A Guide to Energy Efficiency for Maine Businesses

Natural Resources Council of Maine

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Contents


UTILITIES

MAINE
STATE
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of
COMMERCE

Dear Business Manager,

Maine's homes and businesses consume approximately 500 million gallons of heating oil per year, and while we may have limited influence over energy prices, we can control how much energy we use. Through energy efficiency investments, we can reduce consumption and save money.

I am pleased to share with you this energy efficiency resource guide, prepared by the Natural Resources Council of Maine, to help you identify strategies, options, and resources for improving the energy performance of your business, buildings, and operations.

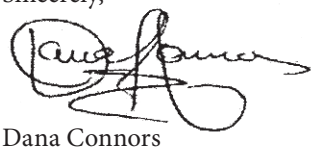
This guide includes case studies of businesses that have secured major reductions in energy waste through changes such as installing high efficiency motors and drives, improved lighting systems, and specialized refrigeration and controls. Improvements such as these routinely reduce energy costs by 20% or more. Many energy efficiency investments deliver almost immediate paybacks in terms of reduced energy costs. Improving the efficiency of our homes, schools, businesses, and facilities is an important strategy for the economic security of our state.

Energy efficiency improvements can also provide greater reliability, reduced maintenance costs, higher quality performance, and improved employee comfort, safety and productivity.

I hope that you find this guide useful in your efforts to reduce energy costs. As you consider making changes and investments in your business or institution, please know that a number of state and federal programs and resources are available to help you. Whether your need is technical or financial, or you simply want to gain confidence that efficiency options are worthwhile, this guide can help you with your decisions, with real world examples, a thorough overview of efficiency technologies, a list of resources, and more.

I am pleased that the Natural Resources Council of Maine has prepared this efficiency guide for Maine businesses and institutions, and I hope that it will prove valuable to you and your company.

Sincerely,



Dana Connors

President, Maine State Chamber of Commerce

1 Case Studies

The following pages include six case studies from businesses around Maine that have saved money through improved energy efficiency.

1. **Morris Yachts, Mt. Desert Island:** Extensive lighting and lighting controls
   "Upgrading our lighting and cutting our energy use is good for our bottom line—and it's the right thing to do. The lighting experts at EMC and Efficiency Maine made it simple from start to finish." Cuyler Morris, President

2. **The Apple Farm, Fairfield:** Pasteurizing machine
   "That old unit would have a problem the second you turned your back. If it ran dry, it would burn. The new unit is very user-friendly. We have not had one breakdown. We can do other things while it pasteurizes the cider. Now the machine works for us instead of us working for it!" Steve Meyerhans, Co-owner

3. **Wastewater treatment plants, Millinocket, Wells, Bath, Portland:** Motors, variable speed drives, lighting

4. **Reny's Stores, Pittsfield, Belfast, Newcastle:** Lighting
   "It's tempting to think 'if it ain't broke, don't fix it,' until you realize how dearly you're paying for inefficient and outdated lighting. The incentives provided by the Efficiency Maine program were just what we needed to take a serious look at the waste of electricity when using obsolete fixtures and bulbs. When you combine both the incentives and quick payback time, energy efficiency becomes an obvious cost-saver and business tool." Mary Kate Reny, Owner

5. **Moody's Collision Centers, Biddeford, Scarborough & Gorham:** Lighting and air compressors
   "Efficiency Maine is a fantastic program. It is like having a partner to help us look at the big picture. With advice from Efficiency Maine, we can be confident that the decisions we are making will save money on our operating costs and the incentives will allow us to invest in the latest technologies for the benefit of our customers and co-workers." Shawn Moody, Owner

6. **Hancock Lumber, Bethel:** Air Compressor, Variable Speed Drive, Lighting
   "The use of variable frequency drives, more efficient lighting and other measures helped us save money, protect jobs and further our company's overall thrust towards energy efficiency and sustainability" Mike Halle, General Manager

CASE STUDY

Manufacturing Facility Lighting

BETTER LIGHTING, LOWER ELECTRIC BILLS & REDUCED EMISSIONS

Objectives:

- Expand production area by 10,000 square feet while holding the line on lighting costs
- Improve rendering of paint colors on boats
- Lower electricity usage throughout the facility and reduce maintenance costs
- Reduce carbon footprint

Solutions

Energy Management Consultants, Inc. (EMC), a lighting energy services company and Efficiency Maine Program Ally, developed a comprehensive program of lighting upgrades:

- Replaced 400-watt metal halide fixtures throughout high-ceiling facilities with 6-lamp high-intensity fluorescent fixtures

  See photo at right.

- Replaced fluorescent strip fixtures in fabrication and finishing shops with high-efficiency fixtures and reflectors

  See photo on back.

- Retrofitted surface-mounted lighting fixtures in offices using High Performance T8 lamps and matching ballasts

- Added infrared occupancy sensor controls, directly mounted to each new high-intensity fluorescent fixture in storage sheds

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Keeping expenses low and quality high at Morris Yachts

As a builder of high-end sailboats, Morris Yachts has always been energy-conscious. But the company's recent growth, along with the rising cost of electricity, gave them extra impetus to examine their lighting systems.

Estimated Annual Savings

Electricity $15,400
Labor..... $ 1,000

Cuyler & Tom Morris

"Upgrading our lighting and cutting our energy use is good for our bottom line—and it's the right thing to do. The lighting experts at EMC and Efficiency Maine made it simple from start to finish."

—Cuyler Morris, President, Morris Yachts

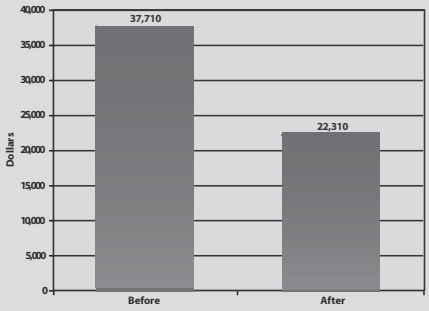
Manufacturing Facility Lighting

New High Performance T8 lamps in the refinishing shops enabled craftsmen to match customer's chosen paint colors more accurately than ever before.

The Plan:

Cuyler Morris, President, and Jeff Toman, Facilities Manager, worked with Energy Management Consultants (EMC), a lighting energy services company, to develop a comprehensive program of lighting upgrades. Efficiency Maine provided $17,615 worth of incentives to help Morris Yachts purchase over 225 new high-efficiency lighting fixtures that were installed in the production, storage, finishing and office spaces.

Annual Lighting Costs



The Results:

Even with an addition of 10,000 square feet of space, Morris Yachts has held the line on electricity consumption, lowered maintenance costs and gained better color rendering—essential to customers buying $100,000 yachts!

Project Benefits

- Reduced electricity costs
- Longer lamp life, which reduced maintenance costs
- Improved color performance
- Eliminated long warm-up time of metal halide fixtures

Financial Analysis

Project costs $78,950

Incentives from Efficiency Maine $17,615

Estimated annual reduction in electricity costs $15,400

Estimated annual labor savings $1,000

Simple payback . . . . . 3.7 years

Project Team

- Morris Yachts
- Efficiency Maine
- Energy Management Consultants, Inc., Program Ally

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The Apple Farm

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casestudy

Ripe with Energy Savings

Energy savings was just one of the many benefits realized when The Apple Farm replaced its large and unreliable pasteurizing machine with a sleek, compact unit that uses ultraviolet light to purify the cider.

Many customers began demanding that apple farms, large and small, pasteurize their cider, following a death linked to E-coli in 1996. The Apple Farm in Fairfield, Maine purchased a pasteurizing machine, a unit designed to process milk, which was the only option available at the time. While effective as a pasteurizer, the machine caused owners Marilyn and Steve Meyerhans a lot of problems. Marilyn said, "Apple juice contains apple fibers and the machine, designed for milk, always had trouble processing the cider. It was becoming less and less efficient, and we were constantly calling a mechanic to get it operating again."

Last summer, with the help of an incentive from Efficiency Maine, the Meyerhans bought the CiderSure 3500, which is designed for cider and uses ultraviolet light to eliminate dangerous contaminants. "We had been following the development of the ultraviolet technology, which has been used for years to clean water. Because cider is not clear, the trick was to design a machine that would allow a thin enough stream so that the ultraviolet light could work with the cider. This unit was approved by the FDA in 2000, and we have been considering it since then."

The Meyerhans purchased the CiderSure just as they were heading into their busiest time of year — the fall. Concerned about the complexity of setting up a new system, the CiderSure sat in the corner of their apple processing room.

Steve Meyerhans said, "We thought putting the new machine into operation would be a big deal, so we put it off and continued to call our mechanic for repairs to the old machine. One day, instead of repairing our old machine, our mechanic surprised us by announcing that the new machine was installed and ready to go! Since we started using the CiderSure, we have not had a single breakdown."

The Meyerhans say the new system offers them energy savings, a superior product, and ease of operation.

The Juicy Details

Energy Savings

The Meyerhans compared their electric bills and were pleased to learn that the new equipment has resulted in a consistent 25-30% reduction in their kWh usage. In addition, the CiderSure is reducing their demand (measured in kilowatts or kW) by 18 kW. Central Maine Power has informed the Meyerhans that The Apple Farm is being moved to a rate class that takes into account the reduced kW. The new, lower rates should result in further savings.

Better Product

One of the reasons that cider producers had resisted pasteurization is that it requires that the cider be heated – and heat changes the flavor. The new unit depends on the ultraviolet light, not temperature, and light does not alter the flavor of the cider.

♦♦♦♦♦

Marilyn said, "The ultraviolet light ensures purity without sacrificing freshness. We take comfort in knowing that our cider is safe to drink and our customers still get to enjoy the juice's taste and nutrients."

♦♦♦♦♦

Ease of Operation

The old machine was large, bulky and unreliable. Steve Meyerhans commented, "That unit would have a problem the second you turned your back. If it ran dry, it would burn. The new unit is very user-friendly. We have not had one breakdown. We can do other things while it pasteurizes the cider. If there is a problem or it runs out of cider, a sensor light comes on and it shuts itself down until an attendant is available. Now the machine works for us instead of us working for it!"

The Meyerhans also like the CiderSure's small, compact size and the fact that it can be moved around easily on its wheels. The machine plugs into a regular 120V wall outlet and does not require special wiring, as the old unit did. It also calculates the number of gallons processed and provides a printout so the output no longer needs to be tracked manually. And, it cleans itself with the touch of a button!

Estimated Energy Benefits
21,783 in kWh annually
18 kW reduction
Estimated annual energy dollar savings of almost $3,200
Moved to a more favorable rate

Improved product
No breakdowns interrupting product flow
No repair expenses
Operates without constant supervision
Smaller and mobile
Easy to clean

How EM Can Help Your Farm

Efficiency Maine offers free advice and cash incentives to help your business become more energy efficient. Call us at 866-376-2463 to find out how you can get started or how we can help you take the next step.

Cash Incentives

For all Maine businesses, the Efficiency Maine Business Program has cash incentives for:

- Qualified lighting
- NEMA Premium® motors
- Qualified HVAC equipment
- Adjustable speed drives for HVAC equipment
- Qualified commercial refrigeration equipment

In most cases, but not all, you must have your application pre-approved before you purchase equipment to be eligible for an incentive. Pre-approval is not required for purchases of motors or agricultural projects where the incentive is less than $1,000.

Custom Incentives

Other electric efficiency projects may also be eligible for "custom incentives." Custom incentives are calculated on a case-by-case basis and always require pre-approval. Call us at 866-376-2463 to discuss your ideas.

Support & More Information

The Efficiency Maine Business Program staff will assist you in applying for Efficiency Maine incentives, as well as other incentives and opportunities, such as the State Energy Program's small business low interest loans for energy efficiency projects. Call us at 866-376-2463 for guidance on eligibility and resources. Or visit the Web site, efficiencymaine.com.

Referrals

Talk to your supplier or vendor about how you can improve the energy efficiency of your business. If you need to locate a contractor who will assist you in determining the energy savings potential in your facility, or who can install or maintain energy efficient electric equipment, we have a network of Efficiency Maine Program Allies throughout the state who can offer guidance on how best to work with the program. You'll find the list at efficiencymaine.com or call us toll-free at 866-376-2463.

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Efficiency Maine is a statewide effort to promote the more efficient use of electricity, help Maine residents and businesses reduce electricity costs, and improve Maine's environment. Efficiency Maine is funded by electricity consumers and administered by the Maine Public Utilities Commission.

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Water & Wastewater Facilities

BENEFIT FROM ENERGY EFFICIENCY

Water and wastewater facilities across Maine have lowered their electricity costs by investing in energy efficient equipment. Efficiency Maine has provided 15 water and wastewater facilities with incentive checks ranging from $45 to $19,500 to help them purchase this equipment.

By investing in efficiency, these facilities choose to keep dollars in their communities and reduce environmental pollution associated with electricity production. The projects assisted by these incentives are saving more than 815,000 kWh annually and will reduce CO_2 emissions by 494 tons each year, the equivalent of taking 97 cars off the road every year that the equipment is in place.

Efficiency Maine provides technical assistance and cash incentives to make it easier for the towns and businesses of Maine to save electric energy. With energy costs rising and cash incentives available, now is the time to invest in energy efficiency.

Opportunities to save energy in your facility

When developing a plan of action, start with those areas that are the biggest energy consumers. In a treatment plant, typically the "activated sludge" process is the largest energy user, so that efficiency measures implemented at this point in the process will have the greatest impact on your energy bill. Efficiency Maine offers incentives on high efficiency electrical equipment including variable frequency drives, motors and lighting. *(See next page for more details.)*

Here's how we can help

Not sure where to start? You can find more information at our Web site, efficiencymaine.com/business or call us at 866-376-2463. Our staff will be glad to work with you and your supplier to give information and technical assistance or provide a list of suppliers familiar with Efficiency Maine. When you are ready to act, we will help you fill out the application. Just let us know how we can help you achieve your electric energy efficiency goals.

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Business Program

Program of the Maine Public Utilities Commission

Energy Efficient Projects at Water & Wastewater Facilities

Augusta Sanitary District – variable frequency drive (VFD)

Bath Water District – VFD

Bridgton Water District – VFD

Carrabassett Valley Sanitary District – motor

Gardiner Water District – VFD

Kittery Water District – motor

KKW Water District – motor

Livermore Falls Water District – VFD

Aqua Maine's Millinocket Central Pumping Station – VFD

Moosehead Sanitary District – lighting

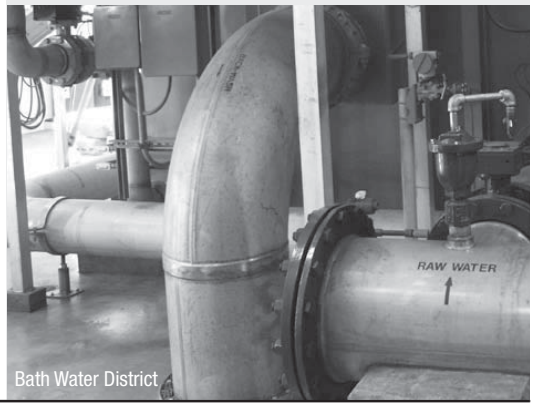
Ogunquit Sewer – VFD

Old Town Water District – lighting

Portland Water District – lighting and VFD

Town of St. Agatha – motor

Wells Sanitary District – VFD



Bath Water District

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CASE STUDIES	SCOPE	Total Project Cost	Eligible Project Cost	Annual Energy Savings	Total Annual Savings	Simple Payback	Efficiency Maine Incentives	Payback After Incentive
AQUA MAINE'S CENTRAL ST. PUMP STATION MILLINOCKET	Replaced one 20 HP and two 30 HP motors with three premium efficient 10 HP motors controlled by variable frequency drives to optimize pumping operations	$48,076	$16,760	31,455 kWh 24 kW	$5,247	3.1 years	$5,866	1.5 years
WELLS SANITARY DISTRICT	Upgraded the District's Pump Station No. 1 by replacing the existing magnetic-coupling drives with variable frequency drives on three 40 HP pumps	$58,400	$38,934	51,480 kWh	$5,148	7.5 years	$19,467	3.75 years
PORTLAND WATER DISTRICT	Retrofitted existing fixtures with HP T8 (super T8) systems and installed new HP T8 fixtures in designated areas	$73,860	$55,232	149,633 kWh 36.2 kW	$14,963	3.7 years	$13,597	2.8 years
BATH WATER DISTRICT	Replaced the existing throttling valve on two 75 HP raw water pumps with variable frequency drives to 3x150 HP high service distribution pumps to optimize pumps operation ("pump slow - pump longer")	$59,870	$59,870	375,940 kWh	$30,074 Raw Water Pumps $22,751 Distribution Pumps $7,323	2 years	$14,968*	1.5 years

** This project was completed during Efficiency Maine's pilot phase.*

Action Steps for Water & Wastewater Facilities

Variable Frequency Drives – Use VFDs on any pump or fan that has a variable load. Examples include effluent pumps, sludge transfer pumps, return activated sludge pumps, supply and/or return fans on variable air volume HVAC systems.

Premium Efficient Motors – Replace motors that have significant hours of operation and low NEMA efficiencies or failed motors with NEMA® Premium Efficiency Motors. Note: Make sure new motors are properly sized. Oversized motors will not save energy since under-loaded motors run at less than name-plate efficiencies.

Lighting – Replace or retrofit existing fixtures with new, more efficient High Performance T8 lamps and ballasts.

HVAC – Establish a maintenance log and maintenance budget for your heating, cooling and ventilation equipment. Proper maintenance can dramatically improve efficiency.

Dissolved Oxygen (DO) – Make sure that DO levels are maintained at designated set-points in the activated sludge. Excess oxygen means aeration equipment is running longer than necessary, thereby consuming more energy than needed.

Solid Retention Time (SRT) – Maintain a constant or target food to microorganism ratio (F/M).

Supervisory Control And Data Acquisition (SCADA) – Consider a SCADA, similar to an EMS (energy management system), which gives you the ability to control VFDs or other mechanical functions and also can trend data from sensor inputs.

Call Efficiency Maine to learn more about available incentives for energy efficiency equipment.

Fall 2007

EM POWER

ENERGY-SAVING NEWS FOR BUSINESS

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Renys: Using New-fangled Technology Helps Maintain Old-fashioned Prices

"It's tempting to think 'if it ain't broke, don't fix it,' until you realize how dearly you're paying for inefficient and outdated lighting. The incentives provided by the Efficiency Maine program were just what we needed to take a serious look at the waste of electricity when using obsolete fixtures and bulbs. When you combine both the incentives and quick payback time, energy efficiency becomes an obvious cost-saver and business tool." **—Mary Kate Reny**

Since 1949, offering quality merchandise at affordable prices has made Renys Stores a vital part of Maine culture. Even so, there is nothing old-fashioned about Renys' commitment to energy efficiency. Over the past year, the company has worked with Efficiency Maine on three projects to install more efficient lighting at retail stores in Pittsfield and Belfast, and in the Newcastle warehouse.

