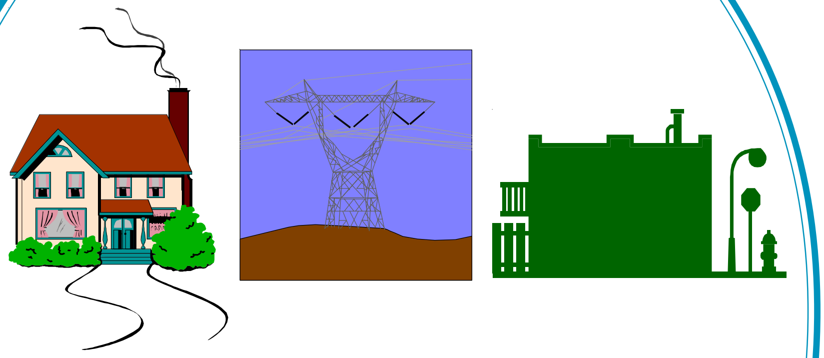
How to Conduct an Energy Audit: A Short Guide for Local Governments and Communities



Creating an environmentally sustainable New Jersey
anchored on an active network of communities
working for the well-being of the
local population and ecosystems
both for the present and future generations

Prepared by:
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Bureau of Sustainable Communities and Innovative Technologies

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How to Conduct an Energy Audit:
A Short Guide for Local Governments and Communities

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Table of Contents

Appendices

Introduction

Improving energy efficiency and conservation are essential to achieving environmental sustainability. They are the simplest ways to reduce greenhouse gas emissions and other forms of air pollution such as acid rain and smog. Good energy management starts with an ***energy audit***. The dual benefits of dollar savings and environmental protection from energy efficiency and conservation improvements are highlighted in such an audit. Energy audits often address other issues, too, such as indoor air quality, lighting quality and ways to improve building-occupant satisfaction.

The purpose of this guide is to provide basic information on how to conduct an energy audit, with a focus on building audits. Buildings consume nearly one-third of the energy used in the United States.

Definitions

An *energy audit* identifies where energy is consumed and how much energy is consumed in an existing facility, building or structure. Information gathered from the energy audit can be used to introduce energy conservation measures (ECM) or appropriate energy-saving technologies, such as electronic control systems, in the form of retrofits. Energy audits identify economically justified, cost-saving opportunities that result in significantly lowered electrical, natural gas, steam, water and sewer costs.

An energy audit, therefore, is a detailed examination of a facility's energy uses and costs that generates recommendations to reduce those uses and costs by implementing equipment and operational changes.

An important part of energy auditing is *energy accounting/bill auditing*. Energy accounting is a process of collecting, organizing and analyzing energy data. For electricity accounts, usage data normally are tracked and should include metered kilowatt-hour consumption, metered peak demand, billed demand, and rate schedules. Similar data are examined for heating fuel and water/sewer accounts. All of this information can be obtained by analyzing typical energy bills. Creating energy accounting records and performing bill audits can be done internally without hiring outside consulting firms. Also, while energy audits as a whole will identify excessive energy use and cost-effective conservation projects, bill auditing will assist in identifying errors in utility company bills and beneficial rate and service options. It could provide an excellent opportunity to generate savings without any capital investment. In addition, accurate data from energy accounting/bill auditing is crucial to making informed energy purchasing decisions in a deregulated energy market such as New Jersey's.

Overview of the Audit Process

An *energy audit team* should be established to organize and manage the process. The team should include the municipal business administrator, facilities manager and environmental and maintenance staff. The capabilities of these staff members should help determine the necessity of hiring outside experts.[1] The expertise of an energy specialist, who generally has an architectural or engineering background, is required for a thorough audit. This specialist should be able to provide up-to-date knowledge of an energy-efficient plant and equipment as well as computer modeling skills for energy use and management. A typical audit cost is 5 percent of the annual energy bill (Oppenheim, 2000).

Energy auditing evaluates the efficiency of all building components and systems that impact energy use. The audit process begins at the utility meters where the sources of energy coming into a building or facility are measured. Energy flows – inputs and outputs – for each fuel are then identified. These flows are measured and quantified into distinct functions or specific uses, then the function and performance of all building components and systems are evaluated. The efficiency of each of the functions is assessed, and energy and cost-savings opportunities are identified. At the end of the process, an energy audit report is prepared.

