Biodiesel: a distillate fuel similar to diesel or number 2 heating oil.

It can be made from several different animal or vegetable oils (e.g. canola, soy), or from recycled restaurant grease.

A 5% biodiesel blended with diesel or heating oil is known as B5; a 20% blend is B20. When biodiesel is blended with heating oil & used for heat, it is often called bioheat. Biodiesel is a domestic fuel and kinder to the environment than diesel.

Ethanol: Made from fermenting grains or sugars, a process similar to brewing alcohol. It is commonly made from sugar cane (Brazil) and corn (U.S.). All gasoline-powered vehicles can run on a blend of 10% ethanol, 90% gasoline (E10).





The Maine State Energy Program (MSEP) launched this clean electricity awareness campaign in September 2004 with the following objectives:

- To provide Maine citizens with information about clean, green electricity, its benefits, costs & availability to them; and
- To increase the rate & level of green power purchases, both supply & Renewable Energy Certificates (REC's), throughout Maine. All campaign activities are “product neutral”



Clean Energy Maine Program



Q: Where & How Do I Purchase Clean Energy?

A: View the renewable energy links on our website:

www.energymaine.com





Q: Why Should I Care?

A: For three very important reasons:

- Economic Benefits: Maine renewable generators pay local taxes & provide local jobs
- Security Benefits: Natural gas, oil & other petroleum fuels must be imported to Maine.
- Environmental & Health Benefits: Wind, solar & hydro power do not pollute.





Q: How Do I Get Clean Energy?

A: Simply put, you buy it. You vote for clean air with your dollars. It's easy to do and there are lots of choices.

Q: What Kind Do I Want?

A: Choices include solar, water, wind, biomass, and landfill gas.

Maine has one of the highest percentages of clean electricity generation in the nation.





The ultimate step in “going green” is to make your home carbon free through this innovative program

- A web-based program that allows home owners to determine how much carbon their home produces and steps to reduce or eliminate their home's carbon footprint
- Looks at no cost options like turning down the thermostat and washing clothes in cold water
- Offers low cost options, like replacing incandescent bulbs with CFLs
- Provides options for buying clean energy and energy credits





Energy Certificates and Energy Credits – the Basics!

“There is no cleaner kilowatt –hour than the one you don’t use”

- Renewable Energy Certificates (REC’s)
- Energy Efficiency Certificates (EEC’s)
- Carbon Dioxide Credits (GHG’s)



Renewable Energy Credits

- In September 1999, the Maine Public Utility Commission adopted rules governing the state's Renewable Resource Portfolio Requirement
- The rules require each competitive electricity provider , including Standard Offer providers, to supply at least 30% of their total retail electric sales, generated by eligible renewable and efficient resources.
- In June 2006, Maine enacted legislation (L.D.2041) created a renewable portfolio goal to increase NEW renewable energy capacity by 10% by 2017
- Capacity standard starts with 1% in 2008 and increasing by one percent annually, for a total of 10% by 2017



Renewable Energy Credits

Commonly called “ **Green Tags** “ or “ REC’s “

- A tradable environmental commodity
- Financial instrument from generating electricity from renewable resources
- Traded in the form of certificates representing savings of 1,000 kwh or 1 megawatt-hour
- Savings are in attributes of CO₂, SO₂, NO_x, and other emissions
- Certified renewable sources include solar energy (thermal and PV), wind, small hydro, biomass, geothermal, fuel cell, tidal, and landfill gas.



Energy Efficiency Certificates

Commonly called “white tags” or “EEC’s”

- A tradable environmental commodity
- Financial instrument from reducing electricity use through the installation of energy efficiency projects
- Traded in the form of certificates representing savings of 1,000 kwh or 1 megawatt-hour
- Savings are in the reduction of environmental attributes CO₂, SO₂, NO_x, and other emissions
- Certified sources of energy use reduction include heating, ventilating, and cooling (HVAC), lighting, motor drives, pumps, demand response, and energy management
- Mandated in CT, PA, NV, but no independent market yet in Maine



Carbon Dioxide Credits

- Carbon Dioxide (CO₂) credits or greenhouse gas (GHG) emission offsets are financial instruments representing the environmental attributes (CO₂ and other greenhouse gases) derived from reducing the GHG from specific offset projects
- Trading is in the form of certificates that are expressed in metric tons of emissions
- Certified sources of GHG emissions reduction include methane from agriculture, wastewater and landfill, thermal based energy efficiency, and certain renewable energy projects
- Maine PUC retains ownership of the certificates as part of the energy efficiency programs they sponsor



Regional Greenhouse Gas Initiative (RGGI)

- Formally established in 2005 and comprised of ten northeastern and mid-Atlantic states (The State of Maine is an original member)
- Designed to reduce carbon dioxide emissions from electricity generation, while expanding the implementation of energy efficiency, renewable energy, and clean energy technologies
- Accomplished by auctioning off the “allowances”, “permits”, or “credits”, and investing the proceeds in the above listed technologies.
- One “allowance” authorizes the emission of up to one ton of CO₂



Regional Greenhouse Gas Initiative (RGGI)

- Power plants across the United States account for 38% of the global warming gases (2nd only to transportation)
- Why power plants? Relatively few in number and state regulated
- The Initiative will cap the amount GHG a generator can emit by region based on an average of emissions over the 2002 through 2004 period
- Program is effective starting in 2009, with a 10% reduction in emissions between 2015 and 2020
- Power plants will purchase through the auction the allowances to cover their emissions and can buy or sell additional allowances
- Participants can purchase up to 50% of their emission reduction offsets

The Impact of Energy Costs



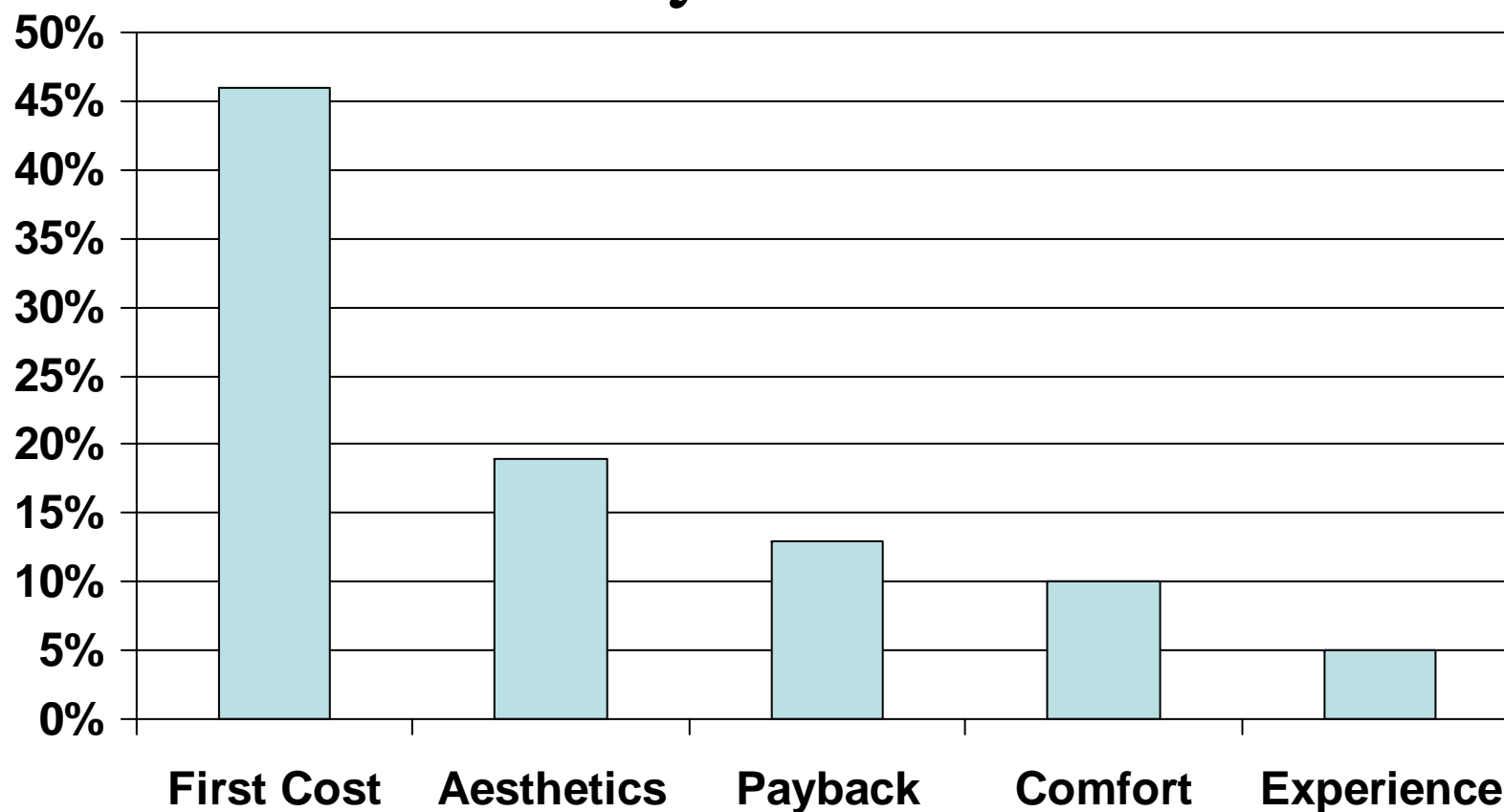


Fuel Cost Per Million BTU's

Fuel Type	Fuel Unit	Fuel Price Per Unit (dollars)	Fuel Heat Content Per Unit (Btu)	Fuel Price Per Million Btu (dollars)	Heating Appliance Type	Type of Efficiency Rating ⁴	Approx. Efficiency (%)	Fuel Cost Per Million Btu (dollars)
Fuel Oil (#2)	Gallon	\$3.59	138,690	\$25.88	Furnace or Boiler	AFUE	80%	\$32.36
Electricity	KiloWatt-hour	\$0.150	3,412	\$43.96	Furnace or Boiler	Estimate	97%	\$45.32
					Air-Source Heat Pump ⁵	HSPF ⁵	155%	\$28.30
					Geothermal Heat Pump	COP	330%	\$13.32
					Baseboard/Room Heater	Estimate	100%	\$43.96
Natural Gas ¹	Therm ²	\$1.53	100,000	\$15.30	Furnace or Boiler	AFUE	85%	\$18.00
					Room Heater (Vented)	AFUE	65%	\$23.54
					Room Heater (Unvented)	Estimate	100%	\$15.30
Propane	Gallon	\$3.13	91,333	\$34.27	Furnace or Boiler	AFUE	80%	\$42.84
					Room Heater (Vented)	AFUE	65%	\$52.72
Wood ³	Cord	\$250.00	22,000,000	\$11.36	Room Heater (Vented)	Estimate	77%	\$14.76
Pellets	Ton	\$300.00	16,500,000	\$18.18	Room Heater (Vented)	Estimate	83%	\$21.91
Corn (kernels)	Ton	\$250.00	16,500,000	\$15.15	Room Heater (Vented)	Estimate	80%	\$18.94
Kerosene	Gallon	\$5.24	135,000	\$38.81	Room Heater (Vented)	Estimate	80%	\$48.52
Coal	Ton	\$300.00	24,916,000	\$12.04	Furnace/Boiler/Stove	Estimate	75%	\$16.05

Source: Paul Hesse, Capstone Corp for EIA/NEIC

The Roadblocks to Energy Efficiency Investments



Business Energy Savings Tips



There are simple things you can do to save energy and valuable dollars for your small business. We encourage you to select one of the following topics if you are interested in saving energy & money at your business.

Remember that when it comes to saving, every bit counts!





Lighting:

- Turn off lights (and other equipment) when not in use
- Install occupancy sensor switches in seldom-occupied areas
- Adjust lighting levels to match needs
- Make use of free day lighting, where possible
- Replace incandescent bulbs with compact fluorescents (CFLs), where possible
- Replace incandescent bulbs and fluorescent exit signs with light emitting diodes (LEDs)
- Schedule cleaning services during the day
- Replace T-12 fluorescent fixtures with energy saving T-8 fixtures & electronic ballasts
- Install controls on exterior lighting





Heating, Ventilation & Air Conditioning (HVAC) Systems:

- Give your HVAC system a pre-season tune-up
- Use free cooling, install economizers to use outdoor air for cooling when outdoor temperatures are lower than indoors
- Install Energy Star ceiling fans to create air movement
- Set thermostats higher in summer, lower in winter
- Weatherize window air conditioners





Hot Water:

- Reduce Hot Water Temperature

Motors:

- Purchase high efficiency replacement motors
- Do not oversize motors
- Use variable frequency drives (VFDs) where appropriate
- Check & maintain motors regularly





Office Equipment:

- Look for Energy Star label when purchasing computers, printers, copiers, fax machines, and other office equipment
- Turn off office equipment at night
- Share equipment
- Purchase high efficiency equipment
- Check gaskets & closing mechanisms on refrigerator doors frequently



Home Energy Savings Tips



Look around your home. There are simple things you can do to save money on your electric bill. We encourage you to select one of the following topics if you are interested in saving energy and money at home.

Remember that when it comes to saving, every bit counts!





Reduce Phantom Load:

- Many appliances continue to draw power when they are switched off
- 75% of electricity used to power home electronics is consumed while the products are turned off





Lighting: compact fluorescent bulbs can give the same amount of quality of light as incandescent bulbs, yet use one-third the amount of energy and last ten times longer. A CFL can save over \$30.00 in electricity costs over the lamps' lifetime compared to an incandescent bulb and save 2,000 times their own weight in greenhouse gases.

- Replace incandescent bulbs with compact fluorescents (CFLs)
- Turn off lights whenever they are not needed
- Use dimmer switches on timers or lights
- Look for the Energy Star label when purchasing lighting fixtures
- Replace halogen floor lamps and torchieres with compact fluorescent models
- Keep bulbs & fixtures clean





Heating & Insulating: Turning down the thermostat by 1 degree F. can save 25-30 gallons of heating oil per year. It is a common myth that turning the thermostat down makes you burn more heating oil in warming the house again.