After nearly 60 years, Renys hasn't lost its magic touch at finding great buys on clothing, food and household products that Mainers love. However, it has become ever more challenging to control overhead costs, including energy. This is why Renys was glad to discover the Efficiency Maine Lighting Incentive Program after getting a copy of this newsletter last year.

Renys and its electrical supplier, WESCO, developed a plan to replace nearly 200 fixtures with T5s at its Newcastle warehouse and offices earlier this year. They calculated that with approximately $15,000 in Efficiency Maine incentives, the new lighting would pay for itself in less than two years. Motion sensors to control lighting usage may yield even greater savings.

Just as important, the T5s have made a world of difference in working conditions at the warehouse. The old lights, aging at different rates, gave off widely varying color spectra; the new ones are far more consistent. The enhanced visibility enables workers to sort clothing by color more accurately.

Based on this successful collaboration with Efficiency Maine, Renys has installed new lighting at two of its much-loved retail stores, and is planning to do so at others.

"We would never have thought about changing our lighting if we hadn't come across the Efficiency Maine newsletter, and that would have been a missed opportunity."
—Al Jasinski, Operations Manager

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Project Highlight: Moody's Collision Centers

Businesses are Painting the Town Green

BIDDEFORD – In the 29 years since Shawn Moody opened Moody's Body Shop, the business has grown to include three auto collision shops – now known as Moody's Collision Centers – in Gorham, Scarborough and Biddeford. Moody's perspective on their business has also grown. "When we started, our goal was to provide a service to local residents that exceeded their expectations. Our primary focus will always be taking care of each customer, but we now also take the macro view and understand that how we do our work affects the environment. We pay attention to being efficient so our customers receive value for their dollar, and we minimize the impact on the planet – which is in the best interest of all of us."

When constructing its Biddeford shop in 2003, Moody's sought the most energy efficient spray paint booths and added energy efficient lighting, for which Moody's received Efficiency Maine incentives. Moody said, "Lighting is critical in our business. We need bright, comfortable work areas for our co-workers to do their best work. They take pride in their work and their work environment, and they were really happy with our lighting in Biddeford."

When Moody's began planning for a new facility in Gorham, they contacted Efficiency Maine in order to take every opportunity to "be as green as possible." Efficiency Maine is working with Moody's contractor Atlantic Coast Electric, and supplier Gilman Electric, to identify the best and most appropriate lighting for the new facility. Shawn Moody said, "We've also found a spray paint booth with a variable speed drive that is so sophisticated it can adjust to variables in the paint products. We are working with our paint manufacturers to maximize the quality of the end product while using the least amount of time, electricity and heat."

♦♦♦♦♦

"Efficiency Maine is a fantastic program. It is like having a partner to help us look at the big picture. With advice from Efficiency Maine, we can be confident that the decisions we are making will save money on our operating costs and the incentives will allow us to invest in the latest technologies for the benefit of our customers and co-workers."

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CASE STUDY

Variable Frequency Drive Motors

BETTER LIGHTING, LOWER ELECTRIC BILLS & REDUCED EMISSIONS

Hancock Lumber: pulling energy savings out of thin air

Hancock Lumber uses compressed air throughout its Bethel sawmill—to saw, dry and mill lumber, as well as for clean-up and maintenance—so it accounts for a major portion of the company's electricity use. To mitigate the impact of a near doubling of its electrical rates, Hancock harnessed the superior efficiency of Variable Frequency Drives (VFD) for its air compressor, as well as fans and water pumps.

Combined with more efficient lighting and new production strategies, the VFDs helped Hancock reduce electricity use at the Bethel sawmill by 25%. Factoring in $45,874 worth of incentives from Efficiency Maine and a $32,960 USDA grant, the project paid back in less than *four months*.

"The use of variable frequency drives, more efficient lighting and other measures helped us save money, protect jobs and further our company's overall thrust towards energy efficiency and sustainability."

-Mike Halle, General Manager, Hancock Lumber's Bethel Sawmill

Estimated Annual Savings

Electricity....$338,772*
Labor.....$3,250
*See note on reverse.

Objectives:

Hancock Lumber wished to reduce electricity use in order to:

- Maintain competitive manufacturing costs despite a projected electricity rate hike
- Protect good jobs at its Bethel sawmill
- Meet corporate goals for environmental sustainability and efficiency

Strategies:

Hancock worked closely with Ingersoll-Rand, manufacturer of air compressors; Progressive Solutions; and the electrical engineers at Trask-Decrow, an Efficiency Maine Program Ally, to identify the following sources of cost-effective electricity savings: switching to VFD-controlled motors; installing more efficient lighting; and implementing new production strategies.

Maine Public Utilities Commissioners, Sharon Reishus (l) and Vendean Vafiades (r), flank Governor John Baldacci presenting Efficiency Maine's 2008 Phillip C. Hastings Award for Energy Leadership to John Cote, Maintenance Supervisor, and Mike Halle, General Manager, of Hancock Lumber.

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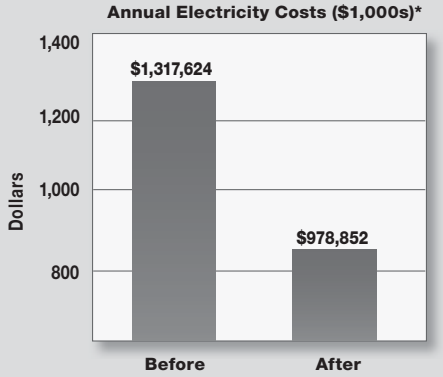
Variable Frequency Drive Motors

The Plan:

The Hancock team implemented the following measures to cut electric use:

- Replaced inefficient air compressor with a new, highly efficient VFD model
- Installed VFD fans and water pumps
- Upgraded to more efficient lighting
- Switched to new production strategies that improved output per shift by 50%



**Note: Costs are based on actual utility billing provided by Hancock Lumber. For the sake of comparison, 2007 electricity cost is adjusted to reflect 2008 rates.*

The Results:

Hancock reduced annual electricity use at its Bethel sawmill by over 25%:

- Using VFDs for air compressor, fans and pumps: 12% savings
- Upgrading to more efficient lighting: 8%
- New production strategies: 6%

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Project Benefits

- Saved more than $300,000 in annual electricity costs
- Reduced maintenance costs
- Increased productivity
- Helped fulfill the company's thrust towards greater energy efficiency and sustainability

Financial Analysis

Project costs	$182,021
Incentives from Efficiency Maine	$45,874
Annual reduction in electricity costs	$338,772[1]
Estimated annual labor savings	$3,250
Simple payback	4.8 months[2]

[1]Savings are based on actual utility billing provided by Hancock Lumber, with 2007 electricity cost adjusted to reflect 2008 rates for comparability.

[2]This is based on the cost less Efficiency Maine incentives. When the USDA grant of $32,960 is factored in, the payback period drops to 3.7 months.

Project Team

- Hancock Lumber
- Efficiency Maine
- Ingersoll-Rand, Manufacturer
- Progressive Solutions
- Trask-Decrow, Program Ally

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2/09 Hancock_case_study

2 Reliable Energy Efficiency Measures

Energy efficiency works and, fortunately, it is not rocket science. There are a host of common-sense, off-the-shelf, proven techniques, practices and technologies that can contribute to the bottom line, saving a business money and energy while maintaining or improving its quality and efficiency.

By investing in energy efficiency measures that outperform the status quo, a business can truly do well by doing good.

Building Envelope

The skin of a building should provide an appropriate barrier between interior and exterior environments. Optimized **thermal insulation** and **air sealing** is important to buffer the interior of the building from the fluctuating temperature outside. In a retrofit, this means finding and air-sealing leaks and insulation gaps that can occur around windows and doors, and also around less obvious places – like the boiler room and the tops of elevator shafts. Sealing air-carrying duct systems is particularly important, as is insulating duct systems whenever they are outside of the conditioned envelope of the building.

Exterior shading, such as horizontal overhangs and vertical fins, provide a good way to decrease the amount of solar gain into a building and can also enhance the exterior esthetics of a structure. In particular, shading windows from direct solar radiation can lower the cooling requirements of a building. This can be accomplished in ways that are consistent with ensuring good passive heating performance in winter months by choosing the geometry of the overhangs and fins with care, and with regard to the angle of the sun in the different seasons.

Due to the high capital cost, replacing existing windows is seldom cost-effective for energy efficiency purposes alone. However, there are a variety of solar films on the market that can be installed on existing windows to achieve some of the glare and heat-reducing properties of conventional glazing.

For new construction, building envelopes can be cost-effectively designed and built to use 20-50% less energy than codes require. Further information is available through Energy Star's Commercial Building Design toolkit at (www.energystar.gov/index.cfm?c=new_bldg_design.new_bldg_design) or the U.S. Green Building Council's LEED program (www.usgbc.org/DisplayPage.aspx?CMSPageID=222)

Lighting

Because it is generally agreed that lighting consumes at least 40% of the energy used in commercial or retail space, replacing virtually any existing fluorescent lamp and ballast system with a **High Performance T8 lamp and ballast system** (sometimes called a "Super T8s System") will provide significant energy savings. HPT8 systems can save 40% compared to older T12 lamps and magnetic ballasts, and will even save 20% over relatively new conventional T8 systems. That means that it may even be cost-effective to reretrofit a lighting system that was just upgraded a few years ago. HPT8 lamps also have better color rendition and longer lives, which means a better working environment and reduced replacement and maintenance costs. Because efficient lighting produces less waste heat, space cooling costs go down as well. Depending on hours of use, availability of incentives, and cost of installation, paybacks for many lighting retrofits are less than three years.

The cost of **compact fluorescent lighting (CFL)** lamps has dropped dramatically in the last few years, and product reliability, quality, and selection is vastly improved. Modern CFLs typically have no hum, good color rendering and an average rated life of between 8 and 15 times that of an incandescent bulb (6,000 and 15,000 hours vs. 750 hours or 1,000 hours). Additionally, the new CFLs are smaller in size, and are available in a wide variety of wattages and decorative and functional choices. There is now a CFL replacement option for virtually any circumstance where an incandescent is in place. The ENERGY STAR program lists over 1,400 CFL bulbs that are "qualified" as high-performance by EPA's criteria (which include life, efficiency, and surface temperature limits). Products are shown by manufacturer and model number at (www.energystar.gov/index.cfm?fuseaction=cfls.display_products_html).

In recent years **light emitting diodes (LEDs)** have emerged as a new lighting source. However, while costs are falling dramatically, they still remain a very expensive option in all but a few niche applications.

One such application is exit signs, which operate round the clock all year long. Because of the long life of LEDs (10 years or more) and their low energy consumption (less than 5 watts per face versus 40 watts) the savings in energy and avoided lamp replacements is substantial. ENERGY STAR qualifying products can be found at: (www.energystar.gov/index.cfm?c=exit_signs.pr_exit_signs).

Another application is task lighting in the typical 8-by-8-foot "personal work station", or office cubicle. The traditional workstation might have 50 watts or more in task and under cabinet lighting, which could be replaced cost-effectively with an 18-watt LED system, consisting of a pair of 6-watt LED free-standing, moveable desk lamps and a 6-watt LED under cabinet light to provide uniform lighting throughout the task area.

Occupancy Sensors further reduce waste, by controlling lighting when offices, conference room, bathrooms and storage spaces are unused, or when natural light is sufficient. The best configuration is the **Vacancy Sensor**, which requires users to manually switch on the lights when they enter a room. (Occupancy sensors do this automatically.) If natural light is sufficient, the user may never switch on the lights. Both the occupancy sensor and the vacancy sensor will shut off lights when a room is unoccupied for a preprogrammed time period, typically 5 to 15 minutes. Their sensitivities and areas of coverage may be adjusted to a degree, dependent upon on the technology used by the sensor, its location, and control settings. Mounting occupancy sensors toward the tops of walls is best for smaller spaces like offices, copy rooms, and bathrooms.

Dual technology occupancy sensor (Source: Watt Stopper)

Ceiling-mounted sensors are best for larger open spaces.

In recent years, the quality and performance of occupancy sensors has become higher while costs have come down. Accordingly, for many applications they can save substantial energy and are quite cost-effective. The trick is to match the right sensor to the right circumstance to maximize energy saving performance while minimizing people hassle and cost. This is a judgment call that is a strong function of the patterns of the people that are using a given space. This is why potential energy savings for various kinds of spaces has such a broad range, as illustrated in the following table.

Range of savings from the use of occupancy sensors

Type of Space	Range of savings (%)
Private office	13 - 50
Open-plan office	20 - 28
Classroom	40 - 46
Conference room	22 - 65
Corridors	30 - 80
Storage areas	45 - 80

(Source: E Source)

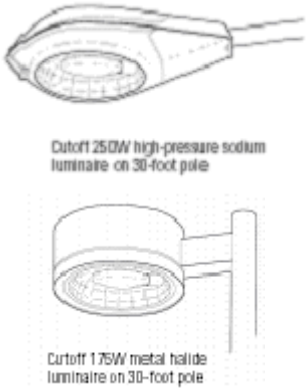
Occupancy controls are also quite useful in hotels and motels where they permit thermostat adjustments on the heating and cooling system as a function of occupancy.

Whenever feasible, lighting retrofits should be combined with **daylighting controls** to maximize energy efficiency. Such controls may locate a sensor outside to measure the amount of light entering spaces through windows or skylights, or be placed above the work plane to gradually or step-dim electric lights in response to the amount of natural light falling on key surfaces. The Step, or **Bi-Level Lighting Control**, is the most economical and reliable.

The ability to control the daylight entering a building is critical to a daylighting design's success. Controlled and well-documented studies show that classrooms with skylights designed with manually-operated internal louvers result in a dramatic increase in student performance. At the same time, it is important to minimize glare caused by uncontrolled daylighting. Daylight from a window penetrates into an interior space a distance of about 1.5 times the head height of the window. Therefore, bi-level switching is most effective in this space closest to the building's perimeter.

Efficient **parking lot lighting fixtures** can reduce the energy use on the site without compromising safety or illumination. "Hockey puck" fixtures, which use 175-watt metal halide bulbs, require fewer poles, cut down on light pollution, have better color rendering, and use 70% less electricity than "cobra head" fixtures using 250-watt high-pressure sodium bulbs.

Also, consider using timers, daylight sensors, or bi-level "stepped" lighting and controls in parking lots. Parking lot and area lighting is another area where LED technology may soon be cost effective, and several national manufacturers have introduced LED products on a limited basis.



Source: Clayton Engineering

HVAC

Packaged Rooftop HVAC Systems are the common technology for heating and cooling smaller commercial buildings, like those we have in Maine. **High-efficiency Packaged Units** provide the same cooling and heating capabilities as their standard counterparts while consuming less energy by using high-efficiency components and controls in their systems. The higher-quality components and controls found in premium-efficiency motors on fans and pumps and high-efficiency, water-cooled chillers allow these components of a central plant to perform more efficiently than standard equipment.

The Consortium for Energy Efficiency (CEE) designates specifications for high-efficiency commercial packaged air conditioning equipment and maintains a database of qualifying products at (www.cee1.org).

Variable-Speed Drives on fans and pumps, **Energy Management Systems** (or Direct Digital Control systems) and other control strategies optimize the operations of HVAC equipment. These controls manage the system so that it works only to meet the actual space conditioning and ventilation requirements of the building spaces, and not just at full output capacity at all times. For example, **Demand-Controlled Ventilation** controls ventilated air to keep CO2 levels below a set point

(for example, 1000 parts per million), thereby allowing ventilation rates to be adjusted to the number of people occupying the space and other variables. This strategy for reducing building ventilation saves energy without compromising indoor air quality, and modern CO2 sensors are both reliable and inexpensive.

The cost-effectiveness of installing **Direct Digital Controls** (DDCs) on an HVAC system varies widely with the specific site and application. DDC systems can save energy if they are used to turn building systems off when they are not needed. In office buildings, DDC systems can modulate HVAC and lighting equipment to achieve energy savings, as well as to trim demand during peak periods. A DDC system should permit programming changes to be easily accomplished in order to alter controls for tenant turnover, to respond to new utility rate structures, or to change control sequences.

Using **occupancy sensors** in conjunction with digital controls can limit energy waste in unoccupied hotel and motel rooms and similar spaces, including offices. Guest room occupancy sensors or central control systems can reduce energy requirements without inconveniencing guests. For example, a central switching system at the front desk can turn on heating or air conditioning as the guest checks in or manually adjust thermostat settings if the room is unoccupied. Heat sensing (infrared) detectors can activate HVAC and lighting systems based on human presence in the room. Turn-off time delays of 10 to 30 minutes can accommodate a guest's departure from the room for short periods of time.

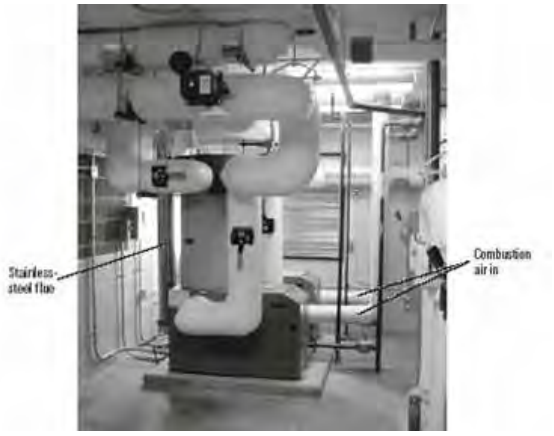
Variable air volume (VAV) air-handling systems with **variable-speed drives** (VSDs) can save considerable fan energy over constant volume systems. Incorporating a VSD on a VAV fan allows it to slow down as load decreases. Because reducing fan speed by one-half will reduce power consumption by seven-eighths, a VSD on a VAV fan system offers compound energy savings that can provide a payback of three to five years. Typical VSD installation costs are $200 to $250 per horsepower of the motor driven. VAV can save energy cost-effectively in systems whose fans are 20 hp or more.

Variable-speed drives are also useful in a number of other commercial and industrial applications, from moving water from boilers or chillers to local heat exchangers to adjusting patterns of irrigation to optimize crop growth while minimizing water use. Motors used in pumping fluids like water or high-pressure air can match pumping rates to instantaneous demands, thereby saving both energy and demand costs.