The report should contain documentation of the use and occupancy of the audited buildings, as well as an assessment of the condition of the buildings and the associated systems and equipment. The report also should include recommendations on how to increase energy efficiency through improvements in operation and maintenance (O&M) and installation of energy-saving technologies and energy conservation measurers (ECM).

Types of Energy Audits

There are three types of audits that are described below in order of increasing degree of detail. The type of audit used is discussed at the preliminary consultation stage. The best way to determine the appropriate type of audit is to look at the Energy Use Index (EUI) of the facility or building involved (see Appendix A).

1. ***Walk-through audit***. This is the least expensive. It involves an examination of the building or facility, including a visual inspection of each of the associated systems. Historic energy usage data are reviewed to analyze patterns of energy use and compare them with sector/industry averages or benchmarks for similar structures. The walk-through audit provides an initial estimate of potential savings and generates a menu of inexpensive savings options usually involving incremental improvements in O&M. Information from this level of audit also serves as a basis for determining if a more comprehensive audit will be needed.
2. ***Standard Audit***. This involves a more comprehensive and highly detailed evaluation. Facilities, equipment, operational systems and conditions are assessed thoroughly and on-site measurements and testing are conducted to arrive at a careful quantification of energy use, including losses.[2] The energy efficiencies of the various systems are determined using accepted energy engineering computational techniques. Technical changes and improvements in each of the systems are analyzed to determine the corresponding potential energy and cost savings. In addition, the standard audit will include an economic analysis of the proposed technological improvements and ECM.
3. ***Computer Simulation***. The computer simulation approach is the most expensive and often is recommended for more complicated systems, structures or facilities. This involves using computer simulation software for prediction purposes (i.e., performance of buildings and systems) and consideration of effects of external factors (e.g., changes in weather and other conditions). With the computer simulation audit, a baseline related to a facility's actual energy use is established, against which effects of system improvements are compared. This audit often is used for assessing energy performance of new buildings based on different design configurations and equipment packages.

As previously noted, the audit could be done either in-house or by use of outside consultants, depending on the level of audit required and availability of expertise and resources. Internal staff could carry out the walk-through audit. When outside help from a consultant, contractor or independent energy auditor is needed, the search and selection should be done carefully to get the best and most reliable service. The following tips might be useful:

- look for licensed, insured contractors
- focus on local companies
- obtain at least three bids with details in writing
- ask about previous experience
- check references
- inquire with Better Business Bureau

In addition, the National Association of Energy Service Companies (NAESCO) has member companies nationwide that specialize in energy auditing for both large commercial buildings and homes. Information about NAESCO can be found on the Web at www.naesco.org.

Steps in Energy Auditing

The audit encompasses several steps[3]: preliminary consultation, initial data gathering and assessment, on-site inspection, data analysis and evaluation, and reporting. The organization of an energy audit team is a prerequisite to this process.

■ Preliminary consultation

The initial step is to consult with knowledgeable parties to determine the most suitable type of audit. The complexity of the facilities, buildings and systems to be covered by the audit are taken into account. Then, the parties discuss and decide upon the criteria required to focus the audit, such as management goal, level of effort and budget ceiling.

■ Initial data gathering and assessment

Prior to actual site inspection of the facilities and buildings, building systems (electrical and mechanical) and their operational characteristics should be assessed. This will yield a series of questions and issues to be addressed during the site visit.

At least two years' worth of utility energy data should be compiled and reviewed. (**Note** – not all municipalities will have these data – many just pay by the meter as the bills come in and do not consolidate any bills. Some reasonable estimate must be made from available information.) The data coverage should include all delivered fuels including electricity, natural gas and fuel oil. The information developed will be the basis for evaluating characteristics of systems operations, establishing energy benchmarks[4] *vis-a-vis* industry/sector standards[5] or averages, determining potential savings, setting an energy-reduction target, and defining a baseline against which to measure the effectiveness of energy efficiency/conservation measures to be implemented.

To ensure all of the necessary information is on hand for an adequate assessment of the energy-consumption data, perform the following tasks:

a) Obtain copies of all monthly utility bills and invoices for delivered fuel;

b) Classify utility bills either by meter or by building and put them together into 12-month blocks using the meter-read dates;

c) Pinpoint location of all meters and sub-meters;

d) Identify which facility, building or space is served by which meter;

e) Estimate the square footage of the conditioned area for each facility/ building.

