Energy Management Basics

For Municipal and State Planners and Managers in Massachusetts

U.S. Dept. of Energy
Rebuild Massachusetts

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INTRODUCTION

Energy is a major operating cost for cities and towns and one of the few that local governments can control. The energy bills paid by city and town government agencies are typically the second largest item in their budgets (personnel being first). In this era of tightening budgets, local governments are taking a new look at how to provide support with fewer resources. With respect to energy resources, local governments are interested in:

- Reducing energy costs to lower the cost of government while maximizing services.
- Minimizing the impacts of energy use on the local environment.
- Preserving our dwindling local and global natural resources.

Balancing the gains of development against the detrimental effects of growth on the natural environment is an ongoing challenge. ***One of the most difficult elements of this challenge is managing energy***.[1] Because of this, the concept of sustainability has gained acceptance and support as awareness of climate change has grown. Sustainability marks a shift away from environmental approaches emphasizing cleaning up to recognition of long-term environmental impacts to consider when making decisions.

Sustainability means long-term thinking, planning and acting. While it is not the intent of this Guide to create a new definition of sustainability, it is important to start with a common understanding of sustainability. The most commonly accepted definition of sustainability comes from the 1987 World Commission on Environment and Development Brundtland Report and is defined as development that "meets the needs of the present without compromising the ability of future generations to meet their needs." ***For the purposes of this guide, planning for urban sustainability means managing today's energy needs without jeopardizing the energy needs of future generations.***

Local governments provide or control many of the most important aspects of sustainability, including land use, transportation systems, waste disposal, building codes, schools, and public housing. Because these public services are the ones most connected with our daily lives, it is often easier to organize citizen action at the local level.

Energy efficiency in local governments serves the public interest by saving money needed for other services. Besides saving money, improved energy efficiency reduces emissions of greenhouse gases, such as CO_2 and air pollutants such as No_x. A comprehensive energy management program not only improves energy efficiency in local government facilities, but takes into account improvements in working conditions and productivity through better lighting quality, heating, daylighting, and indoor air quality.[2]

[1] U.N. Department of Economic and Social Affairs, Division for Sustainable Development
[2] *Tools for the Job: How to Develop a Municipal Energy Program*, 1995, Public Technology, Inc.

A sustainable energy management program for a local government integrates long-term energy planning into the policy-making framework. At the implementation level, planning for a sustainable future means linking local energy policies and programs to broader community goals to improve economic, social, and environmental well being.[3]

Key Elements of a Sustainable System

- *Consistent*
  - *Short-term actions are compatible with long-term goals and the viability of the system.*
- *Renewable*
  - *The system depends on renewable resources and operates using environmentally benign technologies.*
- *Diverse*
  - *Distinct characteristics and capabilities among the individual elements of the system make it better able to adapt to change.*
- *Inclusive*
  - *All elements of the system, including people, are valuable in and of themselves and in relation to the whole system.*
- *Interdependent*
  - *Each element of the system is both dependent on and depended on by other elements; the greater the interconnections, the stronger the system.*

Source: Public Technology, Inc.

How to Use the Guide

Each year the Commonwealth's cities, towns, and state agencies spend millions of dollars to run public buildings. Very often city, towns, and state agencies are unable to deal efficiently with energy issues. The lack of in-house capability and the competing demand placed on staff precludes them from developing the expertise necessary. In addition the learning curve for energy efficiency specific projects and alternative funding opportunities can be steep. The following guide provides *basic conceptual tools* needed to develop, design, and implement energy-efficiency programs for public facilities in Massachusetts.

Defining Energy Management

Energy management is the practice of using energy more efficiently by eliminating energy waste. As defined by Peter Herzog[4] the three fundamental components of effective energy management include:

- **Efficient purchasing** — purchasing energy at the lowest available unit cost
- **Efficient operation** — operating the equipment that consumes energy as efficiently as possible, and
- **Efficient equipment** — upgrading or replacing existing equipment with more energy efficient versions whenever it is cost-effective to do so.[5]

Successful energy management incorporates a commitment to achieve pre-established energy efficiency goals, systematic energy use measurement, and clear communication of the program's success. The amount saved through energy management depends on many things: the design and age of a building, how heavily it is used, the availability of alternate fuels, the amount of capital available to invest, and whether conservation programs are already in place. More often then not, however, conscientious review and management of how a building operates can produce *some* savings.

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[3] Ibid.
[4] Peter Herzog, *Energy-Efficient Operation of Commercial Buildings: Redefining the Energy Manager's Job* (New York: McGraw-Hill, 1996).
[5] ibid.

Most energy efficiency programs concentrate their resources on equipment improvements first, when it would be more cost effective to begin with efficient purchasing and operation. In almost all facilities, the second component – operating existing equipment as efficiently as possible – is the least well understood and the most underdeveloped of the three. Ironically, this activity has a high potential for savings and requires little to no capital outlay.[6]

Benefits of Energy Management

Four Main Benefits

- *Substantial energy savings*
- *Low cost*
- *No sacrifice of comfort or productivity*
- *Better information from which to make capital improvement decisions*

Source: Energy-Efficient Operation in Commercial Buildings, Peter Herzog

The goal of a good energy management program is to use only the energy that is really needed, use it efficiently, reduce waste, decrease emissions, maintain good working air quality and thermal conditions, and reduce unnecessary energy costs. An Energy Management Program can help control energy consumption. From an environmental perspective a good energy management program is usually the most cost effective strategy to reduce outdoor exhaust emissions associated with building mechanical system combustion and electricity consumption. From a fiscal perspective good energy management can stretch limited financial resources to pay for necessary building capital improvements, salaries, and other necessary expenses. From a public health perspective good energy management can improve indoor environmental air quality and provide superior heating and air conditioning thermal comfort.

Cost-Effectiveness Criteria and Program Management

The cost-effectiveness criteria decided upon are strong determinants of which energy efficiency projects to implement. The maximum acceptable payback for an energy efficiency project is an important piece of information when designing an energy management program.

Incentives Can Win Support for the Program

Communicating the amount of money and energy saving potential from improving energy efficiency can help gain support for the program. However, saving energy may not be a high priority to every department in a local government. Although departmental staff may not be directly interested in saving energy, they are likely to be concerned about things such as improved light levels, light quality, better temperature control, reduced maintenance costs and fewer equipment breakdowns. These other concerns may encourage departments to assist with implementing energy efficiency projects.

In some local governments, energy cost savings are:

- *Put in the general fund*
- *Returned to individual departments for their own use to encourage saving energy*
- *Used to fund energy efficiency upgrades*

Source: Urban Consortium Taskforce

Communication and Training are Crucial

Energy efficiency technologies are sometimes disconnected, bypassed, or removed by maintenance staff or facility occupants who may not understand the purpose of the technology. Communicating the function of energy efficiency technologies to the people impacted by them will help ensure that no tampering or removing of the technologies occurs. Providing easy access to energy efficient products for operations and maintenance and training for personnel supports ongoing energy efficiency efforts.

[6] ibid.

A Program That Will Get Results

No two Energy Management Programs are exactly alike – tailoring programs can meet distinct needs. However, good municipal and state energy management programs:

- ***Secure administrative commitment and on-going support "from the top" to assure the program's success.***
- ***Appoint an Energy Manager (EM) and develop an energy management team to coordinate efforts.***
- ***Develop clear energy management goals, a systematic program structure, and strategies for communication and implementation.***
- ***Collect information and inventory building characteristics, past energy consumption, and energy costs for each building.***
- ***Develop an energy budget that demonstrates current conditions and indicates the amount of expected improvements in efficiency.***
- ***Analyze individual building energy budgets and characteristics to identify potential improvements. Implement cost-effective no-cost/low-cost measures.***
- ***Evaluate potential capital investment measures identified during initial building inventories and assess the building to determine future savings.***
- ***Monitor energy use to determine building performance and identify additional opportunities for energy savings.***

Summary

Launching a successful program requires organization. It is important to get support from the chief executive or administrator to the basic objective of having an effective, ongoing program. This support means active involvement: attending key meetings, designating and working with an energy manager and team, and allocating required staff time, resources, and energy consumption accountability. It means providing or actively seeking the financial resources needed for capital improvements such as new lighting or HVAC equipment. Additionally, it means helping to answer any questions arising with staff or other users of the building in relation to needed changes in thermostat settings, lighting levels, or other energy-related conditions.

Include involvement of any policy-making board or similar body in addition to the active support of the chief executive or administrator. Initial support is especially important for the success of the program in carrying out projects requiring substantial financial resources.

I: DECIDE THE NEXT STEPS

Following are the six core next steps for an energy management program:

1. Define energy management project scope
2. Identify energy management stakeholders and project leader
3. Identify State and Federal technical and financial support resources
4. Establish management policies, responsibilities, and priorities
5. Identify and quantify energy consumption
6. Monitor and improve building operating efficiency and performance

Define Energy Management Project Scope

Capturing the maximum savings potential in a project with many building and a $1 million/year utility bill or implementing only the most cost-effective projects for a couple of buildings with a $5,000/year utility cost determines the strategy for meeting energy saving goals. The amount of energy used directly affects the staffing and funding choices made for energy management. A small facility may have less than ten buildings, whereas a large city may have a thousand.

A large city is likely to hire staff for energy management since such a program warrants full-time work for several years. In contrast, a small city is likely to hire the short-term or part-time help of energy consultants. Some funding options are only viable if several million dollars are involved and therefore, only available to local governments with energy management programs that involve a large number of facilities.[7] The scope of the project and the amount of effort to realize results is very different in these two examples.

Barriers to Achieving Efficient Operation

- *Potential for savings is not understood by management*
- *Maintenance procedures are not designed to achieve operating efficiency*
- *Focus is on engineering projects rather than on a management process*
- *Management structure inhibits operating efficiency*
- *No methods are available for managing operating efficiency*

Source: Energy-Efficient Operation in Commercial Buildings, Peter Herzog

Identify Energy Management Stakeholders and Project Leader

Include various stakeholders by forming an energy management team or committee with representation from all groups. Designate one person as the Energy Manager (EM), with prime responsibility for the Energy Management Program and working with other members of the team.

Typical EM responsibilities include planning, organizing, and administrating an energy program. Whoever is designated needs a basic understanding of how buildings use energy and the ability to develop a logical program for energy management and enlist the cooperation of others. An Energy Manager often wears many other hats such as pollution prevention and environmental compliance officer responsibilities.

[7] *Tools for the Job: How to Develop a Municipal Energy Management Program*, 1995, Public Technology Inc.

Energy conservation specific responsibilities include:

- ***Suggest basic energy management goals, help the administrator set up an energy management team, outline an energy management program, and work out program details with the team.***

- ***Meet with user groups and others to explain the program.***

- ***Obtain information about building characteristics and past and present energy use and costs.***

- ***Use this information to develop an energy budget that indicates a potential range of improvement in the energy efficiency of each building.***

- ***Organize building audits including enlisting expert help.***

- ***Analyze audit results and translate them into specific, recommended operational and capital investment measures with technical assistance if needed.***

- ***List specific applicable building operation procedures that would conserve energy; determine if present maintenance and technical staff can implement the procedures or if additional training or outside assistance is needed.***

- ***Prioritize implementation of energy conservation measures to optimize savings; help present capital projects to those responsible for making capital outlay decisions; work out further details.***

- ***Communicate the specifics of the agreed upon energy conservation measures to those responsible for carrying them out (e.g., let the engineering staff know the hours when ventilating equipment is in operation).***

- ***Monitor energy consumption and progress and advise the team and the administrator of problems; keep the administrator and building personnel up-to-date with current energy consumption data.***

- ***Communicate the positive results of the program.***

The EM is a manager and coordinator rather than a technical person, although some technical understanding is desirable. The prime qualities needed are ***organization*** and ***communication***, the ability to develop and articulate a logical sequence of activities and enlist the cooperation of others. The energy savings realized through the implementation of the program often pays for the cost of hiring an Energy Manger.

In addition to the Energy Manager four groups of people are essential to the success of an Energy Management Program:

- **Building maintenance and technical staff** (e.g., engineering): those who maintain the building and are responsible for the control and operation of basic systems such as heating and air conditioning.

- **Administrative personnel**: those who determine the use of the building and staff responsibilities.

- **Financial people**: those responsible for decisions on maintenance expenditures and capital improvements.

- **Building users**: those who use the building on a daily basis, turn lights on and off, open and close windows, etc.

The team makes sure the energy management program is appropriate for their specific building portfolio. They participate in activities such as meetings and building surveys, help spread the word, broaden the understanding of the EM regarding potential problems or barriers, and take into account the buildings occupants' comfort, convenience and safety, health impacts, and staff productivity.

Identify State and Federal Technical and Financial Support Resources

There are many resources for planning and financing energy efficiency programs including state and federal programs that provide guidance and technical assistance, electric ratepayer-funded utility programs that provide audits and rebates, and grant programs from private funds.

In Massachusetts, investor-owned gas and electric utility companies such as Keyspan, NGRID (Massachusetts Electric), NSTAR, Western Massachusetts Electric, and others administer programs designed to reduce demand. Massachusetts electricity customers also contribute to the Renewable Energy Trust Fund administered by the Massachusetts Technology Collaborative. The goal of this program is to bring about significant change in energy use by investing in the advancement of renewable energy technology and applications. Assistance is also available from the United States Department of Energy. Please see Resources at the back of this guide for a list of websites and information.

Establish Management Policies, Responsibilities, and Priorities

An Energy Management Program is a thoughtful and practical approach to efficient use of energy. Well-balanced goals and objectives reflect the fact that the building is valuable and is an environment for people. For instance, using less energy so fuel bills decrease, but using enough so the building remains comfortable, safe and continues to function properly. Initially, develop specific goals to review with the chief executive and others. Goals may include the following objectives:

Goals/Objectives

- ***Changing energy use pattern or standards****: for instance, using different thermostat settings or upgrading the lighting design.*

- ***Making sure to use energy as efficiently as possible****: by fine tuning equipment or switching to equipment that is more efficient.*

- ***Review and, if appropriate, procure more efficient energy sources****: such as switching to more efficient fuel source or using alternative energy sources.*

State your goals in terms of time and energy saved; for example, reducing energy consumption by 10% by a specific date or designing all new buildings that are 90% more efficient than existing buildings. State goals in writing and make them available to those involved in the program.

Define an Action Plan

Attention to the full benefits derived from a project will avoid a shortsighted focus on first costs, quick savings, and simple paybacks—a focus that commonly leads to poor financial decision making.

Effective programs require an action plan with a logical sequence of steps, deadlines and specific responsibilities for carrying out those steps, as well as the necessary resources (people, time, money). Provide in writing the degree of detail necessary for the particular staff and operating methods. ***The following suggestions consist of five basic steps – inventory, analysis, conclusions and recommendations, corrective action, and monitoring.*** Define the program with the concurrence of the EM, the chief administrator or executive, with input from others on the energy management team. It is important that the program is complete, thorough and practical, however, make it reasonable and attainable in the context of the particular organization and buildings and at the same time establish a set of deadlines that will create momentum and provide some early results.