VSD's are also useful in adjusting ventilation rates to ensure good indoor air quality while controlling fan energy use. Instead of operating at fixed fan rates on a predetermined schedule, ventilation rates can be varied to maintain CO2 levels below a given threshold, for example, 1100 parts per million. Inserting a CO2 sensor in the return air stream to give feedback to a simple control algorithm can optimize fan use while safeguarding air quality.

The best new energy-efficient boilers are called **condensing boilers** because their stainless steel heat exchangers wring so much heat out of the exhaust gases that they cool to the point of condensation, thereby releasing extra useful heat. Modern condensing boilers are quite efficient at their peak ratings—90% or so—and even more efficient when they are turned down, reaching 96% or sometimes even better when operating at 10% or so of their peak rating. It is best to run these boilers at lower temperatures than conventional boilers. This minimizes heat loss from the boiler to heat exchangers (coils or radiators) and maximizes overall system efficiency.

To take advantage of high efficiency when demand for heating is moderate, it is usually cost-effective to employ a pair of condensing boilers and operate them both at a fraction of their rated outputs. Such systems can lower heating bills by 30% or more.



This pair of condensing boilers can be fired at a million Btu's per hour or be throttled back to 67,000 Btu's per hour at steady state efficiencies that range from 92–96%. (Source: Jeff Bowers, Veazey Parrot Durkin & Shoulders.)

Condensing boilers with high turn-down ratios can also be used to supply domestic hot water (DHW) through local heat exchangers. Applications like hotels and motels, where demand is heavy but sporadic, are particularly attractive since the large turn-down ratios can meet a range of demands while maintaining good efficiency.

Gas-fired infrared heaters are substantially more efficient than are forced-air systems in spaces like warehouses and high-ceilinged industrial facilities. Instead of heating the entire volume of a space, radiant heating systems produce infrared waves to directly heat objects (and people) in their

line of sight. Because infrared heaters are over 80 percent efficient, use no fans, and heat objects instead of air, they can have a simple payback as short as one year compared with forced-air convection heating systems.

Unit Ventilators with Face and Bypass Controls Modern unit ventilators are optimized for use in school classrooms and other areas. They are quiet, energy-efficient, controllable by modern digital energy management systems, and are able to vary ventilation rates via local CO2 sensors to maintain good air quality while minimizing energy waste. With a face and bypass system, the flow of warm or cool water from a boiler or chiller through the heat exchanger is constant, but the amount of return and outside air that passes through the exchanger is varied with the bypass damper.

Unit ventilators that regulate space-conditioning energy via face and bypass dampers enjoy a number of advantages over units that do this job via control valves. By their nature, control valves introduce resistance to the flow of conditioned water that is reflected in a higher total pressure head that the pumping motors must overcome. Therefore, motors must be larger and electricity consumption is higher. There is, however, an even more serious concern. Valve-control units are at risk of freezing under winter conditions when ventilation air is brought in at times when the thermostat is satisfied, because water flow through the coils is quite low during such periods. Designs to avoid the problem exist, but they add costs and complications that can result in maintenance problems.

Two-pipe HVAC systems went out of style several decades ago, but thanks to the advent of digital controls, efficient boilers and chillers, and sound engineering practices, such systems have made a comeback. Instead of having a pair of pipes for supply and return conditioned cool water from the chiller and another pair from the boiler, each set going to separate heat exchangers, a single pair of pipes is used to supply cooling water or heating water to a single set of heat exchangers. Combined with digital controls responding to strategically-placed sensors, condensing boilers, and high-efficiency chillers, the resulting simplification yields excellent overall energy performance with very low maintenance costs. Modern two-pipe HVAC systems are quite cost-effective retrofits in schools wishing to upgrade older heating-only systems to include cooling. Piping costs are very moderate and modern unit ventilators which use face and bypass controls ensure high comfort and good indoor air quality, while giving each teacher an adequate measure of control of classroom temperature. A two-pipe retrofit of 20 schools in a southern Indiana school system achieved an overall savings of 17% in spite of adding air conditioning to previously un-air conditioned schools.

Ventilation in parking structures can be modulated as a function of information from carbon monoxide sensors, thereby saving energy while ensuring safe air quality. **Demand-controlled ventilation** in parking garages turns on ventilation fans only when levels of carbon monoxide approach unacceptable levels. A demand-controlled ventilation system reduces fan energy consumption during many hours of the day. Alternately, naturally-ventilated parking structures eliminate the need for any mechanical ventilation. In naturally-ventilated parking structures, it's frequently possible to take advantage of daylighting by installing photocells and lighting controls as well.

Air-side economizer systems use dampers with the HVAC's fan system to draw in substantial quantities of exterior air when its temperature drops below indoor air temperatures. Given Colorado's moderate climate, economizer systems can significantly reduce energy use for cooling commercial and industrial buildings during much of the year. Since Colorado evenings are frequently cool even during the summer, the mass of a building may be cooled over night and thereby substantially lessen the need for cooling energy the following day. Economizer systems can work well, but fail when dampers are not controlled appropriately or stick in the open or closed positions. Choosing good quality parts that weather well, maintaining the system, and double-checking control routines is thus essential.

When weather conditions and loads permit, **water-side economizers** use water that is cooled evaporatively in a cooling tower to substitute for water cooled by a compressor cycle. Such systems can be very effective, but in most cases should be operated via a water-to-water heat exchanger to avoid mixing water that flows through the compressor with that which flows through the cooling tower.

Heat Recovery

There are many areas in such buildings as hospitals, manufacturing facilities requiring clean rooms, and laboratories that must be zoned as "once-through" systems in which the air that heats, cools, and ventilates is used only once. However, much of this HVAC energy can be recovered before it exits the building by installing heat-recovery coils in the exhaust air handlers. This heat can then be used to precondition the outside air coming into the building. Energy can be recovered without risk of contamination.

Waste heat recovery on boiler stacks can be used to preheat boiler makeup water, thereby improving overall energy efficiency quite substantially. Heat recovery from stacks in heat treating furnaces is frequently used to preheat combustion air, thereby achieving savings of well over 50%.

Water-to-water heat exchangers are quite useful in a range of applications, from dyeing operations (where energy from a depleted batch of hot dye water is used to pre-heat the next batch) to various operations in chemical plants.

Heat exchangers allow for the transfer of heat from one fluid to another (including air) without the contents of one stream polluting those of the other. When the requirement for ensuring that absolutely no transfer of contents is high (e.g., exhaust air from hospitals), double-wall heat exchangers are used.

Heat exchangers are frequently employed in industry to save energy and enhance the performance of both batch and continuous processes. For example, a plant that uses large quantities of steam to heat batches of dye can install a heat exchanger to preheat the water for fresh batches of dye by using the waste water from an old batch. This both increases the speed of heating the new water and lowers energy requirements precipitously, while retaining good quality control over colors. When water or steam is involved in such heat transfer functions, "counter flow" shell-and-tube or plate-type heat exchangers are routinely employed. These result in good heat transfer coefficients at minimal risk of cross contamination.

Air-to-air heat exchangers are widely employed in processes which require heating materials to high temperatures over long periods of time, such as in ceramics or heat treating applications. Instead of allowing the hot combustion air to be vented directly to exhaust stacks, heat exchangers recover as much as 80% or more of the heat from the exhaust stream and use it to pre-heat combustion air. This can save well over half of the primary energy used in such facilities.

Other examples of the use of heat exchangers include:

- Condensing steam from a boiler to produce hot water for service hot water or other processes;
- Isolating two systems which operate at different pressures while extracting heat from the higher temperature system;
- Moving heat or cool in various refrigerator cycles that may include changing of state from liquids to gases in the heat exchanger; and
- Moving heat into and out of thermal storage containers.

Hot Water

Low flow shower heads and faucet aerators can save very substantial amounts of both water and energy. In order to ensure acceptance by users and long life, high-quality devices should be selected. Shower heads featuring user selectable spray patterns usually satisfy most users and can save two to three gallons of water per minute of shower. Under moderate to heavy use, paybacks for installing low-flow devices are frequently only a month or two.

In high water-using facilities like hotels, motels, and laundries, installing **gray water heat recovery equipment** can save 60 percent or more of the water-heating energy. Systems serving fixtures on upper floors need no pumps and little or no maintenance. For below-grade applications, systems with demand-operated pumps are available. Where there is less simultaneous hot water drain and supply flow (as in laundries), gray water heat-recovery systems with heat storage can be installed. Heat storage systems require more space, as well as regular inspection and cleaning, but they can be very cost-effective.

Gray water heat-recovery systems capture thermal energy from drain water and use it to preheat water going to fixtures. Depending on the end use and the installation, heat recovery efficiencies of up to 82 percent can be achieved.

Indoor swimming pools (natatoriums) routinely require simultaneous heating of water and dehumidification of the surrounding air. Heat pump water heaters can be a cost-effective solution for efficiently serving both of these needs: they heat water and simultaneously produce cool air, which can be used to decrease the natatorium's air temperature and humidity.

Combined Heat And Power

Whenever electricity is generated by using heat to produce mechanical energy to turn the shaft of a generator, substantial thermal losses, typically 60% or more, result. Called the Carnot effect, this law of physics affects all heat engines whether fueled by solid waste, wood, gas, oil, coal, uranium, or the sun. For large power plants located remotely from facilities that could use the heat resulting from the generating process, this thermal energy is wasted. On the other hand, smaller power plants can be located close to or even within facilities which can make good use of the heat resulting from electricity generation, thereby raising the net efficiency of generating electricity by a factor of two or more and saving substantial energy and money. Hospitals, commercial buildings, apartment complexes, and industrial facilities can often take advantage of combined heat and power (CHP) systems. To make them most economical and practical, CHP systems need to have thermal loads somewhat well-matched with the heat supplied through the generation process. In addition to supplying heat for hot water, low pressure steam for heating, sterilizing, and sundry industrial needs, CHP systems can also supply cooling energy via absorption chilling equipment.

Important considerations in planning CHP systems include providing for back-up power during periods of maintenance or malfunction, avoiding potential substantial peak demand charges if connected to a utility, and the possibility of selling electricity to the grid when generating more than is needed.

For additional information, visit the websites:

U.S. Combined Heat and Power Association (www.uschpa.org)

Northeast Combined Heat and Power Center at the University of Massachusetts (www.northeastchp.org).

Refrigeration

Commercial Refrigerators and Freezers Historically, solid door, reach-in commercial refrigerators and freezers have been notoriously inefficient, but the Consortium for Energy Efficiency (CEE) has developed a specification for energy-efficient units that is being met by some manufacturers and have garnered ENERGY STAR certification. Also, EPA has begun ENERGY STAR labeling for efficient refrigeration products. Information is available on the Commercial Refrigerators and Freezers section of CEE's web site at (www.cee1.org/com/com-ref/com-ref-main.php3) and (www.energystar.gov/index.cfm?c=commer_refrig.pr_commercial_refrigerators) for ENERGY STAR.

Walk-in Coolers The floors of some walk-in coolers on farms and in grocery stores are simply concrete slabs that extend out of the cooled area. Accordingly, a good deal of cooling energy is lost to the ground and adjoining areas. Retrofitting these with floor insulation can be accomplished inexpensively using two-inch, closed cell Styrofoam™ tongue-in-groove insulation fastened to the slab using a low volatile organic compound (VOC) liquid adhesive dispensed from a caulk gun. The insulation should be covered by good quality marine plywood attached to the insulation with the same adhesive and power staples, then finished with a sealer like a low-VOC urethane. Cooler door(s) should be designed or retrofitted to ensure good door operation, a tight seal when closed, and a gently sloping ramp to facilitate rolling goods into and out of the cooler. Also consider installing economizers to use cold outside air in season—"free cooling"—to help cool products.

Vending Machines Many commercial buildings operate vending machines provided by merchants who maintain the machines and keep them supplied with bottled drinks. However, most vending machines are very energy inefficient, and the electricity bill is paid by the building operators, not the drink supplier. Two proprietary retrofit products marketed as "Vending Miser" and "Cooling Miser" can save 1,000 to 1,500 kWh per year, or roughly 30% of a vending machine's annual energy consumption. Installed between the line plug of the vending machine and the wall outlet, the Vending and Cooling Misers uses an occupancy sensor to assess the presence of people. After 15 minutes of inactivity, the Misers waits until the end of a compressor cycle, and then turns off the vending machine until it detects someone or two hours have passed, whichever comes first. The effect is to turn off machines when they are not needed, thereby saving electricity while maintaining product temperature and being "open for business" when people come by to make a purchase.

Refrigerators and Freezers Reach-in refrigerators and freezers used in the food service industry account for 17% of all commercial refrigeration energy use, and are notoriously energy inefficient. Unlike residential refrigerators, there are no national standards to regulate their efficiency. ENERGY STAR began rating energy-efficient commercial refrigerator and freezers in 2001. A listing of ENERGY STAR commercial refrigerators and freezers can be found at (www.energystar.gov/index.cfm?c=commer_refrig.pr_commercial_refrigerators).

Ice Makers Ice making machines are in wide use in hospitals, hotels, restaurants, retail outlets, schools, offices, and grocery stores. They account for over 10% of the energy used in commercial refrigeration. Ice makers are rated by the number of pounds of ice they can produce per 24 hours, and models ranging from 250 to 1400 pounds per day are readily available. The index of efficiency for icemakers is energy use per pound, and efficiencies range from 22 to 4 kWh per 100 pounds of ice produced. The least efficient (and least expensive) models use air as a medium for cooling; more efficient models use water. Some models use remote units which discharge heat from the compressor cycle outdoors, thereby lowering both the air conditioning load and compressor noise.

Stainless steel icemaker combined with insulated storage (Source: Manitowoc Company).

Some models use more water than do others for self-cleaning and removing scale, a factor that trades off with maintenance costs. Smart purchasing of ice makers involves matching the size of the machine to demand, taking into account energy and demand costs as well as water consumption and costs, estimating maintenance costs, and lifetime of the appliance. Energy-efficient units both use less electricity per amount of ice made and produce less heat that must be removed by the air conditioning system. Upgrading to ENERGY STAR energy efficient icemakers can result in significant savings over the life of the machine.

The Federal Energy Management Program (FEMP) also provides energy efficiency recommendations at (www.cee1.org/com/com-ref/femp-rep.pdf). Also, ENERGYSTAR maintains a list of qualifying ice makers at: (www.energystar.gov/index.cfm?c=bulk_purchasing.bus_purchasing).

Building Commissioning

Commissioning a building, either when new or after a major retrofit, is the process of testing all elements of a building's energy and mechanical systems to ensure that they are adjusted properly and functioning optimally. Suppliers of services and equipment should be tasked with providing commissioning services as a condition of the purchase agreements. One important element of the commissioning process is to ensure that the building's maintenance staff is fully trained to understand, test, and maintain the equipment, including the consequences of interaction between systems.

Continuous commissioning is a maintenance function through which all critical elements of a building's energy and mechanical systems are routinely monitored for proper adjustment and functioning. The idea is to enhance preventative maintenance chores and solve difficulties before they become real problems. Key elements of a successful continuous commissioning process are the output of the energy management system, regularly inspected energy bills, and a knowledgeable and dedicated maintenance staff. The Energy Systems Laboratory at Texas A&M University, which coined the term "continuous commissioning," has been involved in continuous commissioning projects in Texas that now save well over $20 million per year. Paybacks from such projects are routinely less than three years; many are shorter even than that. According to the National Strategy for Building Commissioning, a thorough commissioning process will confirm that building systems and equipment are operating properly, allowing the owner to realize the benefits of:

- Improved building system control;
- Increased energy efficiency;
- Improved building equipment performance;
- Improved indoor air quality, occupant comfort, and productivity;
- Decreased potential for owner liability; and
- Reduced operation and maintenance costs.

You can learn more at www.peci.org. Also see discussions and references on the web site of E Cube, Inc., a Colorado company that specializes in building commissioning and which works directly with owners, engineers, and Energy Service Companies: (www.ecube.com/commissioning.php).

Energy-Efficient Office Equipment

ENERGY STAR maintains lists of energy-efficient office equipment that meet thresholds of energy efficiency that are markedly improved over standard models. For example:

Computers	Have power management features that save 70% or more than computers without the feature
Copiers	40% improvement over standard models
Fax Machines	Have low-power modes that reduce overall electricity use by 40% over machines without the feature
Monitors	Have sleep modes that save 90% (while sleeping) over machines without it
Printers	Have low-power modes that save 60% over machines without the feature
Scanners	Efficient models save 50% over standard models
Water Coolers	Efficient models can save up to $47 per year over standard models

Details on office equipment that meet ENERGY STAR criteria for energy efficiency are available at (www.energystar.gov/index.cfm?c=ofc_equip.pr_office_equipment).

Motors and Motor Systems

Efficient motors run cooler and generally have longer lifetimes than do less efficient motors. Motor efficiencies vary with horsepower and number of poles. In order to be counted as "premium efficiency," according to the National Electrical Manufacturers Association (NEMA), a motor's efficiency must meet or exceed the values listed in the table below.

In most cases, motors that are more efficient than those listed are available and should be chosen whenever feasible. When purchasing new motors, it is best to look for NEMA Premium brand products. Paybacks over their lifetimes are routinely quite large.

Motor maintenance programs are essential both to long-term reliable performance and to energy savings. Elements of the program should include cleaning; inspection and lubrication of bearings (using a stethoscope, infrared scanner, or digital thermometer as appropriate); motor mount inspection, belt inspection, and alignment; and inspection of overload protection circuitry. In the case of critical motors, additional measures such as vibration analysis, oil sampling, and even partial disassembly may be necessary.

Infrared scanners that produce two-dimensional images of thermal information are particularly useful, and spot radiometers that remotely read temperatures with good precision have become quite inexpensive. Both are helpful in identifying overheating bearings and belts, as well as hot spots in circuit breaker and electrical junction boxes.

Motor repair is often chosen over replacement, particularly for larger industrial motors. However, conventional motor rewinds result in a loss in efficiency of up to 1%. This can result in significantly higher energy costs for a production motor with long hours of operation. However, users can select a repair shop that offers a **"Green Motor" repair. Green Motor repair standards, developed by the not-for-profit** Green Motors Practices Group (www. greenmotors. org), ensure a quality rewind that saves up to 40% of the cost of a new motor, recycles 98.5% of motor materials, and provides third party standards oversight.

Nominal Full Load Efficiencies for EPAct -covered equipment: 1-200 horsepower NEMA design A and B, three phase, integral horsepower, general purpose motors (1200, 1800, 3600 RPM).

