uSave
ENERGY
EFFICIENCY
FUND

PROGRAM GUIDEBOOK

GUIDELINES, FORMATS, PROGRAM REQUIREMENTS & DOCUMENTS

Revised: February 2016

PURPOSE OF THIS PUBLICATION

This **Program Guidebook** provides a road map for engineers who are preparing **Energy Assessment Reports** for the U-Save Energy Efficiency Fund (U-Save). The Guidebook fulfills two goals. First, it explains the procedure for preparing project calculations. Second, it shows the required presentation format for the Governor's Office of Energy Development (OED) technical evaluation.

Questions or comments concerning the guidelines or format should be addressed to the Governor's Office of Energy Development at (801) 538-8724.

For Additional Information Contact:

Shawna Cuan
Building & Industrial Energy Efficiency Specialist
(801) 538-8724
Governor's Office of Energy Development
60 East South Temple, 3rd Floor
Salt Lake City, Utah 84111

and

The Governor's Office of Energy Development website at
www.energy.utah.gov
for forms and other information

TABLE OF CONTENTS

PROGRAM GUIDEBOOK ..... **I**

PURPOSE OF THIS PUBLICATION I

SECTION I – INTRODUCTION **1**

A. U-SAVE SUMMARY 2
B. U-SAVE PROCESS 3
C. SYSTEMS COMMISSIONING 4

SECTION II – QUALIFICATIONS AND RESPONSIBILITIES **6**

A. TECHNICAL ENGINEER AND ORGANIZATION 7
B. SYSTEMS COMMISSIONING ENGINEER AND ORGANIZATION 7
C. BUY AMERICAN PROVISION 8
D. DAVIS BACON ACT (DBA) 8
E. NATIONAL HISTORIC PRESERVATION ACT (NHPA) 9
F. NATIONAL ENVIRONMENTAL POLICY ACT (NEPA) 9
G. WASTE MANAGEMENT PLANS 9

SECTION III – GENERAL INSTRUCTIONS FOR PREPARING THE ENERGY ASSESSMENT REPORT (EAR) **10**

A. UTILITY RATES AND ENERGY COST SAVINGS 11
B. OPERATION AND MAINTENANCE RECOMMENDATIONS (NON-FUNDABLE) 13
C. CLASSIFYING PROJECT TYPES 13
D. CATEGORY I ECMS 15
E. CATEGORY II ECMS 15
F. PROJECT SELECTION PROCEDURES 15
G. ESTIMATING IMPLEMENTATION COSTS 16
H. CHANGE IN SCOPE 18

SECTION IV – SPECIAL INSTRUCTIONS **19**

A. USE OF COMPUTER PROGRAMS FOR ENERGY SAVINGS CALCULATIONS 20
B. EQUIPMENT SELECTION 21
C. EQUIPMENT LOADING 22

SECTION V – TECHNICAL CALCULATION GUIDELINES **25**

A. GENERAL INSTRUCTIONS 26
B. CALCULATION METHODOLOGY 26
C. SAMPLE ELECTRICAL RATE CALCULATIONS FOR COST AVOIDANCE 29

SECTION VI – ENERGY ASSESSMENT REPORT (EAR) TEMPLATE **38**

A. ENERGY ASSESSMENT REPORT FORMAT 39

U-SAVE ENERGY EFFICIENCY FUND **43**

APPENDIX A – DEFINITIONS OF TERMINOLOGY USED IN THIS MANUAL **60**

APPENDIX B – EXAMPLES OF EFFICIENCY IMPROVEMENT OPPORTUNITIES DISCOVERED THROUGH SYSTEM COMMISSIONING **68**

A. TEMPERATURE CONTROLS AND SET POINTS 69
B. AIR AND WATER (CHILLED OR HOT) FLOW 69
C. OUTSIDE AIR CONTROL 70

APPENDIX C – OPERATION AND MAINTENANCE PRACTICES **71**

A. INTRODUCTION 72

B. IDENTIFICATION OF O&Ms 73
C. TYPICAL O&Ms 74
D. O&M CASE STUDIES AND METHODOLOGY 76

APPENDIX D – BTU SAVINGS CALCULATION FOR CATEGORY I PROJECTS 82

APPENDIX E – ECM CASE STUDIES 84

ECM CASE STUDIES 84
A. INTRODUCTION 84
B. CASE STUDIES 84

APPENDIX F – U-SAVE ENERGY EFFICIENCY FUND APPLICATION FORM 105

SECTION I – INTRODUCTION

A. U-Save Summary

U-Save finances energy-related cost reduction retrofits and the incremental costs of new construction energy enhancements for public buildings owned by schools districts, cities, and counties. These low-interest loans are provided to assists these institutions in financing their energy cost reduction efforts. U-Save's revolving loan mechanism allows borrowers to repay loans through the stream of cost savings realized from the projects. The U-Save manager should be contacted for information on current loan interest rates.

Energy Conservation Measures (ECMs) financed through the program include, but are not limited to:

1. energy efficient lighting systems;
2. high efficiency heating, ventilation and air conditioning systems;
3. energy management systems;
4. energy recovery systems;
5. building shell improvements;
6. systems commissioning; and
7. renewable energy systems.

U-Save funds can be used to retrofit existing equipment and installations or to finance the incremental enhancement costs for new buildings. Changes to building components and systems must exceed the minimum requirements of the Utah Energy Code to be eligible for funding. In identifying potential projects, technical analysts are encouraged to evaluate renewable energy technologies, as well as more traditional energy retrofits. Such projects may include rooftop solar, water, and space heating systems, or electric generation with photovoltaic or small wind systems.