Table 1: Example First Steps in Energy Action Program

Week	Task	Responsibility
1	Collect data on building size and characteristics	EM (Energy Conservation Manager)
	Collect data on energy use and costs. Analyze data and costs	EM, business staff
12	Analyze data and determine potential improvements in building energy efficiency	EM
14	Plan and conduct first building audits	EM, administrative person, engineering & maintenance staff
16	Review, determine need for assistance in analyzing complex systems	EM, engineering staff

Identify and Quantify Energy Consumption

Chapter II: Identify and Quantify Energy Consumption, provides basic information needed to recognize and calculate energy consumption, from understanding how a building uses energy to calculating the annual efficiency index. Chapter III: Estimate Energy Savings Potential is about evaluating energy use and potential efficiency.

The first step of the process is to inventory the existing devices and systems that consume energy in the building.[8] To assist in this process, a building survey is provided in Attachment A. The second step involves devoting a limited amount of effort to make rough estimates of how much energy is used for each major device or system surveyed. This is done by assembling energy bill information and then gathering information on operating schedules.[9]

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[8] *Energy-Efficient Operation of Commercial Buildings: Redefining the Energy Manager's Job,* Peter Herzog, (New York: McGraw-Hill, 1996).
[9] ibid.

Monitor and Improve Building Operating Efficiency and Performance

Based on the allocation of energy use from the previous steps, it is possible to determine which systems use the most energy and thus have the greatest potential for savings. Measuring the actual performance of energy consuming devices and systems is the basis for discovering inefficiencies and then correcting them.[10]

Designing a Community Energy Program

Community energy programs can take many forms. While one community may successfully conserve energy through energy-efficiency upgrades of its buildings, another community may be equally successful in a program that converts wind into electricity. Designing a customized energy program is dependent upon the community's specific goals, resources, and conditions. However, there are many resources such as U.S. Department of Energy's Smart Communities Network*, that offer guidelines and step-by-step approaches to developing a program that meets the community's goals.*

[10] ibid.

II: IDENTIFY AND QUANTIFY ENERGY CONSUMPTION

Energy management options may include many alternatives, from turning down the thermostat to installing a whole new heating system. A walk-through building survey may highlight "low cost" or "no cost" measures that involve little or no capital outlay. Decisions relate to the effort required to complete energy efficiency projects balanced against the amount of achievable energy savings.

Note: The people who use the building may be an especially valuable source of ideas for conserving energy – ask for suggestions early in the program. A group effort can get people thinking and contributing new ideas. Consider a reward system, such as offering a prize for every useful energy saving idea to motivate building users.

Understanding How Buildings Use Energy

Determining how to reduce energy consumption requires some "base line" information to understand where things stand and what measures can help reduce energy use. The information needed includes the characteristics of the building and the amount of fuel and electricity consumed.

Use building plans, first-hand measurements and observations, and utility bills to determine:

- **Building age and general condition:** include the types of windows, roofing and wall material and the approximate percentage of glass to wall space.

- **The total conditioned area (heated and cooled interior) of the building:** measured in square feet, not including unheated basement or attic space.

- **The average daily number of occupants:** include normal operating hours and any weekend or special events.

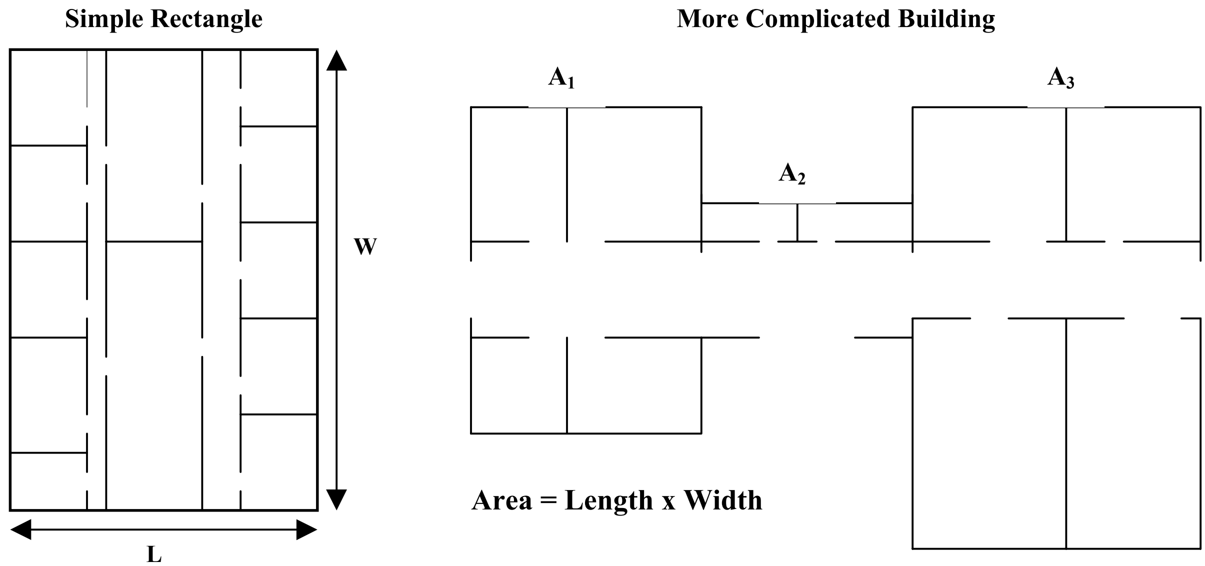
- **The number of hours each day your building is used:** include weekdays, weekends, special holidays, and evening hours.

- **Brief descriptions and the locations of:**
  - ✓ Primary heating systems
  - ✓ Cooling systems
  - ✓ Ventilation systems
  - ✓ Lighting
  - ✓ Hot Water

- **Brief descriptions of any special systems:** include energy using areas such as laundries, kitchens, elevators, machine and electric shops, greenhouses, swimming and locker areas, and data centers.

This information provides a building profile to help identify potential areas of energy waste for each building involved.

Figure 1: How to Measure the Area of a Building



Measure the overall length and width of the building, ignoring interior walls

- Break the building into simple rectangles, Area = A1+A2+A3
- Do not forget to add the areas of upper floors
- Do not count unconditioned areas

Source: DOER

Energy Consumption Data

Using a July-June "energy use year", record the total quantities of electricity, oil and/or gas consumed annually, as well as their costs. Use separate forms, such as the one shown in Table 2, for each building. Obtain figures either by collecting and totaling monthly fuel receipts and utility bills or asking the fuel dealer and utility company to give you the figures. While laborious, the compiling method may be more accurate and provides insight into seasonal patterns

Develop these records for at least the last three years. Average them out to cancel out any variations in climate that may have occurred. Be sure to note differences in building use (e.g., a wing opened or closed), or changes in operation (e.g., thermostat settings reduced 3 degrees last year).

Keeping these records is a fundamental part of energy management. These are the benchmarks against which to measure progress. Remember the objective is to reduce energy ***use,*** and as a byproduct, energy ***cost***. Reducing total energy costs is dependent on total consumption, the time of day the energy was consumed, and the price of each unit of energy. As a general rule, energy consumption records are the cleanest indicator of how well efforts to reduce the amount of energy the building consumes are succeeding.

The following example shows fuel consumption and cost data. Enter fuel codes for electricity (E), natural gas (N), distillate oil (D#2, D#4), etc. Enter the year and month of the data and the quantity in kilowatt-hours, kW (if appropriate) gallons, therms or CCF, etc.

Table 2: Fuel Consumption and Cost Data
(Note: Data is fictitious)

Building Name **Elementary School**

	Fuel Code	**E (electricity)**	**Fuel Code**	**N (natural gas)**	**Fuel Code**	**D (distillate oil #2)**	**Fuel Code**	
FY 2002	**Qty(kWh)**	**Cost**	**Qty (CCF)**	**Cost**	**Qty (gals)**	**Cost**	**Qty**	**Cost**
July	2943	$588.60	2131	$1,949.87	0	0		
August	3078	$615.60	1826	$1,670.79	0	0		
September	3147	$629.40	2066	$1,890.39	345	$427.80		
October	3087	$617.40	5688	$5,204.52	420	$520.80		
November	3338	$667.60	6515	$5,961.23	515	$638.60		
December	3922	$784.40	11149	$10,201.34	1857	$2,302.68		
January	3561	$712.20	12880	$11,785.20	1480	$1,835.20		
February	3488	$697.60	12898	$11,801.67	1469	$1,821.56		
March	3580	$716.00	10239	$9,368.69	1341	$1,662.84		
April	3340	$668.00	9007	$8,241.41	835	$1,035.40		
May	3207	$641.40	4790	$4,382.85	345	$427.80		
June	3292	$658.40	2031	$1,858.37	0	0		
Total	**39983**	**$7,996.60**	**81220**	**$74,316.30**	**8607**	**$10,672.68**		

Source: DOER

The Energy Budget: How well is the Building Doing?

Once it is known how much energy the building consumes each year, it would be helpful to have some standard against which to measure the performance of the building. If, for example, one finds that most similar buildings use less energy (per square foot for example) one could immediately conclude that there is potential for conserving energy. If working with more than one building, compare efficiencies and target the worst ones for the first walk-through building surveys and conservation efforts. This analysis provides an energy budget of present efficiency and potential savings to use as a guide in the conservation program

Energy Consumption: Costs and the Annual Efficiency Index

As previously stated, increasing energy efficiency is a major route to controlling energy costs. Accurate measurement of a building's energy efficiency helps in comparing the efficiency of a building with other similar buildings. Analyses of energy use often require the combination of different forms of energy into one common measure, typically Btus. [11]

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[11] The Btu (British thermal unit) is a standard unit of energy. Other units of energy measure such as kWh and natural gas are multiplied by a conversion factor to convert that unit of energy measure into a similar energy measure, Btu. Dissimilar units of energy measure can then be added together to calculate total energy consumption. A multiplier of 1000 (K) is used to keep the resulting calculations manageable

The "AEI" or Annual Efficiency Index, is a number that measures the energy efficiency for a building, similar to miles per gallon for an automobile. The AEI takes into account the different types of energy used by a building for one year and is calculated in units of energy (kBtus, or thousands of British Thermal Units) per square foot. For example, the AEI for a building might be somewhere between 100 and 200. ***Note that while an efficient automobile has a high number of miles per gallon, an efficient building has a low number of kBtus per square foot.***

Measuring the energy actually consumed, rather than its total dollar cost, to analyze the building's efficiency is important. The value of a unit of energy remains constant even while the price of that unit (e.g., a gallon of heating oil) changes over time. While factors affecting price cannot be controlled (such as inflation and government policies), factors affecting consumption can. These include peoples' habits in the building; the efficiency of the building's equipment, and the tightness of the building's outer surface or "shell". The AEI reflects these factors and the effect of weather.

Using the AEIs calculation from year to year can show how the energy efficiency of the building changes. This information is used to measure the AEI against a "standard AEI" developed for similar buildings. There are several web-based tools to assist in "benchmarking" buildings. One is the Rebuild America at http://www.rebuild.org/lawson/mgr.asp ; another is the EPA's Portfolio Manager at www.epa.gov . The Portfolio Manager software grades the building performance on a scale from 0 to 100 with 75 set as the standard for superior performance. A poor score is an opportunity to improve energy efficiency.

How to Calculate an AEI

Often a given quantity of energy in one unit of measure needs to be expressed it in terms of some other unit. To develop an AEI, first convert units of energy into kBtus using this conversion table:

Table 3: How to Convert to kBtus

Energy Source	Unit of Measure	Multiply Units of Measure by this Factor to get kBtus
Electricity	Kilowatt Hour (kWh)	10.2 (source)*
Electricity	Kilowatt Hour (kWh)	3.4 (site)
Distillate Oil (#2, #4)	Gallon	138.7
Residual Oil (#5, #6)	Gallon	149.7
Coal	Ton	24.5
Purchased Steam	Pound	1.39
Propane	Gallon	95.5
Natural Gas	CCF (hundred cubic feet) or "therm"	103.0

For example: 1,000 gallons #2 oil = 138,700 kBtus

Source: DOER

* The Conversion of electricity is problematic. If one converts one kWh of electricity directly into heat, the amount of energy released is 3,412 Btus. This ratio is known as the 'site' conversion ratio. Site conversion ratio ignores the energy used to produce that one kWh of electricity. An alternative is the 'source' conversion ratio of 10,240 Btus per kWh, which includes the energy used to produce the electricity. Using the source conversion ratio allows for a more accurate comparison of the true energy savings resulting from increases in the efficient use of electricity. Furthermore, the price of electricity is comparable to that of other fuels if using the source conversion ratio, making it useful for comparing dollar savings as well.

Follow these 4 steps to calculate your AEI:

Four Steps for Calculating an AEI

1 Fill in the total quantities of fuel used annually in the appropriate blanks on lines 2-8.

Electricity: Multiply the total kWh consumed times the conversion.

________________ X 10.2 = ________________ kBtus
Total kWh

Distillate Oil (#2, #4): Multiply the total gallons consumed times the conversion factor.

________________ X 138.7 = ________________ kBtus
Total Gallons

Residual Oil (#5, #6) Multiply the total gallons consumed times the conversion factor:

________________ X 149.7 = ________________ kBtus
Total Gallons

Coal: Multiply the total gallons consumed times the conversion factor:

________________ X 24.5 = ________________ kBtus
Total Tons

Purchased Steam: Multiply the total gallons consumed times the conversion factor:

________________ X 1.39 = ________________ kBtus
Total Pounds

Propane: Multiply the total gallons consumed times the conversion factor:

________________ X 95.5 = ________________ kBtus
Total Gallons

Natural Gas: Multiply the total gallons consumed times the conversion factor:

________________ X 103 = ________________ kBtus
Total CCF or Therms

2 Add all MBTUs to arrive at the total annual energy consumption for the building.

Total Energy: ________________ kBtus

3 Enter the total conditioned area (heated/cooled) of the building.

Area: ________________ Square Feet

4 Divide the total energy (Line 9) by the Area (line 10) to get the building AEI.

AEI: ________ kBtus/Square Foot

III: ENERGY ACCOUNTING

Once energy consumption is collected, a system to record, analyze, and report energy use and costs is needed. An ***energy accounting system*** tracks utility bills for facilities and provides information on energy use trends. Energy accounting is useful when evaluating the effectiveness of the energy management program and identifying the most cost-effective energy conservation measures to implement in facilities. Depending on the number of facilities, a system may consist of using a simple spreadsheet (as in Table 2) to installing a robust software program.