- Seal any leaks in your heating or cooling system ducts
- Insulate attic access and basement trap doors with R-19 insulation
- Caulk & weather-strip doors & windows
- Repair any holes in your roof, walls, doors, ceilings, windows & floors
- Seal off electric receptacles & switch boxes with foam gaskets or fiberglass insulation
- Install storm or thermal (replacement) windows





More Heating & Insulation Tips:

- Install energy saving showerheads in your home
- Repair all leaky faucets
- Prevent heat loss & reduce your waterbed's electric use up to 20% by covering it with bedspreads or quilts as soon as you get up
- Turn down your thermostat to 55 degrees when the house is unoccupied, a maximum of 68 degrees during the day, and around 60 degrees when sleeping





Washers & Dryers:

- Wash clothes in cold water, when possible, and only use cold water to rinse (which does not affect cleaning). Match the water level to the size of the load
- Don't overdry clothes you intend to iron
- Clean the dryer filter after each use

Water Heaters:

- Set your water heater thermostat at the lowest temperature that provides you with sufficient hot water, but not lower than 120 degrees F.
- Wrap your water heater with a water heater blanket





Refrigerators:

- Unplug & properly dispose of your extra refrigerator
- Open refrigerator/freezer doors only when necessary
- Keep refrigerator coils clean
- Make sure the seals on your refrigerator/freezer doors are tight

Dishwashers:

- Operate your dishwasher only with full loads
- Choose a dishwasher with several wash cycle selections
- Choose the right size for your home

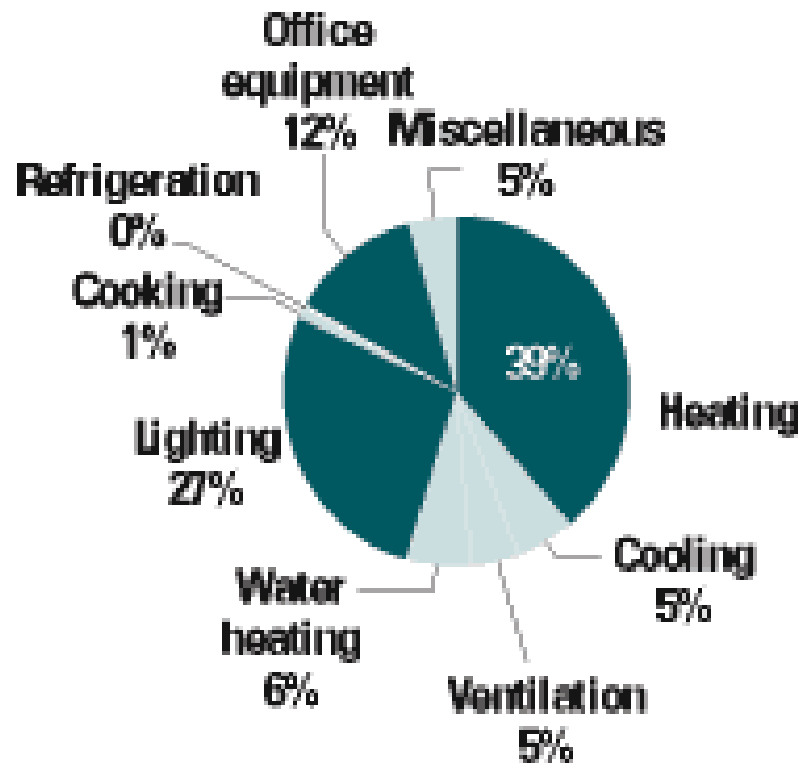




Look at it this way

- Every dollar saved through energy efficient practices is income that can benefit your community.
- Poorly designed – **OR** – maintained systems costs far more in lost productivity than in the energy wasted.

Typical Systems Energy Use in Maine Businesses – All Fuels



- Maine is located in Zone 1:
 - Less than 2,000 CDD
 - Greater than 7,000 HDD

- Overall, HVAC accounts for **approximately 50%** of the building energy use.

Priorities

- Lighting Upgrades
- Lighting Controls
- HVAC Maintenance
- HVAC Upgrades
- Plug Loads
- Commercial Kitchen Equipment

Energy Management:

Response to Energy Crises

➤ 1970's

➤ (the knee-jerk approach)

Energy sacrifices

Energy savings at the expense of quality and service

Emergency installation of untested products

➤ Today

➤ (a more thoughtful approach)

Energy productivity

Savings realized, quality and service maintained or improved

Careful planning and installation of proven products



Lighting Systems

- **The Largest User of Electrical Energy in Buildings**



Efficient Lighting Practices *should:*

- Meet the designed light levels and quality goals:
 - *know what you need and how it will be used*
- Efficiently produce and deliver that light:
 - *use the most efficient equipment*
- Automatically control the operation of that light:
 - *use light only When & Where needed*

Lighting Timeline

70,000 B.C.	Concave Rock Lamp Burning Animal Fat*
700 B.C.	TerraCotta Oil Lamp
1700	Glass Chimney Lamp – Whale Oil, Sesame Oil, Beeswax, Olive Oil
1792	Coal Gas Lamp
1859	Kerosene Lamp
1870	Joseph Swan & Thomas Edison Each Claim Invention of Electric Lighting
1879	Thomas Edison Produces First Commercial Incandescent Lamp
1927	Fluorescent Lamp Developed

** Popular in New Hampshire until 1986*

Key Term: Lumen

The standard measurement of luminous flux.

Lumens are used to quantify the,

Total amount of Light

produced by a source. Lamps are rated by total *lumens*.



75w. A19

1200 *Lumens of Light*

*75 Watts = the Power Consumed
by the Lamp , not the light output*

Key Term: Footcandle

- The illuminance on a surface one square foot in area on which there is a uniformly distributed flux of one lumen.
- Or; lumens (light) delivered to a surface




Type of Activity

Illuminances (fc)

➤ Public spaces	3
➤ Corridors, Lobbies and Stairways	5-10
➤ Auditorium (assembly)	10
➤ Classrooms/Lecture Rooms	30
➤ Science Labs	50
➤ Kitchen Facilities	50
➤ Gymnasiums	
▪ General	30
▪ Competition and Televised Events	50 - 150

Based on IES guidelines, expressed in *average maintained footcandles*.

Source: Illuminating Engineering Society

A decorative maroon shape in the bottom right corner of the slide, consisting of a curved line that starts from the right edge and curves upwards and to the left.

Type of Activity

Illuminances (fc)

➤ Libraries (reading)	30
➤ Lounge and Waiting Areas	10
➤ Offices	
▪ Paper work	30
▪ Computer use (vertical fc on screen)	5
▪ Conference areas	30
➤ Rest Rooms	5
➤ Shop Areas	
▪ Rough to medium bench/machine work	30 - 50

Based on IES guidelines, expressed in *average maintained footcandles*.

Source: Illuminating Engineering Society

Common Lamp Types

➤ Incandescent

- Standard
- Tungsten-Halogen (*H*)
- Halogen Infra-Red (*HIR*)

➤ Fluorescent

- Linear
- Compact
- Inductive

➤ High Intensity Discharge

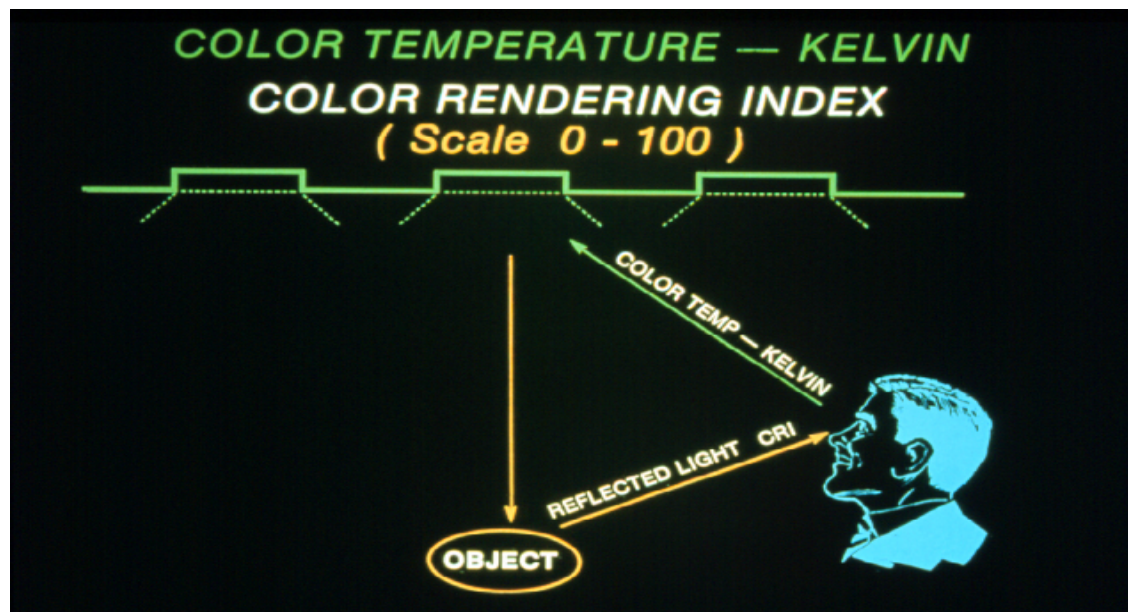
- Mercury Vapor (*MV*)
- Metal Halide (*MH*)
- Compact Metal Halide
- High Pressure Sodium (*HPS*)
- Improved HPS
- Low Pressure Sodium (*LPS*)

➤ Solid State Devices

- *Light Emitting Diode (LED)*

Color Temperature & Color Rendering Index

- The *Color Temperature* represents the appearance of a lamp source, as measured in degrees Kelvin, (K).
- The term *Color Rendering* describes the effect a light source has on the appearance of colored objects or surfaces.



Color Temperature

- The *Color Temperature* represents the appearance of a lamp source, as measured in degrees Kelvin, (K).
 - 3000 Kelvin Warm
 - 3500 Kelvin Neutral
 - 4100 Kelvin Cool White
 - 5000 Kelvin Daylight (Actual Daylight Fluctuates from Very Cool to Very Warm)

Color Rendering Index

The Color Rendering Index (CRI), is a rating from 1 to 100 that quantifies the ability that a light source has to render colors accurately, compared to a “reference” source of the same Color Temperature.

40 - 50

Poor

High Pressure

Sodium

60 - 70

Acceptable

T-12 Fluorescent

80-90

Good

T8 & T5

Fluorescent

Key Term: Efficacy

How effectively a lamp or ballast converts electricity to visible light.

- Measured in *Lumens-per-Watt*
- *Used How?*
 - Combined with fixture performance determines lighting efficiency
 - Codes require minimum efficacy for some lamps
 - Programs such as Efficiency Maine and the Collaborative for High Performance Schools (CHiPS) include efficacy standards
- *Why Not Efficiency?*
 - The Lighting Industry Includes Fixture Performance in Efficiency Ratings

Lamp Nomenclature

What Does This Mean?

F 32 T8 / 835



Lamp Nomenclature

F 32 T8 / 835

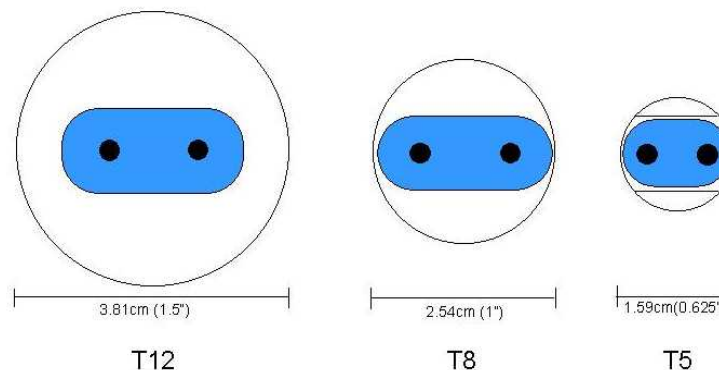
- F** **Lamp Type: Fluorescent**
- T** **Lamp Shape: Tubular**
- 8** **Lamp Size: 8/8” (One Inch)**
- 835** **8 (80-89 CRI) 35 (3500 Kelvin Color Temperature)**

T 12; 8; 5 fluorescent

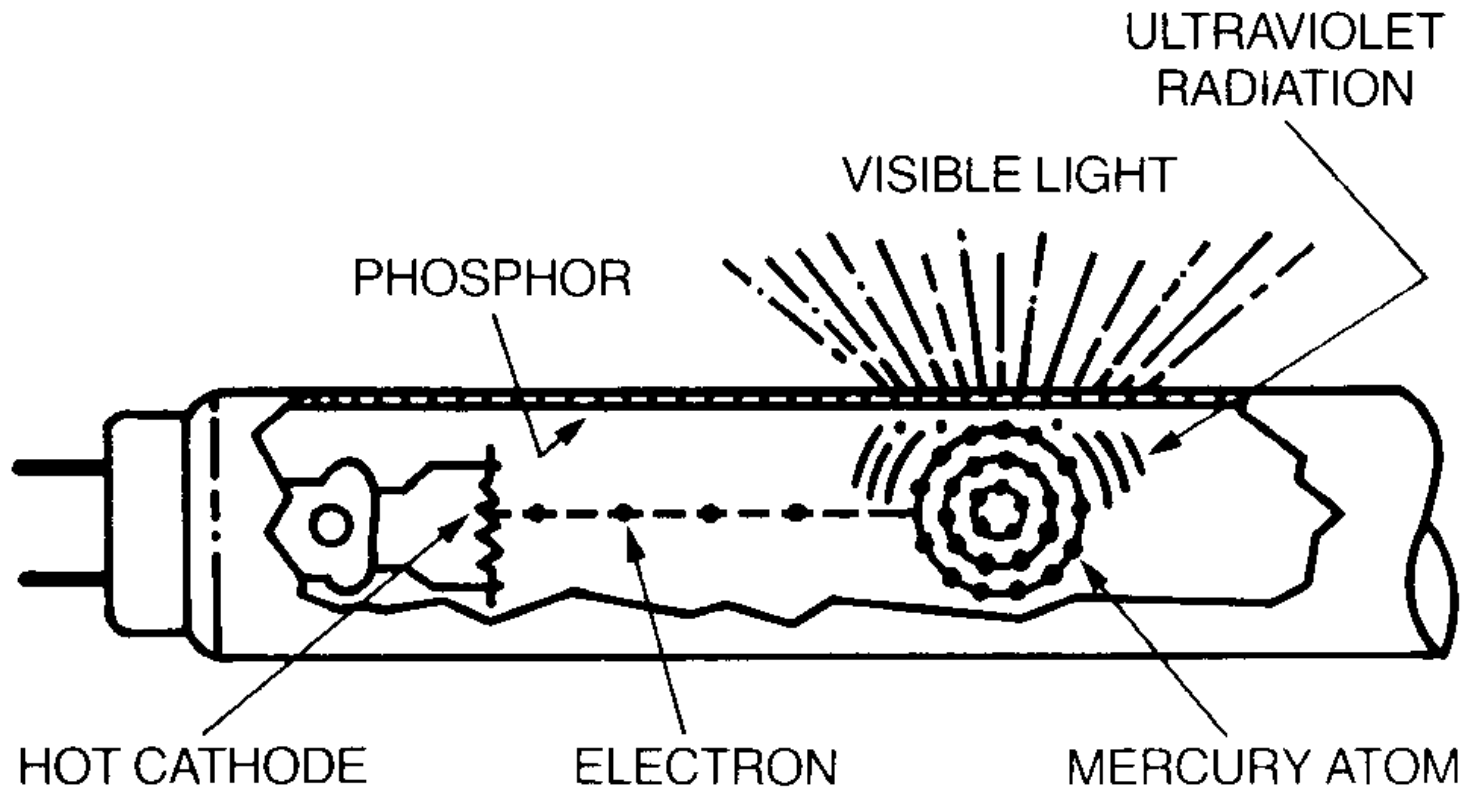
➤ The “T” represents lamp shape—tubular.