Open Dip-Proof (ODP)				Totally Enclosed Fan-Cooled (TEFC)			
HP	1200 RPM	1800 RPM	3600 RPM	**HP**	1200 RPM	1800 RPM	3600 RPM
1	82.5	85.5	77.0	**1**	82.5	85.5	77.0
1.5	86.5	86.5	84.0	**1.5**	87.5	86.5	84.0
2	87.5	86.5	85.5	**2**	88.5	86.5	85.5
3	88.5	89.5	85.5	**3**	89.5	89.5	86.5
5	89.5	89.5	86.5	**5**	89.5	89.5	88.5
7.5	90.2	91.0	88.5	**7.5**	91.0	91.7	89.5
10	91.7	91.7	89.5	**10**	91.0	91.7	90.2
15	91.7	93.0	90.2	**15**	91.7	92.4	91.0
20	92.4	93.0	91.0	**20**	91.7	93.0	91.0
25	93.0	93.6	91.7	**25**	93.0	93.6	91.7
30	93.6	94.1	91.7	**30**	93.0	93.6	91.7
40	94.1	94.1	92.4	**40**	94.1	94.1	92.4
50	94.1	94.5	93.0	**50**	94.1	94.5	93.0
60	94.5	95.0	93.6	**60**	94.5	95.0	93.6
75	94.5	95.0	93.6	**75**	94.5	95.4	93.6
100	95.0	95.4	93.6	**100**	95.0	95.4	94.1
125	95.0	95.4	94.1	**125**	95.0	95.4	95.0
150	95.4	95.8	94.1	**150**	95.8	95.8	95.0
200	95.4	95.8	95.0	**200**	95.8	96.2	95.4

New motors manufactured and imported for the U.S. market must meet or exceed these full load nominal efficiencies. Table courtesy of Consortium for Energy Efficiency, and can be found on-line at (www.cee1.org/ind/motrs/Cee-nema.pdf).

Motor System Optimization

When efficient motors are paired with Variable Speed Drives (VSDs), and are sized well to match their loads, dramatic savings can be achieved. In a 2003 study of 41 industrial motor system optimization projects showed an average annual rate of return of over 40% from energy savings alone[1]. In addition, a third of the projects also recorded increased productivity (in production volume or product quality), and a number of companies reported savings in maintenance costs and avoided equipment purchases. The study projects that if the manufacturing plants in the U.S. that account for 50% of industrial energy consumption implemented similar projects, the annual savings could be 83 billion kWh and $4 billion in avoided electricity costs.

In general, any task where motor power requirements can change provides an opportunity for increasing efficiency. For example, a woodworking facility with 90 work stations, each with a gate for removing sawdust, installed variable frequency drives on a pair of 100 + hp fan motors. The motors are throttled back when some gates are closed, while ensuring that adequate static pressure is maintained to thoroughly remove sawdust from operating work stations and gates. Matching fan power to instantaneous load yields both energy savings and better productivity, since each work station now has constant sawdust-removing power regardless of the activity at the others.

Installing VSDs on motors that drive evaporator fans on large cold storage units housing produce can save over half of the electrical energy while maintaining consistent and uniform temperatures throughout cooled areas[2]. A single electronic package can control devices on all of the fans on a given evaporator coil, so retrofits are relatively inexpensive and payback periods are short. Better matching of cooling power to load saves electricity because under many circumstances

Motor Decisions Matter

Motor Decisions Matter is a national education campaign that has developed a Motor Planning Kit containing tools, internet links, and procedures for organizing a comprehensive motor management plan. For example, the Kit contains observations and graphics like the following:

A typical 75 hp motor running at full load for 6,000 hours per year consumes about $22,000 worth of electricity at $0.075 per kilowatt-hour (kWh). A typical purchase price for such a motor is about $4,000. Over the motor's 10-year life, the purchase price represents just 2 percent of the lifetime costs, while the cost of electricity accounts for 98 percent. And just a 1 percent increase in motor efficiency translates into $2,800 in energy savings over that time, nearly the cost of the motor.

The Motor Planning Kit may be downloaded for free at www.motorsmatter.org. For additional information, access the Motor Systems Toolkit on the website of the Consortium for Energy Efficiency, at (www.cee1.org/ind/mot-sys/mot-sys-tools.php3).

air movement can be cut back to 50% of full flow, which reduces energy requirements for evaporator fan motors to only 15% of peak. Waste heat from the motors themselves is also diminished, thereby further lowering the overall cooling load in the cold storage units.

Analogous circumstances apply in a range of other air moving tasks (including compressed air, see below) as well as to liquid moving tasks. Generally, the slower one can move a fluid through a duct or a pipe, the less motive power is required for the task since motor energy varies as the cube of the fluid velocity. Of course, designs with smaller cross sectional area ducts or pipes and those with many elbows that require abrupt changes in direction are least efficient.

Instead of variable speed drives on a single motor, it is frequently more effective to use several motors, bringing them on incrementally to meet load demand. This can simplify systems and avoid the costs associated with variable speed drives. For example, over a hundred schools in Indiana have two-pipe HVAC systems which use a 7-horsepower motor for circulating warm water to unit ventilators in classrooms and a 15-horsepower motors for circulating cool water (since they are operated at temperatures closer to ambient and require higher flow rates).

MotorMaster+

MotorMaster+ is comprehensive computer software developed by the U.S. Department of Energy that facilitates motor management functions at medium- and large-sized industrial facilities. It was designed for utility auditors, industrial energy coordinators, and plant and consulting engineers, but it also reports cost and savings benefits that are useful for senior management. MotorMaster+ helps motor and motor systems improvement planning by identifying the most efficient choices for a given repair or motor purchase decision. MotorMaster+ can be used to identify inefficient or oversized motors and it computes the energy and demand savings associated with the selection of an energy-efficient replacement model. It contains a motor manufacturers' motor price and performance database that is updated periodically via email. MotorMaster+ performs energy conservation analyses and life cycle costing, and has energy accounting and savings tracking functions. The software also contains a motor inventory module that includes maintenance logging and tracking functions.

Washington State University's Cooperative Extension Energy Program has been involved in the development of MotorMaster for eight years and it has become a "BestPractice" tool supported by U.S. Department of Energy (DOE) Office of Energy Efficiency and Renewable Energy. The latest version can be downloaded free of charge at a U.S. DOE site: (www1.eere.energy.gov/industry/bestpractices/software.html).

Compressed Air Systems

More than 70% of manufacturing facilities in the United States use compressed air for functions such as power sources for tools and equipment like pneumatic actuations, pumping of chemicals, blow offs for cleaning, part orientation, cooling and vacuum. Compressed air is considered industry's fourth utility, but is seldom thought of as contributing to the cost of production. Compressed air systems inherently have low operating efficiencies, typically in the 10 to 15% range and, therefore, can be expensive to operate. Substantial savings opportunities exist because many systems are poorly laid-out, have leaking fixtures, and motor/compressor systems are frequently mismatched to loads.

Limiting waste in **air compressor systems** begins with a thorough inspection to locate and repair leaks (and potential leaks) in couplings, hosing, actuators, and other elements. At a more subtle level, an inspection of the system may reveal opportunities to reroute piping, form a closed loop so flow from compressors to users of compressed air can be split thereby lowering frictional losses, and diminishing the need for high system pressures.

Since every drop of 2 pounds per square inch (psi) of pressure saves 1% of electric energy use, maintaining the system at as low a pressure as practical is desirable. Variable speed drives used on high-efficiency motors along with adequately-sized storage tanks can meet periods of high demand while reaping the energy saving advantages of good efficiency during periods of part load. If there are only several work stations that require high pressure compressed air, it is sometimes cost-effective to meet those requirements with a small, dedicated high-pressure system, thereby allowing the main system to be run at substantially lower pressures. This also allows for the compressor and storage tank that feed the high-pressure system to be located close to the point of use, thereby decreasing frictional losses.

In multi-compressor operations, metering and monitoring of flows, pressures, and energy use is both useful and becoming less expensive with modern electronic equipment. The resulting information can be used to both enhance maintenance quality while lowering costs and ensure that production needs are optimized. In addition, both demand and energy costs can be lowered by cycling compressors and turning off units during periods of low demand.

Older style compressor controls result in wide swings of pressure, which means that higher average pressures need to be maintained in order to ensure a given minimum pressure is always available. Since each psi of higher pressure results in about a half a percent of energy waste, it is valuable to employ modern microprocessor-based controls which can maintain a much narrower range of pressure swings.

Controls which minimize pressure fluctuations can save about 8 percent of compressor energy. Lower overall system pressure also lowers leakage.

Use synthetic lubricants in compressors and motor systems. Industrial data demonstrates that synthetic lubricants have improved characteristics resulting in lowered equipment frictional energy losses. Replacing the lubricant in the air compressors with a synthetic-type lubricant saves energy.

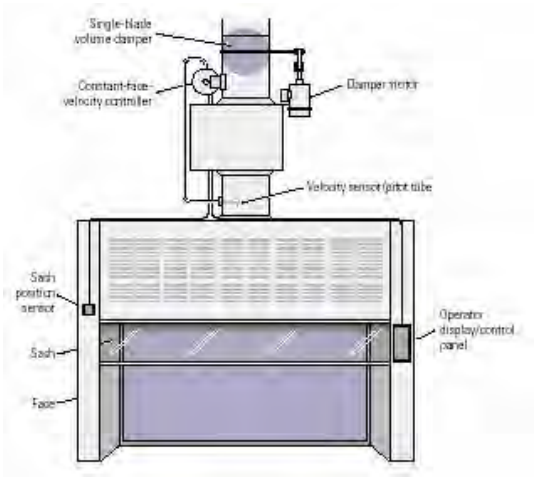
To learn more, visit www.compressedairchallenge.org.

Laboratory Fume Hoods

Fume hoods can be the largest source of energy waste in laboratory buildings since they move large quantities of conditioned air directly outside. This air must be replaced by fresh air which must be heated or cooled, thereby adding to energy needed for both fans and conditioning equipment. Energy-efficient fume hoods use variable air volume motors to drive fans whoses speeds are changed depending on the proximity of the user and the degree to which the sash is opened. As the sash is opened to a greater extent, flow is increased so that the face velocity of air over a given cross section of the sash opening is constant. This safeguards scientists while minimizing air flow, thereby saving HVAC energy. Efficient fume hoods also employ occupancy sensors that automatically increase exhaust air rates when users are close to the hood.

The following sections discuss energy use and recommendations for reducing energy use in a cost-effective manner for eight key commercial sectors, as well as the industrial and agricultural sectors.

Not every energy efficiency measure (see Section 2) will be applicable in every business in the sector, but businesses can get an idea of where to look for energy savings from the "menu" of measures for their sector. Businesses should conduct an energy audit, or have such an audit done by an engineering firm or energy service company, to determine which measures are relevant for their facility.



3 Recommendations by Sector

The following sections discuss recommendations for reducing energy use in a cost-effective manner for eight key commercial sectors, as well as the industrial sector.

Not every energy efficiency measure (see Section 2) will be applicable in every business in the sector, but businesses can get an idea of where to look for energy savings from the "menu" of measures for their sector. Businesses should conduct an energy audit, or have such an audit done by an engineering firm or energy service company, to determine which measures are relevant for their facility.

COMMERCIAL

Grocery Stores

Energy Use

Grocery stores have long operating hours and a complex mix of energy demands. Primary energy use is for lighting (34%) and product refrigeration (30%). Grocery stores that have food service and food preparation areas can have high water-heating loads, representing 10% or more of total energy use. HVAC constitutes most of the remainder of the load in grocery stores, roughly 25%. Many grocery stores are over lit by older fluorescent lamps that suffer from poor color rendering and inefficiencies.

Measures that are frequently found to be cost-effective include the following:

Refrigeration

- It is usually worthwhile to upgrade refrigeration systems in grocery stores to include efficient, state-of-the-art technologies. Include dew point controls for anti-condensate heaters on refrigerated cases so defrosting is matched to actual need. Incorporate efficient cooling system components such as high-efficiency compressors, water-cooled condensers, floating-head pressure controls, and multiple, unequally-sized compressors feeding the same manifold.
- Install floor insulation in coolers. The floors of some walk-in refrigerators in many grocery stores are simply concrete slabs that are neither insulated from the earth underneath nor around their edges. Retrofitting these with floor insulation improves cooler efficiency.
- Install economizers that use cold outside air -- "free cooling" -- to help cool products.
- Use night cooler case covers and shut off case lighting when the store is not open.
- Use efficient lighting in refrigerators, case coolers and freezers, as they save twice: this retrofit lowers the electricity use for both lighting and cooling. (LEDs in case coolers is another market niche where this technology is cost effective.)
- Install door heater controls in coolers and freezers so that heaters activate based on humidity, rather than operate continuously.
- Consider installing Zero Energy Doors on coolers and freezers.
- Install high efficiency evaporator fan motors. Permanent split capacitor and electronically commutated motors operate at variable speeds, offering significant savings when compared with conventional motors.
- Consider operating the refrigeration system using floating head pressure controls. Floating head controls alter compressor head pressure to conform to outdoor air temperature.
- Establish a regular maintenance for coolers and refrigerators. Dirty coils and filters, broken seals and ice build-ups waste energy.
- Use "on demand" defrost controls, rather than programmed timed defrosts.
- Check temperature settings in coolers and refrigerators. Match temperature settings to the product being cooled.
- Commercial ice makers account for about 11% of all commercial refrigeration energy use. Energy efficient ice-makers can produce considerable savings over their lifetime.
- Consider replacing your compressors with either discuss or scroll compressors. Both use less energy than standard compressors and can last up to a third longer.

High-efficiency lighting

- Replace T-12 fluorescent fixtures with High Performance T-8 or T-5 fixtures with electronic ballasts. Select bulbs with good color rendering. Lowering color temperatures (5,000 K or below) give a warmer "feel" to products. Using uplight fixtures eliminates hot spots in the ceiling area, gives shadow-free illumination of the products below, and enables good visual acuity at lower lighting levels. This contributes to making shopping less frenetic and lowers lighting and cooling costs.
- Install and adjust automatic dimming controls to take advantage of daylighting and enable lowering light levels for restocking and cleaning while the store is closed.
- Increasingly new and renovated stores are taking advantage of large scale daylighting through use of skylights and clerestories.
- Install and adjust occupancy controls in warehouse areas.
- Install LED exit signs.
- Upgrade parking lot lighting to save energy and reduce environmental impacts due to light spillage. Light fixtures which illuminate areas that don't need it or the sky itself produce light spillage. Bi-level lighting and other controls can minimize lighting when the store isn't open or has very limited customer traffic.

High-efficiency HVAC

- Install a demand-controlled ventilation system. When only a few people are in a store, energy can be saved by decreasing the amount of ventilation supplied by the HVAC system. A demand-controlled ventilation (DCV) system senses the level of carbon dioxide in the return

air stream and uses it as an indicator of occupancy. DCV can save energy during peak cooling periods when many shoppers are at work and occupancy is low.

- Install variable air volume air handling systems with variable speed drives.
- Choose high-efficiency packaged A/C units listed by the Consortium for Energy Efficiency in their Tier 2 guidelines (www.cee1.org).
- Consider the age of your chiller plant, and, if appropriate, downsize to a new high-efficiency chiller in conjunction with lighting and refrigerator case retrofits. Sizing the HVAC equipment to take into account the cool air leaking from cases and cabinets, and decreased waste heat from lighting, may justify downsizing the chiller, offsetting the higher first cost of high-efficiency equipment.
- Use condensing boilers with large turn-down ratios whose efficiencies improve with turn-down.
- Switch over to direct digital controls.
- Install premium-efficiency motors and variable speed drives.
- Upgrade the energy management system; optimize settings to reflect usage, respond to changing weather patterns, and control peak electric loads.
- Continuously commission the building.

Building Envelope

- Install high-efficiency glazing carefully chosen for each building facade's relation to the sun and other variables. When installing new glazing, choose a product that has high transmission in the visible spectrum (to enhance daylighting within and view from inside and out) but low transmission in the infrared (low solar heat gain coefficient, SHGC, and low emissivity in the far infrared, "low-E") to enhance energy performance during the cooling season. Install overhangs to limit direct beam sunlight coming in store windows.
- Install insulation in strategic areas.
- Undertake air sealing, including duct work and door weather stripping.

Plug Loads

- Use low-energy sleep functions on electronics.
- Choose ENERGY STAR commercial refrigerators, water coolers, and other appliances.
- Install Vending Misers and Cooler Visors.

Employee

- Ensure that stockers, building maintenance people, and cleaning staff are enthusiastic about savings and adopt work habits that support energy efficiency.
- Involve all employees in energy savings efforts, provide efficiency education for work and home, and encourage employee suggestions on energy savings opportunities.
- Track energy use and utility bills and investigate anomalies. Document energy savings and report results to management and employees.

Hospitals

Energy Use

Hospitals have high energy use per unit of floor area and high energy bills, but a number of technologies can be employed to lower them significantly. Hospitals have office spaces and a number of facilities that are open 24 hours per day. Because of the risk of microbial contamination, high ventilation rates with 100 percent fresh air are required. Accordingly, hospitals are dominated by HVAC energy use (45%), but they also consume a lot of electricity to light 24-hour areas (25%). Most also have significant process loads for sterilization, laundering, and cooking. With plug loads, these total 30% in typical facilities.

Measures that are frequently found to be cost-effective include the following:

HVAC

- Recover heat from central plant equipment by installing heat-recovery coils in the exhaust air handlers to capture waste energy without the risk of contamination.
- Recover waste heat from exhaust stacks of boilers to preheat boiler makeup water or combustion air.
- Recover heat from sterilization equipment, laundries, dishwashers, and cleaning equipment to pre-heat fresh hot water.
- Install a waterside economizer for nighttime cooling.
- Downsize to a new high-efficiency chiller in conjunction with lighting and other retrofits.
- Use condensing boilers with large turn-down ratios whose efficiencies improve with turn-down.
- Switch over to direct digital controls.
- Install variable air volume air handling systems with variable speed drives.
- Install premium-efficiency motors and variable speed drives.
- Install demand-controlled ventilation.
- Ventilate garages in response to environmental conditions.
- Upgrade the energy management system. Optimize

settings to reflect usage, respond to changing weather patterns, and control peak electric loads. Lights and air conditioning in spaces occupied only during business hours are often left on all the time. The energy management system can automatically shut off lighting and set back HVAC systems in spaces occupied only during the daytime. A combination of occupancy sensors and time switches can accommodate people who arrive early or stay after the end of the business day.

- ☐ Continuously commission the building.

Combined Heat and Power (CHP) System

- ☐ Install a combined heat and power generation system to supply electricity, heating needs, and (through an absorption chiller) cooling needs. When properly sized and designed, such a system can save substantial money and avoid the large thermal losses associated with conventional power generation at utility plants.