Whether using an excel database or Energy Management software, energy accounting can help:

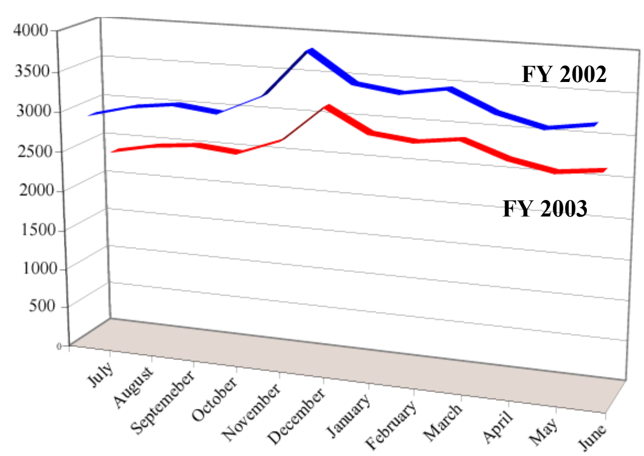
- **Measure energy savings and track the success of the energy management program**.
  Tracking energy savings and costs provides information needed to demonstrate how much energy and money is saved as a result of the energy management program. Most energy accounting software can easily calculate true energy savings considering weather changes and hours of operations.

- **Determine which facilities have the most intensive energy use.**
  Resources available to invest in an energy management system may be limited. In this case, decide which facilities to focus on first. A simple energy accounting system can help calculate where to start. For instance, using the calculated AEI to rank facilities, determine which facilities are the most energy intensive by energy use or energy cost per square foot. Making this type of comparison helps determine which facilities need energy-efficiency improvements the most.

- **Communicate energy data**.
  An energy accounting system makes it easy to communicate energy data. An energy accounting system can create reports and graphs to communicate a variety of energy information.

  Make graphs that answer the following types of questions; How much was energy use in facilities reduced over the last six months? How much energy was saved as a result of lighting retrofit in a particular facility? Give each facility manager a chart that compares energy cost per square foot of each facility or a chart that compares energy use for one year with energy use for the following year to illustrate energy-efficiency improvements.

Energy Management Program Savings (in kWh)



- **Catch billing errors**.
  An energy accounting system makes it easy to spot an energy bill containing errors. For example, the total energy use, energy use per day, total cost, or cost per kilowatt-hour or therm may be unusually high for a particular bill. With an energy accounting system, municipalities can find mathematical errors.

Energy Accounting Software

If there are only a few facilities, an energy accounting system can be created using spreadsheet software such as Excel. Several software packages are available, however, that make energy accounting for facilities easy. Most energy accounting software can easily adjust for changes in variables such as weather, facility operating hours, and square footage to track year-to-year changes in energy use that are truly due to improved energy efficiency. In addition, energy accounting software makes it easy to calculate the avoided cost associated with energy-efficiency projects. Energy accounting software allows preparation of pre-designed graphs and reports, making communicating energy use and cost information simple.

To set up an energy accounting system, first enter basic information about the local government facilities in the energy management program and utility billing information (the energy use data collected). After the system is set up, add energy use and cost data periodically from monthly utility bills and weather data.

If choosing a software package, the following questions can help determine suitability. Does the software package:

- Have the ability to electronically import and export billing data?
- Record monthly billing period dates or the number of billing days?
- Allow entry of the number of occupants per facility?
- Allow for multiple meters per facility?
- Allow entry of energy end uses?
- Allow for tracking electrical demand?
- Track energy types other than electricity and natural gas?
- Allow for tracking non-energy utilities, such as water and solid waste?
- Highlight sharp changes in energy use?
- Adjust energy use for weather (by degree days or average temperature)?
- Allow for variations in facility square footage over time?
- Allow grouping facilities for analysis?
- Provide a comparison of energy use to a baseline for each facility?
- Calculate percent change in fuel use, cost per square foot, total BTUs per square foot, and actual fuel use per square foot for each facility?
- Allow ranking of facilities based on their energy performance?
- Allow data sorts in a variety of useful ways?
- Create the types of reports and graphs needed?
- Provide good documentation, on-line help, and technical support?

Deciding What Information to Collect

One of the first steps to setting up an energy accounting system is assessing what information to collect. Knowing how to use the information collected for the energy accounting system helps determine what data to gather. If there are many facilities, collecting energy use and cost data for all of them may be too time consuming and unnecessary, resulting in worthless data. If there are more than ten facilities, collect enough information to rank facilities by energy cost. Then, collect more detailed data only for those facilities with the highest energy costs – facilities that account for the top 60 to 80 percent of energy costs.

To set up the energy accounting system, collect the following types of data, ideally for the past two or three fiscal years (if data is not available for the past two fiscal years, collect it for the months for which it is available).

- **Organization Information**
  Enter the name and address of the organization, and the month and year to begin your energy accounting period.

- **Departmental information**
  Some energy accounting programs allow the entry of departmental information to facilitate grouping facilities within the organization by department for reporting purposes.

- **Facility information**
  Collect the name, address, contact person, and square footage that is "conditioned" (heated or cooled) for each facility included in your program.

- **Meter information**
  Identify all utility meters in each facility by utility account number to match electric and gas meters to their facilities.

- **Energy-use and cost data by meter**
  Collect monthly energy-use and cost data for all individual meters. This information is available from utility and other fuel bulls. Make collecting energy-use and cost information by meter for all facilities a top priority since this helps determine which facilities have the highest energy costs. It may be possible for the utility to provide this data electronically, thus eliminating the need of entering it manually into an energy accounting system.

- **Weather data**
  Energy accounting software packages can adjust energy use data to account for variations in weather from year to year if provided with weather data, such as monthly average temperatures or heating and cooling degree-days. Such weather data is usually available from a local utility or the National Climatic Data Center. It may also obtain it from the nearest reporting weather station.[12]

Tips for Collecting Data

- *Decide what data to collect: Collect enough information to rank facilities by energy cost, then collect complete energy use and cost data for facilities that use the most energy*
- *Check the data's fit: Some information may not fit the boundaries of the energy management program. For example, when the electricity of several facilities is metered together, use estimates of each facilities' energy usage. (One rough way to do this estimation is to assume that each facility uses the same amount of energy per square foot.)*
- *Check the consistency of the methodology. Evaluate the methodology used to calculate the data collected. Faulty methodologies or different methodologies used at various times impact the data. Accounting for the differences is important for reliability. For example, square footage data for facilities may sometimes be total square footage instead of conditioned square footage.*

Source: Public Technology, Inc.

[12] *Tools for the Job: How to Develop a Municipal Energy Management Program*, 1995, Public Technology, Inc.

IV: ESTIMATE ENERGY SAVINGS POTENTIAL

An energy accounting system provides past and current energy use facilities. This chapter explains some simple methods of determining possible future energy savings. Having an idea of the energy savings potential in all facilities is necessary if the goal is to design an energy management program that captures the greatest amount of those savings. However, performing an energy audit on every facility is usually not cost effective. In this situation, options allow estimates of the potential energy savings in all facilities without actually performing an energy audit on each one.

Savings Estimates

The simplest way to get a rough estimate of the amount of energy savings potential in the facilities is to assume that improving energy efficiency will save twenty percent of the energy use. To calculate what that savings is in dollars, multiply last year's energy cost by 0.20.[13]

Last year's energy costs x 0.20 = total savings potential

For more exact estimate of the amount of energy savings potential, check any existing energy audits for cost saving potential and extrapolate the percent savings of energy costs to similar facilities. An existing energy audits and square footage data for facilities allows an even more exact estimate of the energy savings potential. To do so, divide the projected cost savings for energy conservation measures recommended in existing audits by the square footage of the audited facilities. The result is the amount of money saved per square foot. Then, multiply this result by the total square footage of all facilities. The result is an estimate of the total energy savings potential for all facilities.

For audited facilities:
Projected cost savings x square footage = cost savings/square foot
Then
(Cost savings/square foot for audited facilities) x total square footage for all facilities
= total savings potential

Compare utility costs per square foot in the facilities with average utility costs per square foot for similar facilities in the local area for a more exact estimate of the energy savings potential for all.

Building Survey

A walk-through building survey provides an understanding of how a building uses energy and can reveal many energy savings potentials. An effective walk-through assessment will:

- Match individual utility meters to specific end uses
- Document current equipment operation and building uses and schedules
- Provide a first level indication of the building's current performance (i.e. thermal comfort, lighting, ventilation, indoor environment conditions, operations and maintenance standard practices, end user comments and suggestions)
- Identify target areas for further investigation

[13] ibid.

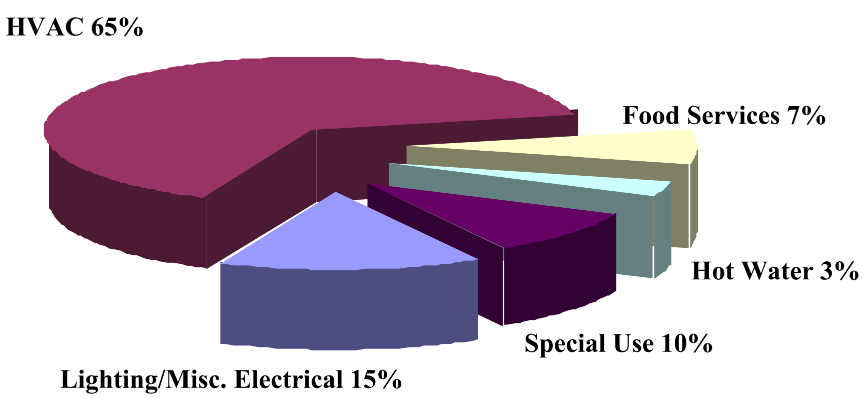
Preparing for the Building Survey

Use the buildings' AEI to determine how energy efficient each building is and how each compares to a standard AEI for that particular building type. This provides a measure to target the least efficient buildings for an energy audit.

Each building has a unique energy profile determined by the age of the building, the location and condition, the efficiency of the energy equipment, the pattern of use, and the special equipment and areas peculiar to the building's function. However, all buildings have in common the energy components that consume energy to create a comfortable indoor environment, these include; the lighting, heating, cooling, ventilation, and domestic hot water systems. The building envelope is also an energy component although it does not consume energy to do its job of retaining the controlled environment inside the building.

The breakdown of energy use for each component in the building will vary, but a typical building may look like the pie chart in Figure 2. In this example the largest amount of energy use occurs in the HVAC system, the next largest for lighting, etc. While the overall profile of energy use in any building may resemble the pie chart and show major areas to tackle, looking at all the components in a building illustrates specific sources of waste and opportunities for savings. Three obvious energy wasters to look for in a walk-through building survey are a poorly operating energy management system, old inefficient boilers, and inefficient lighting.

Figure 2: Typical Energy Use



Source: DOER

Information to Collect and Review before Starting

Collecting the following building information helps target some problem areas.

- Meter locations and end uses served
- The heated/cooled square footage of the building
- The approximate age of the building
- The pattern of daily use (hours of full and partial occupancy)
- The average number of occupants during those hours
- The types of heating, cooling, lighting, and ventilation systems and their condition, and the type of energy used in each system
- The type and condition of the walls, windows and doors, roof and flooring (the building "envelope")
- Any special areas that have unique energy needs or equipment
- The daily and annual peaks of electricity consumption
- End user feedback regarding current building performance

Seven Steps to Take
Before the Walk-Through

1) *Benchmark the building. Calculate and compare the building's AEI or EUI (Energy Use Index) to the standard of similar buildings to determine overall efficiency.*
2) *If several buildings are involved, target the least efficient ones for the first walk-through building surveys.*
3) *Gather and review all the information about occupancy and the energy systems in the building to determine if there is wasted energy.*
4) *If possible, identify the specific energy users (e.g., lighting) and their respective energy sources (e.g., electricity) within each building.*
5) *Review any energy patterns, systems, or procedures to target in advance as problems. Identify these problems by reviewing possible operation and maintenance measures or capital improvements that seem sensible.*
6) *Map out the audit, identifying those areas to audit, and make a full set of audit forms to use in all areas of the building. Mark each form with the appropriate name.*
7) *In advance, mark on the audit form the specific things to look at carefully during your walk-through building survey.*

Source: DOER

This information helps determine how a building uses energy. Try to pinpoint key items before conducting the audit. For instance, it may be known that the HVAC system has outdated or poorly operating controls that do not provide evening setback when the building is unoccupied. An old building with many windows may suggest concentrating on the building envelope. Or it is known that there are peaks of electricity consumption (which are used to determine the demand charge on your electricity bill) so one may pay more attention to potentials for rescheduling or reducing cooking, showering, or using laundry facilities.

Preparation helps save time on the audit and allows for identification of more cost-effective measures.

The Building Survey Forms

A set of forms for use in conducting a walk-through building survey is included in this booklet. Before actually walking through the building, one may be able to note which conservation measures apply and which do not. During the walk-through, determine if an applicable measure is "in place" or not. If they are not, then determine whether existing expertise exists on staff, or whether a more qualified expert is needed to provide technical assistance to analyze and/or implement a measure. After completing the walk-through, calculate potential savings.

Map out an approach that allows staff to cover the building in an orderly and less time-consuming way. Pay particular attention to special use areas – areas that are different such as kitchen and laundry. Organize any tools needed (clip board, forms, safety glasses, etc.) for examining both the interior and exterior of the building.

V: MONITOR ENERGY USE AND IMPROVE EFFICIENCY

Operation & Maintenance Changes

Consider these four operation and maintenance changes:

- Changing the operating procedures of the building staff, such as reducing cleaning hours.
- Increasing preventive maintenance, such as inspecting and changing air filters more frequently.
- Changing the settings on controls, such as reducing the domestic hot-water temperature setting or closing vents that allow outside air to come in (without compromising indoor air quality).
- Installing low-cost items, such as thermostat guards and lighting that is more efficient.

Some of the lower cost energy conservation measures may require further analysis by a professional engineer or someone with the appropriate technical knowledge. Identify a source from either staff or an outside source who is able to provide technical assistance to assess which measures are cost effective.

The O&M changes require some communicating not only to explain the changes needed but also how they are cost effective. Emphasize how these measures implement the goals of the energy conservation program.

Implementing No-Cost and Low-Cost Measures

The walk-through building survey provides information to help quickly reduce energy consumption. Some of these O&M measures are very simple to do and even those involving some minor costs may be the kind normally included in a maintenance budget.

Compile a target project list from information gathered on the walk-through building survey and set a priority level (e.g., 1,2,3, etc.) for each project. Set a savings level such as 10% and calculate the savings using the consumption information. Record the energy and dollar savings along with the estimated costs of making improvements. Share the results with the energy management team and create an implementation schedule. With a tentative approach, make decisions on such things as the use of professional assistance or additional funding.

The following form assumes a 10% annual saving on energy consumption. Separate the list into categories such as, HVAC, lighting, hot water, and building envelope.

Table 4: Target Project List

Priority	Project	Energy Saved (Annual use x .10)	Dollars Saved (Annual cost x .10)	Cost to Implement
	HVAC Project Oil	Annual Gallons x .10	Annual $ x .10	Cost of Project
	Lighting	Annual kWh x .10	Annual $ x .10	Cost of Project
	Hot Water Natural Gas	Annual therms x .10	Annual $ x .10	Cost of Project

Note: Table 4:Target Project List is only a simple estimate. Do not total all project categories together as it exaggerates the potential savings. For example, the first measure implemented reduces the energy load in the building; each measure implemented thereafter lessens, in turn, the reduced energy load resulting from previous measures, not the original energy load. Your actual savings may be less than originally calculated because of the potential cumulative effects of all the energy conservation measures implemented.