Proposed projects must be analyzed by a Professional Engineer who meets the criteria outlined in Section II or have received a utility audit from a utility regulated by the Public Service Commission of Utah. The Professional Engineer or utility audit is selected by the prospective borrower. The analysis (e.g., project descriptions and calculations) is presented in an Energy Assessment Report that follows a prescribed format (see Section VI). The Energy Assessment Report is reviewed and approved by OED technical staff before project financing is authorized.

Projects financed by U-Save must have an average simple payback of between 2 and 12 years, with preference given to projects with a payback of less than 6 years. Borrowers have the option of buying down paybacks to meet the 12-year term.

Project designs are reviewed and resulting projects are monitored during the construction phase and at project completion. Post-project energy savings should be monitored by the borrower to insure that energy is being conserved and energy cost savings are being realized. The level of monitoring may range from utility bill analysis to individual system or whole building metering, depending on the size and types of retrofits and new equipment installed. Loans are also available for systems commissioning to maximize the probability of achieving, or exceeding, calculated savings.

B. U-Save Process

U-Save funds are distributed following a competitive application process based on a set of evaluation criteria. Eligible institutions are encouraged to contact OED as soon as a decision is reached to pursue U-Save funding for energy conservation projects. The U-Save Formal Loan Request (see Appendix F), as well as an Energy Assessment Report must be submitted to OED for review and approval. The OED technical staff or its contractor will review the Energy Assessment Report and approve it for funding. The technical staff may request the report engineer to provide additional information or calculations.

Once project approval has been granted, a Loan Agreement is issued. The Loan Agreement is a document that authorizes the institution to proceed with the design of their projects and includes guaranteed funding for the Energy Conservation Measures (ECMs) stated in the approved Energy Assessment Report. The institution can then begin the process of designing and implementing the projects identified in the report. This process includes several milestones:

1. Selecting a design engineer. The engineer selected to design the projects can be the engineer who prepared the Energy Assessment Report; however, the institution must follow competitive procedures based upon qualifications, to select the Engineer unless the Applicant has an engineer under an existing contract (e.g. engineer is contracted as the city engineer).

2. Preparing the design documents. To ensure that the design specifications match the projects identified in the report, the OED technical staff will typically prepare the following reports:

    a. Design Development Report (50%) – This design review report will be completed when the design process is approximately 50% complete and will verify that the design is proceeding in a direction which conforms with the approved Energy Assessment Report.

    b. Detailed Design Review Report (100%) – This design review report will verify that the completed design conforms with the intent of the approved energy assessment. In addition, it will evaluate the proposed schedule and estimated project construction budget provided by the design engineer.

3. Bidding the work. Institutions must competitively select contractors or bidders as required by state law.

4. Installing the projects. The level of review and involvement by OED on any loan will depend on the scope and complexity of the projects. To ensure that the work meets all technical and state requirements, OED will perform a construction monitoring visit at least once while the work is in progress. The typical monitoring reports generated by OED will be as follows:

a. On-Site Construction Monitoring Report. This report will provide a general overview of construction site activities and will address issues of budget, schedule, conformance of the work with the design documents, and will make recommendations concerning any necessary changes in scope or budget.

b. Final Monitoring Report. This report will be similar to the On-Site Construction Monitoring Report. In addition, it will focus on compliance by the construction contractor with the "close-out" documentation requirements outlined in the bid documents. The report will verify that guarantees, warrantees, releases, Operations and Maintenance manuals, training sessions required, etc. have been provided by the contractor.

5. Closing out the project. Upon completion of the project, the borrower will submit a Final Completion Report to OED.

6. Repaying the loan. OED will forward an Amortization Schedule to the institution based on the incurred loan amount. Loan repayments are due quarterly, beginning the first day of the quarter following the final loan disbursement. The amount of annual loan repayment is based on the energy cost savings projected in the Energy Assessment Report. These projected savings are the basis for the loan. *They are not guaranteed savings*. Therefore, the dollar amount and the number of loan repayments are established in the promissory note and do not vary according to the actual savings. The typical borrower with a five-year payback is obligated to repay the loan in twenty quarterly installments over a five-year period.

7. Forms are available on the OED website. (www.energy.utah.gov/usave)

8. Reporting

C. Systems Commissioning

Systems Commissioning is a process by which building systems efficiency can be "fine-tuned" to produce additional cost savings and occupant comfort once U-Save ECMs have been installed (zero to five years following installation). This process begins with an initial survey of a defined facility to discover any comfort or operational problems that may exist. A cost and projected savings proposal is then presented to the Owner (borrower).

If the U-Save borrower wishes to accept the commissioning organization's proposal, a letter request and a copy of the commissioning proposal must be forwarded to OED for approval. If approved by OED, commissioning funding may be provided either through modification of an existing repayment contract or a separate contract, depending on the circumstances.

Commissioning activities typically include: surveying, interviewing, baseline measurements, analyses, definition of problems, definition of solutions, and implementing solutions, balancing, and verification measurements. Some of these steps may be repeated as necessary to optimize systems operations. In some cases, system considerations extend beyond just the equipment installed under the U-Save ECMs. This is to insure that total building system effects are comprehended and optimized. Since both heating and cooling systems are usually involved in this process, optimization activities may extend over a six-month period or longer. Documentation of findings and corrections, along with recommended operating procedures should be provided by the commissioning organization.