➤ The number following represents lamp diameter in eighths of an inch. A T5 has a diameter of 5/8”.

➤ A T5 has miniature bi-pin bases while T8 and T12 lamps use medium bi-pin bases.



Fluorescent Lamps: How They Work



Electricity excites the electrons which creates an arc between the cathodes (mercury arc discharge). This produces ultraviolet radiation which in turn excites the phosphors which glow and phosphores – thereby creating light

Ballasts

A ballast is a transformer, transforming the line voltage (120, 240, 277, etc) to the lamp operating voltage

Start lamps by providing initial high voltage to strike an arc between electrodes.

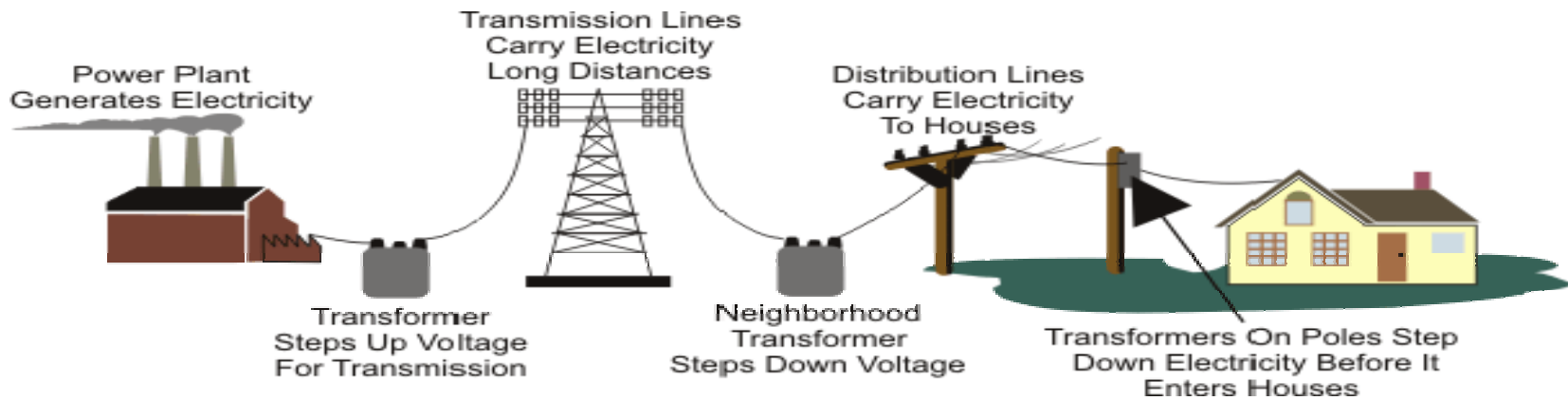
Regulate light output by maintaining normal operating current and voltage.



Basic System



- Electricity is a refined product – work energy
- Generation is the process of refining raw energy into electricity.
- The T&D system delivers the power to “end users”



What is a “High Performance” Ballast?



- 90% of the System Power Makes it to the Lamps
- Saves Additional 2 to 5 watts/fixture (appr. 6%)

How is this accomplished?

- Using High Grade Components
- Optimizing the Ballast Design
- Program participants are offered an **incentive** to install the more efficient product. The **incentive** is used to offset the higher price.



Ballast Types

➤ Magnetic

- Magnetic Core wound with wire
- The standard ballast for:
 - T12 Fluorescent
 - HID
 - Older Compact Fluorescent

➤ Electronic

- Resistors, Diodes, Transistors (Radio Shack in a box)
- The standard ballast for:
 - T8 Fluorescent
 - T5 Fluorescent
 - Modern Compact Fluorescent
- Also available for:
 - HID
 - T12 Fluorescent

Electronic Ballast Advantages

- *Higher efficiency*
- *Cooler operation*
- *Lighter and Smaller*
- *Less noise*
- *No Lamp flicker*
- *1, 2, 3 and 4-lamp designs*
- *Parallel wiring option*
- *Colder starting temperatures* (down to 0 degrees for most)

Fluorescent High Performance “Super” T8 system (HPT8)

- 2-Lamp HPT8 47-56 Watts
- 2-Lamp Standard T8 60-66 Watts
- 2-Lamp EE T12 70-74 Watts
- 2-Lamp Standard T12 80-94 Watts

That is a 10-50% Energy Savings

Plus

HPT8s:

- *Last Longer*
- *Provide Better Color Rendering*
- *Are Only Slightly More Expensive Than Standard T8*

T5 fluorescent

- T5 introduced to US in 1995.
- Innovative-designed compact fixtures with up-to-date optical materials.
- Only Produce Full Output at High Ambient Temperatures (100f)
- Efficacy About Equal to Standard T8
- But; Very Effective in the Right Fixture

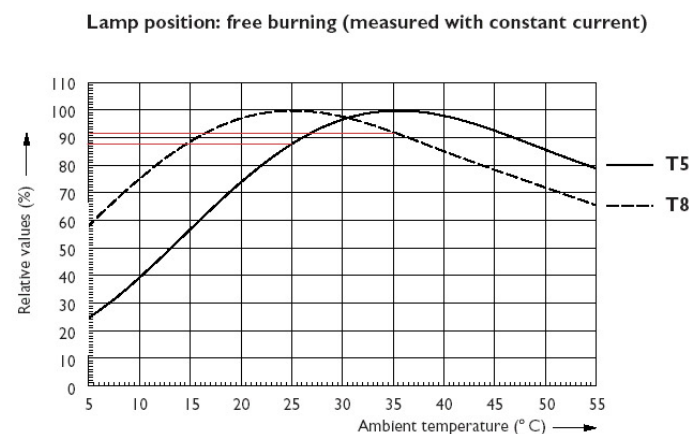
T5 fluorescent

- **Are T-5 fluorescent lamps more energy-efficient than T-8 fluorescent lamps?**

Sometimes

T5 lamps are more efficient than T8 lamps at 35°C (95 °F), but identical at 25°C (77 °F).

- T5 lamps are less efficient than HPT8 Lamps at all temps



T5

Advantages

- Small Diameter Allows Use in Compact Fixtures
- Optical Efficiency Allows them to “Throw” Light Better than T8 or T12 Lamps
- Use in Compact Enclosed Fixtures Allow Temperature to Rise and the Light Output to Improve

HPT8 & T5 fluorescent

Conclusions:

- For Most Applications Choose HPT8:
 - T5 and Standard T8 lamp-ballast systems have nearly identical efficacy values.
 - HPT8 Systems outperform all other fluorescent systems

- For Certain Applications Choose T5:
 - Extra cost of T5 systems is justified when using fixtures specially designed to take advantage of T5 Characteristics
 - T5 and T5 High Output (HO) often work well in gymnasium lighting systems

It's Not All About the Lamps Install Efficient Fixtures

- **Recessed Troffers** **60% - 85% Overall Efficiency**
- **Recessed Parabolic** **45% - 75% Overall Efficiency**
- **Recessed Indirect** **50% - 80% Overall Efficiency**
- **Pendant Indirect & D/I** **70% - 95% Overall Efficiency**
- **Recessed CFL** **35% - 65% Overall Efficiency**

Advanced Recessed Fluorescent HPT8 & T5 Fixtures



Lighting for Human Performance

- Why is lighting important
- Elements of good lighting
 - Illumination level
 - Brightness
 - Color temperature and color rendering
 - Glare and other visual comfort issues



The Essential Elements of Visual Performance

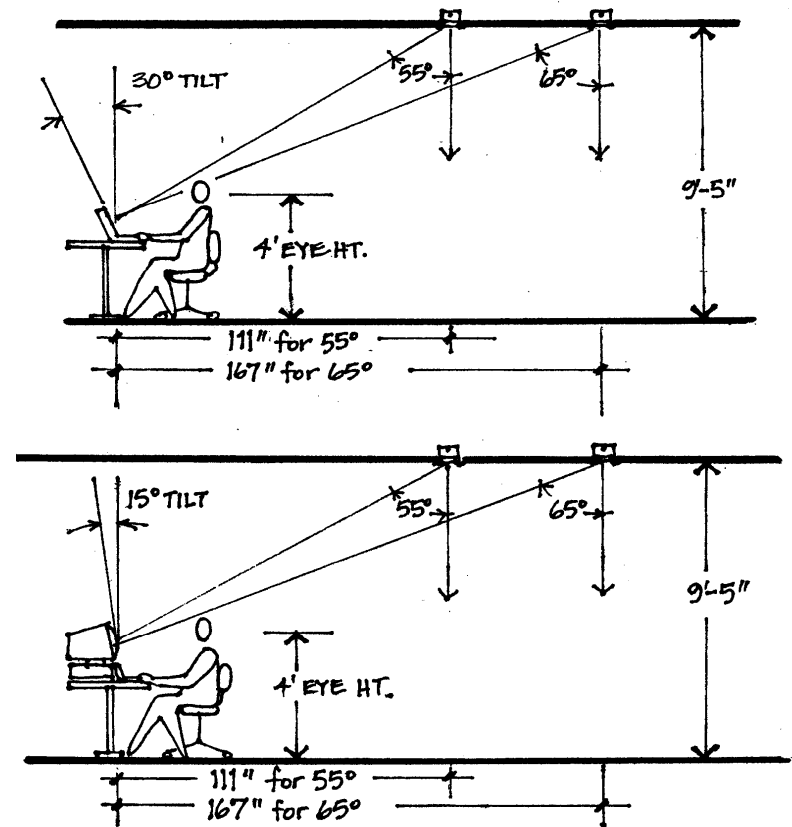
- **Proper Illumination Levels** – the human eye has an amazing ability to adjust, but only so much.
- **Object Contrast** – the ability to see and work with shapes relies on contrast in addition to brightness.
- **Accurate Color Rendering** – The eye and brain must strain to adjust when colors are rendered poorly.
- **Lighting Uniformity** – Large swings in illumination levels within the same space are at a minimum uncomfortable, and can be dangerous.
- **Glare Control** – Both direct and indirect glare needs to be controlled.
- **Daylight Integration** – When daylight is used, it must be properly integrated with the artificial lighting system.

Visual comfort – Glare

- Dealing with Direct Glare
- Using fixtures that hide the direct view of lamps
 - Pendant indirect fixtures
 - Recessed indirect fixtures
 - Cove fixtures
- Using fixtures that cut-off direct glare from some angles.
 - Louvered fixtures
 - Parabolic fixtures

Visual comfort – Glare

➤ Indirect glare



Applications: Office & Classroom Lighting

High Quality Lighting is Essential to a Productive Environment



Classroom Lighting

Lighting for human needs

- Use modern high quality electric light sources
 - Lamps 3500K or 4100K (4100K if mixing with daylight)
 - Color Rendering Index of 80+
- Use wall and ceiling brightness to create mood
 - Bright surfaces = cheerful and clean
 - Dark surfaces = dramatic



Applications: Office lighting

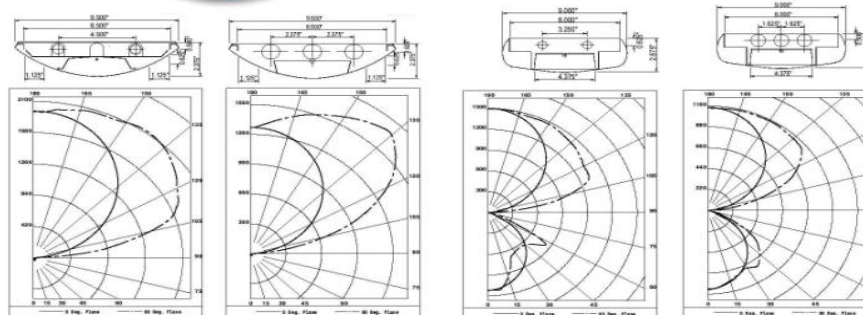
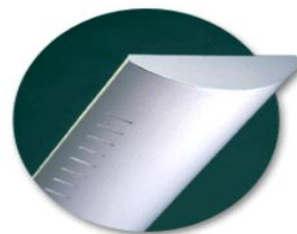
➤ Fluorescent – HPT8, T5

- Recessed Parabolic and Direct/Indirect
- Surface-Mounted Fixtures
- Fluorescent Wall-Washing Fixtures
- Pendant Direct/Indirect
- Pendant Fully Indirect



➤ Controls

- Occupancy Sensing





Efficiency Maine Business Program

Pendant Mounted HPT8 and T5 Incentives

Install New Indirect Pendant HPT8 and T5 Light Fixtures

- 80% or More Indirect Component
- Ceiling Heights Must be High Enough to Allow Even Lighting
- Lamps Should be Hidden From View for Glare Control

Applications: Corridor lighting

- Corridors and hallways are often overlit.
- Avoid the “cave” effect by lighting ceilings and walls.
- Use dedicated lighting for displays and artwork.
- Consider automatic controls.
- Minimize brightness ratios.