Lighting

- ☐ Install compact fluorescent bulbs in place of incandescents in hospital rooms, halls, and elevators.
- ☐ Replace existing T-12 and T8 lamps, ballasts and, if appropriate, fixtures with High Performance T-8 or T-5 fixtures with electronic ballasts.
- ☐ Install and adjust occupancy or vacancy controls. In appropriate specs.
- ☐ Install and calibrate automatic lighting controls in conjunction with skylights and clerestories in open areas to dim lights in response to daylight.
- ☐ Install LED exit signs.
- ☐ Upgrade parking lot lighting to save energy and reduce environmental impacts due to light spillage. Examine possibilities for bi-level lighting and lighting reductions in peripheral areas during low use hours.
- ☐ Upgrade garage parking lighting. (LEDs are an emerging technology that may be cost-effective in 24-hour parking garage operations.)

Building Envelope

- ☐ Install high-efficiency, specularly-selective glazing carefully chosen for sun exposure on each facade and other variables.
- ☐ Install interior or exterior shading devices.
- ☐ Install insulation in strategic locations.
- ☐ Undertake air sealing, including duct work.

Plug Loads

- ☐ Use low-energy sleep functions, and power strips that sense use, on all electronics.
- ☐ Choose ENERGY STAR office equipment and appliances.
- ☐ Install Vending Misers, Snack Misers, and Cooler Misers, as appropriate.

Employee

- ☐ Ensure building maintenance and cleaning staff are enthusiastic about savings and adopt work habits that support energy efficiency.
- ☐ Ensure that key maintenance people are properly trained in the use of all the facility's energy management systems.
- ☐ Involve all employees in energy savings efforts, provide efficiency education for work and home, and encourage employee suggestions on energy savings opportunities.
- ☐ Enroll www.theboc.info/.
- ☐ Enroll key maintenance staff in the Building Operator Certification program (BOC). (www.theboc.info)

Hotels and Motels

Energy Use

Energy use in hotels and motels is strongly affected by occupancy. Guests affect heating and cooling loads in their rooms, consume hot water, and increase energy use in dining facilities. Hotels and motels tend to have quite high hot water heating loads—about 33% of the total—because of showers, laundries, and food service. HVAC loads constitute another 30%, lighting 20%, and plug loads 17%.

Measures that are frequently found to be cost-effective include the following:

Hot Water

- ☐ Inspect for water leaks and repair them. Ignoring such simple maintenance measures is costly since leaks tend to get worse with time and more expensive to fix.
- ☐ Install high-quality, low-flow shower heads. Models

[1] "Industrial Motor System Optimization Projects in the US: An Impact Study," by Robert Bruce Lung, Resource Dynamics Corporation; Aimee McKane, Lawrence Berkeley National Laboratory; and Mitch Olszewski, Oak Ridge National Laboratory, 2003 Proceedings of the ACEEE Summer Study on Energy Efficiency in Industry.

[2] "Focus on Cold Storage Evaporator Fan VFDs Is a Market Transformation Success," by Andy Ekman, Northwest Energy Efficiency Alliance; Philipp Degens, Northwest Energy Efficiency Alliance; Rob Morton, Cascade Energy Engineering; and Steven Scott, MetaResource Group, 2003 Proceedings of the ACEEE Summer Study on Energy Efficiency in Industry.

whose spray patterns may be adjusted by users are best as they communicate to guests that management cares about both comfort and energy, as well as water conservation. Paybacks on the order of weeks are not uncommon.

- ☐ Lower hot water system temperature to 120-130 degrees.
- ☐ Insulate hot water lines wherever accessible.
- ☐ Specify high-efficiency, gas-fired or propane water heating equipment. Small, mid-efficiency, atmospherically-vented water heating systems with energy factors of 0.62 to 0.70 are more cost-effective than standard, less-efficient equipment. Direct vent, sealed-combustion, condensing boilers have even better energy factors—up to 0.86. Commercial boilers that meet ENERGY STAR standards are listed at www.energystar.gov/ia/products/prod_lists/boilers_prod_list.pdf.
- ☐ Consider installing multiple boilers. These provide redundancy and can be staged in a way that more efficiently meets loads, compared with a single large machine.
- ☐ Use heat recovery from waste water to preheat hot water.

HVAC

- ☐ Install occupancy controls for lighting and HVAC in guest rooms.
- ☐ Consider heat-pump water heaters for indoor swimming pools to simultaneously heat water and provide dehumidification.
- ☐ Institute demand ventilation controlled by air quality sensors in public spaces from lobbies and dining rooms to parking garages.
- ☐ If cost-effective, downsize to a new high-efficiency chiller in conjunction with lighting retrofits.
- ☐ Choose high-efficiency packaged A/C units listed by the Consortium for Energy Efficiency in their Tier 2 guidelines (www.cee1.org/com).
- ☐ Use condensing boilers with large turn-down ratios whose efficiencies improve with turn-down.
- ☐ Switch over to direct digital controls.
- ☐ Install premium-efficiency motors and variable speed drives.
- ☐ Verify economizer function and control.
- ☐ Consider using cool air from the cooling tower with water-cooled chillers.
- ☐ Upgrade the energy management system; optimize settings to reflect usage, respond to changing weather patterns, and control peak electric loads.

Lighting

- ☐ Install compact fluorescent bulbs in place of incandescents in guest rooms, halls, and elevators.
- ☐ Install energy-efficient lighting in all other spaces.
- ☐ Install and calibrate automatic lighting controls in conjunction with skylights and clerestories in open areas in order to dim lights in response to daylight.
- ☐ Install LED exit signs.
- ☐ If you have decorative lighting that operates 24/7 consider using CFLs or LED bulbs.
- ☐ Upgrade parking lot /garage lighting to save energy and reduce environmental impacts due to light spillage.

Building Envelope

- ☐ Shade windows and doors from direct sunlight to decrease cooling loads.
- ☐ Install high-efficiency glazing carefully chosen for sun exposure and other variables on each facade.
- ☐ Install insulation in strategic locations.
- ☐ Undertake air sealing, including duct work.
- ☐ Install an ENERGY STAR rated cool roof.

Plug Loads

- ☐ Choose energy-efficient ENERGY STAR appliances throughout the facility. Mini refrigerators placed in guest rooms are notoriously energy wasteful, but ENERGY STAR models are now available.
- ☐ Choose energy-efficient office equipment.
- ☐ Use low-energy sleep functions, and power strips that sense use, on all electronics.
- ☐ Install Vending Misers and Snack Misers on vending machines.
- ☐ Install ENERGY STAR commercial refrigerators and water coolers.
- ☐ Energy-hungry icemakers vary greatly in their energy use. Upgrading to ENERGY STAR energy efficient icemakers can result in significant savings over the life of the machine.

Large Office Buildings

Energy Use

There is no clear distinction between small and large office buildings, but the demarcation line used here is around 50,000 square feet. Nationally, the principal energy uses in most large office buildings is divided between lighting (28%), HVAC (22%), office equipment and miscellaneous plug load (26%), then all other uses (cooking, hot water, etc.). Since lighting, plug loads, people, and solar gain all provide heat that must be removed by the building's cooling system, many large office buildings are in the cooling

mode for most of the year, particularly during periods of substantial occupancy. Retrofit measures that improve the efficiency of lighting and office equipment, as well as those that improve windows and shading, can lower the demand on the cooling system (but may increase heating demand). With comprehensive lighting retrofits, it is sometimes cost effective to replace an older chiller with a smaller energy-efficient unit. The life-cycle savings can be quite substantial.

Measures that are often found to be very cost-effective include the following:

High-efficiency lighting

- Replace T-12 lamps and ballasts (and fixtures, if appropriate) with High Performance T8s or T-5s.
- Install and adjust automatic dimming controls to take advantage of daylighting. The "Cool Daylighting" approach keeps most outside light out of view, thereby controlling for glare, producing better distribution, and lowering cooling costs (see www.daylighting.org/what_is_cool_daylighting.htm).
- Install and adjust occupancy or vacancy controls.
- Install LED exit signs.
- Upgrade parking lot /garage lighting to save energy and reduce environmental impacts due to light spillage. (LEDs are an emerging technology that may be cost-effective in 24-hour parking garage operations.)
- Examine possibilities for bi-level lighting and lighting reductions in peripheral areas during low-use hours.

High-efficiency HVAC

- Consider downsizing to a new high-efficiency chiller with lighting and other retrofits.
- Use condensing boilers with large turn-down ratios whose efficiencies improve with turn-down.
- Switch over to direct digital controls.
- Install variable air volume air handling systems with variable speed drives.
- Install premium-efficiency motors and Variable Frequency Drives.
- Install demand-controlled ventilation.
- Ventilate garages in response to environmental conditions.
- Upgrade the energy management system; optimize settings to reflect usage, respond to changing weather patterns, and control peak electric loads.
- Continuously commission the building.
- Verify economizer function and control.
- Consider using cool air from the cooling tower with water-cooled chillers.

Combined Heat and Power (CHP) System

- Examine cost effectiveness of installing a combined heat and power generation system to supply electricity, heating needs, and (through an absorption chiller) cooling needs. When properly sized and designed, such a system can save substantial money and avoid the large thermal losses associated with conventional power generation at utility plants. For additional information, visit the websites of the U.S. Combined Heat and Power Association and the Northeast Combined Heat and Power Center at the University of Massachusetts (www.northeastchp.org).

Building Envelope

- Install interior or exterior shading devices.
- Install insulation in strategic locations.
- Undertake strategic air sealing, including duct work.

Plug Loads

- Use low-energy sleep functions, and power strips that sense use, on all electronics.
- Choose ENERGY STAR office equipment and appliances.
- Install Vending Misers and Snack Misers on vending machines.
- Install ENERGY STAR commercial refrigerators and water coolers.

Employee

- Ensure building maintenance and cleaning staff are enthusiastic about savings and adopt work habits that support energy efficiency.
- Provide training for key maintenance personnel in the proper operation of the building's energy management system.
- Enroll key maintenance staff in the Building Operator Certification program (BOC). (www.theboc.info)
- Involve all employees in energy savings efforts, provide efficiency education for work and home, and encourage employee suggestions on energy savings opportunities.

Retail Stores

Energy Use

Sales floors are the most energy-intensive areas in retail buildings, so they are the focus here. Of course, most retail stores also include warehouse space and some office space, so users should go to those topics for further

recommendations. Lighting is the highest energy user in retail spaces (40%), which also contributes to the cooling load. HVAC systems typically account for 35% of energy use and plug loads about 22%. Domestic hot water only consumes about 3%.

Customers are the business of retail, and "people load" contributes to space heating in winter and cooling load in summer. The challenge is to maintain an attractive, comfortable environment while limiting energy use and peak demand.

Many retails spaces are leased from building owners who have little interest in improving the energy efficiency of their property when tenants are paying the energy bills. However, it is possible to persuade landlords to make energy-saving improvements a part of long-term lease agreements since these not only improve the property but also save money and make the space more attractive to present and future tenants. Some actions, such as lighting retrofits, are often good investments by tenants even in the absence of landlord contributions, because new, high-quality, energy-efficient lighting gives the retail floor a "fresh" look and shows off product better.

Measures that are frequently found to be cost-effective include the following:

Lighting

- Replace T-12 fluorescent lamps and ballasts, and possibly fixtures, with High Performance T-8s or T-5s. Also, select bulbs with good color rendering properties for display of merchandise.
- Consider CFLs or LEDs for illuminating merchandise. Incandescent and halogen lighting is quite inefficient and both produce objectionable heat.
- Consider incorporating skylights and photocell controls. In many retail designs, standard 4-foot by 8-foot bubble skylights are used. Usually, a skylight-to-floor area ratio of 1:25 balances daylight with space conditioning requirements. Skylights can produce energy savings and enhanced sales can also result.
- Install and adjust automatic dimming controls to take advantage of daylighting.
- Install LED exit signs.
- Upgrade parking lot lighting to save energy and reduce environmental impacts. Consider bi-level lighting to provide adequate security but lower lighting levels when shops are closed.

HVAC

- Install a demand-controlled ventilation system. When only a few people are in a store, energy can be saved by decreasing the amount of ventilation supplied by the HVAC system. A demand-controlled ventilation (DCV) system senses the level of carbon dioxide in the return air stream and uses it as an indicator of occupancy. DCV can save energy during peak cooling periods when many shoppers are at work and occupancy is low.
- Choose high-efficiency packaged A/C units listed by the Consortium for Energy Efficiency in their Tier 2 guidelines (www.cee1.org/com/hecac/hecac-main.php3).
- Install variable air volume air handling systems with variable speed drives.
- Downsize to a new high-efficiency chiller in conjunction with lighting and other retrofits.
- Use condensing boilers with large turn-down ratios whose efficiencies improve with turn-down.
- Switch over to direct digital controls.
- Install premium-efficiency motors.
- Upgrade the energy management system; optimize settings to reflect usage, respond to changing weather patterns, and control peak electric loads.
- Continuously commission the building.

Building Envelope

- Install high-efficiency glazing carefully chosen for each building facade's relation to the sun and other variables. When installing new glazing, choose a product that has high transmission in the visible spectrum (to enhance daylighting within and view from inside and out) but low transmission in the infrared (low solar heat gain coefficient, SHGC) to enhance energy performance during the cooling season.
- Install overhangs to limit direct beam sunlight coming in store windows.
- Install insulation in strategic locations.
- Undertake strategic air sealing, including duct work.

Plug Loads

- Use low-energy sleep functions and power strips that sense use, on all electronics.
- Choose ENERGY STAR appliances.

Employee

- Ensure building maintenance and cleaning staff are enthusiastic about savings and adopt work habits that support energy efficiency.
- Involve all employees in energy savings efforts, provide efficiency education for work and home, and encourage employee suggestions on energy savings opportunities.
- Enroll key maintenance staff in the Building Operator Certification program (BOC). (www.theboc.info)

Schools

Energy Use

Schools are built to last a long time, and many older schools have antiquated energy systems that waste energy, cause discomfort, and are costly to maintain. Planning and executing a comprehensive retrofit can frequently alleviate all three problems cost-effectively. Lighting in many older schools constitutes 40% of the energy budget, followed by HVAC and plug loads at approximately 25% apiece and hot water at 10%. After reducing such internal loads as lighting, it may be possible to install smaller HVAC equipment.

There are many national programs aimed at improving the energy efficiency and physical plants of schools. These include U.S. DOE's Energy Smart Schools program (www.eere.energy.gov/buildings/energysmartschools), U.S. EPA's ENERGY STAR for Schools Program (www.energystar.gov/index.cfm?c=k12_schools.bus_schoolsk12) and the Collaborative for High Performance School - "CHPS" (www.chps.net). The Consortium for Energy Efficiency maintains a directory of these programs at: www.cee1.org/com/bldgs/schools.php3.

Measures that are frequently found to be very cost-effective in schools include the following:

High-efficiency lighting

- Replace T-12 fluorescent lamps and ballasts with High Performance T-8 or T-5 equipment, and replace fixtures if appropriate.
- Replace metal halide fixtures in the gymnasium with High Bay HPT* or T-5 fixtures.
- Use compact fluorescent lights (CFLs) to replace incandescents and save energy and maintenance costs.
- Install and adjust automatic bi-level lighting controls to take advantage of daylighting.
- Install and adjust occupancy or vacancy controls in spaces used intermittently like conference spaces, lounges, and storage rooms.
- Install LED exit signs.
- Upgrade parking lot lighting to save energy and reduce environmental impacts. Upgrade parking lot lighting to save energy and reduce environmental impacts. Consider bi-level lighting to provide adequate security but lower lighting levels when the school is closed.
- Enroll key maintenance staff in the Building Operator Certification program (BOC). (www.theboc.info)

Daylighting

- Consider retrofitting skylights in classrooms, gymnasiums, and media centers. If combined with a roofing retrofit (which may also include enhanced thermal insulation), the incremental cost of installing skylights may be diminished. Install light control by louvers or diffusers to avoid glare. Install and adjust automatic dimming controls to take advantage of daylighting.
- Install light shelves one-third of the way down existing window walls to direct light across the ceiling while shading lower glazing from direct beam solar, thereby avoiding glare. Accompany this retrofit with a fresh coat of semi-gloss white paint on the ceiling or install new light-reflective acoustical tiles.
- If light shelves are impractical, take advantage of existing windows to provide daylighting by using overhangs or other shading devices to keep direct beam solar from causing glare.
- Design supplemental electric lighting systems to optimize daylighting by specifying bi-level ballasts, photo sensors, and daylighting controls. When installed, photocell daylighting controls should be carefully calibrated and tested. School building personnel should be trained in the use of this technology.
- The "Cool Daylighting" approach helps to control for glare, achieves better light distribution, and lowers cooling costs (see www.daylighting.org).

High-efficiency HVAC

- Consider a modern two-pipe retrofit, particularly if adding air conditioning to previously un-air conditioned school buildings.
- Choose high-efficiency packaged A/C units listed by the Consortium for Energy Efficiency in their Tier 2 guidelines (www.cee1.org).
- Downsize to a new high-efficiency chiller in conjunction with lighting and other retrofits. Maintain chilled water temperature as high as is practical.
- Use condensing boilers with large turn-down ratios whose efficiencies improve with turn-down. Maintain hot water temperatures as low as is practical.
- Switch over to direct digital controls (from hydraulic or manual controls).
- Install variable air volume air handling systems with variable speed drives.
- Install premium-efficiency motors and variable speed drives.
- Install demand-controlled ventilation to ensure good indoor air quality while minimizing energy use. This strategy is especially effective in intermittently used spaces such as auditoriums and gymnasiums, but is also useful in classrooms.

- Install energy-efficient unit ventilators with face and bypass controls.
- Upgrade the energy management system; optimize settings to reflect building usage, weather patterns, and to shave peak electric loads.
- Verify economizer function and control.
- Consider using cool air from the cooling tower with water-cooled chillers.

Other Measures

- Install high-quality, low-flow shower heads. Lower hot water system temperature to 120 degrees.
- Insulate hot water lines wherever accessible.
- Replace chilled water drinking fountains.
- Install energy-efficient office equipment and use energy-saving features like sleep modes and power strips that sense use, on all electronics.
- Use the duplex mode on copying machines to save energy and paper.
- Educate students about energy efficiency. Involve them in turning off equipment and lights, and encourage their input in suggesting operational and retrofit options for saving.
- Check out the various energy curricula available to increase student awareness of energy issues generally and energy conservation and renewables specifically.
- Continuously commission buildings; educate maintenance staff to anticipate as well as respond to energy-related problems.
- Enroll key maintenance staff in the Building Operator Certification program (BOC). (www.theboc.info)
- Install Vending Misers and Snack Misers on vending machines.