Examples of improvement opportunities discovered through systems commissioning can be found in Appendix B.

SECTION II – QUALIFICATIONS AND RESPONSIBILITIES

A. Technical Engineer and Organization

Since U-Save repayments are determined by the projected paybacks of funded projects, it is critical that reports identifying and analyzing prospective energy projects be clear, concise, objective, and technically sound. The Energy Assessment Report, which identifies and documents project costs and paybacks, is prepared by the technical analyst. This report becomes a part of the loan application and is reviewed and approved by OED before financing is authorized.

The technical analyst who prepares and certifies the Energy Conservation Measures may be a utility that is regulated by the Public Service Commission of Utah and conducts an analysis using a utility audit generated through an energy efficiency incentive program. Technical analysts that are not regulated utilities must meet the following criteria:

1. Be a professional mechanical or electrical engineer with current Utah registration;

2. Have extensive knowledge of energy-using systems found in institutional and commercial buildings, a working knowledge of energy efficient retrofits utilizing state-of-the-art technologies, and a specific understanding of building operation and maintenance procedures;

3. Be experienced in conducting energy analyses identifying energy efficient retrofit projects in institutional or commercial buildings and in preparing comprehensive reports on the findings;

4. Have no financial interest directly or indirectly related to the purchase or installation of energy efficient equipment; and

5. Be involved in on-site work to gather project data; have a working knowledge of the buildings(s) and its energy-using systems; direct or perform all aspects of the data collection, project selection, analysis, and cost estimation; and provide final recommendations for U-Save funding.

In order to conserve report preparation time and cost, analysts should focus on fundable projects (those which will result in a composite payback of twelve years or less).

It is also the responsibility of the analyst/utility project manager to expedite the preparation of the report and to respond in a timely manner to any comments, questions, or necessary revisions resulting from the U-Save technical review.

B. Systems Commissioning Engineer and Organization

Systems commissioning may be provided by a utility that is regulated by the Public Service Commission of Utah as part of the utility's systems commissioning energy efficiency incentive program. If the organization performing systems commissioning is not a utility regulated by the Public Service Commission of Utah, then the organization must possess the following qualifications for the project to be funded through the U-Save program:

1. Work shall be performed under the direction and supervision of a professional mechanical or electrical engineer with a current Utah registration.
2. The engineer and commissioning organization shall have extensive knowledge of energy-using systems found in institutional and commercial buildings and a working knowledge applicable to installation, testing, measurement, control, and balancing technologies that apply to these systems.
3. The engineer and commissioning organization shall have documented commissioning experience in institutional or commercial buildings.
4. Neither the engineer of record nor the commissioning organization shall have any financial interest directly or indirectly in equipment purchased or leased for installation as a result of the commissioning process
5. The engineer of record shall have a working knowledge of the building(s) and energy-using systems. This engineer shall direct or perform all aspects of data collection, analysis, cost estimation, savings estimation, systems modifications, testing and balancing, recommended system modifications, and recommended operating procedures.

C. Buy American Provision

The Buy American provision in the American Recovery and Reinvestment Act of 2009 (section 1605 of Title XVI), provides that, unless one of three listed exceptions applies (non-availability, unreasonable cost, and inconsistent with the public interest), and a waiver is granted, none of the funds appropriated or otherwise made available by the Act may be used for a project for the construction, alteration, maintenance, or repair of a public building or public work unless all the iron, steel, and manufactured goods used are produced in the United States.

Guidance documents and the Buy American Desk Guide can be obtained by visiting the following link: http://www1.eere.energy.gov/recovery/buy_american_provision.html

D. Davis Bacon Act (DBA)

DBA applies to contracts in excess of $2,000 for the construction, alteration, and/or repair of public buildings or public works, including painting and decorating, where the United States or the District of Columbia is a direct party to the contract. DBA specifies that each covered contract contain provisions, found at Title 29 CFR 5.5, requiring contractors to pay the laborers and mechanics employed on the project's site of the work, on a weekly basis, no less than the wages and benefits that are prevailing in the area as determined by the Secretary of Labor. Construction includes activities performed on the site of the work such as preparation for construction (e.g., demolition of existing structures, equipment and material set-up, etc.), fabrication of materials, installation of materials, and post-construction clean-up. The federal agency awarding the contract must make the determination that DBA applies to the project and must incorporate the applicable DBA clauses and wage determinations (also referred to as "wage decisions") into the requirements of the contract.

Guidance documents and A Desk Guide to the Davis Bacon Act can be obtained by visiting the following link: http://www1.eere.energy.gov/wip/davis-bacon_act.html

E. National Historic Preservation Act (NHPA)

Prior to the expenditure of federal funds to alter any structure or site, the applicant is required to comply with Section 106 of the NHPA. Section 106 applies to historic properties or sites that are listed on or eligible for listing on the National Register of Historic Places. In order to fulfill the requirements of Section 106, the applicant must contact the State Historic Preservation Officer (SHPO) to coordinate the Section 106 review as set forth in 36 C.F.R. Part 800 and consistent with DOE's 2009 Letter of Delegation of Authority. SHPO contact information is available at the following link: http://www.ncshpo.org/find/index.htm. The applicant must also notify OED in the event that consultation with a Tribal Historic Preservation Officer (THPO) may be necessary so that OED and DOE may initiate any necessary tribal consultation. Indian tribes may agree to the delegation of DOE's consultation responsibilities to an applicant.