Critical factors that will influence ongoing savings (as compared to the baseline):

Table 5: Hypothetical Baseline Adjustment Checklist

Electrical
Extra (or less) electrical load
- Lights
- Heating
- Fans
- Operating equipment
- Computers
- Office equipment
- Refrigeration
- Cafeteria
- Classroom equipment

Water: as above plus
- Additions or changes to school grounds
- Higher concentration or quality of grasses on sports grounds
- Additional toilet blocks
- Additional drinking fountains or taps
- Unreported water leaks

External influences
- Unseasonable weather Summer/Winter

Operating conditions
- Number of students (may increase/decrease of over 10%)
- Number of student groups (i.e. number of groups for each grade)
- Number of classes
- Timetable
- Night classes
- Adult education
- Community group usage
- Sporting group usage
- Weekend usage
- Special events

Buildings
- Extra buildings
- Extra Rooms
- Consolidation of room
- Change of use

Source: U.S. DOE

The Massachusetts Division of Capital Asset Management
Greenhouse Gas Reductions

The Division of Capital Asset Management (DCAM) Sustainable Design & Energy Efficiency Programs have resulted in reductions of greenhouse gases from state owned and operated buildings. A total of 194 DCAM energy conservation programs, at a total cost of $125,139,222, have saved to date (FY02):

- *$133,220,209*
- *Annual savings of $19,890,705*
- *Over 1,050,000 tons Carbon Dioxide equivalents*

VI: CAPITAL IMPROVEMENTS

Deciding on capital improvements requires further study by a professional engineer or architect and the attention of financial and administrative personnel to determine funding sources and uses. However, identifying potential capital measures during the walk-through is a good initial step to begin this process.

The objective is to select the most cost-effective capital improvements. A walk-through building survey provides a preliminary list of capital improvements, however not all of these are cost-effective. The EM needs information to carefully evaluate each measure and select those improvements that save the most energy at the least cost. Further study is needed to determine the nature, costs, and savings presented by these improvements.

What is a Technical Audit?

To obtain the best information, there is no substitute for a professional engineer or other qualified person to provide on-site technical assistance in the form of a professional technical assistance audit. An engineer or architect trained in the design and maintenance of mechanical and electrical systems can conduct an objective and detailed on-site audit of the building, quickly recognizing the sources of energy waste and the options available to correct them. An audit is a wise investment particularly if the building has a complex HVAC system or unique or special purpose areas. A large building with sophisticated systems may have an annual energy budget of half-a-million dollars. Saving 10% ($50,000) in energy consumption is highly significant. Expect to receive a complete, professional audit report that includes:

- A detailed analysis of the energy profile of the building, including consumption analysis at current levels and at levels of optimal efficiency.
- A listing of O&M measures not already identified, along with potential savings.
- A description and analysis of all applicable capital measures, including estimated costs of design, acquisition, and installation.
- The expected useful life of each capital improvement, and
- The estimated savings over the useful life of the improvement.

In addition, the auditor can look at such options as solar and renewable energy projects and bring to the fore any zoning ordinances, building codes or other regulations that pertain to energy conservation plans or the possible need for an environmental study.

The audit is not only focused on the specifications for a particular capital investment, but also the overall potential efficiency of the building and ways in which to improve it. Since energy systems are highly interrelated, evaluating one possible alteration must include an analysis of how that change might affect other parts of the energy system. For example, doing major work on part of the HVAC system may require that the entire system be rebalanced by a qualified HVAC technician, or excessive delamping in an area with incandescent lights may increase the heat demand for that area due to the loss of heat from removed lamps.

Finding a Qualified Auditor

Choosing the right auditor is a difficult decision. There are many firms offering a variety of energy conservation services. Obtain information from several firms before making a decision. Ask each firm to provide background information on the qualifications of their staff, the scope of services they provide, a list of references, and a cost estimate for conducting an audit. Be sure to determine the type of audit wanted, provide some information about the building, and identify any financial constraints to allow each auditor to make an accurate appraisal of his/her services and costs.

Look at each firm's capabilities carefully, choosing one that gives evidence of keeping up to date on new energy saving products. Experienced auditors are preferable, so check references carefully to see whether other clients were completely satisfied. Look for experienced firms with the confidence to guarantee that the cost of their services will be recovered through savings within a period of time following the implementation of their recommendations. Be wary of professional auditors who are connected with a specific product or service – instead look for an objective, overall study.

Maximize Energy Audit Benefit

Maximize the benefit of using outside services by collecting and providing key audit information in advance. Provide data on fuel consumption, hours of operation and occupancy, as well as a set of building plans. Some firms offer analysis using computer models that simulate existing energy patterns as well as the most efficient energy patterns possible. While such a simulation is useful in providing insight into a variety of potential improvements for the building, it does not replace the detailed on-site audit.

Evaluating Potential Capital Investments

Like any investment, an investment in energy conservation provides a return that justifies its cost. Many of the capital improvements identified may provide these returns but at differing rates and over varying lengths of time. To get the "most for your money" select the improvements that pay for themselves in a reasonable period of time. Use the following "simple payback period" method to do your analysis. Rebuild America provides several on-line calculators to assess savings potential at http://www.rebuild.org/lawson/calculators.asp.

Simple Payback Period (PB)

Simple payback period (PB) is the amount of time it takes for an investment to pay for itself. More specifically, the result of an PB calculation is the length of time, in years, required for an investment to yield savings that repay the original cost of the investment. The following information is needed to calculate PB:

1) The initial cost of the project, including all design and installation costs.
2) The estimated annual savings resulting from the project, based on the dollar cost of the fuel you save.
3) The estimated life of the project.

To calculate the PB, simply divide the initial cost by the annual savings:

$$\frac{\textbf{Initial Cost (\$)}}{\textbf{Annual Savings (\$/yr.)}} = \textbf{PB (years)}$$

The PB result is the number of years it takes for the project to pay for itself. Now compare the PB with the estimated life of the project. If the PB is shorter than the project life, then the project is a worthwhile investment. The shorter the payback period, the more savings is achieved above and beyond the investment. Disregard any project that does not pay for itself within its lifetime[14].

Compare the PB of each energy project to a standard limit used for all projects. Many institutions establish an acceptable maximum for the number of year to payback to lower the risk on investments (e.g., if an improvement wears out prematurely) and to maximize savings achieved beyond recovery of the investment cost. Rate the projects in order of the time that each recovers its cost or for a comprehensive plan combine several projects with varying payback periods into one project.

[14] Note that some measures such as mechanical systems have multiple life expectancy numbers of which to be aware. Most of the components in a $500,000 cogeneration system, for example, will last 10 years or more, however the entire engine block will probably need to be replaced after 5 years due to normal wear and tear.

Combine measures, such as lighting, with shorter payback periods with HVAC measures, with a longer payback period, into one project to derive an acceptable maximum payback. Doing this avoids “cream skimming”.[15]

There are several, more sophisticated, techniques for financial analysis than PB. All of these techniques include the concept of the time value of money.[16] Among the more complex techniques are net present value, internal rate of return, benefit-cost analysis, and life cycle costing. Using these methods provides more accurate information about investment options. Although it does not account for the factors discussed above, using the simple payback period is an acceptable method of analyzing potential capital investments because the other factors not accounted for in PB are taken into account across the board for all of the projects – taking the discount rate into account affects all PB evaluations in a similar manner.

Net Savings (NS)

The net savings are the difference between the total life-cycle cost (TLCC) calculated without the energy conservation project and the TLCC with the project. If the net savings is greater than zero, the project is cost effective. Net savings may be used to determine whether a project is cost effective.[17]

Savings to Investment Ratio (SIR)

The saving to investment ratio is the value of benefits from a project divided by its cost. For example, a $1000 investment that saves $500 each year for five years has a benefit of $2500 and saving to investment ration of 2.5. SIR may be used to prioritize projects or determine whether a project is cost effective. The saving to investment ratio for cost effective projects is greater than one.[18]

Internal Rate of Return (IRR)

The internal rate of return is the annual percentage yield from a project. For example, a $1000 investment that saves $500 each year has a 50 percent rate of return on investment. IRR may be used to prioritize projects or determine whether a project is cost effective. The IRR for a project must be greater than or equal to the minimum acceptable rate of return for the project to be cost effective.[19]

Lifetime Cost (TLCC): An Important Difference

One factor to investigate carefully in projects with similar payback periods is the lifetime cost of keeping the improvements in working condition. Life cycle costing is the process of evaluating a project in the context of all significant ownership costs including the energy operating costs of facilities and services over its lifespan. This includes the capital costs of construction, maintenance, upgrading and decommissioning, plus the recurrent costs of operation, maintenance, cleaning, utilities and staffing.[20] The more repair work needed over time, the higher the overall cost (not just the initial cost). Additionally, factors such as inflation affect the overall cost. As a rule, the PB allow you to make reasonable initial decisions among investment options provided there are not great differences in overall lifetime costs. With large investments, you may want to use some of the financial techniques mentioned.

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[15] “Cream skimming” is often an undesirable yet common practice of investing in simple projects with relatively low initial costs and quick paybacks. See glossary for further definition.
[16] The time value of money is the fundamental concept that a dollar today is worth more than a dollar in one year. This is because the dollar in your hand today can earn interest for the year, while the dollar you receive a year from now cannot. To take onto account this time value of money, the more complex financial analysis methods “discount” future savings.
[17] *Tools for the Job: How to Develop a Municipal Energy Management Program*, 1995, Public Technology, Inc.
[18] ibid.
[19] ibid.
[20] *Energy Management Guidelines*, April 1998, Government of South Australia, Office of Energy Policy

Other Methods of Financial Analysis

A concern for financial advisors is that PB, while easy to determine, does not show the whole picture. Specifically, PB does not take into account:

- Escalating fuel prices.
- The cost of maintaining the project over time, such as operating labor costs, repair work, and the cost of materials needed to keep the project in good operating condition.
- The rate of depreciation and the “scrap value”, if any, of the equipment.
- The discount rate. The discount rate compensates for the price of raising the investment money. It may be the same as the interest rate paid on a capital investment loan from a bank or the interest paid on a municipal bond issued to raise the money. If there is money in the budget, the discount rate is considered the rate of return on an investment one might have made – the next best alternative for investing money or the opportunity cost.
- The rate of inflation, which erodes the value of an investment dollar. One way inflation affects energy projects is to boost the cost of a capital improvement if one delays implementing measures.

Choosing Cost-effectiveness Indicators

The correct cost-effectiveness indicator to use depends on the type of decision made. Using the following four main questions can help determine different types of energy decisions:

- Is the ECM cost effective?
- Which ECM design is the most cost effective? (For example, determining the type and amount of insulation to install.)
- Which combination of interdependent ECMs is the most cost effective.
- How does one prioritize independent ECMs if one does not have sufficient funding to implement all of them?

Total life cycle cost and net savings may be used to make most energy decisions. Use the savings to investment ratio and the internal rate of return to prioritize projects when budget for the energy projects is limited. The following lists the cost-effectiveness criteria used to make different types of decisions.

Type of Decision	TLCC	NS	SIR	IRR
Is the project cost effective?[1]	✓	✓	✓	✓
Which project design is most cost effective?[1]	✓	✓		
Which combination of interdependent projects is most cost effective?[2]	✓	✓		
What is the relative priority of independent projects?[2]			✓	✓

[1] Choose the project, project design, or combination of projects that has either the lowest TLCC or the greatest NS
[2] Prioritize projects with larger SIRs or IRRs more highly than those with lower SIRs or IRRs. Delete projects from your prioritized list if the SIR is less than one or the IRR is less than the minimum acceptable IRR. Select projects to implement according to the prioritized list until all project funds have been allocated.[21]

[21] *Tools for the Job: How to Develop a Municipal Energy Management Program*, 1995, Public Technology, Inc.

Monitoring and Feedback

An important aspect of an energy management program is to monitor the program to provide information for decision-making. An on-going effort to obtain information identifies new areas of potential savings and monitors the success of past conservation efforts. This information indicates whether the plan is meeting the energy conservation goals. The EM is the person to develop and coordinate this ongoing process.

- **Monthly Energy Use Records**. Keep up-to-date records of monthly fuel and electricity consumption and costs. Enlist staff to develop a regular procedure to enter this information on a spreadsheet.

- **Operation and Maintenance Schedules and Data**. Develop and maintain a regular schedule for inspecting equipment and record important data such as HVAC filter changes, temperature settings on equipment, and building operating hours. Post a checksheet where each O&M measure is actually performed.

- **Opportunities for "Feedback" from Operators and Users of the Building**. Make it easy for people to let management know what they think of the conservation efforts, e.g., quality of lighting. The energy management team may be a good source of, or channel for, this kind of information. Items such as a suggestion box are also useful.

- **Audit Update**. A substantial audit update can periodically find and correct new problems. This audit may include a burner/boiler efficiency test, inspecting caulking and weather-stripping, and checking the condition and operation of HVAC equipment and controls. Check if there is in-house staff with the expertise to perform an update.

Environmentally Preferable Product Procurement

The Massachusetts Operational Services Division (OSD) is responsible for coordinating the Commonwealth of Massachusetts' efforts to increase State purchases of environmentally preferable products, including goods that: contain recycled materials, minimize waste, conserve energy and/or water, contain fewer toxic materials, conserve natural resources, protect open space, and/or minimize impact to public health.

One of the resulting environmental benefits of the EPP Program at the OSD is a reduction in emissions of greenhouse gases through the purchasing of energy efficient office equipment and recycled products. Results of a report in FY01 that quantify the greenhouse gas reductions attributable to the EPP Program's purchasing from that year show:

- *A reduction of 4408 tons CO_2 in 2001, equivalent to removing 1379 cars from the road every year*

VII: FINANCING ENERGY PROJECTS

Rebuild America offers a series of technical and business manuals designed to provide information on completing energy efficiency projects. The following information includes excerpts from ***Financing Energy Efficiency in Buildings***. The Resource section provides the website to obtain copies of the original guide. Manuals and guides can be obtained from the ***Solution Center*** at the referenced site.

Internal Financing

Internally financed energy-efficiency improvements are paid directly with available cash drawn from an organization's current operating or capital funds. Internal financing is the simplest and most direct way to pay for improvements. One attraction of internal financing is that it allows the organization to retain all energy-cost savings. It also allows quick project implementation by avoiding complex contract negotiations or transaction delays often associated with other financing mechanisms.

However, available internal funds are commonly constrained by budget limitations and competing operating and capital investment needs. Internal operating funds are most commonly used to finance smaller, short-term projects. These projects often have relatively low capital costs and short payback periods. Some organizations have used cash from operating budgets to start revolving investment funds, or more extensive capital budgeting programs. The use of internal financing normally requires the inclusion and approval of energy-efficiency projects within an organization's annual operating or capital budget-setting process.