Small Office Buildings

Energy Use

The principal energy efficiency opportunities in most small office buildings are found in lighting with HVAC, and plug loads following. Retrofit measures that improve the efficiency of lighting and office equipment, as well as those that improve windows and shading, can lower the demand on the building's cooling system. Combined with such retrofits, it's often possible to install an energy-efficient new chiller that is substantially downsized from the old one, saving over $1,000 per ton. This can result in both initial and life-cycle savings that are quite substantial. Careful glazing and overhang designs can increase the contributions of passive solar in the winter months, while variable output, energy-efficient boilers can take up the slack as needed.

Many small offices are leased from building owners who have little incentive to improve the energy efficiency of their property, as the tenants generally are paying the energy bills. However, it is sometimes possible to persuade landlords to make energy-saving improvements a part of long-term lease agreements since these not only improve the property but also save money and make the space more attractive to present and future tenants. Indeed, such measures as lighting retrofits are often good investments by tenants even in the absence of landlord contributions.

Measures that are frequently found to be cost-effective include the following:

High-efficiency lighting

- Replace T-12 fluorescent lamps and ballasts with High Performance T-8 or T-5 equipment, and replace fixtures if appropriate.
- Use compact fluorescent lights (CFLs) to replace incandescents and save energy and maintenance costs.
- Install and adjust automatic bi-level lighting controls to take advantage of daylighting.
- Install and adjust occupancy or vacancy controls.
- Install LED exit signs.
- Upgrade parking lot lighting to save energy and reduce the environmental impacts associated with lighting the sky instead of the parking lot. Consider bi-level lighting to provide adequate security but lower lighting levels when the building is unoccupied.

HVAC

- Downsize to a new high-efficiency chiller in conjunction with lighting and other retrofits.
- Choose high-efficiency packaged A/C units listed by the Consortium for Energy Efficiency in their Tier 2 guidelines (www.cee1.or).
- Use condensing boilers with large turn-down ratios whose efficiencies improve with turn-down.
- Switch over to direct digital controls.
- Install variable air volume air handling systems with variable speed drives.
- Install premium-efficiency motors and variable speed drives.
- Install demand-controlled ventilation.
- Ventilate garages in response to environmental conditions.
- Upgrade the energy management system; optimize settings to reflect usage, respond to changing weather patterns, and control peak electric loads.

- Continuously commission the building.
- Verify economizer function and control.

Building Envelope

- Install high-efficiency glazing carefully chosen for sun exposure on each facade and other variables.
- Install interior or exterior shading devices.
- Install insulation in strategic locations.
- Undertake air sealing, including duct work.

Plug Loads

- Use low-energy sleep functions and power strips that sense use, on all electronics.
- Use the duplex copying mode to save energy and paper.
- Choose ENERGY STAR office equipment and appliances.
- Install Vending Misers or Snack Misers on vending machines.

Employee

- Ensure building maintenance and cleaning staff are enthusiastic about savings and adopt work habits that support energy efficiency.
- Enroll key maintenance staff in the Building Operator Certification program (BOC). (www.theboc.info)
- Involve all employees in energy savings efforts, provide efficiency education for work and home, and encourage employee suggestions on energy savings opportunities.

Warehouses

Energy Use

Overall, warehouses generally have lower illumination requirements as well as lower space conditioning requirements than do other building types. Accordingly, overall energy use is generally lower than for most other buildings. Warehouses are often ventilated sporadically, only partially heated, and rarely cooled. Energy for lighting is the largest use (68%), followed by ventilation and plug loads (24%), and miscellaneous (8%). (For energy-efficiency strategies for administrative areas, see Small Office Buildings.)

Measures that are frequently found to be cost-effective include the following:

Lighting

- Incorporate skylights and photocell controls. Standard 4-foot by 8-foot bubble skylights equal to 4 percent of the floor area are adequate. Place skylights above warehouse isles to achieve best daylighting distribution.
- Install photo sensors and occupancy controls to control electric lighting, and make sure they are carefully calibrated.
- Replace T-12 fluorescent lamps and ballasts with High Performance T-8 or T-5 equipment, and replace fixtures if appropriate.
- Consider replacing metal halide and low-pressure sodium fixtures with High Bay HPT8 or T-5 fixtures.
- Provide task lighting controlled by occupancy sensors in narrow aisles to more efficiently illuminate tall storage racks. Mount fluorescent fixtures on storage racks to facilitate access to the storage aisles and avoid the need to install extra fixtures at the ceiling level.

HVAC

- Control heating, ventilating, and cooling systems as a function of occupancy and the needs of goods stored using automatic controls as appropriate.
- Use variable-speed drives, high-efficiency motors, and cast aluminum fan blades for ventilation fans, using demand control to adjust ventilation rates as needed.
- Install gas-fired infrared heaters instead of forced-air convection heating systems.

Building Envelope

- Ensure that entry doors are weather-stripped and other sources of infiltration are carefully air-sealed.

INDUSTRIAL

General

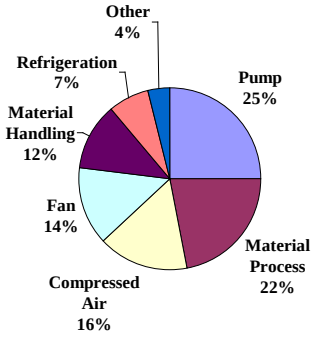
Energy Use

Principal energy use in industrial facilities depends strongly on the energy needs of the process that produces raw materials or turns raw materials into finished products. A plant that produces frozen vegetables uses large amounts of electrical energy for refrigeration while a plant that heat treats metal uses lots of natural gas to fire furnaces. However, in virtually all industrial facilities, motors play a key role. More than half of the electrical energy used in the U.S. powers motors and half of that is in the industrial sector. While waste in motor use is widespread, there are usually cost-effective options to raise efficiency and save money.

Motors are used in industry drive devices such as pumps, fans, compressors, and conveyors. The pie chart below shows national numbers on industrial motor systems end use.

Note that pump, compressed air, and fan electric energy together constitute 55 percent of electric motor use in the

industrial sector. These items are discussed here, as are a number of others applicable to most industrial facilities.



Motor Systems Efficiency

There are two general tactics for saving energy that powers motors: ensuring that the motor itself is highly efficient; and matching instantaneous motor power most efficiently to the needs of the task. Implementing an effective motor strategy involves carefully considering both and taking practical action. The results are likely to save energy, demand charges, and maintenance costs—and they may improve productivity in the bargain.

Replace low-efficiency motors with premium-efficiency motors. Over its lifetime, the cost of a motor can be outstripped by the cost of the energy it uses by a factor of 100 or more. Accordingly, an improvement in efficiency of only several percent is usually a cost-effective investment. See the Motors and Motor Systems measure description for a table of premium-efficiency ratings by horsepower.

Match motors with loads. Failure to match motors with loads is a leading cause of needless electrical energy consumption. In many industrial, agricultural, and commercial applications, motors are oversized for all or most of the time. Installing a Variable Speed Drive (VFD) that allows the motor to run as efficiently as possible for the instantaneous needs of the task can be a particularly cost-effective retrofit for motors that move fluids, such as pumps, fans, and air compressors. Cutting back on motor power to the point where flows are just adequate saves considerable energy. In addition, installing multiple pumps, fans, or compressors and staging their operations to match loads is another practical energy and cost savings strategy.

Institute a motor maintenance program. This includes routine inspections of all motors (with emphasis on those critical to production), including the drive train, which should be realigned and lubricated as needed; measuring energy use; and identifying overheating of mechanical and electrical components.

When a large motor fails, and you choose to have it rewound, seek out a repair shop that can provide a high-quality "Green Rewind". (Go to: www.greenmotors.org for more information.)

Air Compressor Options

More than 70% of manufacturing facilities in the United States use compressed air for functions such as power sources for tools and equipment like pneumatic actuations, pumping of chemicals, blow offs for cleaning, part orientation, cooling and vacuum. Compressed air is considered industry's fourth utility, but is seldom thought of as contributing to the cost of production. Compressed air systems have low operating efficiencies, typically in the 10 to 15% range and, therefore, can be expensive to operate. Substantial savings opportunities exist because many systems are poorly laid out, have leaking fixtures, and motor/compressor systems are frequently mismatched to loads. Suggestions for curbing energy waste in air compressor options include the following:

- Use properly-sized, energy-efficient compressors driven by energy-efficient motors and associated storage tanks that are matched to loads.
- Replace inappropriate end use with suitable end uses.
- Isolate single high pressure users.
- Monitor pressure props in the system.
- Install nozzles on open blow offs.
- Install solenoid valves to shut off air.
- Identify large demand events.
- Decrease discharge pressure set point.
- Replace clogged filters to reduce pressure drops.
- Install efficient part-load compressors and controls.
- Consider installing multiple stage compressors.
- Install central sequencer control for multi-compressor plants.
- Increase storage capacity.
- Install efficient dryers.
- Utilize demand flow controllers.
- Recover heat from compressors.
- Replace timer drains.
- Meter energy, flow, and other parameters to assess performance and minimize system air pressure.
- Optimize mechanical design, using a closed loop system if practical.
- Detect and fix leaks.

Lighting

Lighting is responsible for approximately 9% of total electricity use in the industrial sector. Essential considerations for lighting performance include:

- **Proper illumination levels for the task** – Lighting levels that are too high or too low make production tasks difficult, cause worker fatigue, and present dangerous environments.
- **Object contrast** – Even with proper illumination levels, if the contrast is weak, it becomes difficult to perform typical production tasks. Object contrast is particularly critical for quality control functions.
- **Accurate color rendering** – Lighting sources vary in their ability to render colors accurately. When lamps with low color rendering abilities are used, object contrast goes down. In addition, the human vision system works to correct for poor color rendering, which can cause fatigue. The ability to render colors accurately is measured by the Color Rendering Index (CRI) scaled from 1-100, with natural daylight receiving a score of 100.
- **Lighting uniformity** – Moving from very bright to very dim areas is tiring and dangerous. Lighting should be kept reasonably uniform within work areas.
- **Glare control** – Direct glare from lamps and windows, and indirect glare from work objects, can undermine productivity and create dangerous situations.

When retrofitting lighting for visual comfort and performance, designers should strive to supply the correct amount of light on the task area, combined with an appropriate level of background illumination. Recommended guidelines for lighting levels have been established by the Illuminating Engineering Society and are made available by most lighting fixture manufacturers. Visual comfort considerations also include the color temperature and the color rendering. Differing from the CRI (described above), the Correlated Color Temperature (CCT) relates to the actual appearance of the light with higher numbers (4,000 – 5,500) referring to cooler light, and lower numbers (2,700 – 3,500) referring to warmer light. Lighting glare is controlled by keeping high brightness lamps and sunlight out of the sightline of the workers. Using larger numbers of low brightness fixtures, indirect lighting, glare controlling baffles and shades are all strategies that help to control workplace glare.

Specific measures frequently found to be practical include:

- Paint ceilings and sidewalls with a white semi-gloss paint. This will enhance the lighting quality at most work stations by raising brightness levels and softening shadows and glare whether light is from electric fixtures or from the sun.
- Consider replacing conventional high intensity discharge lighting in medium and high bays with fixtures that use more efficient T-5 fluorescent lamps that may be step-dimmed when daylighting is available.
- Replace T-12 fluorescent lamps and ballasts with High Performance T-8 or T-5 equipment, and replace fixtures if appropriate.
- To prevent glare from direct beam sunlight, install reflectors ("light shelves") either inside or outside high bay windows on the east, south, and west to redirect light onto the white ceiling. High bays with windows toward the top are ideal for providing natural lighting, but they can also be a source of glare from direct beam sunlight. Light shelves allow the ceiling itself to function as a source of diffused natural light, creating an attractive, virtually shadow-free lighting environment at the work stations below.
- Install systems that redirect direct beam sunlight from rooftop windows onto light-colored ceilings, thereby controlling for glare and converting sunlight into a diffuse lighting source.
- Install and adjust automatic dimming controls to take advantage of daylighting. The "Cool Daylighting" approach keeps most outside light out of the field of view, thereby controlling for glare, producing better distribution, and lowering cooling costs. See www.daylighting.org.
- Install LED exit signs.
- Upgrade parking lot lighting to save energy and reduce the environmental impacts associated with lighting the sky instead of the parking lot. Consider bi-level lighting to provide adequate security but lower lighting levels when the building is unoccupied.

Combined Heat and Power (CHP) System

Install a combined heat and power generation system to supply electricity for process loads, low pressure steam or hot water for heating needs, and provide cooling (through an absorption chiller powered by low-pressure steam). When properly sized and designed, such a system can save substantial money and avoid the large thermal losses associated with conventional power generation at utility plants. Such systems may be sized to merely control peaks, to supply all of the electrical and some thermal needs, or to supply all thermal needs and provide extra electricity to the local power company.

Power Factor

Most utilities charge industrial consumers for reactive loads. Hence, low power factors, usually due to the running of

large motors, increases the electric bill. The solution is to balance the inductive load with a bank of capacitors. These can be brought on as needed to maximize the power factor and lower the reactive load cost.

Laboratories and Hospitals

Energy Use

These notes address laboratories generally, from biological or chemical facilities at universities to experimental and production facilities operated by industrial concerns. Most such facilities have very high energy use, primarily due to large HVAC demands. Because of the risk of microbial or chemical contamination, high ventilation rates with 100 percent fresh air are required in laboratory areas because conditioned air cannot be circulated as is the case with most other buildings. Some laboratories also have significant process loads for sterilization or for the need to maintain computer, animal, or equipment areas at specific temperatures. Plug loads for serving special purpose equipment, much of which must be functioning 24 hours per day, also contribute to high electric energy use.

Efficiency measures that are frequently found to be cost-effective include the following:

HVAC

- Separate areas in the building that must have once-through air from those which can recirculate air. This allows for substantial economies in the areas where air may be recirculated. Care in air sealing the environmentally-sensitive areas from those where air is recirculated is essential, and environmentally-sensitive areas should be maintained at negative air pressure with respect to the remainder of the building.
- Use modern variable air volume (VAV) fume hoods equipped with occupancy sensors. VAV systems respond to the degree to which the hood is opened so as to maintain constant negative pressures across the opening to whisk potentially contaminated air up the exhaust. Occupancy sensors which increase hood exhaust rates when scientists are using the system further protects air quality and user health while maintaining flows that are as low as practical.
- Use high-efficiency motors with variable speed drives to adjust exhaust and make up air fans in HVAC systems serving laboratory areas. Employ controls that vary air flow rates in response to instantaneous exhaust hood usage. When fume hoods are used only moderately, air exchange rates may be safely lowered, thereby saving substantial fan power and conditioning energy. When laboratories are equipped with modern fume hoods with VAV equipment, it is frequently possible to downsize HVAC system fans.
- Recover heat from central plant equipment by installing heat-recovery coils in the exhaust air handlers to capture waste energy without the risk of contamination.
- Recover waste heat from exhaust stacks of boilers to preheat boiler makeup water or combustion air.
- Recover heat from sterilization equipment, laundries, dishwashers, and cleaning equipment to pre-heat fresh hot water.
- Install a waterside economizer for nighttime and winter cooling.
- Install a high-efficiency chiller in new facilities or existing facilities when replacing an older chiller. Right-size the chiller in consideration of other efficiency measures that lower cooling loads, like energy-efficient lighting.
- Use condensing boilers with large turn-down ratios whose efficiencies improve with turn-down.
- Switch over to direct digital controls.
- Upgrade the energy management system; optimize settings to reflect usage, respond to changing weather patterns, and control peak electric loads. Lights and air conditioning in spaces occupied only during business hours are often left on all the time. The energy management system can automatically shut off lighting and set back HVAC systems in spaces occupied only during the daytime. A combination of occupancy sensors and time switches can accommodate scientists who arrive early or stay after the end of the business day.
- Verify economizer function and control.
- Consider using cool air from the cooling tower with water-cooled chillers.

Combined Heat and Power (CHP) System

- Install a combined heat and power generation system to supply electricity, heating needs, and (through an absorption chiller) cooling needs. When properly sized and designed, such a system can save substantial money and avoid the large thermal losses associated with conventional power generation at utility plants.

Lighting

- Install compact fluorescent bulbs in place of incandescents in laboratories, halls, and elevators.
- Install energy-efficient lighting in all other spaces, being sure to replace fluorescent lamps and ballasts with High Performance T-8 or T-5 equipment, and replace fixtures if appropriate.
- Install and calibrate automatic lighting controls in

conjunction with skylights and clerestories in open areas to dim lights in response to daylight.

- Install LED exit signs.
- Upgrade parking lot lighting to save energy and reduce environmental impacts due to light spillage.
- Upgrade garage parking lighting. Consider bi-level lighting to provide adequate security but lower lighting levels when the building is unoccupied.

Building Envelope

- Install high-efficiency, specularly-selective glazing carefully chosen for sun exposure on each facade and other variables. ENERGY STAR windows with low solar heat gain coefficients are frequently good choices.
- Install interior or exterior shading devices.
- Install insulation in strategic locations.
- Undertake strategic air sealing, including duct work.

Plug Loads

- Use low-energy sleep functions and power strips that sense use, on all electronics.
- Choose ENERGY STAR office equipment and appliances.

Employee

- Ensure that key maintenance people are trained to properly use and monitor the building's energy management system.
- Enroll key maintenance staff in the Building Operator Certification program (BOC). (www.theboc.info)

4 Financing Energy Efficiency Improvements

Improving the energy efficiency of buildings and commercial operations can have substantial bottom line benefits for businesses of all sizes. By reducing the amount of energy used or using energy more efficiently, businesses can often reduce their operating expenses and ultimately increase cash flows.

It is important to think of energy efficiency improvements as capital investments that are made with the anticipation of a return on that investment. They are not simply one-time sunk costs, but medium- or long-term investments that can make a business more efficient and profitable.

As with any capital cost, a business needs to determine how it will make the investment. There are a variety of options. If a business cannot make energy efficiency improvements with its own resources, an alternative is to seek financing in the form of loans and related options.

It may be surprising, but experience from energy efficiency programs across the country show that many if not most energy efficiency retrofit projects are paid for directly by the company, without third-party financing. Most companies will simply pay for investments where benefits and paybacks are high—which means doing the analysis is an important step.

Evaluating Energy Efficiency from a Financial Perspective

Following are some ways to determine whether or not an energy efficiency improvement is viable and also a description of the most common kinds of financing.