Guidance documents regarding historic preservation requirements can be obtained by visiting the following link: http://www1.eere.energy.gov/wip/historic_preservation.html

F. National Environmental Policy Act (NEPA)

All Projects receiving financial assistance from DOE though OED must be reviewed under the National Environmental Policy Act (NEPA) of 1969 – 42 U.S.C. Section 4321 et seq. The first step in DOE's NEPA review process requires financial assistance recipients to submit information to DOE regarding the potential environmental impacts of the project receiving DOE funds. Applicants must complete the Environmental Checklist (DOE PMC EF-1) on-line at the following site: https://www.eere-pmc.energy.gov/NEPA.asp

Guidance documents and templates regarding NEPA requirements and categorical exclusions can be obtained by visiting the following link: http://www1.eere.energy.gov/wip/nepa_guidance.html

G. Waste Management Plans

All applicants shall provide a waste management plan addressing waste generated by each proposed project prior to receiving financing from the U-Save Energy Efficiency Fund. The waste management plan describes the plan to dispose of any sanitary or hazardous waste (e.g., construction and demolition debris, old light bulbs, lead ballasts, lead paint, piping, roofing material, discarded equipment, debris, and asbestos) generated as a result of the proposed project. The applicant shall make the waste management plan and related documentation available to OED and the United States Department of Energy (DOE) on OED's or DOE's request (for example, during a post-award audit). The applicant shall ensure that the project complies with all Federal, state and local regulations for waste disposal.

The plan, at a minimum, should contain the following information: (1) type(s) and estimated volume(s) of waste that the project proponent anticipates will be generated; (2) the disposal path for each waste stream (e.g., landfill disposal, recycling, reuse). Please note that **waste items cannot be reused** without prior approval from OED.

SECTION III – GENERAL INSTRUCTIONS FOR PREPARING THE ENERGY ASSESSMENT REPORT

A. Utility Rates and Energy Cost Savings

1. Costs of Utilities

Utility expenses used in the U-Save report should **reflect real-world energy costs.** Calculate savings using energy costs from the actual rate schedule which applies to the particular building. If the electric rate schedule has a "block" construction, whereby different rates per kWh are charged for different usage levels, calculate the savings using the incremental cost per kWh; i.e., the cost applicable to the block into which the building's electrical consumption falls. Add the average cost of fuel adjustment, over the most recent 12 months available, to the per kWh cost. A preferable alternative in many cases is to use a forecast of the cost of fuel adjustment provided by the utility. Some of the larger utilities provide reliable forecasts. The Public Service Commission of Utah may offer help in this area of forecasting if the utility cannot.

Use existing rate schedules unless it is known that a significant change in rates will take effect within the next six months. Include a copy of the current or pending rate schedule and applicable riders in the appendix. Use actual demand and power factor penalties, where applicable, in savings calculations.

Where summer and winter rates are different, the calculated savings must take into account these differences. For recommended measures where kW and kWh savings accrue evenly throughout the year, an annual cost per kW or kWh may be applied.

Where savings accrue primarily during a certain part of the year, use the applicable summer or winter rate.

2. Central Plants

Avoided costs developed for borrower-owned central plants should be based on the overall cost to operate the plant. This includes the utility and fuel costs, maintenance and operating costs, and capital depreciation (based on actual expected lifetime of the equipment). If it is a cogeneration plant, these costs should be reasonably prorated among electrical and thermal energy output. If a borrower-owned plant continuously purchased supplemental energy and any savings reduced the purchased amount instead of the produced amount, then the rate schedule for the purchased utility should be used.

3. Avoided Costs of Natural Gas

Avoided cost for natural gas is determined by summing the total consumption in the twelve-month period, summing the total cost for the same period, and dividing the cost by the consumption. Most utilities bill in cost per unit of volume ($/Mcf), although a few will use cost per energy unit ($/therm, $/MBtu). U-Save is written to use $/Mcf. The following conversion may be helpful:

$/therm	→	$/Mcf divide by 0.103
$/million Btu	→	$/Mcf divide by 1.03

Total cost includes all charges for the natural gas, including customer charge, transport, franchise tax, city tax, cost and delivery guarantee fees, and final adjustment costs as applicable.

4. Avoided Costs of Oil

Avoided cost for fuel oil, butane, or propane is calculated by summing the total cost for the fuel over the previous twelve months, summing the volume of fuel represented by these costs, and dividing the cost by consumption. Calculations for these fuels differ from those for electricity and natural gas in that these fuels are generally purchased on a non-periodic basis. In other words, fuel is purchased prior to the beginning of the "season" and replenished as needed. The volume of fuel on-site and its value must be determined at the beginning of the twelve-month period and again at the close of the twelve-month period. The prorata share of fuel and cost is added to those purchases made during the twelve-month period, and the prorata share of fuel on hand at the end of the period is subtracted.

Fuel cost is generally stated in terms of dollars per gallon, pound, or Mcf and must be referenced to an energy density (Btu/lb., etc.).

5. Avoided Costs of Electrical Energy and Demand

The avoided costs of electrical energy and demand are the unit costs that will be avoided because of the energy savings generated by implemented ECMs. They are expressed as $/kWh for energy savings or $/kW for demand savings. The applicable kWh/yr. energy savings or kW/yr. demand savings are then multiplied by these avoided costs to compute the potential annual dollar savings of the ECM.