A study by the City and County of San Francisco revealed that there is never an economic advantage to borrowing money if internal capital is available immediately. Indeed, the benefit of using internal funds is larger for projects with a long payback period, since the interest costs more and more. There may be political or social advantages to borrowing, however, if internal capital use would result in rate increases in the short term. Furthermore, borrowing funds in order to avoid delaying the project's implementation is advantageous.

Source: Public Technology, Inc.

Operating Budgets: Small projects with high internal rates of return can be scheduled for implementation during the budget year for which they are approved (an exception to this is a project funded by a performance based contract).[22]

Capital Budgets: Large projects can be scheduled for implementation over the full time period during which the capital budget is in place. Local governments may have multi-year capital budgeting requirements (e.g., a five-year capital improvements plan and a one-year capital budget).

Budget constraints, competition among alternative investments, and the need for high rates of return can significantly limit the number of internally financed energy-efficiency improvements. Nevertheless, internal financing should support at least part of an organization's investment portfolio.

Revolving Investment Funds

Taking a percentage of the acquired savings from energy efficiency projects and reinvesting it in subsequent projects is another financing option. Some cities and counties use savings from energy efficiency projects to pay the salary of their energy manager. For example, in Florida, "it is the policy of this state to encourage school

[22] See *Energy Management Services* at www.mass.gov/doer

districts, state community colleges and state universities to reinvest any energy savings resulting from energy conservation measures into additional energy conservation efforts."[23]

Creating a revolving investment (or loan) fund can capture the returns from energy-efficiency investments that can significantly leverage financing for internally financed projects. In this approach, an initial investment of internal money is made for one or more energy-efficiency projects. As savings accrue from avoided energy costs some or all of the savings are earmarked for repayment to the revolving fund, thus replenishing the initial investment. Any surplus savings in excess of costs are proceeds that allow the fund to grow even larger. These may be reinvested in additional energy projects. As the energy savings compound, so do the returns to the fund and the proceeds that can be reinvested.

City of Phoenix, Arizona

The City of Phoenix has a revolving fund program that invests in building retrofits in new buildings. The fund has been in place since 1984 and initially began with a $50,000 investment derived from $150,000 energy savings. The program has documented savings of $27 million compared to $12 million project implementation cost.

Source: U.S. Department of Energy, Rebuild America

Even with small initial capital resources, revolving funds can grow quickly through reinvested revenues. The main drawback with revolving funds is the relatively long period of time required to realize the full savings of energy upgrades. However, use of internal financing combined with a revolving investment fund can provide excellent capital leveraging and a remarkably profitable return on investment.

Debt Financing

Debt financing can be as simple as a loan from a lending institution to a borrower, or as complex as a bond issued and marketed to investors in the open market. Both approaches can be used to finance energy-efficiency improvements that are beyond the size and scope of internal financing. Loans are generally used to finance smaller, short-term projects. Bonds are more appropriate to raise capital for large single projects, or to support a series of smaller projects where the principal amount borrowed is of sufficient size to justify the expense of the bond's issuance and marketing costs. State and local governments can issue tax exempt bonds or other debt instruments at substantially lower interest rates than are available to private entities. All savings from debt-financed efficiency measures are retained internally. Equipment depreciation and interest costs are tax deductible by the borrower.

Debt financing for small energy-efficiency improvements is relatively uncommon among private organizations and local governments. Issuing bonds to finance large energy-efficiency initiatives or to provide reduced rate loans for private firms, non-profit organizations, and local governments is a more common practice among agencies of state government. Energy-efficiency debt financing may be designed so that debt is issued to support a variety of capital projects of which energy-efficiency improvements are just one part (e.g., bonds issued for construction of new municipal buildings and school additions, with efficiency improvements included as a part of the project).

Debt financing for energy-efficiency improvements can be financed through simple two-party loans for smaller projects, or from bond proceeds issued by an organization for large or multiple projects.

- **Direct Loans**: At its simplest, debt financing takes the form of a loan to a borrower from a lending institution. Terms for repayment of principal and interest can usually be negotiated so that savings from increased energy efficiency provide at least break-even cash flow for a borrower. Some utilities and Federal and state governments can reduce a borrower's financing costs through equipment rebates, reduced rate loans for selected improvements, and/or guarantees or insurance that lowers credit risk to a private lender. Direct, market-rate loans are rarely used by public organizations to finance energy-efficiency improvements.

[23] Florida Statutes Title XVI, Chapter 235.215 (1)

- **Municipal Bonds**: Municipal bonds are long-term debt obligations of states, local governments, and their authorities and agencies. They are generally, but not always, exempt from Federal and state taxes. They are most commonly issued to finance public buildings and schools, streets and bridges, water and wastewater treatment facilities, and other major infrastructure development or rehabilitation projects. They may also be used to finance capital investments that are clearly in the public interest, such as infrastructure for economic development, housing for lower income families, and, of course, energy-efficiency improvements. Like all debt obligations, municipal bonds are essentially promissory notes that require the issuer to make scheduled interest payments at specific periods at an agreed upon interest rate, and to return the principal on the date the issue matures.

In general, bond-backed debt financing is most applicable for large individual projects or for smaller projects that can be combined into a single debt issue. For large projects, municipal bonds are the least expensive way to borrow money in private capital markets. Given tax-exempt interest rates, municipal bonds place a lower financial burden on the issuing government than do direct market rate loans. Governments using bond-backed debt financing must consider debt volume-caps and weigh the complexity of issuing bonds against the size and return of a project.

Lease and Lease Purchase Agreements

Lease and lease-purchase agreements are contracts that allow the use of equipment for a fixed period in return for a regularly scheduled installment payment. In a lease, energy-efficiency equipment is acquired and financed by a third party (the lessor) with little or no up-front cost to a customer (the lessee). Payments made by the lessee to the lessor can be spread over a period of 1 to 15 years or more. Leases can be used to obtain such equipment as vehicles, telecommunications systems, or office equipment, and can be used for single or multi-agency purposes.

Lease and lease-purchase arrangements allow a building owner or institution to avoid cash limitations associated with internal financing, as well as complex and volume-capped debt financing. Since leasing arrangements can be used for both large and small projects, they provide a flexible instrument for projects of widely varying sizes. Finally, lease financing can often be structured so that payments are considered an operating expense. This means that the value of the lease will not be carried as a debt incurred by an organization.

- **Operating Leases**: In an operating lease, the lessor retains ownership of the equipment. At the end of the lease period, the lessee can re-negotiate and extend the term of the lease, buy the equipment at its residual fair market value, or return the equipment to the lessor. Because the lessee does not have a long-term equity interest in the equipment, the lease value and payments are not considered debt liabilities on the lessee's balance sheet. As a general rule, if the lease is designed so that the equipment and improvements leased will have significant residual value at the end of the lease period, chances are high that the lease will be considered as an offbalance sheet financing instrument.

- **Capital Leases**: Also called a financing lease, capital leases differ from operating leases in that the lessee pays for the equipment and/or improvements in equal monthly installments over the period of the lease. Because of this structure, payments are generally higher than those for an operating lease, but the lessee can purchase the equipment at the end of the lease period for a nominal amount (often $1.00). The lessee is considered the owner of the equipment.

- **Guaranteed Savings Leases:** A guaranteed savings lease may be either an operating or a capital lease in which the lessee is guaranteed that payments will not exceed energy savings generated by the leased equipment. Payments to the lessor are structured so that if savings are less than those guaranteed the lessee pays the smaller amount (the amount saved) and receives credit for the difference. Many energy performance contracting agreements are guaranteed savings leases. Energy performance contracts are described in further in this section.

- **Municipal (or tax-exempt) Lease/Lease-Purchase**: Both operating and capital leases can be made available to tax-exempt entities at significantly lower financing rates than for private-sector borrowers. Since the lessor is not required to pay federal or state taxes on that portion of the lessee's payments that represent interest, a lower rate can be offered than for other types of leases. Municipal leases were developed as an alternative to procuring equipment by internal or debt financing. Their use has increased significantly in recent years because of their flexibility and a growing need for off-balance sheet financing in response to debt limits.[24]

Utility Financing

In Massachusetts, each electricity customer contributes to energy conservation programs. This charge covers the cost of energy conservation programs offered by your local utility. These programs seek to reduce energy use by consumers by using energy more efficiently. Natural gas customers may also take advantage of energy efficiency programs. Check with your local gas or electric utility to see if you qualify.

State Government Loans

Some states offer loans to local jurisdictions' energy projects. These loans may be limited in the amount available to any given jurisdiction, but can provide good terms and low overhead cost where available.

The Louisiana Department of Natural Resources -- Energy Fund

The Energy Fund is a public-private cooperative endeavor that provides publicly funded entities the low-cost financing necessary to implement energy conservation strategies.

Funds are available through the Department of Natural Resources, in coordination with the Louisiana Public Facilities Authority, and may be used for guaranteed shared savings contracts, also known as performance contracts.

Qualifying projects are pooled by the Louisiana Public Facilities Authority to achieve further economies of scale in transaction costs. A "private bond issue" backed by the pooled projects will generate funds.

The Department of Natural Resources provides credit enhancement to partially "buy down" the interest rate associated with the bond issue. This buy down makes the cost of financing more affordable, especially for entities with a poor credit rating or no credit rating at all.

Energy Fund recipients are required to provide the Department of Natural Resources, on a quarterly basis, the first full year's energy savings.

For information on Louisiana's program go to:
http://www.dnr.state.la.us/SEC/EXECDIV/TECHASMT/financial/index.html

Energy Services Companies

Energy services companies (ESCOs) are private companies that identify, design, and implement energy efficiency retrofits. ESCOs often offer financial services. The cost of borrowing money this way is usually higher than borrowing it directly through financial institutions, but may still be attractive if the additional

[24] U.S. Department of Energy, Rebuild America, *Financing Energy Efficient Buildings*

administrative cost of pursuing funds directly is burdensome. It is always possible to use ESCOs for their expertise in designing and installing retrofits while obtaining financing separately. ESCOs also guarantee savings to minimize the client's financial risk.

Third-party Financing

Using internal funds or borrowing money is far better than using third party financing. If, however, internal funds are not available and local government has incurred as much debt as it can afford, third party financing may be a viable option. In third party financing, a party other than local government owns the energy efficiency equipment associated with the project, has the burden and risk of ownership, and arranges financing based on their organization's balance sheet. The borrowing capacity of your local government is unaffected by third party financing.

Deciding which Financing Option to Use

Achieving the energy savings potential for a local government with many facilities usually requires more funding than is available through traditional levels of internal funding. The financing option chosen depends on a number of factors, including the size of the project and its payback period.

Although researching financing restrictions that apply to a specific local government is necessary for preparation of an energy management program, operational management and design considerations should guide development, not financing. After determining the basic design of the energy management program, decide which financing options best apply to the particular situations. The following table compares the characteristics of different financing options.

Municipal leases are best suited for smaller government agencies, smaller projects (those under $15 million), and projects financed for less that fifteen years. Municipal leases usually have a higher interest rate, but the associated costs are small. Master leases are well suited to fund a series of projects, if the timing or amount of funds needed is unknown. Determine the best form of financing to use on a case-by-case basis in consultation with bond counsel and financial advisor or underwriter.

External Funding vs. Internal Funding

To see the trade-off between using internal funding versus external funding, compare these options by using the net present value (NPV) of each. The NPV of a funding option is its value in today's dollars. The advantage of internal funding is the avoidance of the interest cost of a loan. A loan, on the other hand, may enable earlier implementation of projects for which internal funding is not yet available, thus avoiding the cost (the unrealized savings) associated with delaying the project.

Consideration of Cost Effectiveness for Outside Funders

Note that outside funders may or may not consider cost effective as a requirement for funding, while utility-funded programs *must* consider a prescribed cost effectiveness criteria for program eligibility. On the other hand, private funders are not usually concerned with cost effectiveness of an energy project as long as they feel secure about repayment. They tie repayment more closely to the overall financial capability of the borrower than to the project itself. A pledge of a revenue stream, even if from an unrelated source (as opposed to a direct tie to energy savings) fulfills the lender's need for security.

Financing Expertise

Arranging a lease or other financing option requires financial expertise that may not be available in a local department, but is elsewhere within the local government. Leases are commonly used to buy computer systems, motor vehicles, and other expensive equipment, so local governments typically have staff experienced with leases. In fact, it may be advantageous to package energy projects with other equipment purchases because it may result in a lower interest rate and provide the lender with the security of more potentially reclaimable equipment.

Use in-house financing expertise or a financial advisor to determine and secure the best type of financing for energy projects. Your in-house finance staff or financial advisor is likely to need the following information:

- A list of individual project locations
- A brief descriptions of each project
- Estimated start and completion dates for each project
- Project cost
- The timing of expenditures for each project
- An estimate of each project's life
- The estimated annual savings for each project

Arranging project financing is time consuming. Allot time for administrative tasks when planning.

Staff Resources and Technical Expertise

While the aforementioned financing options may enable one to undertake larger projects, a related restriction on project size is the capability to identify and manage energy efficiency projects financed through outside funders. Weigh the benefit and cost of committing time and staff to identifying and implementing large-scale projects with the parameters of unfamiliar financing requirement since doing so will inevitably mean diminished effort in another area.

Larger projects may require new skills, as well as knowledge of an unfamiliar project financing mechanism. Consider relying on the expertise of an ESCO or consultant for tasks that require specific knowledge, such as identifying complex HVAC measures. Lenders are typically willing to structure a loan to include early costs such as project identification and design.[25]

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[25] *Tools for the Job: How to Develop a Municipal Energy Management Program*, 1995, Public Technology, Inc.

GLOSSARY[26]

Adjustable Speed Drive - An electronic device that controls the rotational speed of motor-driven equipment such as fans, pumps, and compressors. Speed control is achieved by adjusting the frequency of the voltage applied to the motor.

Air Change - A measure of the rate at which the air in an interior space is replace by outside (or conditioned) air by ventilation and infiltration; usually measured in cubic feet per time interval (hour), divided by the volume of air in the room.

Air Conditioner - A device for conditioning air in an interior space. A Room Air Conditioner is a unit designed for installation in the wall or window of a room to deliver conditioned air without ducts. A Unitary Air Conditioner is composed of one or more assemblies that usually include an evaporator or cooling coil, a compressor and condenser combination, and possibly a heating apparatus. A Central Air Conditioner is designed to provide conditioned air from a central unit to a whole building with fans and ducts.

Air Conditioning - The control of the quality, quantity, and temperature-humidity of the air in an interior space.

Air Pollution - The presence of contaminants in the air in concentrations that prevent the normal dispersive ability of the air, and that interfere with biological processes and human economics.

Air-Source Heat Pump - A type of heat pump that transfers heat from outdoor air to indoor air during the heating season, and works in reverse during the cooling season.