When financing energy efficiency improvements, as with any investment, it is critical to determine if it makes economic sense, and if you can pay for it either through cost savings or existing cash flow.

An Energy Star guide – *Building Upgrade Manual*[1] – on investment analysis for energy efficiency upgrades in buildings recommends that any organization, whether for-profit or non-profit, should determine the value of a particular investment based on expected cash flows. Chapter 3 of that guide provides a very user-friendly description of three cash flow analysis tools that are often used to evaluate energy efficiency investments: payback period, net present value and internal rate of return.

One of the simplest and most common of the three is the payback period. When determining the payback period of an energy efficiency project, the following information is helpful:

- Purchase price of the equipment or materials;
- Installation cost;
- Expected lifetime of equipment;
- Cost of energy (e.g., residential electric rate in cents per kilowatt hour); and
- Amount of energy saved.

Specifically, the payback period is the amount of time it takes for an energy efficiency project's energy cost savings to cover its purchase, installation, and operating costs. It is calculated as the cost of a project divided by the annual savings resulting from the project. If a project costs $100,000 and is expected to save your business $20,000 annually, the payback period will be five years. The better investment is typically the project with a shorter payback period. But any investment where the equipment will last longer than the payback period is considered cost-

1 This guide can be found at: (www.energystar.gov/index.cfm?c=business.bus_upgrade_manual)

effective. This method is useful because it is simple, but its disadvantages are that it does not take into account any benefits that occur after the payback period and it ignores the time value of money.

You should use whatever method is easiest for you but consider the weaknesses of each method. If you would like to learn more about how to calculate the payback period, net present value, and internal rate of return, as well as their strengths and weaknesses, please refer to *Chapter 3: Investment Analysis* in the report cited above.

Using Loans and Related Options to Finance Energy Efficiency

If you cannot use internal funds, grants and/or cash incentives to pay for the up front costs of energy efficiency improvements, the next most common option is to finance the improvements with a loan or other financial option. Many banks and credit unions now offer energy efficiency loans. Most states, including Maine, as well as the federal government, have loan and loan guarantee programs.

Examples of Loans and Related Financing Options[2]

Some of the most common private financing options are:

- **Direct loans:** The most familiar direct loans are fixed-term and can be secured (borrower pledges collateral as security) or unsecured (loan backed solely by borrower's promise to pay). Such loans are typically self-amortizing, whereby each payment includes both interest and principal payments.
- **Lines-of-Credit:** These are pre-approved loan ceilings against which borrowers can draw at any time during the term, which is usually a year. Principal and interest vary as the borrower draws and repays, but approvals and credit checks occur only once, at the beginning of the term.
- **Second Mortgages:** Long-term loans secured by an interest in real property.
- **Credit Cards**

Table 1: Advantages and Disadvantages of Loans and Related Financing Options

Type of Financial Instrument	Advantages	Disadvantages
Direct Loans	• Very familiar • Short terms (3-5 years) can be convenient • Good way to finance quick payback items • Interest is deductible as a business expense • Many institutions competing for good customers	• Lenders often unwilling to do small loans (e.g., <$10,000) • Loan processing can be time-consuming • Some private lenders only consider creditworthiness, not necessarily the cost-effectiveness of the improvement, even if the measure may produce a revenue stream to repay the loan. • Because of short-term nature and relatively high interest rate of most conventional loans, only the most cost-effective projects will make economic sense • Some cost-effective projects have 7-10 year or longer payback periods. In that case, a short-term length is a disincentive to make the investment.
Lines-of-Credit	• Flexibility and instant access, which can be very helpful for replacement of failed equipment	• Lending institution can call line at any time
Second Mortgages	• Provide long-term capital at lowest rates • Relatively long payback is incorporated into the building and increases efficiency and value	• Long-term debt that appears on a company's balance sheet and further burdens its real property • In current environment, lenders may be reluctant to provide second mortgages
Credit Cards	• Flexibility and instant access	• High interest rates

2 The examples and analysis of advantages and disadvantages in this section, unless otherwise noted, are summarized from the following report by Douglas Baston: "Just a Little Money: Financing Modest Investments in Energy Efficiency and Renewable Energy for Residential and Small Business Customers in a New Energy Marketplace." Prepared for: The Chicago Regional Support Office of Energy Efficiency and Renewable Energy, U.S. Department of Energy. June 15, 1998.

Federal, state and local governments often have their own loan programs, some of which have preferential terms and rates. For example, the Public Utilities Commission, in partnership with the Finance Authority of Maine (FAME) with Efficiency Maine offers loans up to $35,000 at 3% interest to small businesses to fund eligible energy conservation measures. (See Section 5 of this guide for more information.) Larger loans are also available through FAME.

Energy Performance Contracting[3]

Another option is energy performance contracting, a way to finance and install proven energy-efficient technologies, improve your facility's energy performance, and save money and energy. Through performance contracting, you can implement energy efficiency projects that pay for themselves through the energy savings, and in many cases require no up-front financial investment. For this reason they are especially suitable to public sector institutions.

Energy performance contracting works by combining energy savings and financing together to ensure the projects are cash-flow positive or neutral. The savings are used to *directly* offset the cost of financing, installing, operating, and maintaining the energy efficiency measures. The energy efficiency plan tailored to a particular business is typically designed and installed by an energy service company, or ESCO. A business pays the ESCO through reduced energy bills, typically sharing the energy cost savings over a predetermined length of time, after which all of the energy savings revert to the business or the facility owner.

A business can benefit from a performance contract in the following ways:

- Reduced risk – the ESCO takes on the risk of not achieving the prescribed savings
- Turn-key services – the ESCO provides all required services
- Your business or institution needs less internal expertise
- Project financing can be "off balance sheet' and not affect debt load"
- State-of-the-art products and services are used
- Additional efficiency improvements can be paid for out of the energy savings

The ESCO will recommend cost-effective improvements, work with you to implement the recommendations you choose, and can guarantee that the resulting savings will cover all project costs.

Unfortunately, because of the economies of scale involved, most ESCOs are typically focused on fairly large-scale projects such as school systems, industrial facilities or hospital campuses with project sizes of $100,000 and up. ESCOs also capture a portion of the savings and payoff from efficiency for themselves – to pay for their services, risks, ease of use, etc. Familiar ESCOs working in Maine that are household names include Honeywell, Siemens, and Johnson Controls. In addition, some Maine-based ESCO's include: Freedom Electric, Self-Gen, and Trane.

3 Most of this information is taken directly from the State of Colorado's Energy Efficiency Guide for Colorado Businesses at: www.coloradoefficiencyguide.com/introduction/default.htm

5 Directory of Programs and Resources

STATE PROGRAMS

Note: In June 2009, Maine's legislature voted to restructure and consolidate energy efficiency program administration in Maine "for the purpose of developing, planning, coordinating and implementing energy efficiency programs in the state." (35-A MRSA §10103) In the summer of 2010, several programs described below will be subsumed into a single Efficiency Maine Trust, which will be the primary point of contact for Maine businesses. Existing programs will continue at least through that date, and after that date many programs will continue with relatively little change from the customer perspective. In addition, federal economic stimulus funds for energy efficiency programs are allowing Maine to immediately expand efficiency opportunities for Maine businesses. Details for new and expanded programs from stimulus funds are still being developed as of publication—please contact Efficiency Maine to learn more.

Efficiency Maine Business Program

Overview

The Efficiency Maine Business Program has a number of efficiency services for businesses including: cash incentives, free small business energy audits, a small business low interest loan program, a business ally network, and independent, expert technical advice. In addition, Efficiency Maine is connected with other energy programs at the Public Utilities Commission, like renewable power rebates and grants.

Efficiency Maine's Business Program has nearly 600 Program Allies across the state. Program Allies are vendors, contractors, suppliers and professionals who are familiar with Efficiency Maine, and who can help identify qualifying energy-efficient equipment and assist with the application process.

Cash Incentives

Since 2003, Efficiency Maine has paid incentives to more than 1500 Maine businesses to help them purchase and install electric energy saving equipment such as energy-efficient lighting, HVAC equipment, motors, system controls and refrigeration. This equipment is saving Maine businesses more than 98 million kilowatt hours (kWh) annually. These incentives reduce or eliminate any incremental up-front cost for energy efficient equipment over traditional choices, thus reducing payback periods.

All prescriptive incentives are available to eligible business participants, regardless of the number of employees (see Eligibility). Custom incentives are also available for electricity-saving equipment that is not on the list of prescriptive incentives.

Eligibility Incentives are available to all non-residential customers – that includes commercial businesses as well as nonprofit organizations, public and private schools, colleges, local and county governments, state buildings, farms, airports, water and wastewater facilities, quasi-governmental and other regional organizations.

Pre-approval is not required for agriculture and motors applications. It is also not required for lighting and refrigeration projects when the incentive is under $1,000.

Pre-approval is required for lighting and refrigeration applications with incentive payments over $1,000. It also is required for all HVAC, variable frequency drive and custom applications.

Incentives are available for retrofit applications or new construction, unless otherwise specified.

Each business is eligible for Efficiency Maine incentives up to $100,000 per business, per calendar year.

This offer may be changed, revised, or discontinued at any time by Efficiency Maine.

Small Business Energy Audit and Loan Program

Free walk-through energy audits are available for small to medium-sized commercial, non-profit, and manufacturing facilities resulting in possible energy savings, with accompanying cost and waste reductions. This program is limited to organizations or businesses with fewer than 50 employees or sales under $5 million. The Maine Public Utilities Commission (PUC) and Finance Authority of Maine (FAME) have partnered to make energy conservation funds more available to Maine's small businesses. A loan program providing loans up to $250,000 currently at 3% interest to small businesses to fund Efficiency Maine approved energy conservation measures. Federal economic stimulus funds will be used starting in summer of 2009 to expand the fund and reduce interest rates to 1%. FAME assists Efficiency Maine with the management of this program by providing a credit analysis, and preparing loan documents. Funding, disbursement and repayment of loans are all processed through Efficiency Maine. Loans terms vary depending on project, the loan amount, and client cash flow. Collateral is required to secure the loan. (See the FAME section on page for other loan options.)

Eligibility Businesses with less than $5 million in annual sales or fewer than 50 full-time employees are generally eligible. Schools, hospitals, and facilities with residential components, such as apartment buildings, condominiums, or private residences are not eligible for participation in this program. To qualify, a business must undergo an energy audit to identify necessary improvements. The audit may be performed free of charge by an Efficiency Maine contractor or for a fee by an energy auditor approved

by Efficiency Maine. After the audit is completed, the business may submit an application to the Maine State Energy Office (SEO), housed at the PUC, for a specific loan amount, based on the merits of the project. Following approval by the SEO, the application will be forwarded to FAME to determine the creditworthiness of the business.

Building Operator Certification Program

Efficiency Maine will help you reduce the energy consumption of your building. Electricity use in commercial and government buildings can be cut by 20 percent or more when building operators manage and maintain their structures and building systems more effectively. Building Operator Certification is a nationally recognized training program designed to educate facilities personnel in the energy and resource efficient operation and maintenance of building systems. The normal training and certification program takes eight days over 2-4 months. Starting in 2009, Efficiency Maine will use federal stimulus funds to also offer abbreviated two-day workshops across the state.

Other Services for Maine Businesses

In addition to cash incentives and programs listed above, the Efficiency Maine Business Program offers the following services:

- Assistance with qualifying and applying for Efficiency Maine incentives as well as other incentives and opportunities
- Information and guidance for purchasing energy-efficient electric products and equipment
- Education and training workshops
- Self-survey tools to help businesses identify and evaluate electricity savings opportunities
- Help locating participating suppliers and contractors who can assist in the installation and maintenance of energy-efficient electric equipment

New Opportunities through Federal Stimulus Funds

The following new or expanded programs are being developed at the time of publication. Please contact Efficiency Maine if you are interested in details.

- Enhanced commercial energy audits;
- Additional all-fuel grants and incentives of up to $50,000, pending completion of an energy audit;
- New commercial construction program to provide assistance and incentives for construction beyond compliance with building codes;
- Large project competitive grants, focused on business projects with large, immediate impact on jobs and energy savings;
- Retro-Commissioning for commercial energy control systems that are operating out of specifications and where large energy savings can be achieved;
- Industrial process assistance to study and identify savings opportunities in large and small industrial businesses.

Contact:
Efficiency Maine (PUC)
18 State House Station, Augusta, ME 04333
Efficiency Maine is located at 242 State St.
1 (866) 376-2463 FAX: (207) 287-1039
www.efficiencymaine.com

Multifamily Home Energy Loan Program

Overview

MaineHousing's Multifamily Home Energy Loan Program (Multifamily HELP) provides energy efficiency financing to multifamily housing owners within the housing authority's portfolio.

Programs and Services

Multifamily HELP offers 4.75% fixed rate financing to improve the energy efficiency of eligible affordable housing developments and reduce project operating costs. Property owners who make improvements identified in an energy audit may reduce energy consumption by 15-20% annually.

Loans may be used to finance:

- Heating system repair and replacement (including alternative fuel sources)
- Insulation, air sealing and weather stripping (required if replacing a heating system)
- Energy Star rated windows and appliances
- Storm doors and storm windows
- Ventilation and moisture controls
- Roof repairs (if the attic is insulated to R60)

Borrowers pay third-party fees such as the cost of the energy audit, title update, credit report, recording fee, and (in some cases) appraisal of the property. These fees may be included in the loan.

Eligibility This program is currently offered only to multifamily housing owners within MaineHousing's portfolio.

Improvements financed with a Multifamily HELP loan must be recommended by a certified energy auditor and approved by MaineHousing. Work also must comply with MaineHousing's Green Standards. The cumulative Savings to Investment Ratio for all improvements financed with the Multifamily HELP loan must be 1 or greater.

Contact:
Maine State Housing Authority
Asset Management Dept
353 Water Street, Augusta, Maine 04330
(207) 626-4600 or 1 (800) 452-4668
www.mainehousing.org

Finance Authority of Maine

Overview

FAME has made available additional, low-cost energy funds for Maine businesses. FAME has reduced the interest rate on all new energy-related Economic Recovery Loans and set aside additional funds within this program for energy savings purposes; set aside $1 million for Energy Conservation Loans to provide additional funding for businesses to improve energy efficiency; and partnered with Maine banks to provide low-cost Energy Audit Equipment Loans for graduates of MaineHousing's energy auditor and weatherization technician classes. Some loans are available through the Maine Public Utilities Commission's Efficiency Maine Business Program, others require direct application to FAME.

Economic Recovery Loan Program

The loans set aside under the Economic Recovery Loan Program provide subordinate (GAP) financing to assist businesses in their efforts to save on energy costs to remain viable and/or improve productivity. Through March 31, 2009, the interest rate on all new Economic Recovery Loan Program loans will be reduced from Prime + 2% to Prime. All applications for this set-aside must be received by FAME by March 31, 2009. The maximum loan amount is $200,000. Larger loans, up to $1,000,000, may be available if substantial public benefit is demonstrated.

Eligibility Eligibility includes Maine-based businesses that exhibit a reasonable ability to repay the loan and demonstrate that other sources of capital have been exhausted.

Contact:
Finance Authority of Maine
6 Community Drive, PO Box 949, Augusta, ME 04332-0949
(207) 623-3263 or 1 (800) 228-3734 FAX: (207) 623-0095
info@famemaine.com www.famemaine.com

Energy Conservation Loan Program

FAME has set aside $1 million for low-interest Energy Conservation Loans to help Maine businesses improve workplace energy efficiencies. Provided by FAME and the Maine Public Utilities Commission, FAME now may fund 90% of a total project up to $250,000 at a 3% interest rate. Efficiency Maine offers a small business loan up to $35,000 (See the Efficiency Maine section on page). However, for projects in need of loans in excess of $35,000, FAME will fund 90% of a total project, up to a maximum of $250,000. Loan terms cannot exceed five years, with a maximum fifteen-year amortization period. There is a 3% fixed interest rate for the term of the loan, which is usually 5 years. Longer terms may be negotiated depending on the useful life of the assets being financed or additional collateral pledged. There is security for assets being financed and other collateral, as required.

Eligibility Eligibility includes Maine-based businesses whose projects are approved by the Maine PUC. Businesses must exhibit a reasonable ability to repay the loan. Contact the PUC (Efficiency Maine) to determine project eligibility. The PUC will submit completed applications to FAME for underwriting.

Contact:
Efficiency Maine (PUC)
18 State House Station, Augusta, ME 04333
Efficiency Maine is located at 242 State St.
1 (866) 376-2463 FAX: (207) 287-1039
www.efficiencymaine.com/business_programs.htm

Energy Audit Equipment Loans

Energy Audit Equipment Loans are available for graduates of MaineHousing's energy auditor and weatherization technician classes, who will need to purchase equipment to complete energy audits. Low-interest loans up to $15,000 will help new energy audit businesses get up and running. The rates, terms, and specific underwriting criteria are determined by each participating bank. This is a small business loan up to $15,000. The rate is from Prime +1% to Prime +2%, in most cases, and the loan term is up to 60 months typically, but may vary.

Loan decisions can be expected to range from 48-72 hours in most cases; however, please allow up to two weeks from time of completed application to actual disbursement of funds. Loans may be submitted by banks for consideration under FAME's 60% OLA (On-Line Answer) Commercial Loan Insurance program. An immediate answer will be received.

For more information, please contact your local bank. Participating banks include: Bangor Savings Bank, Biddeford Savings Bank, Damariscotta Bank & Trust Co., Franklin Savings Bank, Kennebunk Savings Bank, Machias Savings Bank, Norway Savings Bank, Saco & Biddeford Savings Bank, Sanford Institution for Savings, Skowhegan Savings Bank, and TD Banknorth.

Related Loan Programs

Clean Vehicle Fuel Program

This program is for businesses purchasing clean fuel vehicles or clean fuel vehicle components. There are reduced interest loans available up to $50,000.

Waste Reduction and Recycling Loan Program

This program is for businesses that meet the goals of the State's Waste Management Plan. There are loan rates available for as low as 4%.

Contact:
Finance Authority of Maine
6 Community Drive, PO Box 949, Augusta, ME 04332-0949
(207) 623-3263 or 1 (800) 228-3734 FAX: (207) 623-0095
info@famemaine.com www.famemaine.com

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State Planning Office
38 State House Station, Augusta, Maine 04333-0038
(207) 287-5759 or 1 (800) 662-4545 FAX: (207) 287-6489
www.recyclemaine.com

Energy & Carbon Savings Trust ("RGGI Trust")

Overview

The Energy & Carbon Savings Trust (otherwise known as the RGGI Trust, after the Regional Greenhouse Gas Initiative) is an independent entity to fund programs and projects which reduce electricity consumption through energy efficiency or reduce carbon emissions through fossil fuel efficiency. The trust is funded by periodic auctions of carbon "allowances", required by power plants in the Northeast under the RGGI cap & trade program. In 2009 the Trust is expected to spend roughly $17 million in efficiency grants and incentives. Initiated in the fall of 2008, the Trust is a new entity—and will be subsumed into the Efficiency Maine Trust in July 2010—so program details are not yet complete.