Use appropriate recording forms[6] to enter data and sum up. The following should be recorded: (1) energy usage in appropriate units[7] (kWh, therms, gallons, etc.); (2) electric demand (kW); and (3) cost/ rate schedule.

For facilities using only purchased energy, monthly use of each type of fuel must be determined. The utility and fuel bills will provide information about past usage of each type of purchased energy. A sample form[8] for recording such data is shown in Table 1.

Table 1 - Monthly Energy Record

Month	**Electricity**			**Natural Gas**		
	kWh Used	Billing Demand	Actual Demand	CCF Used	Cooling Degree Days	Heating Degree Days
January						
February						
March						
April						
May						
June						
July						
August						
September						
October						
November						
December						

Note: Making sense of a facility’s energy costs can be complicated. For more information, it may be useful to visit the Web sites of electric and gas utilities operating in your area. The electricity or gas supplier can provide information on the rate schedule applicable to each of a facility’s accounts. The following Web sites of electric and gas utilities in New Jersey may have information on rates and available rebate programs.

- Atlantic City Electric: www.atlanticcityelectric.com
- Jersey Central Power and Light: www.firstenergycorp.com
- New Jersey Natural Gas: www.2.njng.com
- Elizabethtown Gas: www.elizabethtowngas.com.
- Rockland Electric Company: www.oru.com
- South Jersey Gas: www.sjindustries.com/sjg/
- Public Service Electric & Gas Company: (PSE&G) www.pseg.com

Demand and usage are the two basic cost components that should be inspected on any commercial electric monthly billing.[9] By closely examining each of these items, one can determine where electricity costs are being incurred and where it would be most beneficial to spend time in reducing them (Studebaker, 2000). These electricity cost components are (as reflected in Table 1 above):

Demand – Demand, as it applies to the monthly electricity billing, is defined as “the reservation of the capacity the utility has to maintain for the customer 24 hours a day, seven days a week, usually expressed in kilowatts (kW).” The fee for the reservation of capacity does not include actual use of electricity for a given period. Usage is billed separately.

> Peak or maximum demand charges are applied to the maximum demand for energy required by a system in a given period of time. Utilities charge a monthly fee based upon the maximum power (expressed as kilowatts, or kW) required in a given period of time, usually either a 15- or 30-minute interval. The peak or maximum demand charge can vary from less than $2 to more than $18 per kW per month. A control strategy to reduce these peaks can result in sizeable savings. Two steps can assist in determining and controlling peak demands. The first is to look at the monthly utility bill to determine the current maximum demand and the monthly charges related to it. The second is to contact the utility and request that a record of demand be provided for at least a one-month period (preferably one month in the summer [July] and one month in the

winter [January]). The purpose of this record is to document (by day as well as time-of-day) variations in the electrical demand of the facility. Once the information is received on the peak periods, a determination can be made as to the corrective action[10] to take.

Usage – Usage (kWh) is a function of connected load (i.e., power required to run a defined circuit or system, such as a refrigerator, building, or an entire electricity distribution system) multiplied by hours of usage (e.g., 1 kWh = 1,000 watts sustained for a one-hour period). Ten 100-watt incandescent lamps operated for one hour result in the use of 1 kWh of electrical energy; or, one 1,000-watt piece of equipment operated for one hour would mean 1 kWh of electrical energy usage. Reducing usage (kWh) of electricity requires the use of more energy-efficient equipment or a reduction of the quantity or time of operation of individual pieces of electrical equipment. Each individual analysis for usage (kWh) reduction is unique, based upon the peculiarities of a given situation.

■ On-site inspection

This step involves detailed inspection of building components and systems and responding to issues/questions raised in the initial assessment. As a rule of thumb, an entire day is recommended to be spent on-site for each facility/building. The actual amount of time needed will depend on how thorough the initial data gathering and assessments have been, the need for measurement and testing equipment, and complexity of the facility/building and their associated systems.

The inspection is essentially a comparison to “best practices” and entails an assessment of how the various systems are set up, their actual operating conditions, and the control methods used to manage the building systems.

Before the inspection, the auditor and facilities/building manager should go over the energy-consumption profiles developed in the earlier step (initial data gathering and assessment). This review should elicit important information such O&M practices, plans that may affect energy consumption, and occupancy schedules.