Alternating Current - A type of electrical current, the direction of which is reversed at regular intervals or cycles; in the U.S. the standard is 120 reversals or 60 cycles per second; typically abbreviated as AC.

Alternative Fuels - A popular term for "non-conventional" transportation fuels derived from natural gas (propane, compressed natural gas, methanol, etc.) or biomass materials (ethanol, methanol).

Ambient Air - The air external to a building or device.

Ambient Temperature - The temperature of a medium, such as gas or liquid, which comes into contact with or surrounds an apparatus or building element.

Ampere - A unit of measure for an electrical current; the amount of current that flows in a circuit at an electromotive force of one Volt and at a resistance of one Ohm. Abbreviated as amp.

ASHRAE - Abbreviation for the American Society of Heating, Refrigeration, and Air-Conditioning Engineers.

Audit (Energy) - The process of determining energy consumption, by various techniques, of a building or facility.

Average Demand - The demand on, or the power output of, an electrical system or any of its parts over an interval of time, as determined by the total number of kilowatt-hours divided by the units of time in the interval.

[26] Source: U.S. Department of Energy, Energy Dictionary at http://www.eren.doe.gov/consumerinfo/glossary.html

Avoided Cost - The incremental cost to an electric power producer to generate or purchase a unit of electricity or capacity or both.

Ballast - A device used to control the voltage in a fluorescent lamp.

Benefits Charge -The addition of a per unit tax on sales of electricity, with the revenue generated used for or to encourage investments in energy efficiency measures and/or renewable energy projects.

Bin Method - A method of predicting heating and/or cooling loads using instantaneous load calculation at different outdoor dry-bulb temperatures, and multiplying the result by the number of hours of occurrence of each temperature.

Boiler - A vessel or tank where heat produced from the combustion of fuels such as natural gas, fuel oil, or coal is used to generate hot water or steam for applications ranging from building space heating to electric power production or industrial process heat.

Boiler Feedwater - The water that is forced into a boiler to take the place of that which is evaporated in the generation of steam.

Boiler Horsepower - A unit of rate of water evaporation equal to the evaporation per hour of 34.5 pounds of water at a temperature of 212 degrees Fahrenheit into steam at 212 degrees F.

Boiler Pressure - The pressure of the steam or water in a boiler as measured; usually expressed in pounds per square inch gauge (psig).

Boiler Rating - The heating capacity of a steam boiler; expressed in Btu per hour (Btu/h), or horsepower, or pounds of steam per hour.

British Thermal Unit (Btu) - The amount of heat required to raise the temperature of one pound of water one degree Fahrenheit; equal to 252 calories.

Building Energy Ratio - The space-conditioning load of a building.

Building Heat-Loss Factor - A measure of the heating requirements of a building expressed in Btu per degree-day.

Burner Capacity - The maximum heat output (in Btu per hour) released by a burner with a stable flame and satisfactory combustion.

Calorie - The amount of heat required to raise the temperature of a unit of water, at or near the temperature of maximum density, one degree Celsius (or Centigrade [C]); expressed as a "small calorie" (the amount of heat required to raise the temperature of 1 gram of water one degree C), or as a "large calorie" or "kilogram calorie" (the amount of heat required to raise one kilogram [1,000 grams] of water one degree C); capitalization of the word calorie indicates a kilogram-calorie.

Candle Power - The illuminating power of a standard candle employed as a unit for determining the illuminating quality of an illuminant.

Capacity (Effective, of a motor) - The maximum load that a motor is capable of supplying.

Capital Costs - The amount of money needed to purchase equipment, buildings, tools, and other manufactured goods that can be used in production.

Carbon Dioxide - A colorless, odorless noncombustible gas with the formula CO_2 that is present in the atmosphere. It is formed by the combustion of carbon and carbon compounds (such as fossil fuels and biomass), by respiration, which is a slow combustion in animals and plants, and by the gradual oxidation of organic matter in the soil.

Cathode Disconnect Ballast - An electromagnetic ballast that disconnects a lamp's electrode heating circuit once is has started; often called "low frequency electronic" ballasts.

Caulking - A material used to seal areas of potential air leakage into or out of a building envelope.

Chiller - A device for removing heat from a gas or liquid stream for air conditioning/cooling.

Circuit - A device, or system of devices, that allows electrical current to flow through it and allows voltage to occur across positive and negative terminals.

Circuit Breaker - A device used to interrupt or break an electrical circuit when an overload condition exists; usually installed in the positive circuit; used to protect electrical equipment.

Cogeneration - The generation of electricity or shaft power by an energy conversion system and the concurrent use of rejected thermal energy from the conversion system as an auxiliary energy source.

Combustion - The process of burning; the oxidation of a material by applying heat, which unites oxygen with a material or fuel.

Commissioning - The process by which a power plant, apparatus, or building is approved for operation based on observed or measured operation that meets design specifications.

Conditioned Space - The interior space of a building that is heated or cooled.

Conservation - Protecting something from loss or depletion. Energy Conservation involves using energy resources carefully by implementing energy efficient technologies and by avoiding unnecessary uses of energy.

Cooling Degree Day - A value used to estimate interior air cooling requirements (load) calculated as the number of degrees per day (over a specified period) that the daily average temperature is above 65 degrees Fahrenheit (or some other, specified base temperature). The daily average temperature is the mean of the maximum and minimum temperatures recorded for a specific location for a 24-hour period.

Cream Skimming - An often undesirable yet all too common practice of investing in simple projects with relatively low initial costs and quick paybacks. While such investments are financially attractive in the short term, pursuing them may prevent a building owner from capturing significant long-term benefits likely to result from more comprehensive retrofits. Cream-skimming projects have impressive initial returns on investment, yet they commonly yield lower absolute energy and cost savings when compared to projects that are all-inclusive. Moreover, due to their emphasis on short-term paybacks, cream skimming weakens an organization's ability to finance more capital intensive improvements that leverage the value of those short-term paybacks.

Cubic Foot (of Natural Gas) - A unit of volume equal to 1 cubic foot at a pressure base of 14.73 pounds standard per square inch absolute and a temperature base of 60 degrees Fahrenheit.

Current (Electrical) - The flow of electrical energy (electricity) in a conductor, measured in amperes.

Daylighting - The use of direct, diffuse, or reflected sunlight to provide supplemental lighting for building interiors.

Decommissioning - The process of removing a power plant, apparatus, equipment, building, or facility from operation.

Degree Day - A unit for measuring the extent that the outdoor daily average temperature (the mean of the maximum and minimum daily dry-bulb temperatures) falls below (in the case of heating, see Heating Degree Day), or falls above (in the case of cooling, see Cooling Degree Day) an assumed base temperature, normally taken as 65 degrees Fahrenheit, unless otherwise stated. One degree day is counted for each degree below (for heating) or above (in the case of cooling) the base, for each calendar day on which the temperature goes below or above the base.

Demand - The rate at which electricity is delivered to or by a system, part of a system, or piece of equipment expressed in kilowatts, kilovoltamperes, or other suitable unit, at a given instant or averaged over a specified period of time.

Demand-Side Management (DSM) - The process of managing the consumption of energy, generally to optimize available and planned generation resources.

Discounting - A method of financial and economic analysis used to determine present and future values of investments or expenses.

Discount Rate - The interest rate at which the Federal Reserve System stands ready to lend reserves to commercial banks. The rate is proposed by the 12 Federal Reserve banks and determined with the approval of the Board of Governors.

Distributed Generation - A popular term for localized or on-site power generation.

Distribution System - That portion of an electricity supply system used to deliver electricity from points on the transmission system to consumers.

Double-Pane or **Glazed Window** - A type of window having two layers (panes or glazing) of glass separated by an air space. Each layer of glass and surrounding air space reradiates and traps some of the heat that passes through thereby increasing the windows resistance to heat loss (R-value).

Dual Duct System - An air conditioning system that has two ducts, one is heated and the other is cooled, so that air of the correct temperature is provided by mixing varying amounts of air from each duct.

Duct(s) - The round or rectangular tube(s), generally constructed of sheet metal, fiberglass board, or a flexible plastic-and-wire composite, located within a wall, floor, and ceiling that distributes heated or cooled air in buildings.

Efficacy - The amount of energy service or useful energy delivered per unit of energy input. Often used in reference to lighting systems, where the visible light output of a luminary is relative to power input; expressed in lumens per Watt; the higher the efficacy value, the higher the energy efficiency.

Effective Capacity - The maximum load that a device is capable of carrying.

Efficiency - Under the First Law of Thermodynamics, efficiency is the ratio of work or energy output to work or energy input, and cannot exceed 100 percent. Efficiency under the Second Law of Thermodynamics is determined by the ratio of the theoretical minimum energy that is required to accomplish a task relative to the energy actually consumed to accomplish the task. Generally, the measured efficiency of a device, as defined by the First Law, will be higher than that defined by the Second Law.

Electric Meter: A device that measures the amount of electric energy used by a home or apartment. Electric Energy is measured in units of Kilowatt-hours

Electrical System - All the conductors and electricity using devices that are connected to a source of electromotive force (or generator).

Electrical System Energy Losses - A measure of the amount of energy lost during the generation, transmission, and distribution of electricity.

Electric Circuit - The path followed by electrons from a generation source, through an electrical system, and returning to the source.

Electric Energy - The amount of work accomplished by electrical power, usually measured in kilowatt-hours (kWh). One kWh is 1,000 Watts and is equal to 3,413 Btu.

Electric Furnace - An air heater in which air is blown over electric resistance heating coils.

Electricity Generation - The process of producing electricity by transforming other forms or sources of energy into electrical energy; measured in kilowatt-hours.

Electric Rate - The unit price and quantity to which it applies as specified in a rate schedule or contract.

Electric Rate Schedule - A statement of the electric rate(s), terms, and conditions for electricity sale or supply.

Electric System - The physically connected generation, transmission, and distribution facilities and components operated as a unit.

Electric System Loss(es) - The total amount of electric energy loss in an electric system between the generation source and points of delivery.

Electric Power Plant - A facility or piece of equipment that produces electricity.

Electric Power Transmission - The transmission of electricity through power lines.

Electric Utility - A corporation, person, agency, authority or other legal entity that owns and/or operates facilities for the generation, transmission, distribution or sale of electricity primarily for use by the public.

Energy - The capability of doing work; different forms of energy can be converted to other forms, but the total amount of energy remains the same.

Energy Audit - A survey that shows how much energy you use in your house or apartment. It will help you find ways to use less energy.

Energy-Efficient Lights: Lights that require a small amount of **Power** (**Watts**) and produce a large amount of useable light. Light intensity is measured in **Lumens**. **Fluorescent Lights** are efficient because most of the power they require is used to produce light instead of heat. Reflectors can improve the **Efficiency** of any light bulb by directing light to where it is needed.

Energy Factor (EF) - The measure of overall efficiency for a variety of appliances. For water heaters, the energy factor is based on three factors: 1) the recovery efficiency, or how efficiently the heat from the energy source is transferred to the water; 2) standby losses, or the percentage of heat lost per hour from the stored water compared to the content of the water: and 3) cycling losses. For dishwashers, the energy factor is defined as the number of cycles per kWh of input power. For clothes washers, the energy factor is defined as the cubic foot capacity per kWh of input power per cycle. For clothes dryers, the energy factor is defined as the number of pounds of clothes dried per kWh of power consumed.

Energy Service Company (ESCO) - A company that specializes in undertaking energy efficiency measures under a contractual arrangement whereby the ESCO shares the value of energy savings with their customer.

Fan - A device that moves and/or circulates air and provides ventilation for a room or a building.

Fenestration - The arrangement, proportion, and design of windows in a building.

Filter (air) - A device that removes contaminants, by mechanical filtration, from the fresh air stream before the air enters the living space. Filters can be installed as part of a heating/cooling system through which air flows for the purpose of removing particulates before or after the air enters the mechanical components.

First Law of Thermodynamics - States that energy cannot be created or destroyed, but only changed from one form to another. First Law efficiency measures the fraction of energy supplied to a device or process that it delivers in its output. Also called the law of conservation of energy.

Flashing - Metal, usually galvanized sheet metal, used to provide protection against infiltration of precipitation into a roof or exterior wall; usually placed around roof penetrations such as chimneys.

Floor Space - The interior area of a building, calculated in square feet or meters.

Flow Restrictor - A water and energy conserving device that limits the amount of water that a faucet or showerhead can deliver.

Flue - The structure (in a residential heating appliance, industrial furnace, or power plant) into which combustion gases flow and are contained until they are emitted to the atmosphere.

Fluorescent Light - The conversion of electric power to visible light by using an electric charge to excite gaseous atoms in a glass tube. These atoms emit ultraviolet radiation that is absorbed by a phosphor coating on the walls of the lamp tube. The phosphor coating produces visible light.

Foot Candle - A unit of illuminance; equal to one lumen per square foot.

Forced Air System or Furnace - A type of heating system in which heated air is blown by a fan through air channels or ducts to rooms.

Fossil Fuels - Fuels formed in the ground from the remains of dead plants and animals. It takes millions of years to form fossil fuels. Oil, natural gas, and coal are fossil fuels.

Fuel Efficiency - The ratio of heat produced by a fuel for doing work to the available heat in the fuel.

Geothermal Energy - Energy produced by the internal heat of the earth; geothermal heat sources include: hydrothermal convective systems; pressurized water reservoirs; hot dry rocks; manual gradients; and magma. Geothermal energy can be used directly for heating or to produce electric power.

Glazing - A term used for the transparent or translucent material in a window. This material (i.e. glass, plastic films, coated glass) is used for admitting solar energy and light through windows.

Geothermal Heat Pump - A type of heat pump that uses the ground, ground water, or ponds as a heat source and heat sink, rather than outside air. Ground or water temperatures are more constant and are warmer in winter and cooler in summer than air temperatures. Geothermal heat pumps operate more efficiently than "conventional" or "air source" heat pumps.

Global Warming - A popular term used to describe the increase in average global temperatures due to the greenhouse effect.

Greenhouse Effect - A popular term used to describe the heating effect due to the trapping of long wave (length) radiation by greenhouse gases produced from natural and human sources.

Greenhouse Gases - Those gases, such as water vapor, carbon dioxide, tropospheric ozone, methane, and low level ozone that are transparent to solar radiation, but opaque to long wave radiation, and which contribute to the greenhouse effect

Green Power - A popular term for energy produced from renewable energy resources.

Heat - A form of thermal energy resulting from combustion, chemical reaction, friction, or movement of electricity. As a thermodynamic condition, heat, at a constant pressure, is equal to internal or intrinsic energy plus pressure times volume.

Heat Absorbing Window Glass - A type of window glass that contains special tints that cause the window to absorb as much as 45% of incoming solar energy, to reduce heat gain in an interior space. Part of the absorbed heat will continue to be passed through the window by conduction and reradiation.

Heating Degree Day(s) (HDD) - The number of degrees per day that the daily average temperature (the mean of the maximum and minimum recorded temperatures) is below a base temperature, usually 65 degrees Fahrenheit, unless otherwise specified; used to determine indoor space heating requirements and heating system sizing. Total HDD is the cumulative total for the year/heating season. The higher the HDD for a location, the colder the daily average temperature(s).