Applications: Gymnasium Lighting

➤ Fluorescent – HPT8, T5, CFL

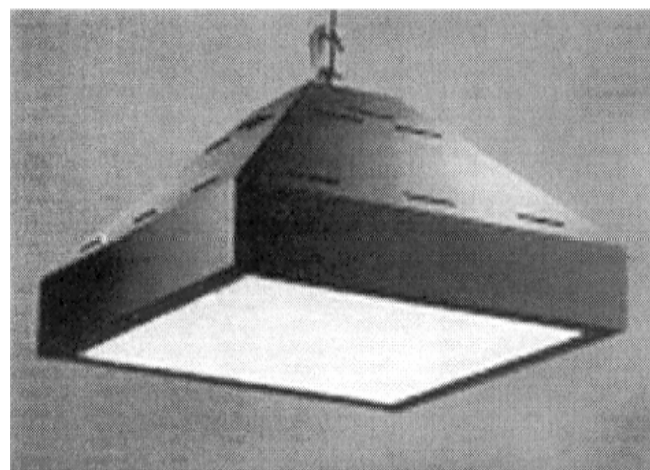
- T5 High Bay
- T8 High Bay
- CFL High Bay

➤ HID

- Pulse Start Metal Halide

➤ Controls

- Occupancy
- Hi/Low Dimming



Fluorescent Replacements for HID

T-5 and HPT8 Fluorescent high and low-bay fixtures

- Improved lumen maintenance over metal halide and compact fluorescent
- Lamp life equal to metal halide and longer than compact fluorescent
- Designed to operate on electronic ballasts
- Reduced glare
- Improved vertical illumination
- Improved on/off controllability
- Adaptable for multi-level lighting





High Intensity Fluorescent (HIF) High Bays

Install New HIF Fixtures

- Excellent Replacement for 250 & 400 Watt Metal Halide
- No Warm-up or Re-strike Wait Allows Fixtures to be Turned Off
- Available with Integral Occupancy Sensors and Hi/Low Dimming
- Large Energy Savings and Better Color Rendering
- Eliminate HID Ballast Buzz

Gym & High Bay Lighting



	400w Metal Halide	6 Lamp T8 HIF	4 Lamp T5 HIF
Watts	455	221	234
CRI	60	85	85
Lumens (Initial)	36,000	21,400	20,000
Lumens per/watt	79.12	96.83	85.47
Lumen Depreciation	40%	5%	5%
Fixture Efficiency	70%	95%	95%
Net Lumens	15,120	19,260	18,000
Activation	Warmup	Instant	Instant
Avg. Rated Lamp Life	20,000 hrs.	36,000 hrs.	30,000 hrs.
Operating Temp.	Hot	77° F	95° F
Weight	30 lbs.	8 – 15 lbs.	8 – 15 lbs.
Recycling (L & B)	\$2.00 to \$20.00	Less than \$5.00	Less than \$5.00
Fixture Relamp Costs	\$25.00	\$15.00	\$30.00

Miscellaneous Facts: HID lamps typically operate above 1,400° F
 T8 lamps lose 40% of lumens if ambient is above 135° F
 T5 lamps lose 50% of lumens if operating below 50° F

Quantifying Energy Savings



Typical Gymnasium:

Existing: (20) 400w metal halide fixtures, operating 2,500 hrs/yr.
 $450w \times 20 \text{ fixtures} = 9,000w$
 $9,000w / 1,000w/kw = 9.0kw$
 $9.0kw \times 2,500hrs/yr = 22,500kwh \times \$.15/kwh = \$3,375.00$

Proposal: (20) 6-lamp HPT8 fluorescent fixtures, operating 2,500 hrs./yr.
 $221w \times 20 \text{ fixtures} = 4,420w$
 $4,420w / 1,000w/kw = 4.4kw$
 $4.4kw \times 2,500hrs/yr = 11,050kwh \times \$.15/kwh = \$1,650.00$

Energy Savings:	Existing:	\$ 3,375.00
	<u>Proposal:</u>	<u>\$ 1,658.00</u>
		\$ 1,717.00 or 51% Reduction



Do the Right Thing!

➤ **Flourescent**

- Lamp: approximately \$0.07/foot
- Ballast: approximately \$0.27 to \$0.40 per pound

➤ **Metal Halide**

- Lamp: approximately \$1.00 to \$2.00/lamp
- Ballast: approximately \$2.00 to \$20.00 per pound or free

Note: Does not include shipping costs.



Applications: Outside lighting

Light pollution

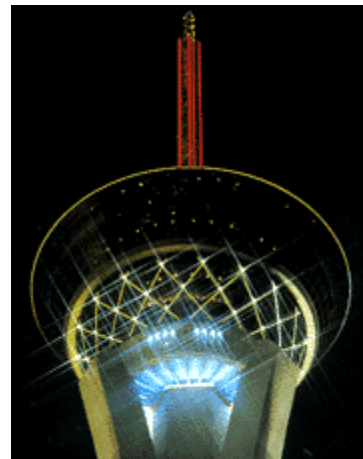


Applications: Outside lighting

- **Pulse Start Metal Halide**
- **High Pressure Sodium**
- **Full Cut-Off Fixtures**
 - Eliminates All Stray Light Pollution
 - Provides Effective Light Where Needed



- **Control**
 - Photocell
 - Outdoor Photocell 1g



Applications: Outside lighting

Light pollution

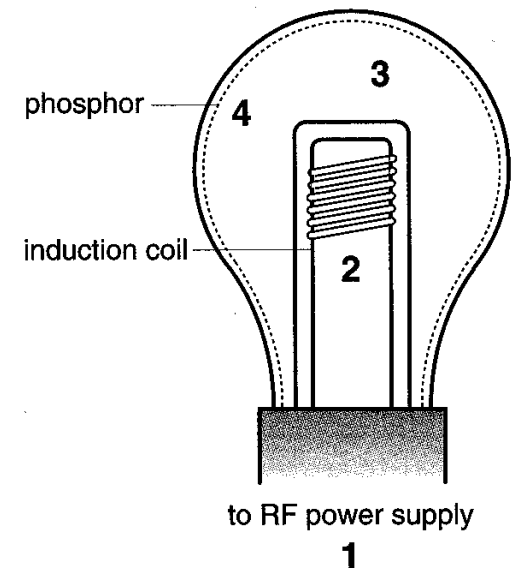
- **International Dark-Sky Association.** Source for information. www.darksky.org
- **The Outdoor Lighting Pattern Book.** From Lighting Research Center, RPI. Comprehensive treatment of outdoor lighting design, with emphasis on use of full-cutoff fixtures and other strategies to minimize light pollution. www.lrc.rpi.edu

New: Induction Lighting

➤ Available in: 55, 85, or 165 watts

Alternative to low wattage HID lamps: (*Street Lighting retro-fits*)

- Three parts to the system
 - high frequency generator (2.65mhz)
 - power coupler
 - discharge vessel (lamp)
- instant starting
- 100,000 hours average life
- 65 - 70 lumens / watt
- 85 CRI
- 3000°K, 3500°K, and 4100°K





Outdoor Lighting

Replace Existing Outdoor Lighting and/or Add Controls

- Replace Incandescent with Outdoor Rated CFLs
- Replace High Wattage HID with Lower Wattage Pulse Start Metal Halide
- Replace Manual Control with Timing System or Photocell Control

All Outdoor Lighting may be Eligible for Efficiency Maine Custom Incentive

Daylighting



Advantages of Daylighting

Improved Productivity: What the Studies Reveal

- Work performed under controlled, comfortable, natural daylight enhances worker comfort, productivity, and accuracy.
- Recent studies, including those performed by the Heschong Mahone Group on both worker and student performance in various environments, support this theory.
- Additional studies provide evidence that retail sales improve under daylit conditions.
- Many types of daylighting designs connect the workers with the outside world, reducing or eliminating the feeling of being trapped in an artificial environment while at work.

Workplace Performance and Lighting

Growing body of evidence on the relationship between productivity in the workplace and various features of lighting...

- e.g. Heschone Mahone Group studies on daylighting:
- School students progress 20% faster with improved math and reading test scores in daylit classrooms
- Database of evidence at
- www.betterbricks.com

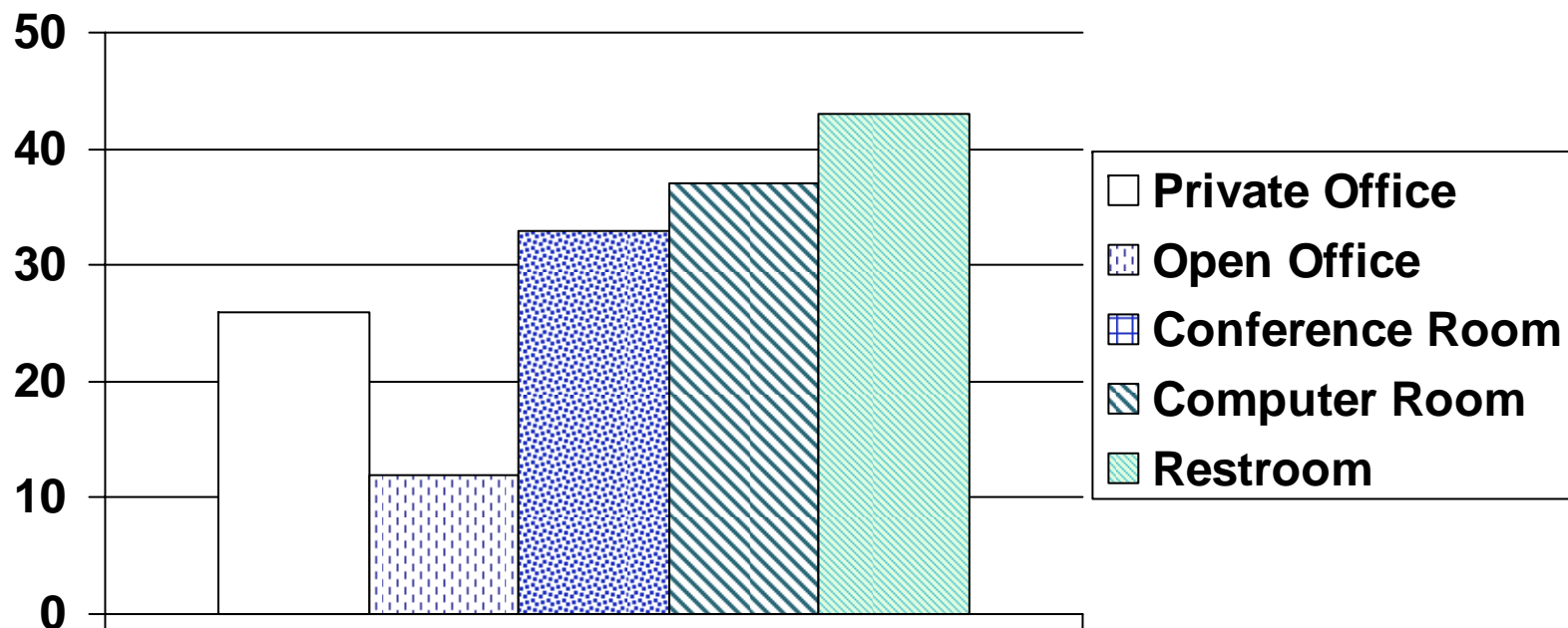


Recent Applications of Old Ideas



Occupancy Sensors Strategies

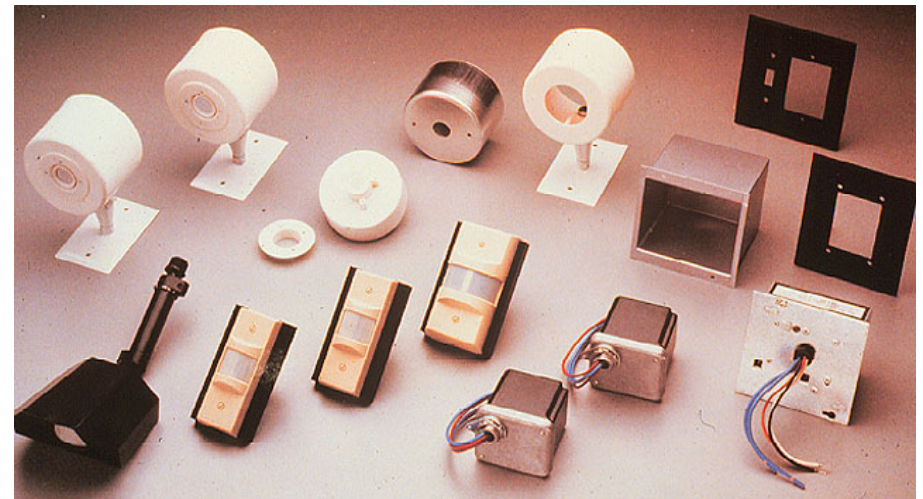
Typical Energy Savings (%)



Occupancy Sensor Types

- *Infrared*
- *Ultrasonic*
- *Sound Activated*
- *Dual Technology*
 - Infrared + Ultrasonic
 - Infrared + Sound Activated
 - Occupancy Sensor + Photocell control

- **Remote (Not Switch Plate Sensors) Occupancy Sensor Efficiency
Maine Standard Incentive - \$50.**



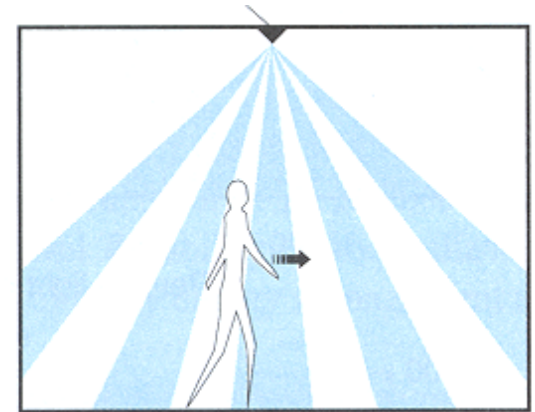
Infrared Sensors Applications

➤ *Best Applications*

- small enclosed spaces without obstructions
- hallways and storage aisles
- as wall switch replacements

➤ *Poor Applications*

- partitioned restrooms
- storage areas with obstructions
- large enclosed spaces with low ceilings



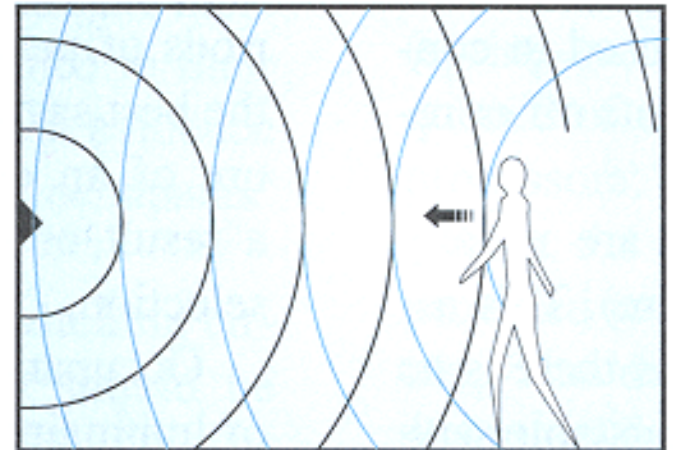
Ultrasonic Sensors Applications

➤ *Best applications*

- large offices and classrooms
- enclosed areas up to 2,000 square feet.
- storage areas with obstructions
- partitioned restrooms