■ Data analysis and evaluation

Follow-up assessment to the on-site inspection is a necessary and important step in ensuring the audit's value. Information obtained during the inspection has to be evaluated. The analysis of audit data involves calculating energy efficiencies. Electric demand data and thermal data analyses should be used to assess energy savings opportunities. Recommendations on mechanical, electrical, lighting, structural, operational and maintenance improvements will be developed at this stage. These recommendations comprise ECM and O&M measures that are identified based on key indicators (see Appendix A) derived from the audit data, records examined and actual inspections.

The energy efficiency of each piece of equipment, process or system that are used or operated within the facility should be determined. Energy efficiency can be defined as:

EE = {(energy input – energy wasted)/energy input} x 100

A variety of tools and technologies used to perform residential building energy audits and commercial building energy audits include measurement of energy waste. Examples of technologies needed to measure energy waste are:

Blower Door - This device includes a fan mounted on an insert that fits inside a doorway, allowing negative pressure to be generated inside a building to measure air leakage.

BASIC BLOWER DOOR FAN SET-UP

Infrared Imaging - Infrared photographs create a visual indication of heat leaks from a building.

Duct Leakage Testing - Most heating and cooling ducts leak energy, so technologies are available for testing ducts for leaks. For further information, visit www.eere.energy.gov/EE/buildings_energy_audits.html.

The calculated energy efficiency of the relevant components can be compared to industry norms and standards. Any component whose efficiency is significantly lower than industry norms is obviously a candidate for improvement.

An important task at this point is the evaluation of the investment merit of the recommendations. This includes the determination of the cost-effectiveness of each of the recommended ECM or retrofit options. A number of methods have been developed and are available to provide a uniform method of comparison. The simple payback (SPB) method[11] is the least complicated to use. SPB is calculated by dividing the cost of the retrofit by the annual energy cost savings. The result is the number of years after which the investment will have paid for itself. Those projects with the shortest paybacks are assumed to be the most cost-effective.

- **Reporting**

The last and final step is the organization of the audit into a comprehensive report. The audit report should be prepared keeping in mind the various audiences that will be using each section.

The final written report should include data, recommendations, savings estimates, and cost estimates for recommended conservation measures and systems improvements. ***Appendix* B** shows an outline of the fundamental elements of an audit report.

Note: After the audit has been conducted and the report reviewed, your local government may decide to implement energy-efficiency strategies as part of your next steps. ***Appendix* D** contains a brief description and contact information on the New Jersey Clean Energy Program (CEP), which provides financial and other incentives for energy-efficiency projects. Additional financial incentives for renewable energy can be obtained from the NJ Board of Public Utilities (BPU), the agency managing the CEP.

Appendix A - Key Energy Audit Information and Indicators

1. Building Profile

Since energy audits usually focus on buildings, it is necessary to develop a building profile, which includes collecting architectural, mechanical and electrical blueprints, drawings and specifications of the original building; inspecting any building remodeling or additions; and reviewing previous studies or energy audits involving the building.

Based on the information gathered, a *building profile narrative* should be written. This narrative would include a description of the building, its age, occupancy, and current characteristics of the architectural, electrical and mechanical systems. It is important that the profile should pinpoint the principal energy-using equipment or systems. It also should reveal systems and components that are inefficient. It is useful to have a number of copies of a simple floor plan on hand so notes can be made during the site inspection. A copy should be set aside for taking notes of the location of the heating, ventilation and air-conditioning (HVAC) equipment and controls, chiller and boiler controls, light levels, heating zones, and other energy-related systems. In case the floor plan or architectural drawings are not available, an alternative would be emergency fire exit plans that usually are posted on each floor of a building.

Another useful item that should be obtained or made is a site sketch of the building, facility or complex. The following data items should be shown on the sketch:

- Orientation of the building, facility or complex;
- If there are several buildings, the relative location and outline of each building;
- Name and building number of each building;
- Year of construction of each building and additions;
- Dimensions of each building and additions;
- Location, fuel type and identification numbers of utility meters; and
- Central plants (if any).

During the pre-site inspection review, areas of specific interest should be noted along with questions about equipment maintenance practices, HVAC zone controls, setback operation, and lighting systems and controls.