The most accurate method of calculating avoided costs is to perform a series of monthly electrical bill calculations based on initial consumption and consumption after each ECM, including dependencies. This calculation can be shown as a series of steps:

a. Calculate all electric bills for the year.
b. Correct for changes in fuel cost and peak demand.
c. Calculate the electrical energy savings by month for the first ECM.
d. Recalculate the monthly energy bills based on the new calculated energy consumption and electrical demand, including blocks and rachets.
e. The cost savings is the difference in the two energy costs.
f. Calculate the electrical energy savings by month for the second ECM.
g. Recalculate the monthly electrical bills based on the new energy consumption and electrical demand, including blocks and rachets. Calculate a new rachet demand if justified.
h. Repeat for all ECMs incorporating applicable dependencies.

A simplified calculation for avoided cost of electricity has been approved as follows: (1) calculate avoided electrical energy cost on a per kWh basis assuming the use is in the last block of actual consumption, and (2) calculate avoided electrical demand cost, if any, assuming a full use last block basis. The last block is generally the lowest electrical cost rate. Applicable fuel and cost recovery costs are to be added. The last demand block is calculated with no rachet or consumption limits on the block extension clauses. These rates will not change as a function of energy savings and will be identified in the following examples as the **simplified electrical energy rate** and **simplified electrical demand rate**.

Utility rate schedules employ a seemingly complex array of terms and charges to determine the total utility charges billed to the customer. An example of how to analyze a utility rate schedule is provided in Section IV, Paragraph C.

B. Operation and Maintenance Recommendations (Non-fundable)

Operation and Maintenance (O&M) projects are not candidates for U-Save funding and should not be included as part of an ECM project. If the recommended action is eligible for funding under U-Save, it is an ECM. For instance, a recommendation with a 0.2-year payback that has a $50 purchase price and is eligible for U-Save financing should be classified as an ECM. Additionally, cleaning and/or greasing of equipment, though it may take 25 hours of staff time, would be classified as an O&M. Payback period and cost of implementation are irrelevant to this distinction. One helpful technique is to ask the following question, **"Is the recommended action something that the building staff should be doing ordinarily as a regular part of their duties?"** If the answer is yes, the recommended action is an O&M.

Recommendations which involve turning machines on/off may be borderline cases. Obviously, a maintenance staff which is performing its duties to the fullest will turn off all equipment after normal building occupancy hours, if use of equipment is not necessary after hours. However, this kind of manual on/off control is the exception rather than the rule. In these cases, consider:

- Does the maintenance staff have the manpower to comfortably operate all equipment manually?
- Can the staff reasonably be expected to perform this duty in a reliable manner?

If the answer to either question is no, then recommend investment in automatic control equipment (i.e., time clocks, energy management systems, etc.) and classify the project as an ECM, rather than recommending manual performance of these tasks as an O&M. Analysts are encouraged to include recommended O&M items in the appendix of the Energy Assessment Report.

Appendix C in this Guidebook provides a further description of operations and maintenance as well as case studies and methodology.

C. Classifying Project Types

Financing for cost reduction projects may be approved for existing buildings, or building renovations.

1. Retrofit Measure - This is an ECM project initiated by the analyst in an existing building in which the purpose of the project is to save utility consumption or utility dollars. If the

facility is owned by the state, the project(s) must meet or exceed the state energy code (2006 International Energy Conservation Code, Utah Code, Title 15A, Chapter 2, Section 103). Projects undertaken in buildings not owned by the state must meet state energy codes and all local, county, and state building codes as applicable.

2. Major Renovation - This is a project which takes place as part of a renewal. A renewal is defined as the renovating of 50% or greater of a defined space. Any project completed as a part of a "renewal" in a state facility is also required to meet the current state energy code. Projects completed in non-state facilities must meet those standards set for retrofit measures. Funding eligibility will be based on the incremental cost and savings, and resulting simple payback.

ECMs can be calculated at three different levels of detail (see definitions of Categories I, II, and III on the following pages). A list of Category I ECMs can be found in Paragraph D below.

D. Category I ECMs

Paybacks for Category I ECMs (sometimes called **“dipstick” “deemed” or “stipulated” savings ECMs**) are based on three items: (1) an implementation cost per unit to be installed or removed; (2) a good estimate of the number of units affected; and (3) historical paybacks. **The annual cost savings are determined by dividing the total implementation cost by the payback from Table 2.1 shown below.**

Table 2.1 - Payback Criteria for Category I ECMs

ECM	Payback (Years)
Delamping	1
Repair Steam Traps	2
LED Exit Signs	8
Photocells on Exterior Lights	3
Incandescent to H.P. Sodium	4
Programmable Thermostats	3
Time Clock Shut Down of Equipment	3

E. Category II ECMs

If a retrofit project is not, for calculation purposes, identified as a Category I ECM, it must be treated as a Category II ECM. Category II ECM analysis may be more complex and require detailed utility cost savings calculations and documentation. Examples of Category II ECMs include: Energy Management Systems, Cooling Towers, and Thermal Energy Storage projects.

F. Project Selection Procedures

The technical analyst should take the following steps to identify the most cost effective projects in existing buildings for U-Save funding:

1. Meet with administrative and maintenance personnel of the borrowing entity to consider:

    a. Their ideas of what would work in their facilities to reduce costs.

    b. The annual cost and consumption of utilities.