➤ *Poor applications*

- non-enclosed areas
- areas with high air movement
- high ceiling areas (over 15 feet)



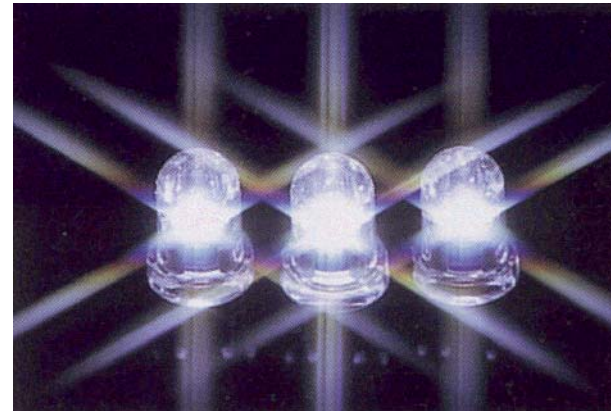
Summary: Lighting Cost Control Strategies

- *Maintain and make better use of existing lighting equipment.*
- *Take advantage of daylight when appropriate.*
- *Reduce lighting levels and operating hours where appropriate.*
- *Install more efficient lamps, ballasts and fixtures.*
- *Install Automatic Controls*

LED lighting

The fastest growing segment of the lighting industry

- Exit signs
- Casinos
- Amusement Parks
- Hotels
- Restaurants
- Retail
- Signage
- Festivals



General Advantages of LEDs

- Long life, low maintenance
- Vibration resistant
- Design flexibility
- Low voltage (10-24 volts)
- Dimming Control
- Allows for color/spectrum control (red/green/blue)
- Environmentally friendly (Hg & Pb free)
- Compact design allows for unique luminaire styling
- Low energy consumption
- Cold weather tolerant

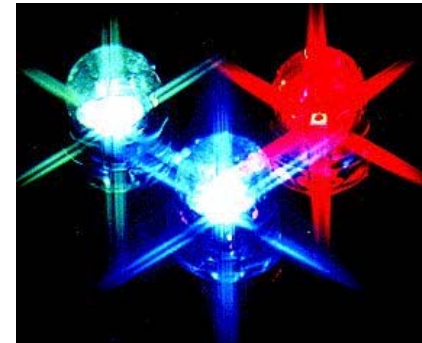
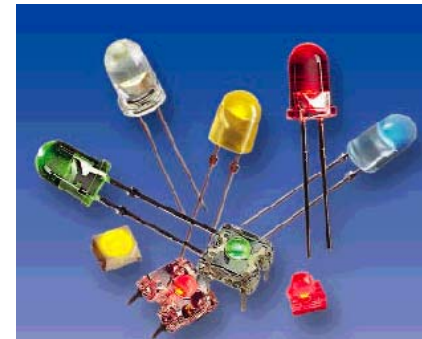
LED exit signs

- Incandescent Exit Sign
 - 30 - 40 Watts
 - Lamp Life – 8 Months
- LED Exit Sign
 - 3 - 8 Watts
 - Diode Life – 20+ Years
 - Cost - \$ 25 - \$ 50
 - Efficiency Maine Incentive - \$ 10

LED display lighting

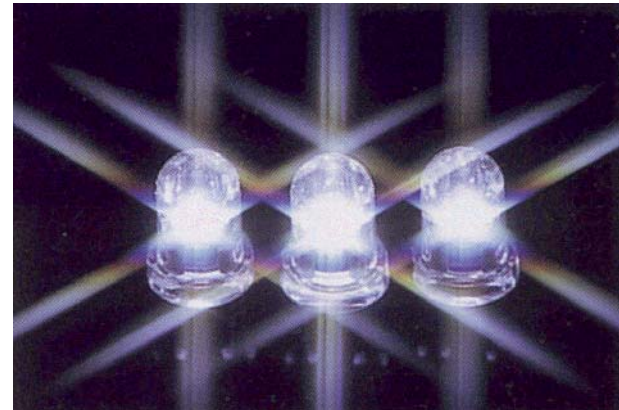
➤ Colored LEDs

- Long life
- Low maintenance
- Great flexibility
- Dimmable
- Highly directional
- Durable



White LEDs

- Not quite ready for prime time
- Wide manufacturing tolerances for color temperature and intensity
- Efficacy = fluorescent lamps
- Poor lumen maintenance
- Expensive
- But; Advancing Fast



LED vs. Fluorescent - Refrigeration/Freezer Case Lighting



- Improved product visibility
 - Directed light
 - Distributes light evenly
 - Uniform color
- Energy savings
 - Lighting load
 - Compressor load
- Reduced maintenance cost
 - 50,000 Vs 15-24,000 Hours average rated life
 - Less frequent re-lamping required
 - No tube guards or shields to replace
- Environmentally friendlier
 - No mercury

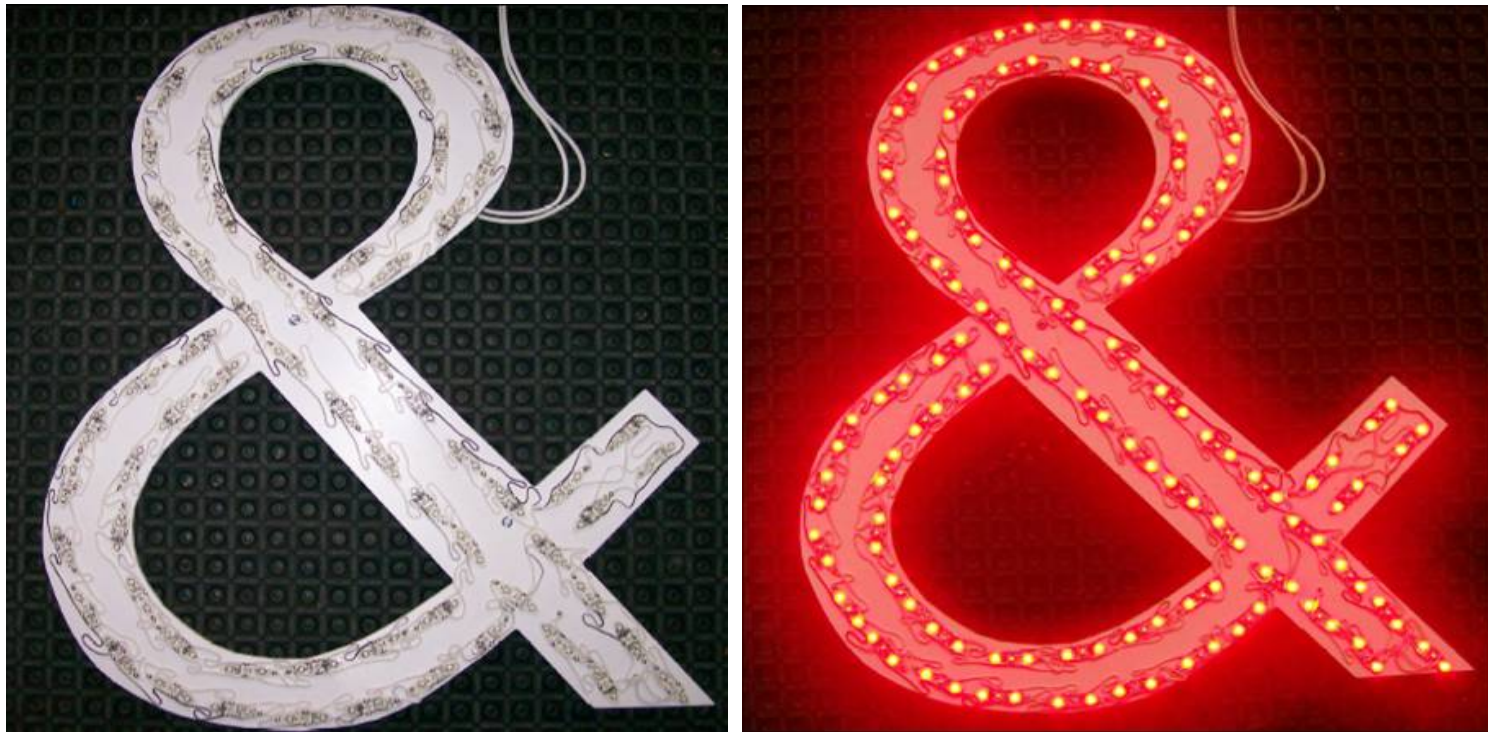
Sign w/ Backlight Orange



Chain for White Neon Replacement



LED Template System



LED Templates are Precision Engineered to
Provide Optimum Light Output, Uniformity &
Consistency

Electric Lighting in the Future

- **ElectroCeramescent Lighting (Ecer).** Flat and uniformly lit panel produces virtually no heat, glare, or halo even in adverse weather conditions. Reduces power for typical signage by 90%.
- **Hybrid Solar Lighting (HSL).** Collects and distributes the visible portion of sunlight using optical fibers, which are combined with electric lamps in lighting fixtures. The fibers convey sunlight inside a building for illumination. When less sunlight is available, the electrical light can be increased to maintain illumination levels.
- **Sulfur Lighting.** Couples high-power sulfur lamps to a light pipe system that distributes the light. No lumen depreciation.
- **Organic Light Emitting Diode (OLED).** Technology that is based on organic molecules that emit light when an electric current is applied.



WWW.EFFICIENCYMAINE.COM

- Online Tools & Services
- Tools
 - Insulation Facts
 - Heating Fuel Cost Comparisons
 - Home Energy Saver
 - Energy Efficient Residential Construction
 - New Energy Tax Credits
 - Wood Burning Stove Standards
 - Solar Primer
 - Small Wind Systems





WWW.EFFICIENCYMAINE.COM

- Visit our Web Catalog of Energy Efficient Products:
 - Compact Fluorescents (CFLs)
 - Controls
 - Switches
 - Crank Radios
 - Educational Items
 - Electricity Monitors
 - Bulbs: Hardwired, Plug-ins, Battery
 - Solar Cooking
 - Space Heaters
 - Thermometers
 - Thermostats
 - Ventilation & Fans
 - Water Related Items
 - Weatherization



Power Strips



The power strips on the following slide will not just help protect electronic devices from voltage surges, but will also help to reduce energy consumption.

The BITS Smart Strip power strips include one "monitored socket" and multiple "controlled sockets". When the device connected to the monitored socket is turned off, the power is cut to each of the controlled sockets, insuring that devices connected to those items are also off.

The Watt Stopper Isole product takes a different approach, using a motion-sensing remote that controls specific sockets on the power strip. The "controlled" sockets will automatically turn on when you approach your desk, and automatically turn off after you have walked away.



Power Strips



Globe Electric Power Strip Timer

Type: Timer

Outlets: 8

Surge Protection: na

US\$18.95



BITS Smart Strip Timer Power Strip

Type: Current Sensing

Outlets: 8

Surge Protection: 48000 amps

US\$29.95



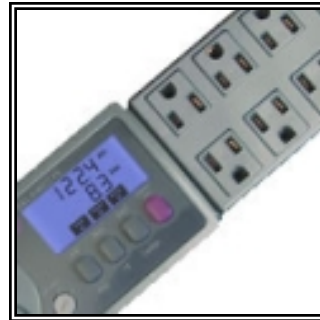
BITS Smart Strip Power Strip

Type: Current Sensing

Outlets: 10

Surge Protection: 84000 amps

US\$39.95



P3 Kill A Watt™ PS Electricity Monitor

Monitor: 8 Devices

Watt Display: Yes

Volt Display: Yes

Amp Display: Yes

Cost Display: Yes

PC Interface: No

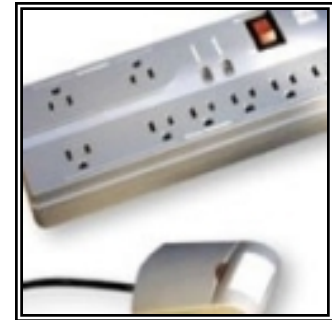
Web Interface: No

Power Switching: No

Memory: None

Connection: Plug

US\$79.95
Free shipping (UPS Ground)
Free shipping (USPS Parcel)



Isolé® IDP-3050 Plug Load Control

Type: Motion-Sensing

Outlets: 8

Surge Protection: 48000 amps

US\$89.95

Electricity Monitors



The use of electricity monitors will give you the information you need to understand what the operating costs are with various appliances & devices in your home or office.

The Kill-A-Watt monitor plugs directly into an outlet & immediately presents basic information about a device's electricity usage. It is very easy to use.

The Watts Up? monitors are more sophisticated with three models available. Key differences include – number of data points logged, PC interface, additional data storage, software, “real time” viewing and graphing of data along with automatic email notifications.