2. Energy Use Index

In order to compare the energy use of a building to similar building types or to track usage from year to year, an indicator (i.e., measurement) is needed. An appropriate indicator is the Energy Use Index (EUI). The EUI, expressed in British Thermal Units per square foot per year (BTU/ft^2/yr), is calculated by converting annual usage of electricity and consumption of all fuels to BTUs, and then dividing by the area of the building (gross square footage). Compared to a benchmark[12] for the building type being audited, the EUI is a good measure of the relative potential for energy savings. A relatively low EUI points to less potential for large energy savings. To calculate the BTUs and cost per square foot, the cooled/heated ("conditioned") area for each building needs to be determined. The area or dimensions of each floor of a building can be extracted from blueprints. Alternatively, the outside of the building can be measured to obtain gross area. Multiplying this gross area by the number of floors will give the total building area. Mechanical rooms and basement areas are not typically included as conditioned areas.

By monitoring the EUI[13] based on a rolling 12-month block of utility bills, the performance of a building can be assessed in terms of decreasing or increasing energy-use trends. However, a minimum of two years of energy-usage data will be needed in order to get a trend line.

3. Load Factor

Another important indicator to consider is Load Factor (LF), which relates electric demand (kW) and electric use (kWh). LF is derived by dividing the monthly electric use by the demand by the number of hours in the billing period. This yields a ratio of average demand to peak demand and therefore indicates the cost-savings potential of shifting some electric loads to off-peak hours to reduce peak demand. A sample LF computation is shown below:

Monthly electric use = 648,400 kWh
Demand = 4,184 kW
No. of hours of operation = 600 hrs.

LF = [648,400 kWh / 4,184 kW] / 600 h = 0.26

Theoretically, the maximum LF for a building/facility that uses electricity at a steady rate at the highest demand registered on the demand meter is one. A load factor of one implies that there are no time-of-day peaks in demand, or simply that consumption does not vary. LF is normally below the theoretical maximum because most facilities do not operate at full capacity on a 24-hour basis. A low LF indicates that a building or facility experiences substantial peak demand at some time in the billing period, relative to average energy demand during the billing period. The causes of demand peaks have to be pinpointed and controlled. In the case of buildings and facilities with high LF, there is no way to reduce demand except by using highly efficient electrical equipment.

It is therefore critical to monitor the LF and determine what is normal for each building/facility, watching out for deviations in the normal pattern of electric use and LF. Facility management could restrict operation of nonessential equipment during peak demand periods, shifting their schedule of operation to off-peak hours. Energy management control systems are equipped with capabilities to limit demand and shed load, and these can help maintain acceptable load factors. Peak demand also can be reduced by installing more efficient equipment (this is the rationale behind utility demand-side management programs).

4. Base and Seasonal Loads

It also is helpful to differentiate between base loads and seasonal loads. Base loads comprise energy-using systems that use a continuous amount of energy throughout the year. Office equipment, domestic hot water, lighting, ventilation and appliances are examples of base loads. High base loads signal that energy management should give more attention to these areas. Seasonal loads comprise energy-using systems such as heating and air conditioning that usually are associated with changes in weather or operation of the facility. High seasonal loads should trigger consideration of ways to reduce energy use by such means as making improvements to the heating and air conditioning equipment, temperature controls, the building envelope, or to other systems affected by seasonal operation. Once utility use has been allocated to seasonal or base loads, an inventory should be prepared listing the main energy-using systems in the facility/building and estimating the time when each system is in operation throughout the year. This inventory should help describe how each system uses energy and what are the potential savings. When the seasonal and base loads are well understood, it is easier to identify those building systems with the largest savings potential. Such systems as lighting, hot water, and heating and cooling then can be targeted for more detailed data collection.

Appendix B - Annotated Outline of the Energy Audit Report*

1. **Executive Summary**

   Includes a brief introduction to the facility and describes the purpose of the audit and overall conclusions.

2. **Building/Facility Information**

   This section provides a general background of the facility, building components, mechanical systems, electrical systems and operational profile. A description of the building envelope, age and construction history, operating schedules (e.g., for mechanical lighting), number of employees, occupancy patterns, and a discussion of the O&M program should be included.

   The building information section also should contain a floor plan, selected photos of the facility and mechanical systems, a description of energy types used, and a description of the primary mechanical systems and controls.

3. **Utility Summary**

   This section provides energy accounting information for a minimum of the last two years, as well as selected charts and graphs that should be easy to understand and should demonstrate the overall energy-usage patterns of the facility or building.