2. After assessing inputs from administrative and maintenance staff, survey the building(s) in the manner listed below:

    a. Look for O&M opportunities which will save utilities or utility dollars and should be recommended as a regular O&M practice of the facility.

b. Look for “standard” projects that will normally payback within twelve years and which can be handled as a Category I ECM.

c. Look for additional projects that normally payback within twelve years but will not be a Category I ECM.

d. Look for other projects that are unique to these facilities. These will be calculated as Category II, or detailed, ECMs but may have extended paybacks.

e. Make a quick assessment of the expected cost and savings associated with projects identified in the steps above by reviewing typical paybacks for projects selected.

f. If the combined payback meets the twelve-year payback criteria, complete data collection for a Category I ECM on-site and select projects for Category II ECMs.

g. If the combined payback does not meet the twelve-year payback criteria, confer with the borrowers and determine if they would be interested in “buying down” the payback. Then complete data collection for Category I ECM on-site, select projects for Category II ECMs, and compute expected composite cost (after buy down).

G. Estimating Implementation Costs

Implementation costs must be estimated and documented in sufficient detail to meet U-Save Program requirements. In general, these costs should be estimated as close as possible to the costs that can be realistically expected so that the adding of a small escalation to these costs will virtually assure a final actual cost that is less than or equal to the estimated cost.

A detailed budget for the installation of each retrofit must be included. Implementation cost estimates should be as detailed as practical and conform to the acceptable documentation discussed below. The budget must include a Work Breakdown Structure (WBS) including each major element required to install the retrofit. The WBS should list:

- equipment cost,
- materials cost,
- labor cost,
- contractor costs,
- additional design/engineering/administration cost,
- escalation allowance, and
- total costs.

Equipment or material should be identified by specified type, size, capacity, or other required attributes in order to describe the required purchase. It can be identified by the equipment cut sheet, specific manufacturer's model number, description, etc. as long as it is understood that other manufacturer’s equivalent items can be substituted.

The implementation costs must include monies for the removal and proper disposal of materials and equipment to be replaced under this program. These materials would include, but not be limited to, items such as light bulbs, ballasts, switches, controls, HVAC equipment, refrigerants, pumps, fans, blowers, piping, valves, conduit, wiring, and boilers. Special care should be taken to budget sufficient funds to properly dispose of materials that are hazardous to the environment.

If an **ECM installation estimate equals or exceeds $100,000** (labor, construction equipment, and contractor's overhead and profit), the **technical analyst should obtain and include at least one written estimate from a reputable regional contractor.** If labor is to be performed by borrower's staff, include their hourly rate for the trade required and do not include a mark-up for the contractor costs.

If an ECM installation estimate is **less than $100,000**, the technical analyst may estimate by subtotaling **equipment, materials**, and **labor costs** for each ECM requiring the services of an **installation contractor** and **adding 20 - 30% for contractor's indirect cost, overhead, and profit.**

The following represent acceptable documentation of the implementation costs:

- **A recent quotation from a bona fide regional contractor for furnishing labor, materials, supplies, and equipment to implement the retrofit**. This should be referenced in the implementation portion of the report, and the quotation document should appear in the ECM (or the appendix if voluminous).

- In the absence of a quotation from a contractor for the installation of the ECM, a **quotation from bona fide suppliers** or the price from the state contract list for furnishing the equipment or materials required in the implementation of the savings is satisfactory, if accompanied by a labor estimate and contractor's overhead and profit based on generally accepted construction cost data (see below). This should be referenced in the implementation portion of the report, and the backup or justification documentation should appear in the ECM (or in the appendix if voluminous).

- Where quotes from contractors or suppliers are not available or cannot be obtained for the costs of materials, supplies, and equipment, or for the productivity and cost of labor, this information can be obtained from a recognized **construction cost database** such as those produced by the R. S. Means Company. This information should be referenced in the implementation portion of the report listing the source (including the year) and the specific line item quoted so that the information can be reviewed for correctness. This should include an analysis of labor productivity as outlined by the database used. However, **the pay rates used and the materials costs should be indexed to reflect the costs of the locale in which the buildings studied are located, if there is any significant variation**.

- Where in-house personnel are used to implement projects, a referenced statement from an administrator of the borrower to justify the rates used will be acceptable. In this case the base pay rate plus applicable burden should be used.

For retrofit measures in detailed reports that require additional design/engineering/ administration**,** and the analyst does not normally perform these functions, a letter quote from a consulting A/E firm or an engineering firm who does perform these functions shall be obtained. If the technical analyst also provides design and engineering services of the type required in the retrofit measures, they may provide the estimate for this work. This should be included in the implementation portion of the report and should appear in the ECM cost. This estimate should contain, as a minimum, the total dollars necessary to complete the plans and specifications, and for providing sufficient quality control to ensure that the project is installed as designed.

An escalation allowance may be included in the cost buildup at the engineer's discretion, using up to 15% of the total estimated project cost in order to assure that sufficient loan funds are available to complete the retrofit.

H. Change in Scope

An institution’s loan is awarded based on the Energy Assessment Report submitted with the Loan application. Sometimes during the design phase or implementation of the retrofit projects, it becomes necessary to deviate from the original plan. Changes in project scope will be reviewed by the OED Monitor during the construction monitoring visit. Calculations will be required if there is reason to believe net savings will significantly decrease as a result of implementing the change. In most cases, the Monitor will be able to approve changes in scope at the time of the monitoring visit.