Electricity Monitors



P3 Kill A Watt™
Electricity Monitor

Monitor: 1 Device
Watt Display: Yes
Volt Display: Yes
Amp Display: Yes
Cost Display: No
PC Interface: No
Web Interface: No
Power Switching: No
Memory: None
Connection: Plug

US\$24.95
 Free shipping (UPS Ground)
 Free shipping (USPS Parcel)



P3 Kill A Watt™
EZ Electricity Monitor

Monitor: 1 Device
Watt Display: Yes
Volt Display: Yes
Amp Display: Yes
Cost Display: Yes
PC Interface: No
Web Interface: No
Power Switching: No
Memory: None
Connection: Plug

US\$40.95
 Free shipping (UPS Ground)
 Free shipping (USPS Parcel)



P3 Kill A Watt™ PS
Electricity Monitor

Monitor: 8 Devices
Watt Display: Yes
Volt Display: Yes
Amp Display: Yes
Cost Display: Yes
PC Interface: No
Web Interface: No
Power Switching: No
Memory: None
Connection: Plug

US\$79.95
 Free shipping (UPS Ground)
 Free shipping (USPS Parcel)



E.E.D. Watts Up?
Monitor

Monitor: 1 Device
Watt Display: Yes
Volt Display: Yes
Amp Display: Yes
Cost Display: Yes
PC Interface: No
Web Interface: No
Power Switching: No
Memory: None
Connection: Corded Plug

US\$89.00
 Free shipping (UPS Ground)
 Free shipping (USPS Parcel)



E.E.D. Watts Up? Pro
Monitor

Monitor: 1 Device
Watt Display: Yes
Volt Display: Yes
Amp Display: Yes
Cost Display: Yes
PC Interface: Yes
Web Interface: No
Power Switching: No
Memory: None
Connection: Corded Plug

US\$115.00
 Free shipping (UPS Ground)
 Free shipping (USPS Parcel)

Electricity Monitors



Blue Line Powercost Monitor™

Monitor: House
Watt Display: Yes
Volt Display: No
Amp Display: No
Cost Display: Yes
PC Interface: No
Web Interface: No
Power Switching: No
Memory: None
Connection: Wireless
 US\$140.00
 Free shipping (UPS Ground)
 Free shipping (USPS Parcel)



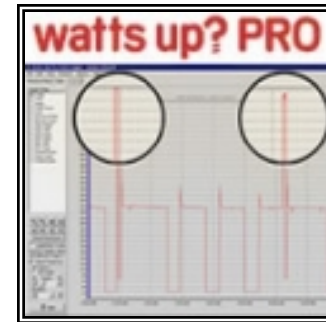
E.E.D. Watts Up? Pro/ES Monitor

Monitor: 1 Device
Watt Display: Yes
Volt Display: Yes
Amp Display: Yes
Cost Display: Yes
PC Interface: Yes
Web Interface: No
Power Switching: No
Memory: 8000 pts
Connection: Corded Plug
 US\$195.95
 Free shipping (UPS Ground)
 Free shipping (USPS Parcel)



E.E.D. Watts Up? .Net Monitor

Monitor: 1 Device
Watt Display: Yes
Volt Display: Yes
Amp Display: Yes
Cost Display: Yes
PC Interface: Yes
Web Interface: Yes
Power Switching: Yes
Memory: 8000 pts
Connection: Corded Plug
 US\$235.95
 Free shipping (UPS Ground)
 Free shipping (USPS Parcel)



E.E.D. Watts Up? Pro RT Software

Sophisticated software for Pro models
 US\$72.95
 Free shipping (UPS Ground)
 Free shipping (USPS Parcel)

Useful Websites



- www.energycymaine.com – Official Website of Efficiency Maine
- www.eere.energy.gov/greenpower – USDOE Energy Efficiency & Renewable Energy
- www.energystar.gov
- www.energytaxincentives.org
- www.maineenergyinfo.com
- www.cee1.org – Consortium for Energy Efficiency
- www.dsireusa.org



Break



HVAC Maintenance



Low-cost / no-cost HVAC Maintenance “Must Do’s”

- Train your building operators!
- Purchase & Populate a PM System
- Know thy utility reps!
- Change your filters
- The \$0.89 solution
- Electric motor game plan
- Take a field trip



Low cost / no cost

Purchase & Populate a Preventative Maintenance System

- Garbage in / garbage out
- Good memory
- Head's up
- SchoolDude.com



Low cost / No cost Change your filters



Low cost / no cost

What is the \$0.89
solution?



Low cost / no cost

Electric motor game plan

- “When I die, replace me with a ...”
- www.MotorUpOnline.com
- What do motors really cost?



Cost of Motors?

Cost of Running Pump Motor:

1. 4,000 hours run time
2. 30 HP
3. 1 HP = 0.746 KW
4. Annual kWhrs = $4000 \times 30 \times .746 = 89,520$ kWhrs
5. Cost per kWhr = \$0.15
6. Cost energy = \$13,428.00 every year!



Low cost / no cost

Take a field trip

- Why is that running?
- What is that noise?
- How is that controlled?
- When is that turned off?
- What the _____ is that???



Low cost / No cost

At Least the Kids Will Know What's for Lunch



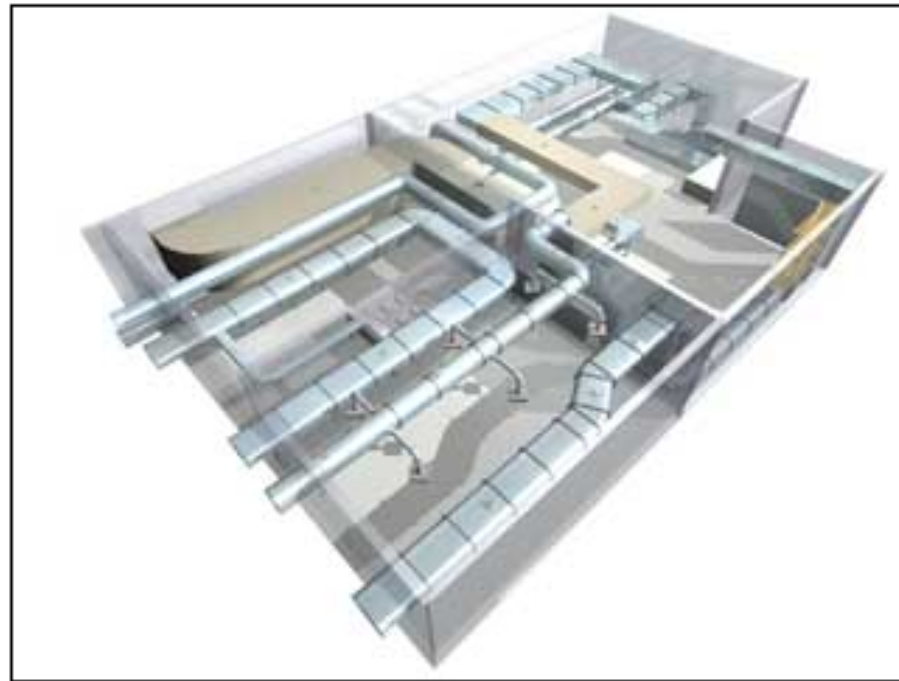
Some-cost/ BIG return HVAC Maintenance “Must Do’s”

- Repair leaky ductwork
- Service your steam traps
- Boiler maintenance items we all should be doing.
- Furnace maintenance items...ditto
- Retro-commissioning

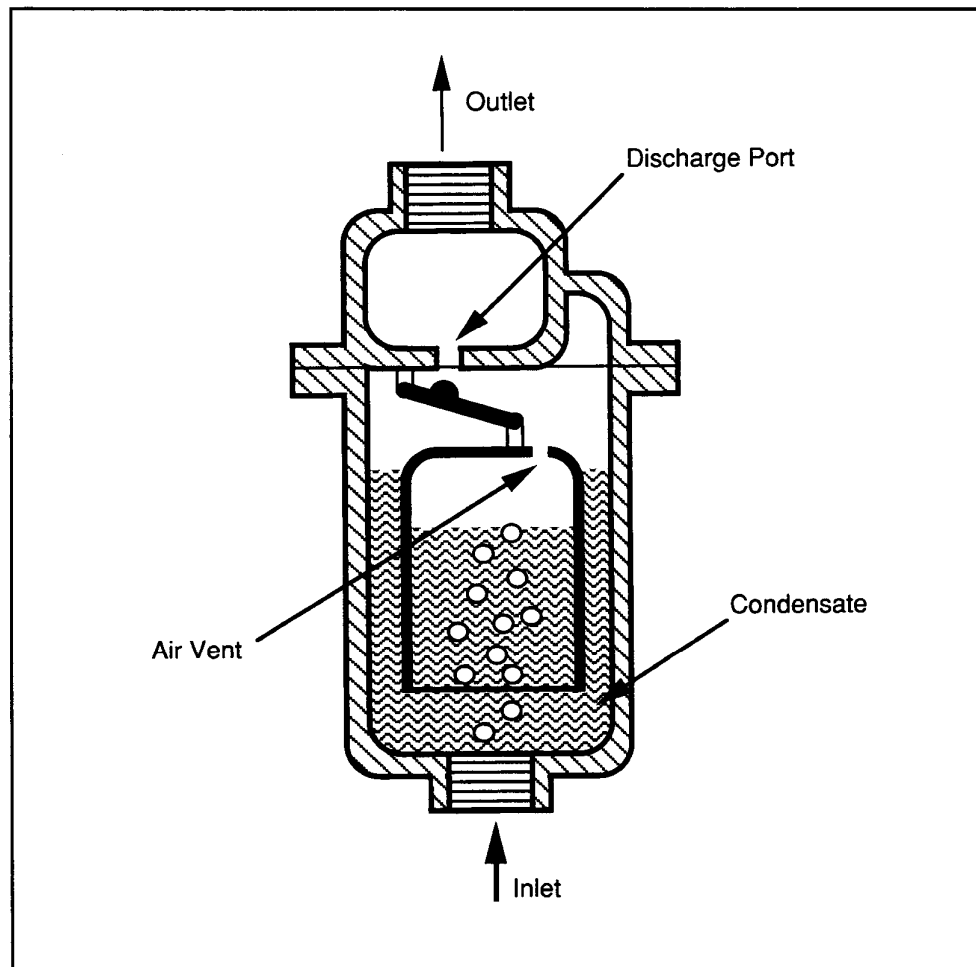


Some-cost/ BIG return

Repair leaky ductwork!



Steam Traps



Boiler Maintenance Items

- Exchangers
 - fireside & waterside
- Water treatment
 - blow-down
 - chemical treatment
- Draft fans
 - belt inspection & tightening
 - lubrication
- Periodic tune-ups
 - stack gases - O₂
 - stack temperature
 - burner adjustment
- Air vents
 - inspect for proper function
- Pump lubrication
 - feedwater
 - condensate

Boiler Maintenance Items

- Reduce excess air.
- Install stack economizer.
- Preheat oil.
- Reduce blowdown losses.
- Lower boiler water temperature or pressure.
- Insulate boiler shell.
- Turn off during cooling season.
- Preheat combustion air.

Furnace Maintenance

- Filter replacement
 - Monitor pressure drop across filter.
 - Check manufacturer's recommendations against actual facility operating conditions.
- Fan lubrication and shaft wear
- Inspection of exchanger for deposits and fouling
- Cleaning of cabinets and plenums

Retro-Commissioning

“ Changing occupant needs, space reprogramming, building renovations, and obsolete systems play havoc with building system efficiency and cause significant occupant complaints. Such issues drive up energy and maintenance costs and make facilities less attractive to new and existing occupants.”



Building Recommissioning

- A process designed to bring facilities back to their original and optimal operation through diagnosis and implementation
- Shown to reduce energy costs of large end-users by an average of 15 percent
- Should be incorporated as part of on going systems maintenance



Building Recommissioning: Targeted Systems

- Supply Air-handling Systems
- Exhaust Systems and Fume Hoods
- Automatic Temperature Controls
- Steam, Condensate and Hot Water Distribution
- Illumination and Lighting Controls



Benefits of Recommissioning

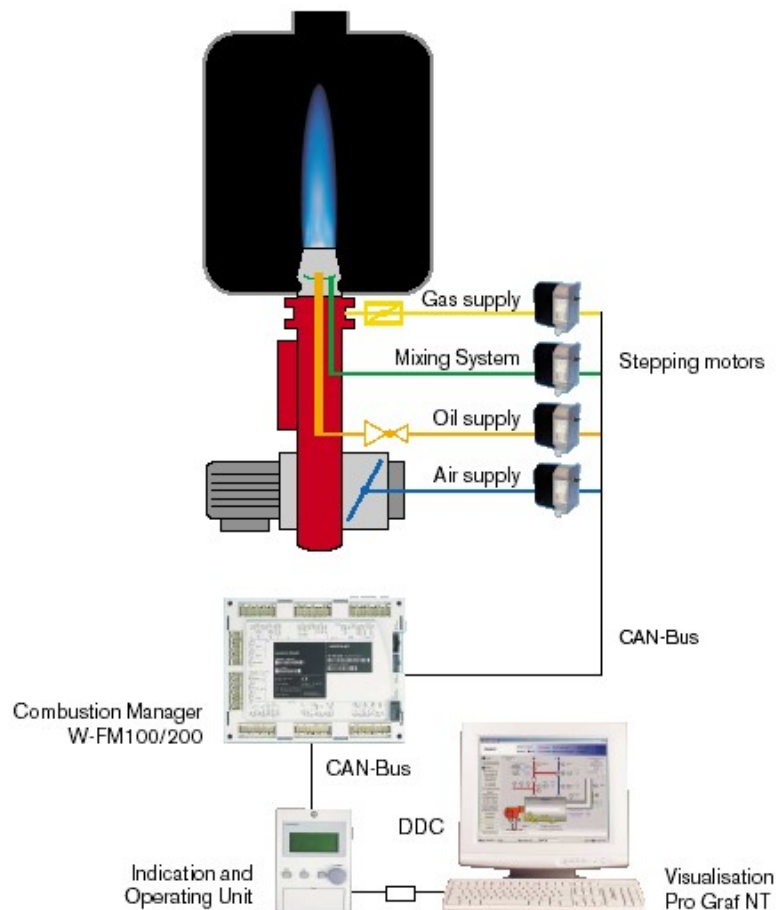
- Continued Energy Savings
- Lower Maintenance Costs
- Fewer Equipment Failures and Longer Operating Life
- Better Comfort and Health of Building Occupants
- Reduced Risk of Indoor Air Quality Complaints
- Improved Building Documentation to Aid in Troubleshooting and Support Efficient Operation



HVAC System Upgrades



Improving Boiler Efficiency by Operating in Modulation Mode



➤ Control Strategies:

- Hot Water Temperature
- Steam Pressure
- Stack Flue Gas Temperature

➤ Best Solution: VFD on Burner Fan and Fuel Pump

Improving Boiler Efficiency by Reducing Excess Air

- Oxygen trim is used to control excess air
- Oxygen sensor needs calibration – typically, every six months to one year
- Most oxygen sensors need replacement every five years



PTAC – Packaged Terminal Air Conditioner

- Electrically powered
- Also known as “unitary” system
- Air to air, through-the-wall cooling unit
- Quickly removes heat and moisture from indoor air

PTHP – Packaged Terminal Heat Pump

- Similar to PTAC except that it also provides heating
- Struggles to maintain space temperature when outside air temperature drops to 30°F
- May require electric coils to make up difference



PTAC vs. PTHP



- Manufactured by GE, Trane, Lennox, LG, Carrier, Amana, McQuay, Friedrich & Others
- Electric heat & hydronic options exist
- COP as high as 3.6
- EER as high as 12.8
- EMS Options – setback, occupancy controls, temperature limits, maintenance, central control, radio frequency, remote thermostats, unit diagnostics
- Heat & cool only the space required
- Not as efficient as a ground source system