   Pie charts of energy use and cost by fuel type can offer compelling documentation of overall energy uses and expenses. The utility summary also includes reports of overall facility benchmarks, energy-use indices, and comparisons with sector/industry averages. A copy of the utility rate schedules and any discussion or evaluation of rate alternatives for which the facility may qualify can be part of this section.

4. **Energy Conservation Measures (ECMs)**

   This section summarizes the ECM that meet the financial criteria established by the facility owner or manager. The report should provide the estimated cost, estimated savings, and simple payback[14] for each measure in a summary chart. A one- or two-page description of each ECM and supporting calculations should follow this summary chart. The description of each ECM should include energy use and savings calculations and economic analysis and list any assumptions that were made regarding operation or equipment efficiency. ECMs that were considered but did not meet financial criteria should also be identified.

* Adapted from: Younger, B. 2000. “Energy Audits” in *Energy User News.* July 10, 2000.

5. Operation and Maintenance Measures

This section covers observations on items that will reduce energy usage and costs, address existing problems, or improve practices that will help prolong equipment life of systems not being retrofit. Costs and energy savings of each O&M recommendation should be listed.

6. Appendices

Information in this section may include floor plans and site notes; photos, audit data forms; motor, equipment, and lighting inventories; and equipment cut sheets of existing or recommended systems.

Appendix C - Economic Analysis Methods for Energy Projects

An economic evaluation must be conducted of each of the energy-efficiency projects or ECM identified in the energy audit. A number of the economic methods described below are available for this purpose. A more detailed discussion of financing and analysis of energy-efficiency investments may be found in the various references/tools developed by the *Energy Star* program such as Financing Energy Projects (www.energystar.gov/ia/business/government/Financial_Energy_Efficiency_Projects.pdf) and Energy Star Cash Flow Opportunity Calculator (energystar.gov/ia/business/CFO_01July04.xls).

Simple Payback (SPB) – This is the least complicated of the available methods. SPB measures how long it takes to recover an initial investment in a cost-saving measure. For example, a $1,000 investment that saves $200 per year has an SPB of $1,000/$200/year = 5.0 years. Although widely used to support decisions, SPB fails to consider the time value of money and to properly consider the impact of cash flows.

Discounted Payback (DPB) – The time value of money issue can be resolved by discounting future cash flows to their present value and determining the DPB period, or the length of time it takes for the cumulative present value of savings to equal the investment cost.

Return on Investment (ROI) – Sometimes referred to as the simple rate of return or the investor's rate of return, the ROI is the reciprocal of the SPB expressed as a percentage. ROI expresses the percentage of the investment cost that will be returned annually by savings. Per our previous example, ROI = $200/$1,000 = 0.2 = 20%.

Internal Rate of Return (IRR) – This method calculates the discount rate that makes the present value of the costs equal to the present value of the revenues (or savings). A project is worthwhile according to this measure when the IRR is greater than the rate of interest at which the money was borrowed to finance the project, or is greater than the rate that could be obtained from alternative investment opportunities, whichever of the two rates is higher.

Net Present Value (NPV) – This method also employs discounting. The NPV is obtained by discounting both costs and revenues (or savings) at a specified rate, and then subtracting the resulting present value of the costs stream from the present value of the revenue (or savings) stream. A project is worthwhile according to this measure if the NPV is positive.

Life-Cycle Cost Analysis (LCCA) – An economic method of project evaluation in which all costs over the life of a project are considered to be important. The life-cycle cost (LCC) is the total cost of owning, operating, maintaining, and eventually disposing of the project over a given period, with all costs adjusted or discounted to reflect the time value of money. LCCA is appropriate for considerations of new construction alternatives as well as renovation or retrofit project alternatives. For a thorough discussion of LCCA, refer to the National Institute of Standards and Technology (NIST) Handbook 135 (1995 edition), Life-Cycle Costing Manual for the Federal Energy Management Program.

Savings-to-Investment Ratio (SIR) – This method calculates the benefit-to-cost ratio of the present value of the savings over the study period (related to the life of the project) to the present value of the investment-related costs. SIR is useful as a reliable means of ranking independent projects for purposes of allocating limited investment capital. When faced with a large number of energy/cost saving projects, each of which is cost-effective but where funding limits the number of projects that can be implemented, ranking by highest-to-lowest SIR will ensure the greatest return for investment of the available capital.