SECTION IV – SPECIAL INSTRUCTIONS

A. Use of Computer Programs for Energy Savings Calculations

In general, detailed computer analyses or sophisticated computer modeling programs are not necessary. Carefully prepared, concise calculations based on simplified utility cost saving calculation procedures are usually easier to follow during the technical review process, and are often sufficiently accurate to meet the basic objective of a technical assessment report.

The technical analyst may, however, find some advantage in using a computer program to analyze a complex ECM. **The "tool," however, cannot be substituted for the procedure itself**. The analyst may submit computer programs utilizing clearly identified energy calculation procedures, if the following guidelines are followed:

1. **The simplified energy calculation procedures and equations and the calculations/assumptions that provide the documentation for claimed energy savings must be included in the report. Key tabulated numbers and column headings must be clearly identified**. Voluminous or meaningless printouts will not be accepted.

2. **The name of commercial computer programs and their origin or vendor should be clearly indicated**. In the case of computerized heat gain/loss calculations, detailed calculation procedures need not be documented as long as the load calculation method (i.e., ASHRAE transfer function method, bin method, etc.) is specified. All pertinent input and output data should be shown, with key values highlighted or underlined. **Approved energy use simulation programs must comply with ASHRAE Standard 140-2001, Standard Method of Test for the Evaluation of Building Energy Analysis. Computer programs like Carrier E20, Trane Trace, ASEAM, Blast, and DOE-2 currently meet this requirement.**

3. "Black box" computer programs which do not show formulae used, assumptions made, and calculate the final results with very little input information are not acceptable.

To summarize, **analysts are encouraged to calculate utility savings manually, wherever practical, using simplified energy calculation methods based upon accepted engineering procedures, such as those recommended by ASHRAE and IES**. These basic calculations should be presented in a concise, logical sequence. If the analyst elects to use a computer program or spreadsheet to calculate energy savings, simplified energy calculation methods must be identified, and the printouts and solutions should be clearly marked and self-explanatory. **Annual consumption predicted by computer simulation models must match actual utility data (for each energy type) within 5%. Monthly consumption variations may not be more than 15% in any case.**

B. Equipment Selection

1. Minimum Equipment Energy Efficiency

   All recommended equipment must meet or exceed state and local codes and must meet or exceed the equipment efficiency standards as embodied within the current version of the ANSI/ASHRAE Standard 90.1-2010 or most current version. In special circumstances, permission from the Office of Energy Development may be sought for selection of equipment that does not meet the ANSI/ASHRAE Standard 90.1-2010. References (including associated addenda), are given below:

   - Lighting mandatory provisions and power density standards are presented in Section 9.
   - Minimum nominal efficiencies for electric motors are given in Section 10.
   - Minimum duct insulation and pipe insulation standards are given in Tables 6.2.4.2A, 6.2.4.2B, and 6.2.4.5 respectively.
   - Minimum performance standards for air conditioners, heat pumps, and water chillers are given in Tables 6.2.1A through 6.2.1D, and 6.2.1H through 6.2.1M.
   - Minimum performance standards for boilers are given in Table 6.2.1F.
   - Minimum performance standards for warm air furnaces and combination warm air furnaces/air conditioning, warm air duct furnaces, and unit heaters are given in Table 6.2.1E.
   - Minimum performance standards for water heating equipment are given in Table 7.2.2.

2. Environmental Concerns

   A concern for future equipment selection arises from the mandates of the Clean Air Act of 1990, Title VI-Stratospheric Ozone Protection. Title VI specifies a schedule for phase-out of the use and manufacture of chlorofluorocarbons (CFCs) and hydro chlorofluorocarbons (HCFCs) that are currently used in air conditioning and refrigeration systems, and in other devices. Many chillers and building air conditioning units continue to use CFC-11, CFC-12, and HCFC-22 refrigerants (also known as R-11, R-12, and R-22, respectively).

   The Clean Air Act as originally passed specified that all CFCs, such as R-11 and R-12, would not be manufactured after January 1, 2000. However, this was amended to stop production of these refrigerants effective January 1, 1996. The currently available alternative for R-11 is HCFC-123, and for R-12 a hydrofluorocarbon HFC-134a. HCFC-123 manufacture will cease January 1, 2030 by the current mandates. HFC-134a has no ozone depletion potential and is not subject to the current regulations. The originally mandated end of production of R-22 was January 1, 2030, but that has been moved up to January 1, 2020. There is no currently available alternative to this refrigerant, but much industry research is in progress for finding a suitable substitute.

The EPA Energy Star Buildings Manual provides some approximate guidelines dealing with chiller retrofit/replacement options as a result of the phase-out of refrigerants. Chillers that are less than ten years old are recommended for retrofits compatible with the new refrigerants. These retrofits will involve installing new gaskets and seals, replacing or rewinding the existing motor, and modifying the impellers. The retrofit is recommended to occur at the same time as major overhauls of the equipment to minimize overall costs. If the chiller is over ten years old, replacement may be the better option from the standpoint of increased operational efficiency. The original equipment manufacturers can be consulted concerning efficiency of the current unit, how the unit will perform with the new refrigerants, and how newer units would be expected to operate. Particularly for chillers that are closer to twenty years old, the replacement option becomes the recommended choice considering the remaining lifetime of the equipment.