Heating Seasonal Performance Factor (HSPF) - The measure of seasonal or annual efficiency of a heat pump operating in the heating mode. It takes into account the variations in temperature that can occur within a season and is the average number of Btu of heat delivered for every watt-hour of electricity used by the heat pump over a heating season.

Heating Value - The amount of heat produced from the complete combustion of a unit of fuel. The higher (or gross) heating value is that when all products of combustion are cooled to the pre-combustion temperature, water vapor formed during combustion is condensed, and necessary corrections have been made. Lower (or net) heating value is obtained by subtracting from the gross heating value the latent heat of vaporization of the water vapor formed by the combustion of the hydrogen in the fuel.

Heating, Ventilation, and Air-Conditioning (HVAC) System - All the components of the appliance used to condition interior air of a building.

Heat Loss - The heat that flows from the building interior, through the building envelope to the outside environment.

Heat Gain: The amount of heat gained, measured in BTU's, from a space to be conditioned, at the local summer outdoor design temperature and a specified indoor design condition.

Heat Pump - An electricity powered device that extracts available heat from one area (the heat source) and transfers it to another (the heat sink) to either heat or cool an interior space or to extract heat energy from a fluid.

High-Intensity Discharge Lamp - A lamp that consists of a sealed arc tube inside a glass envelope, or outer jacket. The inner arc tube is filled with elements that emit light when ionized by electric current. A ballast is required to provide the proper starting voltage and to regulate current during operation.

High-Pressure Sodium Lamp - A type of High-Intensity Discharge (HID) lamp that uses sodium under high pressure as the primary light-producing element. These high efficiency lights produce a golden white color and are used for interior industrial applications, such as in warehouses and manufacturing, and for security, street, and area lighting.

Horsepower (hp) - A unit of rate of operation. Electrical hp: a measure of time rate of mechanical energy output; usually applied to electric motors as the maximum output; 1 electrical hp is equal to 0.746 kilowatts or 2,545 Btu per hour. Shaft hp: a measure of the actual mechanical energy per unit time delivered to a turning shaft; 1 shaft Hp is equal to 1 electrical Hp or 550 foot pounds per second. Boiler Hp: a measure to the maximum rate to heat output of a steam generator; 1 boiler Hp is equal to 33,480 Btu per hour steam output.

Illuminance - A measure of the amount of light incident on a surface; measured in foot-candles or Lux.

Incandescent - These lights use an electrically heated filament to produce light in a vacuum or inert gas-filled bulb.

Insulation - Materials that prevent or slow down the movement of heat.

Internal Gain - The heat produced by sources of heat in a building (occupants, appliances, lighting, etc).

Joule - A metric unit of energy or work; the energy produced by a force of one Newton operating through a distance of one meter; 1 Joule per second equals 1 Watt or 0.737 foot-pounds; 1 Btu equals 1,055 Joules.

Kilowatt (kW) - A standard unit of electrical power equal to one thousand watts, or to the energy consumption at a rate of 1000 Joules per second.

Kilowatt-hour - A unit or measure of electricity supply or consumption of 1,000 Watts over the period of one hour; equivalent to 3,412 Btu.

Latent Cooling Load - The load created by moisture in the air, including from outside air infiltration and that from indoor sources such as occupants, plants, cooking, showering, etc.

Law(s) of Thermodynamics - The first law states that energy can not be created or destroyed; the second law states that when a free exchange of heat occurs between two materials, the heat always moves from the warmer to the cooler material.

Lethe - A measure of air purity that is equal to one complete air change (in an interior space).

Life Cycle Cost - The sum of all the costs both recurring and nonrecurring, related to a product, structure, system, or service during its life span or specified time period.

Light Quality - A description of how well people in a lighted space can see to do visual tasks and how visually comfortable they feel in that space.

Line Loss (or Drop) - Electrical energy lost due to inherent inefficiencies in an electrical transmission and distribution system under specific conditions.

Load - The demand on an energy producing system; the energy consumption or requirement of a piece or group of equipment.

Load Duration Curve - A curve that displays load values on the horizontal axis in descending order of magnitude against the percent of time (on the vertical axis) that the load values are exceeded.

Load Factor - The ratio of average energy demand (load) to maximum demand (peak load) during a specific period.

Load Forecast - An estimate of power demand at some future period.

Load Leveling - The deferment of certain loads to limit electrical power demand, or the production of energy during off-peak periods for storage and use during peak demand periods.

Load Management - To influence the demand on a power source.

Load Profile or Shape - A curve on a chart showing power (kW) supplied (on the horizontal axis) plotted against time of occurrence (on the vertical axis) to illustrate the variance in a load in a specified time period.

Load Shedding - Turning off or disconnecting loads to limit peak demand.

Load Shifting - A load management objective that moves loads from on-peak periods to off-peak periods.

Lumen - An empirical measure of the quantity of light. It is based upon the spectral sensitivity of the photosensors in the human eye under high (daytime) light levels. Photometrically it is the luminous flux emitted with a solid angle (1 steradian) by a point source having a uniform luminous intensity of 1 candela.

Lumens/Watt (lpw) - A measure of the efficacy (efficiency) of lamps. It indicates the amount of light (lumens) emitted by the lamp for each unit of electrical power (Watts) used.

Magnetic Ballast - A type of florescent light ballast that uses a magnetic core to regulate the voltage of a florescent lamp.

Make-Up Air - Air brought into a building from outside to replace exhaust air.

Metal Halide Lamp - A high-intensity discharge lamp type that uses mercury and several halide additives as light-producing elements. These lights have the best Color Rendition Index (CRI) of the High-Intensity Discharge lamps. They can be used for commercial interior lighting or for stadium lights.

Modified Degree-Day Method - A method used to estimate building heating loads by assuming that heat loss and gain is proportional to the equivalent heat-loss coefficient for the building envelope.

Moisture Control - The process of controlling indoor moisture levels and condensation.

Motor Speed - The number of revolutions that the motor turns in a given time period (i.e. revolutions per minute, rpm).

Multi-Zone System - A building heating, ventilation, and/or air conditioning system that distributes conditioned air to individual zones or rooms.

Natural Gas - A hydrocarbon gas obtained from underground sources, often in association with petroleum and coal deposits. It generally contains a high percentage of methane, varying amounts of ethane, and inert gases; used as a heating fuel.

Natural Ventilation - Ventilation that is created by the differences in the distribution of air pressures around a building. Air moves from areas of high pressure to areas of low pressure with gravity and wind pressure affecting the airflow. The placement and control of doors and windows alters natural ventilation patterns.

Net Present Value - The value of a personal portfolio, product, or investment after depreciation and interest on debt capital are subtracted from operating income. It can also be thought of as the equivalent worth of all cash flows relative to a base point called the present.

Nitrogen Dioxide - This compound of nitrogen and oxygen is formed by the oxidation of nitric oxide (NO) which is produced by the combustion of solid fuels.

Nitrogen Oxides (NO_x) - The products of all combustion processes formed by the combination of nitrogen and oxygen.

Occupancy Sensor - An optical, ultrasonic, or infrared sensor that turns room lights on when they detect a person's presence and off after the space is vacated.

Occupied Space - The space within a building or structure that is normally occupied by people, and that may be conditioned (heated, cooled and/or ventilated).

Ohms - A measure of the electrical resistance of a material equal to the resistance of a circuit in which the potential difference of 1 volt produces a current of 1 ampere.

Ohm's Law - In a given electrical circuit, the amount of current in amperes (i) is equal to the pressure in volts (V) divided by the resistance, in ohms (R).

Outside Air - Air that is taken from the outdoors.

Passive/Natural Cooling - To allow or augment the natural movement of cooler air from exterior, shaded areas of a building through or around a building.

Payback - The amount of time required for positive cash flows to equal the total investment costs.

Phase - Alternating current is carried by conductors and a ground to residential, commercial, or industrial consumers. The waveform of the phase power appears as a single continuous sine wave at the system frequency whose amplitude is the rated voltage of the power.

Plenum - The space between a hanging ceiling and the floor above or roof; usually contains HVAC ducts, electrical wiring, fire suppression system piping, etc.

Power - Energy that is capable or available for doing work; the time rate at which work is performed, measured in horsepower, Watts, or Btu per hour. Electric power is the product of electric current and electromotive force.

Power Factor (PF) - The ratio of actual power being used in a circuit, expressed in watts or kilowatts, to the power that is apparently being drawn from a power source, expressed in volt-amperes or kilovolt-amperes.

Present Value - The amount of money required to secure a specified cash flow at a future date at a specified return.

Psi - Pounds of pressure per square inch.

Radiation - The transfer of heat through matter or space by means of electromagnetic waves.

Radiator - A room heat delivery (or exchanger) component of a hydronic (hot water or steam) heating system; hot water or steam is delivered to it by natural convection or by a pump from a boiler.

Radiator Vent - A device that releases pressure within a radiator when the pressure inside exceeds the operating limits of the vent.

Radon - A naturally occurring radioactive gas found in the U.S. in nearly all types of soil, rock, and water. It can migrate into most buildings. Studies have linked high concentrations of radon to lung cancer.

Rated Life - The length of time that a product or appliance is expected to meet a certain level of performance under nominal operating conditions; in a luminaire, the period after which the lumen depreciation and lamp failure is at 70% of its initial value.

Real Price - The unit price of a good or service estimated from some base year in order to provide a consistent means of comparison.

Recirculated Air - Air that is returned from a heated or cooled space, reconditioned and/or cleaned, and returned to the space.

Reflectance - The amount (percent) of light that is reflected by a surface relative to the amount that strikes it.

Reflective Window Films - A material applied to window panes that controls heat gain and loss, reduces glare, minimizes fabric fading, and provides privacy. These films are retrofitted on existing windows.

Reflective Glass - A window glass that has been coated with a reflective film and is useful in controlling solar heat gain during the summer

Refraction - The change in direction of a ray of light when it passes through one media to another with differing optical densities.

Refrigerant - The compound (working fluid) used in air conditioners, heat pumps, and refrigerators to transfer heat into or out of an interior space. This fluid boils at a very low temperature enabling it to evaporate and absorb heat.

Relamping - The replacement of a non-functional or ineffective lamp with a new, more efficient lamp.

Retrofit - The process of modifying a building's structure.

Return Air - Air that is returned to a heating or cooling appliance from a heated or cooled space.

Return Duct - The central heating or cooling system contains a fan that gets its air supply through these ducts, which ideally should be installed in every room of the house. The air from a room will move towards the lower pressure of the return duct.

Rigid Insulation Board - An insulation product made of a fibrous material or plastic foams, pressed or extruded into board-like forms. It provides thermal and acoustical insulation strength with low weight, and coverage with few heat loss paths.

Rock Wool - A type of insulation made from virgin basalt, an igneous rock, and spun into loose fill or a batt. It is fire resistant and helps with soundproofing.

Roof Ventilator - A stationary or rotating vent used to ventilate attics or cathedral ceilings; usually made of galvanized steel, or polypropylene.

R-Value - A measure of the capacity of a material to resist heat transfer. The R-Value is the reciprocal of the conductivity of a material (U-Value). The larger the R-Value of a material, the greater its insulating properties.

Sealed Combustion Heating System - A heating system that uses only outside air for combustion and vents combustion gases directly to the outdoors. These systems are less likely to backdraft and to negatively affect indoor air quality.

Seasonal Energy Efficiency Ratio (SEER) - A measure of seasonal or annual efficiency of a central air conditioner or air conditioning heat pump. It takes into account the variations in temperature that can occur within a season and is the average number of Btu of cooling delivered for every watt-hour of electricity used by the heat pump over a cooling season.

Second Law Efficiency - The ratio of the minimum amount of work or energy required to perform a task to the amount actually used.

Second Law of Thermodynamics - This law states that no device can completely and continuously transform all of the energy supplied to it into useful energy.

Setback Thermostat - A thermostat that can be set to automatically lower temperatures in an unoccupied house and raise them again before the occupant returns

Sheathing - A construction element used to cover the exterior of wall framing and roof trusses.

Smart Window - A term used to describe a technologically advanced window system that contains glazing that can change or switch its optical qualities when a low voltage electrical signal is applied to it, or in response to changes in heat or light.

Sodium Lights - A type of high intensity discharge light that has the most lumens per watt of any light source.

Steam - Water in vapor form; used as the working fluid in steam turbines and heating systems.

Steam Boiler - A type of furnace in which fuel is burned and the heat is used to produce steam.

Storage Tank - The tank of a water heater.

Storage Water Heater - A water heater that releases hot water from the top of the tank when a hot water tap is opened. To replace that hot water, cold water enters the bottom of the tank to ensure a full tank.

Storm Door - An exterior door that protects the primary door.

Storm Windows - Glass, plastic panels, or plastic sheets that reduce air infiltration and some heat loss when attached to either the interior or exterior of existing windows.

Supply Duct - The duct(s) of a forced air heating/cooling system through which heated or cooled air is supplied to rooms by the action of the fan of the central heating or cooling unit.

Tankless Water Heater - A water heater that heats water before it is directly distributed for end use as required; a demand water heater.

Task Lighting - Any light source designed specifically to direct light a task or work performed by a person or machine.

Therm - A unit of heat containing 100,000 British thermal units (Btu).

Thermography - A building energy auditing technique for locating areas of low insulation in a building envelope by means of a thermographic scanner.

Thermostat - A device used to control temperatures; used to control the operation of heating and cooling devices by turning the device on or off when a specified temperature is reached.

Triple Pane (Window) - This represents three layers of glazing in a window with an airspace between the middle glass and the exterior and interior panes.

Ultraviolet - Electromagnetic radiation in the wavelength range of 4 to 400 nanometers

Vapor Retarder - A material that retards the movement of water vapor through a building element (walls, ceilings) and prevents insulation and structural wood from becoming damp and metals from corroding. Often applied to insulation batts or separately in the form of treated papers, plastic sheets, and metallic foils.

Vent - A component of a heating or ventilation appliance used to conduct fresh air into, or waste air or combustion gases out of, an appliance or interior space.

Ventilation - The process of moving air (changing) into and out of an interior space either by natural or mechanically induced (forced) means.

Ventilation Air - That portion of supply air that is drawn from outside, plus any recirculated air that has been treated to maintain a desired air quality.

Vent Pipe - A tube in which combustion gases from a combustion appliance are vented out of the appliance to the outdoors.

Volt - A unit of electrical force equal to that amount of electromotive force that will cause a steady current of one ampere to flow through a resistance of one ohm.

Voltage - The amount of electromotive force, measured in volts, that exists between two points.

Volt-Ampere - A unit of electrical measurement equal to the product of a volt and an ampere.