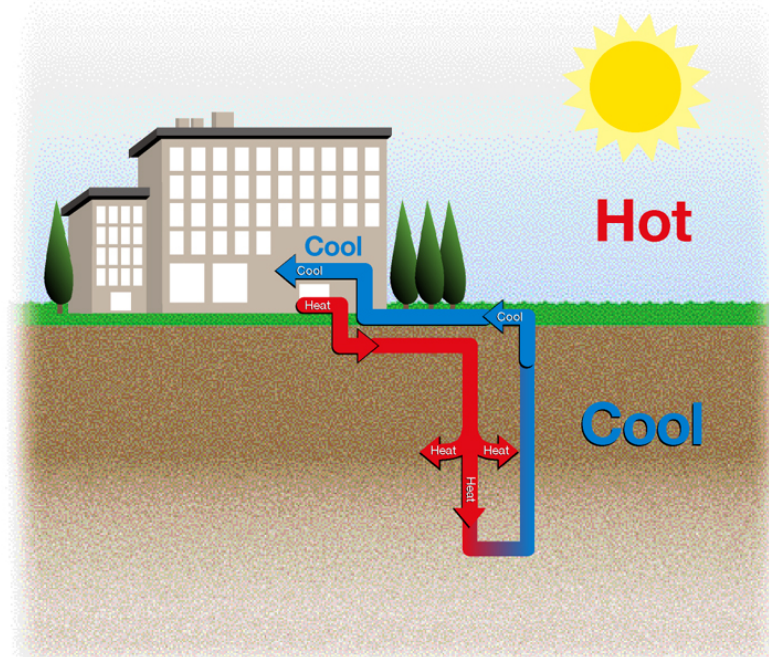
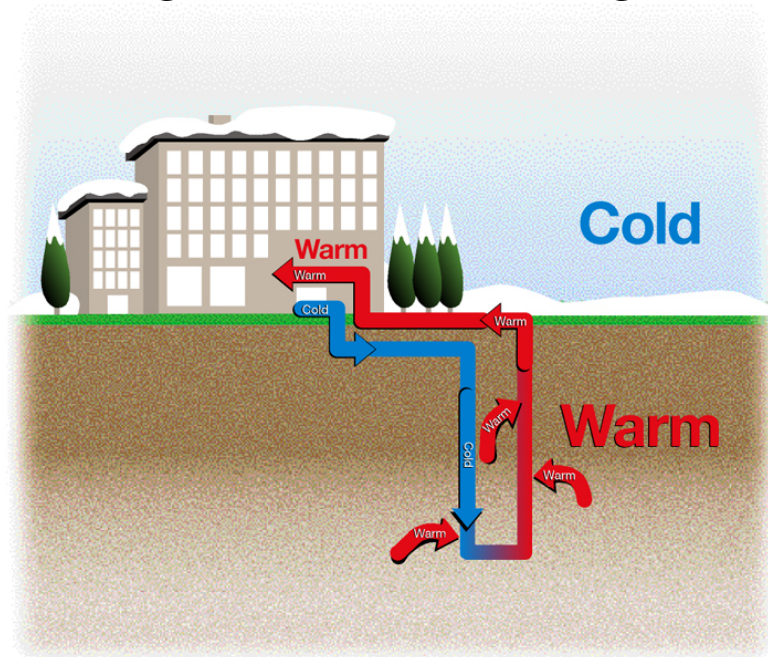
➤ **Unit Ventilator:**

- Typical for schools
- Usually not for air-conditioning
- Through-the-wall with fan
- Contains a coil with hot water the typical medium provided from a central boiler plant



Ground Source (Geothermal) Heat Pump

Not Cost Effective for Buildings Unless Providing Air Conditioning & Heat



Geo-Thermal or Ground Source Heat Pump (GSHP)



- Basic principle is to use the earth's temperature as a heating or cooling source
- Provides both heating & cooling
- EPA named geo-thermal the "most energy efficient & environmentally sensitive of all space conditioning systems"
- Underground temperature is constant year round at approximately 50°



Geo-Thermal or Ground Source Heat Pump (GSHP)



Homes:

- Closed loop system
- Polyethylene pipes buried vertically or horizontally
- Water or glycol mix is pumped through pipes
- In winter, fluid transfers heat from earth into the home
- In summer, system reverses itself by pulling heat from the living space back into the ground
- Typical energy savings is 30% to 50% on cooling bills
- System cost approximately 30% more than traditional
- Simple payback of 5 to 7 years
- Approximately 3 times more efficient than fossil fuel burning systems



Geo-Thermal or Ground Source Heating Pump (GSHP)



➤ **Businesses:**

- Reduce energy consumption (25% to 50%)
- Lower peak demand
- Competition life cycle costs
- Reduce or eliminate boiler or chiller maintenance
- All electric, eliminates multiple utility services
- System cost approximately 30% to 50% more
- Very quiet
- Multiple heating & cooling zones
- Environmentally friendly, no ozone depletion
- Eliminate need for rooftop or exterior equipment
- No external venting
- Precise climate control



Unit Replacement

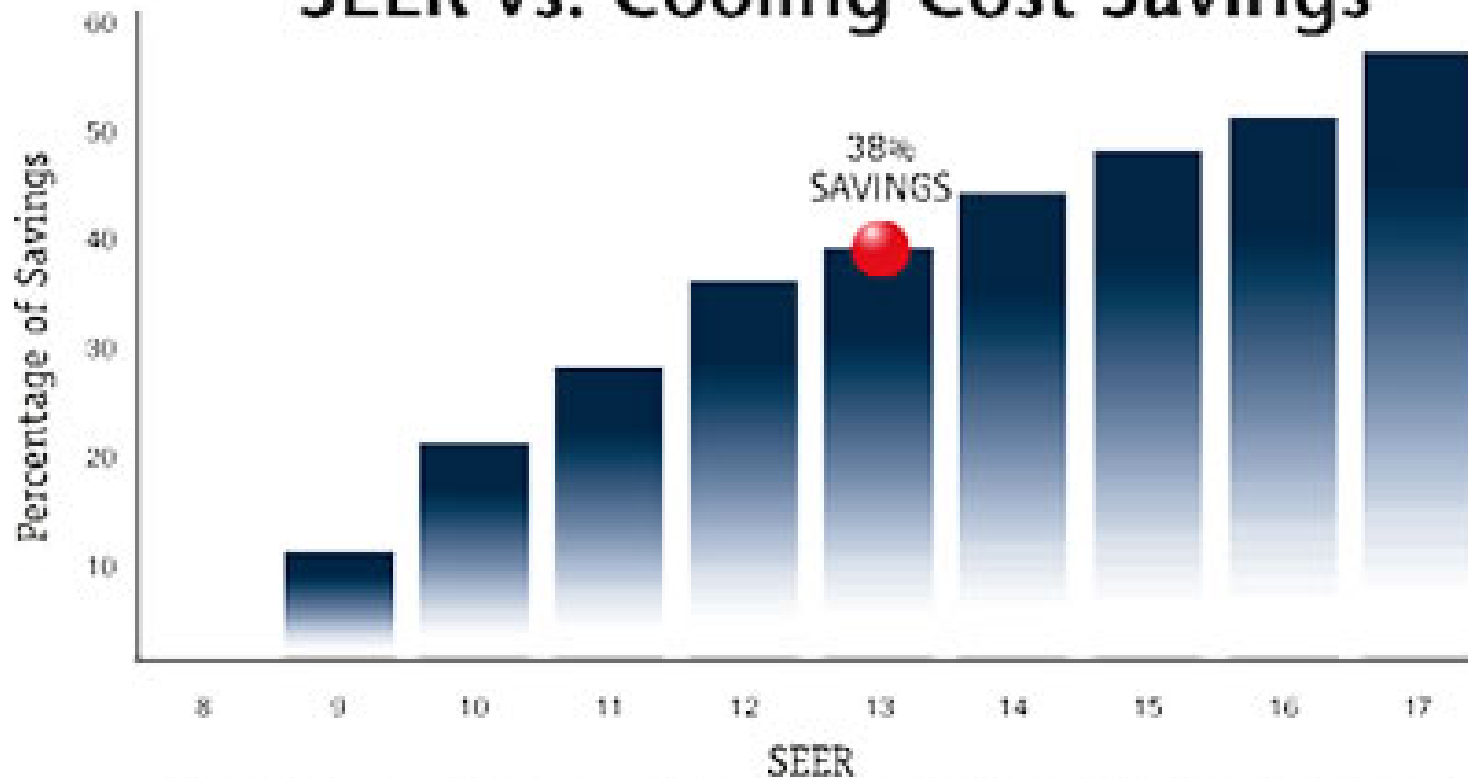
➤ High Efficiency Equipment

- Central Systems
 - Heat Pump Loops
 - Water Cooled Chillers
 - Air Cooled Chillers
 - Hot Water Boilers
- Distributed Systems
 - Packaged Rooftop Systems
- Unitary Systems
 - PTACs
 - Heat Pumps



Higher Efficiency Benefits

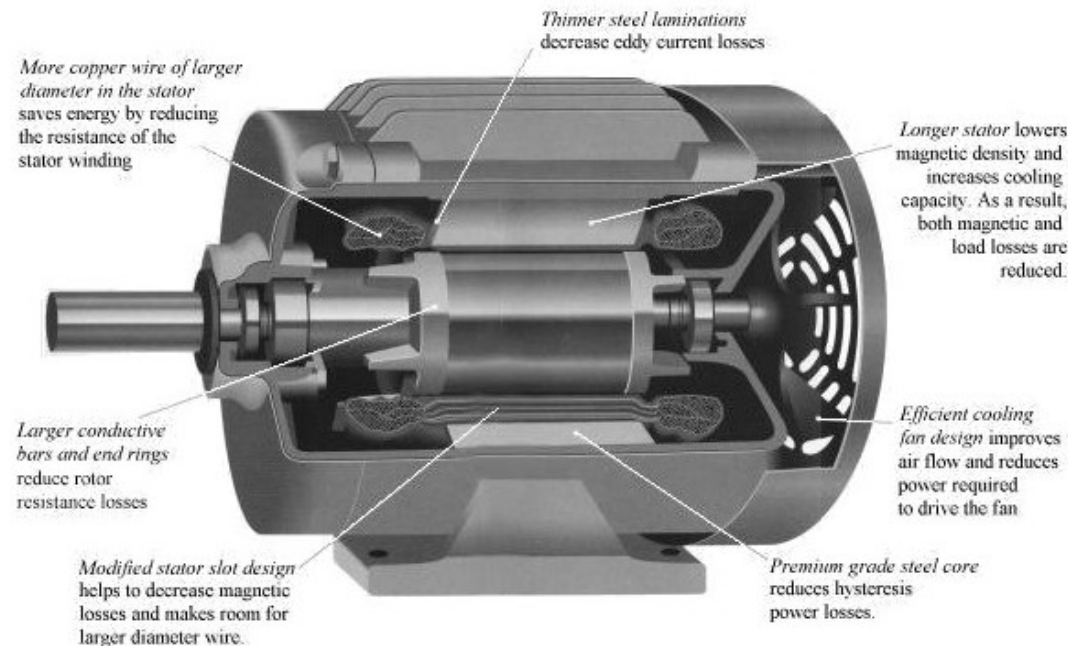
SEER vs. Cooling Cost Savings



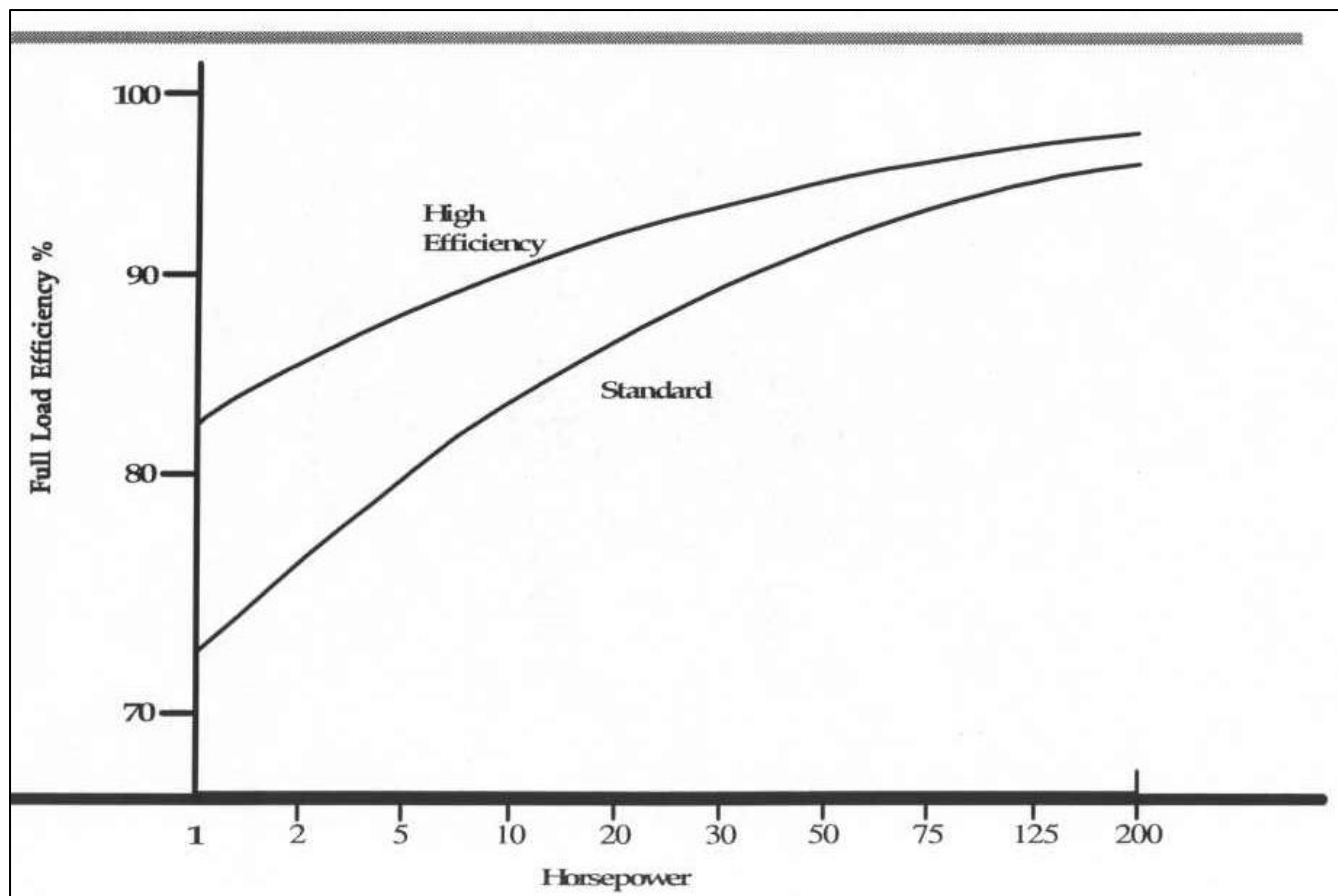
Percentage based on national averages; may vary according to efficiency of current unit and installation.