As of publication, the Trust will channel some funds for residential and commercial consumers through Efficiency Maine. In addition, the Trust expects to offer at least $5 million in competitive grants (with a minimum size of $100,000 and a maximum of $1,000,000) to large energy consumers. The Trust and Efficiency Maine hope to produce a joint application for this fund and for a large consumer program at Efficiency Maine funded by federal economic stimulus funds for 2009-2010. Application guidelines are expected in the summer of 2009.

Contact:
Energy & Carbon Savings Trust
c/o Public Utilities Commission
18 State House Station, Augusta, ME 04333
1 (866) 376-2463 FAX: (207) 287-1039

Community Development Block Grant Economic Development Funds

Overview

The Community Development Block Grant (CDBG) program is a flexible program that provides communities with resources to address a wide range of unique community development needs. The CDGB's three main economic development funds are Economic Development Infrastructure (EDI), Business Assistance, and Development Fund.

Economic Development Infrastructure (EDI)

Grants provided to municipalities for up to $400,000 for the construction of public infrastructure projects such as water lines, roads, utilities, publicly owned buildings, wastewater treatments, and rail spurs. The funding guideline is $10,000 per job created or retained.

Business Assistance

Grants provided to businesses via their municipality for up to $400,000, not to exceed 40% of the total project costs to finance fixed assets including capital equipment, commercial or industrial buildings, fixtures or real property improvements. The funding guideline is $10,000 per job created or retained.

Development Fund

Loans provided to businesses via their municipality for up to $250,000, not to exceed 40% of a business' development activities to be used for either fixed asset investments or working capital. The funding guideline is $10,000 per job created or retained.

Eligibility Eligibility for the three funds includes businesses that require GAP financing, which is critical to their development or expansion and will lead to the creation or retention of jobs for persons of low to moderate income.

Contact:
Department of Economic & Community Development
59 State House Station, Augusta, ME 04333-0059
(207) 624-7484 FAX: (207) 287-8070
www.econdevmaine.com/

Northern Utilities Commercial Energy Efficiency Program

Overview

Northern Utilities offers rebates for multifamily buildings, small/medium business, and large business natural gas customers. In additional to these rebates, Northern Utilities will also perform an energy audit for commercial and industrial customers, make recommendations, and pay a portion of the qualified installation cost of suggested upgrades.

Northern Utilities will share a portion of the cost to design, purchase and install any qualified energy efficiency upgrades. Northern Utilities will pay 50% of the qualified installed cost, up to a maximum of $50,000 per master meter. Customers must sign a "Partners in Energy Installation Agreement" prior to the commencement of any energy-related work.

Eligible energy-efficient upgrades are similar for all three programs with slight variations; customers should check the website for which measures qualify in which programs. Upgrades include: attic, roof, wall, ceiling, floor, basement, heating pipe, duct and hot water pipe insulation, temperature turn down, boiler reset control, automatic temperature controls, water heater tank rap, low-flow showerheads, faucet aerators, heat recovery potential, chillers, etc.

Rebates for Multifamily Buildings

The Basic Program includes:

- Attic/roof/wall insulation (R-11 or less existing)
- Floor/basement/ceiling insulation
- Heating pipe/duct insulation
- Hot water pipe insulation
- Temperature turndown
- Boiler reset control
- Automatic temperature controls
- Water heater tank wrap
- Low-flow showerhead
- Faucet aerator

The Custom Program adds:

- Heating system electronic/pilotless ignition
- Burner replacement
- Other measures determined on a site-specific basis

Eligibility Eligible multifamily buildings have more than four units, a master-metered account, and use gas heat and/or gas hot water, and must be on a firm commercial rate.

Rebates for Small-Medium Businesses

The Basic Program includes:

- Attic/roof/wall insulation (R-11 or less existing)
- Floor/basement/ceiling insulation
- Heating pipe/duct insulation
- Hot water pipe insulation
- Temperature turndown
- Boiler reset control
- Automatic temperature controls
- Water heater tank wrap
- Low-flow showerhead
- Faucet aerator

The Custom Program adds:

- Heating system electronic/pilotless ignition
- Burner replacement
- High-efficiency gas heating system (Customer must install applicable Basic measures to qualify for heating system replacement.)
- Other measures determined on a site-specific basis

Eligibility Customers who have a commercial or industrial building that has an annual gas usage of 40,000 therms or less and they must be on a firm commercial rate to qualify for the small/medium business customers program.

Rebates for Large Businesses

The program begins with Northern Utilities conducting, at no cost to the customer, a simple walk-through evaluation of your facility to identify possible energy efficiency upgrades.

Areas of your facility that will be evaluated include:

- Boiler/burner improvements
- Heating system improvements
- Water heating system improvements
- Gas-fired process equipment improvements
- Control improvements
- Heat recovery potential
- Ceiling/wall insulation
- Gas-fired steam absorption chillers

Based on the outcome of the walk-through study, Northern Utilities and the customer will determine the need to

conduct a more comprehensive energy evaluation and scoping study to qualify specific energy efficiency upgrades for financial incentives under the guidelines of our program.

Northern Utilities will pay 50% of the cost for a licensed professional engineer to perform the scoping study up to a maximum amount of $7,500. The customer may employ an engineer of his/her choice, or select one from a list of engineers provided by Northern Utilities.

Eligibility All firm gas customers, whose annual use exceeds 40,000 therms, plus all municipal buildings, hospitals, and universities, qualify for the large business program. (All other commercial and industrial customers are eligible for the small commercial and industrial conservation program listed above.)

High Efficiency Rebates

Northern Utilities, as a member of GasNetworks, also offers high efficiency space and water heating equipment rebates. Rebates range from $25 to $1,000, depending on equipment type. All equipment must meet certain energy efficiency standards listed on the program web site.

Utility Rebate Program

The Utility Rebate Program includes a base rebate of 50% of installation cost (maximum of $50,000 per master meter), a scoping study rebate of 50% of cost, and additional equipment rebates of $25-$1,000.

Eligibility Includes *efficiency technologies* (water heaters, chillers, furnaces, boilers, heat recovery, programmable thermostats, building insulation, custom/others pending approval, low-intensity infrared heating, fryers) and *applicable sectors* (commercial, industrial, schools, local government, multi-family residential, institutional).

Contact:
Partners in Energy Intake Center
1 (800) 232-0120
www.northernutilities.com/business/eneraudit.htm

Maine Department of Environmental Protection: Office of Innovation & Assistance

Overview

In 2003, Maine became the first state in the nation to set into statute the goals achieved by the 2001 Agreement among the New England Governors and Eastern Canadian Premiers to reduce greenhouse gases. These goals call for specific reductions to be made to 1990 levels by 2010, and to 10% below 1990 levels by 2020. Overall reductions of 75% to 80% from 2003 levels of greenhouse gases are to be achieved.

Part of Maine's Climate Change law directs the Maine Department of Environmental Protection (DEP) to develop agreements with businesses and non-profit organizations to accomplish these goals. The Office of Innovation's work emphasizes the development of innovative approaches, going beyond traditional regulatory approaches, to lead facilities toward sustainability—both environmentally and economically.

Governor's Carbon Challenge

Join the Governor's Carbon Challenge to save energy, save money, and reduce your carbon footprint all at the same time. They will conduct a walk-through energy audit of your facilities to help you identify some of the easiest and lowest cost energy-efficiency investments. Participants also join an active network of businesses with energy experiences to share.

Contact:
Department of Environmental Protection's
Office of Innovation & Assistance
17 State House Station, Augusta, Maine 04333-0017
(207) 287-4432
www.maine.gov/dep/innovation/gcc/

Maine's Environmental Leader Certification - Lodging Businesses and Restaurants

See yearly cumulative savings and environmental impact reductions. On Average, each participating business has saved over $7,000 per year in energy and chemical costs.

Become a certified Environmental Leader in the lodging and dining sectors and receive free benefits:

- Environmental Leader flag and decals to display at your property.
- Environmental Leader logo to use for advertising (website, literature, decals, etc.).
- A listing on the Maine Tourism Association and Maine Office of Tourism web sites and for members, a listing on the Maine Inn Keeper's Association website, all of which identify your business as Maine- certified environmentally preferable.
- A listing on a brochure available at Maine Visitor's Centers.
- Free on-going technical assistance from Maine Departmental of Environmental Protection on how to continue to reduce environmental impact while saving money.

Visit the website for more information on how to join the

program. Free technical assistance is available from DEP's Pollution Prevention Program Manager to help any business achieve enough points to be eligible for the program. Additionally, low cost recommendations will be given to help businesses achieve more points.

Contact:
Green Business Certification, Maine DEP
312 Canco Road, Portland, ME 04103
(207) 791-8101 FAX: (207) 822-6303
www.state.me.us/dep/innovation/greencert/index.htm

FEDERAL PROGRAMS

Rural Energy for America Program (REAP)

Overview

The REAP is administered by the U.S. Department of Agriculture Rural Development (USDARD). REAP expands and renames the program formerly called the Renewable Energy Systems and Energy Efficiency Improvements Program. Under the expansion, hydroelectric source technologies will be added as eligible; energy audits will be included as eligible costs, and; loan limits will be increased.

Programs and Services

REAP promotes energy efficiency and renewable energy for agricultural producers and rural small businesses through the use of (1) grants and loan guarantees for energy efficiency improvements and renewable energy systems, and (2) grants for energy audits and renewable energy development assistance.

Of the total REAP funding available, 96% is dedicated to grants and loan guarantees for energy efficiency improvements and renewable energy systems. These incentives are available to agricultural producers and rural small businesses to purchase renewable energy systems (including systems that may be used to produce and sell electricity), to make energy efficiency improvements, and to conduct relevant feasibility studies. Eligible renewable energy projects include wind, solar, biomass and geothermal; and hydrogen derived from biomass or water using wind, solar or geothermal energy sources. These grants are limited to 25% of a proposed project's cost; loan guarantees may not exceed 75% of total eligible project costs, and may be for amounts up to $25 million. A combination grant and guaranteed loan may not exceed 75% of the project's cost. In general, a minimum of 20% of the funds available for these incentives will be dedicated to grants of $20,000 or less. The USDA has announced the availability of funding for this component of REAP through a Notice of Funds Availability (NOFA).

Eligibility The USDA will also make competitive grants to eligible entities to provide assistance to agricultural producers and rural small businesses "to become more energy efficient" and "to use renewable energy technologies and resources." These grants may be used for conducting and promoting energy audits; and for providing recommendations and information related to energy efficiency and renewable energy. These grants are generally available to state government entities, local governments, tribal governments, land-grant colleges and universities, rural electric cooperatives and public power entities, and other entities, as determined by the USDA. Of the total REAP funding available, 4% is dedicated to competitive grants to provide assistance to agricultural producers and rural small businesses.

Contact:
United States Department of Agriculture Rural Development
967 Illinois Avenue, Suite 4, P. O. Box 405
Bangor, ME 04402-0405
(207) 990-916

Commercial Building Tax Credit Program

Overview

The Energy Policy Act of 2005 included a new tax incentive to improve the energy efficiency of commercial buildings. The "Commercial Building Tax Deduction" establishes a tax deduction for expenses incurred for energy-efficient building expenditures made by a building owner. The deduction is limited to $1.80 per square foot of the property, with allowances for partial deductions for improvements in interior lighting, HVAC and hot water systems, and building envelope systems.

Commercial Building Tax Deduction

The Commercial Building Tax Deduction essentially has two levels depending on whether one wants to achieve savings targets for the entire building—interior lighting, HVAC/hot water and building envelope—or each of these systems individually. There is no limit to the amount of money available to fund this incentive.

There is no special form to claim the deduction. The IRS instructions to business forms (e.g., Form 1120 for corporations, Form 1120-S for S corporations, and Form 1065 for partnerships) indicate that the taxpayer should include the amount of the deduction in the amount in the "Other deductions" line of the tax return. A statement listing the types and amounts of "other deductions" should be attached to the return. In addition, it is important that a taxpayer obtain and retain the necessary certifications and documentation to claim the deduction (see, IRS Notice 2006-52 for these requirements).

The Commercial Buildings Deduction offers an accelerated tax deduction that is the lesser of:

- The complete cost of installing "energy-efficient commercial property"
- $1.80/sq.ft.

Eligibility "Energy-efficient commercial building property" is defined as:

- Interior lighting systems, HVAC/hot water systems and building envelope features, which are …
- Otherwise depreciable as a cost, and …
- Installed in the United States or its territories, and …
- Part of new construction or renovation within the scope of the ASHRAE/IES Standard 90.1-2001, and …
- Certified to reduce total annual energy and power costs to at least 50% less than a building satisfying ASHRAE/IES Standard 90.1-2001.

Contact:
National Electrical Manufacturers Association (NEMA)
1300 17th Street, Suite 1752, Rosslyn, VA 22209
(703) 841-3274
www.efficientbuildings.org/

Commercial Lighting Tax Deduction

The Energy Policy Act of 2005 created the Energy Efficient Commercial Buildings Deduction, which allows building owners to deduct the entire cost of a lighting or building upgrade in the year the equipment is placed in service, subject to a cap. Go to the Commercial Lighting Tax Deduction website (www.lightingtaxdeduction.org/), which was developed by the Lighting Systems Division of the National Electrical Manufacturers Association (NEMA) in cooperation with the Commercial Building Tax Deduction Coalition, to find more information about the lighting aspects of the deduction and resources to help with its implementation. It was created as the first of a series of lighting education initiatives by the lighting industry addressing lighting quality and efficiency.

Contact:
National Electrical Manufacturers Association
www.lightingtaxdeduction.org/

ENERGY STAR

Overview

ENERGY STAR is a joint program of the U.S. Environmental Protection Agency and the U.S. Department of Energy working to help individuals and businesses save money and protect the environment through energy efficient products and practices.

Because a strategic approach to energy management can produce twice the savings — for the bottom line and the environment — as typical approaches, EPA's ENERGY STAR partnership offers a proven energy management strategy that helps in measuring current energy performance, setting goals, tracking savings, and rewarding improvements.

EPA provides an innovative energy performance rating system which businesses have already used for more than 62,000 buildings across the country. EPA also recognizes top performing buildings with the ENERGY STAR.

ENERGY STAR for Small Businesses

Whether you own your building or are a tenant, you typically need lighting, heating, air conditioning, power for office equipment, and other services to stay in business. With free, unbiased information and technical support from ENERGY STAR, you can more easily improve your company's financial performance by reducing energy waste and energy costs, while protecting the earth's environment.

Support Services:

- Free, accurate, unbiased information
- Technical support through our Email a Technical Question service and Technical Resources
- "How-to" guide for analyzing and upgrading your facility
- Find Finance Resources and Success Stories in your state
- Energy equipment and service contractors and utilities
- Information about ENERGY STAR labeled products
- National and local recognition
- Public relations materials to promote your efforts.

Contact:
US EPA ENERGY STAR Hotline (6202J)
1200 Pennsylvania Ave NW, Washington, DC 20460
(888) STAR-YES / (888-782-7937)
www.energystar.gov/index.cfm?c=small_business.sb_index

ENERGY STAR for Industry

Partner with ENERGY STAR. Improve your corporate bottom line while you become an environmental leader. ENERGY STAR can help you develop and refine your corporate energy management program. Find out how you can manage energy with the same expertise used to manage other parts of your business.

Be Strategic About Energy Management

- Prepare an Energy Strategy for the Future
- Read the Guidelines for Energy Management
- Assess Your Energy Management Program

- Assess Your Facility Energy Program
- Elevate Energy Management to Senior Managers

Contact:
US EPA ENERGY STAR Hotline (6202J)
1200 Pennsylvania Ave NW, Washington, DC 20460
(888) STAR-YES / (888-782-7937)
www.energystar.gov/index.cfm?c=industry.bus_industry

Industrial Assessment Center Energy Efficiency Program

Overview

New England's Industrial Assessment Center (IAC) is a federally sponsored industrial energy efficiency program operating within the Center for Energy Efficiency and Renewable Energy (CEERE) at the University of Massachusetts. The IAC program is funded by the Office of Industrial Technology, under the US DOE Assistant Secretary for Energy Efficiency and Renewable Energy. This program has been in existence for over twenty-one years and is nationally recognized for its economic assistance to small and medium-sized industrial manufacturers.

The IAC have been instrumental in assisting companies in conserving energy, reducing pollution, increasing productivity, and lowering operating costs. 600 plants having annual gross sales totaling over $9.1 billion, with more than 65,000 employees and 36 million square feet of building space have been visited since 1984. Annual energy use at these plants exceeds the equivalent of 3.9 million barrels of oil at a cost of over $155 million.

Programs and Services

An industrial assessment is an in-depth assessment of a plant site; its facilities, services, and manufacturing operations. This term is used to refer to a process which involves a thorough examination of potential savings from:

- energy efficiency improvements
- waste minimization and pollution prevention
- productivity improvement

Assessments are performed by local teams of engineering faculty and students from 26 participating universities across the country.

The assessment begins with a university-based IAC team conducting a survey of the eligible plant, followed by a one or two day site visit, taking engineering measurements as a basis for assessment recommendations. The team then performs a detailed analysis for specific recommendations with related estimates of costs, performance and payback times.

Within 60 days, a confidential report, detailing the analysis, findings, and recommendations of the team is sent to the plant. In two to six months, follow-up phone calls are placed to the plant manager to verify recommendations that will be implemented.

Assessments are performed entirely at the expense of the US Department of Energy, and information received and recommendations made as a result of the assessment remain strictly confidential. Over 2,200 Assessment Recommendation measures (ARs) have been identified with an average annual recommended cost savings of $56,000 per year and an average simple payback of 1 year.

Eligibility IAC clients must be manufacturing plants in Standard Industrial Codes 20-39.

Assistance is offered to small and medium-sized companies in the New York and New England area with no in-house energy expert, gross annual sales of less than $100 million, not more than 500 employees, and energy costs totaling at least $100,000 but no more than $2.5 million per year.

Contact:
The Center for Energy Efficiency and Renewable Energy,
Industrial Assessment Center
(413) 545-0684
www.ceere.org/iac/index.html

Natural Resources Council of Maine
3 Wade Street,
Augusta, ME 04330-6317
(800) 287-2345
www.nrcm.org