Water Jacket - A heat exchanger element enclosed in a boiler. Water is circulated with a pump through the jacket where it picks up heat from the combustion chamber after which the heated water circulates to heat distribution devices. A water jacket is also an enclosed water-filled chamber in a tankless coiled water heater. When a faucet is turned on water flows into the water heater heat exchanger. The water in the chamber is heated and transfers heat to the cooler water in the heat exchanger and is sent through the hot water outlet to the appropriate faucet.

Watt - The rate of energy transfer equivalent to one ampere under an electrical pressure of one volt. One watt equals 1/746 horsepower, or one joule per second. It is the product of Voltage and Current (amperage).

Watt-hour - A unit of electricity consumption of one Watt over the period of one hour.

Wattmeter - A device for measuring power consumption.

Weatherization - Caulking and weatherstripping to reduce air infiltration and exfiltration into/out of a building.

Weather-stripping - A material used to seal gaps around windows and exterior doors.

RESOURCES

Alliance to Save Energy
http://www.ase.org

American Council for an Energy Efficient Economy
http://www.aceee.org

American Institute of Architects
http://www2.aia.org/myaia/communities/community.asp?UserID=2&CommunityID=200

American Society of Heating, Refrigerating and Air-conditioning Engineers
http://www.ashrae.org

Association of Energy Engineers
http://www.aee.org

Austin, City of, Green Building Program
http://www.ci.austin.tx.us/greenbuilder/publications.htm

Energy Ideas Clearinghouse
http://www.energyideas.org

Energy Information Administration
http://www.eia.doe.gov

Energy Smart Schools, U.S. Department of Energy
http://www.energysmartschools.gov/energysmartschool/index.html

Environmental Protection Agency
http://www.epa.gov

Massachusetts Division of Energy Resources
http://www.mass.gov/doer

Massachusetts Municipal Association
http://www.mma.org

Massachusetts Technology Collaborative
http://www.mtpc.org

Rebuild America, U.S. Department of Energy
http://www.rebuild.org

Smart Community Network, U.S. Department of Energy
http://www.sustainable.doe.gov/municipal/arttoc.shtml

Public Technology Inc.
Tools for the Job: How to Develop a Municipal Energy Management Program
http://pti.nw.dc.us

Herzog/Wheeler & Associates
Energy-Efficient Operation of Commercial Buildings: Redefining the Energy Manager's Job
(available through Herzog/Wheeler)
2183 Summit Avenue
St. Paul, MN 55101-1051

ATTACHMENT A: BUILDING SURVEY FORM

Auditor:____

Telephone:______________________________Date____________________

GENERAL FACILITY BACKGROUND

Facility Name______________________________ -

Address__________________________________ -

Owner___________________________________

Management Contact

____

Title

____

Phone/Fax/Email

Operations Contact

____

Title

____

Phone/Fax/E-mail

Building Survey Number	Building Name	Building Type (e.g., School, Office)	Gross Square Footage	Year(s) Constructed/ Renovated
01				
02				
03				
04				
05				
06				
07				
08				
09				
10				
11				
12				
13				

BUILDING SURVEY FORM
(COPY THE FOLLOWING PAGES FOR EACH BUILDING SURVEYED)

A. BUILDING NAME____

Name of building operator or facility engineer________________________________

Phone/Fax/Email____

Mail/UPS Address____

B. OCCUPANCY SCHEDULE:

Weekdays ____

AREA	HOURS			NO. OF EMPLOYEES
____________	________	TO	________	____________
____________	________	TO	________	____________
____________	________	TO	________	____________
____________	________	TO	________	____________
____________	________	TO	________	____________
____________	________	TO	________	

Weekend ____

AREA	HOURS			NO. OF EMPLOYEES
____________	________	TO	________	____________
____________	________	TO	________	____________
____________	________	TO	________	____________
____________	________	TO	________	____________
____________	________	TO	________	____________
____________	________	TO	________	

Planned Shutdowns ____

C. BUILDING DESCRIPTION

Year(s) Constructed: ____________

Building Envelope:

Construction Type: wood frame ☐ masonry ☐ block ☐ steel ☐ concrete ☐
other _______________

Number of floors: ____________________________, Area: conditioned space _______________________sq. ft,
Area: unconditioned ___________________________sq. ft, roof ______________sq. ft, other __________
Insulation (est. R value): roof __________________________ walls________________ other __________

Is a ROOF replacement planned? NO ☐ YES ☐ if yes, when? _________________________

.ocation	Area (Sq. ft.)	Flat or Peaked	Condition/Age	Insulation Type/ R value
1.				
2.				
3.				
4.				
5.				
6.				

In Office Areas:

1. Total floor area______________________sq. ft.

2. HVAC System
   - a. Heating: hot water ☐ steam ☐ electricity ☐ hot air ☐ other____________
   - b. Fuel: natural gas ☐ propane ☐ oil ☐ grade of oil ______, other____________
   - c. Cooling: none ☐ packaged rooftop ☐ central ☐ window ☐ other_______
   - d. Ventilation rate: _______________ cfm, or _______________ air changes per hour
   - e. Heated area: _______________ sq.ft. Cooled area _______________ sq.ft.

3. Lighting:

Area 1: Primary function ____

- a. Type: fluorescent ☐ incandescent ☐ mercury vapor ☐ metal halide ☐
  other________________
- b. Describe predominant types and approx. % of fixtures
  (e.g., 4ft- 4-lamp, 32-watt, elec. ballast, 80%):
- c. Lamp type: current ____________ replacement _____________, % _____________
- d. Method of control: breaker panel ☐: wall switches ☐ : timer☐:
  EMS controls ☐: occupancy sensors ☐
- e. Control operation: currently on hours/week ____________;
  necessary on hours/week ____________.

Area 2: Primary function ____

a. Type: fluorescent ☐ incandescent ☐ mercury vapor ☐ metal halide ☐
other__________________________ Describe predominant types and approx. % of fixtures (e.g., 4ft- 4-lamp, 32-watt, elec. ballast, 80%):

b. Lamp type: current _________________ replacement _________________ %

c. Method of control: breaker panel ☐ wall switches ☐ timer ☐
EMS controls ☐

d. Occupancy sensors ☐

e. Control operation: currently on hours/week ____________
necessary on hours/week ____________

In Non-office Areas:

1. Floor area_________________________sq. ft.

2. HVAC System:
   a. Heating: hot water ☐ steam ☐ electricity ☐ hot air ☐ other___________
   b. Fuel: natural gas ☐ propane ☐ oil ☐ grade of oil _____ other ______
   c. Cooling: none ☐ packaged rooftop ☐ central ☐ window ☐ other______
   d. Ventilation: Exhaust: wall fans ☐ ducted ☐ other_____________
   Rate: ______________________cfm, or ____________________air changes per hr
   Outside Air Makeup: tempered ☐ untempered ☐
   e. Heated area: ________ sq.ft: Cooled area __________ sq.ft.
   Ventilation only_______ sq.ft.
   f. Working hours maintained:
   _____________weekdays, _________________Saturday, ___________________Sunday
   g. Critical climate areas: _____________________

3. Lighting
   a. Type: fluorescent ☐ incandescent ☐ mercury vapor ☐ metal halide ☐
   other _______________
   b. Describe predominant types and approx. % of fixtures
   (e.g., 4ft- 4-lamp, 32-watt, elec. ballast, 80%):
   c. Lamp type: current _________________; replacement ____________, % _______
   d. Method of control: breaker panel ☐ wall switches ☐ timer ☐
   EMS controls ☐ occupancy sensors ☐
   e. Control operation: currently on hours/week ____________
   necessary on hours/week ____________

Exterior Area:

Lighting:

a. Type: fluorescent ☐ incandescent ☐ mercury vapor ☐ metal halide ☐
Other_____________________

b. Method of control: breaker panel ☐ wall switches ☐ timer ☐ EMS controls ☐
occupancy sensors ☐

c. Control operation: currently on hours/week ____________ necessary on hours/week __________.

D. EQUIPMENT

Boilers

Year of installation: _________________ remaining life: __________________________

Boiler type (fire tube, condensing, etc.): ____

Burner type: __________________________________ Age ______________________________

Process hot water: YES ☐ NO ☐ temperature (if known) _____________

Process steam: YES ☐ NO ☐ Capacity: ________ ghp; ___________MMBtu/hr

Pressure: ____________ psig, Average lb/hr: ________________ Peak lb/hr ___________

Date of last combustion efficiency test: _________________________ never ☐__

Combustion efficiency ______________%; source of data (manuf., test) ________

Primary fuel: (natural gas, #6 oil, other) ____

Dual-Fuel: YES ☐ NO ☐ If yes, alternate fuel type ____________________

Is natural gas available? YES ☐ NO ☐ ____________________________________

Distribution System -- Hot Water or Steam

Type: ____

____

Steam traps: quantity estimate_________

Maintenance program for traps? YES ☐ NO ☐

Last time they were checked/replaced: ____

If hot water, any temperature reset control? ______________________________________

Ventilation and Air Conditioning

List A/C and air handling units (AHUs) individually and unit ventilators (UVs) by groups. Note any economizers.

Identifier/ Type	Motor HP, VFD?	cfm – total % outside air economizer (Y/N)	Area served (sq. ft.), Number of occupants	Hours of operation (actual/ necessary)
1.				
2.				
3.				
4.				
5.				
6.				

Refrigeration (Space Cooling)

Type: chilled water ☐ direct expansion (DX) ☐ ______________________________

Compressor type: centrifugal ☐ screw ☐ other __________________________________

Total Size: ________ Tons; No. of compressors: ___________ Motor size(s):_______ HP

Fuel: Electric ☐ gas ☐ steam ☐ other ☐ _________ Absorption: YES ☐ NO ☐

Cooling Tower or Condenser: Induced draft ☐: forced draft centrifugal ☐: evaporative condenser ☐air cooled condenser ☐ ____

Air Compressors: YES ☐ NO ☐

Max PSI (if known): ____

Total equipment hp or SCFM (if known): ____

Domestic Hot Water

Type: Stand-alone ☐ off boiler ☐ ____

Storage tank: YES ☐ NO ☐ Size (gallons): ____

Insulation on storage tank: YES ☐ NO ☐ R-value: _________________________________

Fuel type: _____, estimated quantity per year: ____

Circulation pump: YES ☐ NO ☐ , control type: ___________________________________

Building Control Systems (BCS)

Type: Pneumatic ☐ Electric ☐ Electronic DDC ☐_____________________________________

BCS fully functional: YES ☐ NO ☐ ____

Manufacturer/model description (e.g., Honeywell Delta 1000): __________________________

Comfort problems: YES ☐ NO ☐ Describe: ____

____

Control problems: YES ☐ NO ☐ Describe: ____

____

Are air-side dampers & linkages functional? YES ☐ NO ☐ ; If no, explain:

____

Are waterside control valves functional? YES ☐ NO ☐ If no, explain:

____

Setback temperature setting/procedure: ____

Any experience with an EMS? ____

HVAC Maintenance

Describe HVAC and Controls Maintenance Procedure, including existence of preventive maintenance (PM) contracts: ____

____

____

____

Heat Recovery Potential (large facilities only)

Boiler economizer? YES ☐ NO ☐ _

Ventilation heat recovery? YES ☐ NO ☐ Indicate hours of operation of larger AHUs (min. 60 hrs/wk, 2,000 cfm outside air): ____

Motors

Provide a motor schedule. Indicate estimated run hours, age of motors, and list any controls (e.g., variable frequency drives, soft start): ____

____

____

____

Wastewater Treatment System: YES ☐ NO ☐

Process type (primary ☐ secondary ☐ tertiary/aerobic ☐ anaerobic ☐

Size: _________________ MGD, Age of System: _____________________ years

Permit limits (BOD, pH, TSS, flow, etc.): ____

Waste Stabilization: YES ☐ NO ☐ ; Primary (clarifiers, settling tanks): ________________________

____

Secondary/Aerobic Process? YES ☐ NO ☐

Type: mechanical (paddle) ☐ pneumatic (compressed air) ☐ other ___________________

If mechanical: VSD ☐ 2-speed motor ☐ other ________________________________

If pneumatic, diffuser type: coarse ☐ fine ☐

Aeration control (oxygen sensor): ____

Secondary/Anaerobic Process: YES ☐ NO ☐ . Type: digester ☐ or clarifier ☐

Disinfection: by chlorine ☐ UV ☐ ozone ☐ ________________________________

Motors: Attach a detailed motor schedule - run schedule, age of motors, age of equipment operated by each motor, controls (VFD, 2-speed) ____

Is there a standby or backup unit? ____

Sludge Dewatering Process: YES ☐ NO ☐

Vacuum filter ☐ age__________ condition ________________________________

Other ☐ describe: ____

____

Disposal process (if incineration, indicate yearly fuel consumption): _____________________

____

____

____

Attach a detailed schedule for wastewater treatment motors: Include run-times, motor ages, served equipment ages; Controls - kinds (VFD, 2-speed), status (active/standby), etc.

Other major process/production equipment (list):

____

____

____

____

Power Generation Equipment: YES ☐ NO ☐ if yes, describe __________________________

____

E. UTILITY SERVICE

	Supplier	Rate Schedule (ave. $/unit, if no schedule)
Electricity:	______________	/ ______________
Fuel Oil # ___:	______________	/ ______________
Fuel Oil # ___:	______________	/ ______________
Natural Gas:	______________	/ ______________
District Steam:	______________	/ ______________
Liquid Propane:	______________	/ ______________
Other (_________):	______________	/ ______________
Other (_________):	______________	/ ______________
Water:	______________	/ ______________

Fuel/Water Consumption

Peak Demand	Annual Quantity	Annual Cost
Electricity:	______________	________
Fuel Oil #___:	______________	________
Fuel Oil #___:	______________	________
Natural gas:	______________	________
District steam:	______________	________
Liquid propane:	______________	________
Other (______):	______________	________
Other (______):	______________	________
Water:	______________	________

Where and how is water used? ____
____

ATTACH COPIES OF ENERGY AND WATER UTILITY BILLS:
For the most recent 2 years, or at least 15 months.

F. ENERGY AND WATER CONSERVATION PRACTICES

Is there a designated energy manager in the company? YES ☐ NO ☐
Is there a working energy management plan? YES ☐ NO ☐

List all Major Conservation Measures (pick one)	Date Completed?	In Progress?	Under Consideration?

G. ISSUES AND CONCERNS
(Please identify all that apply)

☐ Energy costs: ____________________

☐ Water costs: ____________________

☐ Fuel switching: ____________________

☐ Equipment efficiency: ____________________

☐ Impending equipment replacement/modification: ____________________

☐ Impending facilities modification/refurbishment/expansion: ____________________

☐ Other: ____________________

H. ARE THE FOLLOWING MATERIALS AVAILABLE FOR REVIEW BY AN AUDITOR?

- ☐ Plans and drawings
- ☐ Specifications
- ☐ Maintenance and service records
- ☐ Test reports (as applicable to energy use)
- ☐ Plant log data
- ☐ Past surveys, energy or water conservation reports, audits
- ☐ Combustion efficiency reports
- ☐ Submetering surveys
- ☐ Other: ____________________