Appendix D - The New Jersey Clean Energy Program (NJCEP)

New Jersey's
Clean Energy
PROGRAM™
Your Power to Save
njcleanenergy.com
New Jersey Board of Public Utilities
Office of Clean Energy

The program provides financial and other incentives to the state's residential customers, businesses and schools that install high-efficiency or renewable-energy technologies to reduce energy usage, lower customers' energy bills and reduce environmental impacts. The program is authorized and overseen by the New Jersey Board of Public Utilities (BPU).

Two programs under NJCEP would be of interest to local governments:

1. Commercial and Industrial Construction Program consists of the following components:

- **NJ SmartStart Buildings**
- **Building O&M**
- **Compressed Air**

The program is designed to address key market barriers to efficient construction on the part of developers, designers, engineers and contractors in the commercial sector. It is available to school, commercial, industrial, governmental, institutional and agricultural customers. The program focuses on both new construction and retrofits of existing buildings.

The program offers a wide variety of incentives. Rebates for measures such as high-efficiency lighting, heating and cooling equipment and motors are offered to help offset the incremental cost. Design incentives and support are available to cover a portion of the cost for additional energy-efficiency design services, and technical support is provided to help customers evaluate energy-efficiency options.

An important component of this program supports efficient design and construction in schools. The state has an $8.6 billion school construction program and the program's *NJ SmartStart Buildings Program* is working to ensure schools take into consideration the life-cycle costs of energy design and equipment purchasing decisions, not just up-front costs. The goal is to have designers make decisions that produce the lowest total costs over the life the schools, with energy savings that more than offset any incremental up-front costs.

2. **Customer-Sited Clean Generation Program** relates to renewable energy and offers a number of incentives for customers to invest in renewable-energy systems for their homes and businesses. It also provides technical assistance to help customers evaluate the benefits of renewable-energy systems, along with complimentary training to municipal electrical inspectors, electrical contractors and utility engineers. By offering significant rebates covering up to 60 percent of the initial costs of renewable-energy systems, the program encourages the use of photovoltaic (solar electric) systems, wind generators, and sustainably grown and harvested biomass-fueled systems. These technologies do not decrease the need for power, but instead reduce the need for the traditional energy grid to produce that power. These technologies also have the added benefit of producing clean power on site.

Another major component program of NJCEP caters to individual residents or customers and is comprised of the following: Residential New Construction Program (NJ ENERGY STAR Homes), the Residential Gas & Electric Heating, Ventilation, and Air Conditioning Program (*Warm Advantage* and *Cool Advantage*), the ENERGY STAR Products Program (*NJ for Energy Star*), the Residential Retrofit Program (*NJ Energy Smart*), and Residential Low-Income (*Comfort Partners*). The NJ Energy Smart program helps residential customers perform an energy self-audit of their homes and provides customized, energy-saving recommendations and estimated payback periods.

There are a number of townships already availing themselves of NJCEP incentives in the implementation of energy- and cost-saving measures or projects. According to the 2002 annual NJCEP report, a New Jersey township is saving significant energy dollars due to the *NJ SmartStart Building* program. The installation of the state-of-the-art gas heating and cooling system is expected to save the school district of the township more than $500,000 during the projected lifetime of the equipment. Additional savings will come from the energy-efficient lighting system. Montclair Township obtained rebates from the *NJCEP SmartStart* program for its installation of energy-saving LED (light-emitting diodes) in the traffic lighting system. The total cost of the system was $37,300. With a rebate of $8,600, the net cost to the township was $28,700.

For more information about the NJCEP, visit www.njcleanenergy.com or contact BPU's Office of Clean Energy at www.bpu.state.nj.us.

A related, federally supported program, *Rebuild America,* is a network of hundreds of community-based partnerships across the nation that are saving energy, improving building performance, easing air pollution through reduced energy demand, and enhancing quality of life through energy efficiency and renewable-energy technologies. Created by the U.S. Department of Energy (DOE) in 1994, *Rebuild America* serves as a mechanism for revitalization and job creation in many communities. Using an integrated systems approach to schools, housing, public and commercial buildings, factories, vehicles and electricity transmission systems, the program helps to:

- Increase the number of high-performance buildings
- Implement energy efficiency and renewable-energy improvements
- Provide technical-assistance tools, resources and services