Premium Efficiency Motors

- Higher Efficiency
- Lower Operating Cost
- Incentives Offset Higher First Cost



Premium vs. Standard Efficiency Motors





Efficiency Maine – Motors Incentives

Size (HP)	OPEN DRIP-PROOF MOTORS (ODP)			Incentive (\$/Motor)	Size (HP)	TOTALLY ENCLOSED FAN-COOLED MOTORS (TEFC)			Incentive (\$/Motor)
	Speed (RPM)					Speed (RPM)			
	1200	1800	3600			1200	1800	3600	
	NEMA Nominal Efficiency				NEMA Nominal Efficiency				
1	82.5%	85.5%	77.0%	\$45	1	82.5%	85.5%	77.0%	\$50
1.5	86.5%	86.5%	84.0%	\$45	1.5	87.5%	86.5%	84.0%	\$50
2	87.5%	86.5%	85.5%	\$54	2	88.5%	86.5%	85.5%	\$60
3	88.5%	89.5%	85.5%	\$54	3	89.5%	89.5%	86.5%	\$60
5	89.5%	89.5%	86.5%	\$54	5	89.5%	89.5%	88.5%	\$60
7.5	90.2%	91.0%	88.5%	\$81	7.5	91.0%	91.7%	89.5%	\$90
10	91.7%	91.7%	89.5%	\$90	10	91.0%	91.7%	90.2%	\$100
15	91.7%	93.0%	90.2%	\$104	15	91.7%	92.4%	91.0%	\$115
20	92.4%	93.0%	91.0%	\$113	20	91.7%	93.0%	91.0%	\$125
25	93.0%	93.6%	91.7%	\$117	25	93.0%	93.6%	91.7%	\$130
30	93.6%	94.1%	91.7%	\$135	30	93.0%	93.6%	91.7%	\$150
40	94.1%	94.1%	92.4%	\$162	40	94.1%	94.1%	92.4%	\$180
50	94.1%	94.5%	93.0%	\$198	50	94.1%	94.5%	93.0%	\$220
60	94.5%	95.0%	93.6%	\$234	60	94.5%	95.0%	93.6%	\$260
75	94.5%	95.0%	93.6%	\$270	75	94.5%	95.4%	93.6%	\$300
100	95.0%	95.4%	93.6%	\$360	100	95.0%	95.4%	94.1%	\$400
125	95.0%	95.4%	94.1%	\$540	125	95.0%	95.4%	95.0%	\$600
150	95.4%	95.8%	94.1%	\$630	150	95.8%	95.8%	95.0%	\$700
200	95.4%	95.8%	95.0%	\$630	200	95.8%	96.2%	95.4%	\$700

VFD - Variable Frequency (Speed) Drives

- Adjust motor speed to the minimum required to meet a given load
- Reduce energy use when the motor is operating at less than full load
- Percentage of saving depends on the application

VFDs Applications

➤ Pumps

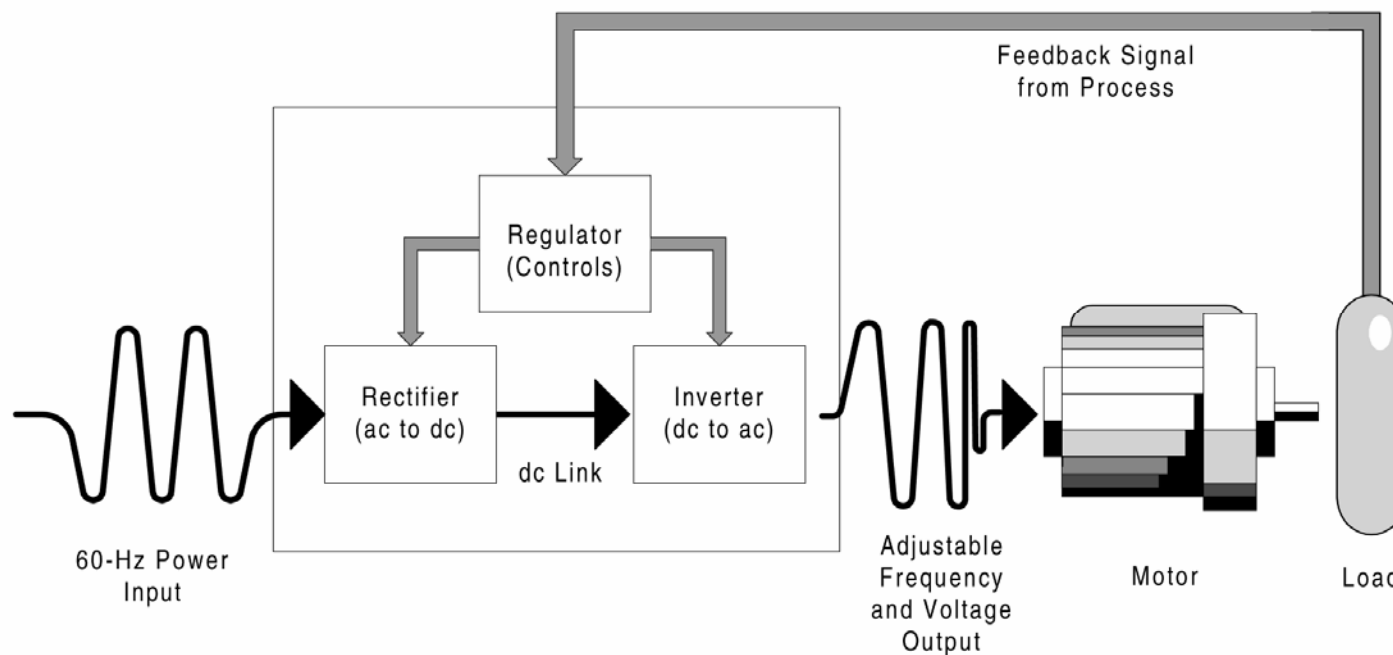
- Chilled Water Supply
- Hot Water Supply
- Reheat Water Pumps

➤ Fans

- Supply Fans
- Return Fans
- Ventilation Fans
- Cooling Tower



VFDs - How They Work



Efficiency Maine – VFD Incentives

Cumulative Motor HP Controlled by Each VFD	Maximum Incentive (\$)
7.5	\$1,700
8	\$1,730
9	\$1,760
10	\$1,800
11	\$1,840
12	\$1,880
13	\$1,920
14	\$1,960
15	\$2,000
16	\$2,100
17	\$2,200
18	\$2,300
19	\$2,400
20	\$2,500

- Other VFD measures, including larger sizes and process applications, may be eligible for custom incentives using the custom approach
- Minimum Operating Hours Requirements
- Harmonics Filtering Requirements

HP	Supply Fan	Return Fan	Exhaust Fan	Chilled Water Pump	Boiler Pump
7.5 – 10	3600	2000	2000	3000	4000
11 – 15	2800	2000	2000	3000	4000
16 – 20	2000	2000	2000	3000	4000

Electronic Programmable T-Stat

- Energy Savings due to Setback/Set-forward
- Seven Days Scheduling



Temperature Setback Savings – Maine Climate Zone

Set back	8 hours per day	16 hours per day	24 hours per day
5°	5%	10%	15%
7°	7%	14%	21%
11°	11%	22%	33%
13°	13%	26%	39%

Energy Management Systems (EMS)

- Optimal Start/Stop
- Scheduling
- Temperature Set Point Control
- Ventilation Control
- Demand Control



EMS Considerations

- **An EMS does not save energy!** The proper use of it does.
- EMS adds complexity to the HVAC system – more problems to troubleshoot.
- Compatibility/Proprietary Issues
- Continuous commissioning / re-commissioning is critical

Demand Control Ventilation (DCV)

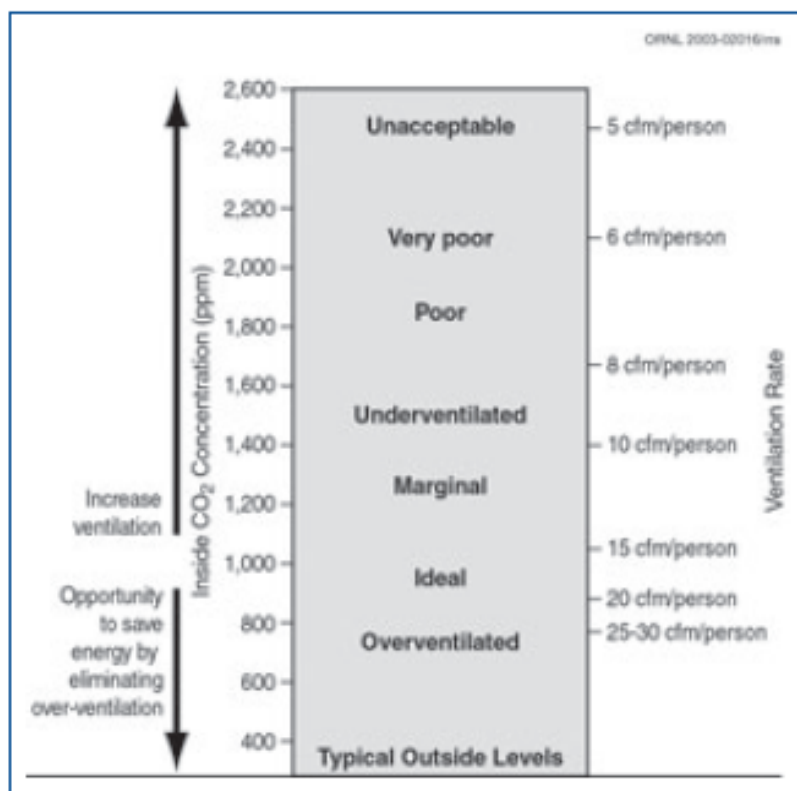


Figure 1. The relationship between CO₂ and ventilation rates, assuming office-type activity.



Figure 2. Typical non-dispersive infrared spectroscopic CO₂ sensor.

DCV Considerations

- System balancing is critical
- In duct installation is not recommended for all applications
- Interaction with air-side economizers should be considered
- Volatile gases that causes odors should be identified before installing DCV
- In-all applications of CO₂-based DCV, a minimum base ventilation rate must be provided at all times the building is occupied.

Heat Recovery

- Heat Recovery
 - Heat Wheels
 - Reverse Flow
 - Heat Pipes
 - Heat Pumps



Heat Recovery Benefits

- Typical savings vary by building type and building use
- Reduce the load of the HVAC equipment
- Increase efficiency by recovering the otherwise waste energy from the exhaust air
- Reduce cost of conditioning air to meet ASHRAE Standard 62

Vending Machines

- VendingMiser:
 - Reduces power consumption of a cold drink machine by an average of 46% without impacting sales or drinks.
 - Equipment is powered up when anyone approaches the machine, and is powered down when the area is vacant.
 - Approved by Coke and Pepsi



Energy Star Monitor Power Management

- Use System “Control Panel” to Automatically turn off Monitor and Drives When Not in Use
- Free tools from the US DOE:
 - EZ Wizard - Web-based software that allows power management on computer monitors.
 - EZ Save - Centrally-administered software tool that manages settings over a network.
- Flat Screen Monitors



Energy Efficient Kitchen

- Turn off Hood Ventilation When Not Cooking
- Don't Cool Empty or Near Empty Refrigerators and Freezers
- Control Hot Water Usage
- Consider Energy Efficient Ranges and Fryers

Excellent Commercial Kitchen Info:

<http://www.fishnick.com>



Plug Loads

Typical Appliance Wattage Values and Operating Costs		
Equipment	Watts	Annual Operating Cost
Computer (older monitor)	200	\$263
Fax Machine	300	\$394
Radio or Clock Radio	75	\$99
Coffee Maker	800	\$1,051
Microwave Ovens (50% Use)	1,400	\$460
Vending Machines	3,500	\$4,599
Refrigerator/Freezer, dorm size	350	\$460
Refrigerator/Freezer, standard	700	\$920
Ceiling Fan	100	\$66
Portable Heater (6 months)	1,500	\$986
Aquarium Heater	110	\$145
Engine Block Heater (6 months)	1,000	\$657
All Wattages are dependent on age, size, specific features and use patterns.		
Annual Cost is calculated using typical hrs/year and \$0.15 per kWh.		

Plug Loads

Typical Appliance Wattage Values and Operating Costs		
Equipment	Watts	Annual Operating Cost
Computer (Laptop)	65	\$85
Computer & Printer On	550	-
Television (32")	85	\$37
Toaster	700	-
Paper Shredder	183	-
Boom Box	8	\$10
Stair Lift Chair	234	-
Makita Table Saw	856	-
Ryobi (10" Chop Saw)	655	-
Delta Scrolling Saw	63	-
All Wattages are dependent on age, size, specific features and use patterns. Annual Cost is calculated using typical hrs/year and \$0.15 per kWh.		

How Did You Calculate That?



Home Computer – Measured Load: 110w

$$110\text{w}/1000\text{w}/\text{kw} = 0.110 \text{ kilowatts}$$

$$0.110\text{kw} \times 8,760 \text{ hrs/yr} = 964 \text{ kilowatt hours/yr}$$

$$964\text{kwh/yr} \times \$0.15/\text{kWh} = \$144.00 \text{ per year}$$




Plug Loads

- Turn-off Copiers at Night
- Plug D.C. Transformers into Power Strips and Turn-off at Night
- Choose Computer Power Saving Settings in “Control Panel”
- Don’t Chill Air in Refrigerators and Freezers
- Purchase Energy Star Rated Appliances



A Priorities Reminder

- Lighting Upgrades
 - Lighting Controls
 - HVAC Maintenance
 - HVAC Upgrades
 - Plug Loads
 - Commercial Kitchen Equipment
- 
- A decorative maroon shape in the bottom right corner, resembling a quarter-circle or a corner piece.

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<http://www.theboc.info>
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Questions?



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Getting Started Savings Energy – Fall 08

Presented by: Chuck Porter
Efficiency Maine Business Program
October 30, 2008



Leading the Way to a Brighter Future

Program of the Maine Public Utilities Commission