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End Notes

1. Ideally, the energy audit should be conducted by a team of individuals who have significant experience in the design and operation of the facility to be audited. A survey team and an analysis team are needed to conduct a detailed audit. The survey team is responsible for identifying opportunities and collecting data, while the analysis team is responsible for analyzing opportunities and calculating energy balances. Typically, a survey team may be composed of an area foreman, a facility engineer and a maintenance supervisor. The team should include at least one person who is from the facility being surveyed and at least one from outside. Team members should be familiar with current O&M practices. On the other hand, the analysis team may be composed of many different part-time personnel. Depending on the scope of the audit, the analysis team may consist of one or two core members with an engineering background, supported by persons with accounting, finance and computer skills, as needed.

2. For example, energy is lost through the envelope of an old building. A building envelope refers to those building components that enclose conditioned spaces and through which thermal energy is transferred to or from the outdoor environment. It is estimated, in some cases, that significant energy is lost through the windows, approximately 20 percent is lost to the unintentional leakage of outside air, and nearly 30 percent, based on some estimates, can be attributed to other opaque elements in the building envelope, roofs, walls and floor.

3. The time required for each step can be estimated. This is essential in order to make a thorough and helpful audit report possible.

4. Benchmarking is essentially an energy account that lists every piece of equipment, along with why it needs to be used, when it is operating, and what its peak and off-peak loads are. From this, one can draw an energy profile for the building that includes energy (kWh) consumed and energy demand (kW) across a time period, e.g., two years.

5. ENERGY STAR, a voluntary labeling program sponsored by DOE and the U.S. Environmental Protection Agency, is reflective of industry/sectoral standards. The ENERGY STAR label promotes energy-efficient choices. In the appliances sector, the ENERGY STAR label aids consumers in identifying products and equipment that save energy and money. For buildings, energy consumption is benchmarked on a zero to 100 scale. Buildings qualify for the award by earning a score of 75 or greater while maintaining an acceptable indoor environment. In this context, a subtle distinction between benchmarks and standards should be noted. There is as much value in taking a building from a rating of 52 to a rating of 72 even though the building does not receive an ENERGY STAR label as it does in improving a building rating from 72 to 76 and receiving a label.

6. Could also be recorded/processed through use of an appropriate computer spreadsheet.

7. Some useful conversion values to take into account (based on DOE information):

   1 therm of gas = 100,000 BTU; 1 kWh of electricity = 3,413 BTU
   1 gallon heavy oil = 150,000 BTU; 1 gallon #2 heating oil = 139,700 BTU

8. The form for recording purchased energy is designed for general-purpose use and can be modified to suit specific circumstances of each local government or community.

9. In certain cases, two other items will have to be considered as part of the total cost: **power factor** (PF) and **fuel adjustment**. PF is a measure of the phantom currents that are needed to set up the magnetic field required for the operation of a motor. These currents are sometimes labeled phantom because they do not show up in the kWh recorded in the standard electric meter. They do, however, reflect energy lost in heating transmission lines and transformers. For this reason, if a large portion of the load is in electric motors, the utility may be adding an additional charge to your bill for low PF. The fuel adjustment charges on kWh consumption are also added to kWh charges for each piece of equipment.

10. Initially, it is advisable to not try to reduce demand to an unattainable level, but rather aim at a more practicable goal, e.g., to reduce the top 25 percent or 30 percent of the peak periods.

11. SPB is the easiest method to use and does not require any consideration of future value factors such as discount rates, inflation, and other annual costs during the life of the measure. More sophisticated types of payback analyses entail consideration of changes in operating costs, return rates on money invested, fuel cost escalations, and life cycle costing. The other most common economic evaluation methods used in energy audit reports include net present value (NPV), internal rate of return (IRR), and life cycle cost (LCC). ***Appendix* C** provides brief descriptions of these and other economic analysis methods.

12. A good reference on which energy benchmarks could be based is the Commercial Buildings Energy Consumption Survey (CBECS) of the Energy Information Administration (EIA)/Department of Energy (DOE) [EIA/DOE, 1995]. Please see ***References*** above.

13. For an example of a spreadsheet tool, which can be used to calculate EUI, visit www.energy.state.or.us/sb1149/Schools/EUI/Calculation.xls.

14. Or other appropriate method such as NPV, IRR, or LCC. See Appendix **C** on economic analysis methods for energy projects.