C. Equipment Loading

A major source of error in U-Save reports is assuming that equipment is fully loaded. Frequently chillers, boilers, and pumps were originally oversized to provide a margin for future growth or unknowns in sizing. Often loads change after equipment is installed. It is recommended that the analyst verify the loading of the equipment as utilized using sub metering/data logging. Another way to verify use is to record the power drawn under appropriate environmental conditions. A third method, although less accurate, is to use accepted guidelines for estimating loads (Btu/ft^2, ft^2/Ton, cfm/ft^2). Another measure for pumps and fans is to measure pump head or fan static pressure, as applicable, for use with pump and fan curves.

The following problems have been identified in Texas LoanSTAR energy audits, the revolving loan program after which U-Save is modeled:

1. A school administration area was originally designed as office space then later used as cool dry food storage. Later, a partition was constructed to make two offices. One thermostat (not in an office) controlled all spaces.

2. It was decided that one suite of offices at a school was not receiving enough cooling, so approximately 800 cfm was ducted in from an adjacent rooftop unit. No control changes were made.

3. A rooftop package unit served three classrooms. One classroom was converted to a storage room without changes to the system or single control.

The rationale for the load used in U-Save analysis should be noted in the report.

D. Equipment Efficiency

Knowledge of equipment efficiency is necessary for adequate analysis of potential ECMs. Two areas for concern are efficiency decay and inaccurate conversion between performance measures.

The efficiency of a ten-year-old residential/commercial HVAC unit is generally less than when the system was placed in service. A typical unit with an EER of 9 may exhibit a current EER of 7.5 – 8.0. A natural gas furnace with an original efficiency of 75% may now have an efficiency in the 65 - 70% range depending on maintenance and use. One approach to determination of efficiency is to obtain data from the manufacturer for that model and decrease the efficiency by some reasonable amount; e.g., 5 to 10%. Any adjustment to performance characteristics should be noted and rationalized.

Conversion of one performance measurement to another frequently leads to error. The use of EER and SEER interchangeably is an example. Energy Efficiency Ratio (EER) is a measure of the performance of a cooling system based on the Btus of cooling produced by one watt of electric power. Typical values range from 8-12 Btu/W. Performance is measured at 95°F ambient condenser temperature and 80°F db/67°F wb entering air conditions. Fan motor heat is included in the load.

Seasonal Energy Efficiency Ratio (SEER) is defined as the amount of cooling performed during a cooling season divided by the total electrical power expended to produce the cooling effect. Cooling measurements are given in Btus and power consumption in watts. Actual certification is performed in a laboratory under controlled conditions. EER and SEER are not interchangeable. Contact the manufacturer for values with suitable units. (Systems 60,000 Btu/hr. and less are generally specified in SEER units). In the absence of definitive information, the equivalent EER for a SEER system can be estimated as follows:

$$\text{Estimated EER} = (\text{SEER} - 6) \times 0.75 + 6$$

A third measure of cooling performance is the Integrated Part-load Value (IPLV) which is used for larger water chilling equipment which is capable of significantly unloading and is placed in an application where load and condensing temperatures vary during the cooling season. Data is taken at four load levels (100%, 75%, 50%, and 25%) and specified condenser conditions. A weighted average is then calculated. Results are usually provided in kW/Ton but sometimes in EER or COP. IPLV is not directly interchangeable with SEER.

A fourth measure of cooling performance is the Non-standard Part-load Value (NPLV) which is similar to IPLV, but efficiency is determined under conditions other than IPLV conditions. NPLV and IPLV are not interchangeable.

E. Light Levels

The analyst must use caution to ensure that ECMs which reduce light output will meet or exceed the lighting levels recommended by the IES standards (the current version of the IES Lighting Handbook, Reference Volume, Appendix A). In addition, the lighting power allowance must meet the standards of the current version of ANSI/ASHRAE Standard 90.1-2010 as applicable (primarily Sections 6 and 9). Data should be provided showing the measured existing light output in typical areas affected by the ECM, the proposed light output subsequent to the retrofit, and recommended minimum values. In the event lighting levels are increased, a simple statement to that effect giving the light output of old and new lamps and the source of the data will be sufficient.

Cleaning is not sufficient to justify light output level increases unless it is to be part of a new, regular ongoing maintenance program described in the report and which did not exist before.

SECTION V – TECHNICAL CALCULATION GUIDELINES

A. General Instructions

Calculation methodologies are expected to be consistent with industry norms, and it is suggested that ANSI/ASHRAE Standard 90.1-2010 and the associated ANSI/ASHRAE Standard 90.1-2010 Standard be followed as a preferred methodology. Common methods employed in the calculation process allow for a uniform and swift review of the submitted reports.

In calculating the total utility consumption and utility cost savings expected from the acquisition or installation of all energy conservation reduction measures, **the analyst must take into account the (possible) interaction between the "applied for" measures**. This is required because, due to dependency effects, the total energy savings (for example) which result from the combination of several ECM projects may be less than the sum of the independent energy savings of each project.

It is also the responsibility of the analyst to carefully document any and all assumptions made with regard to estimated implementation cost and cost savings. These assumptions must be clearly identified to assist the borrower and the reviewer in determining the validity of the individual ECMs. For example, if the retrofit work requires disruption to an occupied space, the analyst should state that the cost estimate is based on the work performed after hours or on weekends at a premium rate. If the analyst assumes that the borrower will vacate a given area for the retrofit work to be done, this should be clearly noted. In the case of school retrofits, if the analyst assumes that all retrofit work will be performed during the summer months, this should be clearly stated so that the borrower will be able to anticipate any scheduling conflicts. The same is true for assumptions made with regard to equipment run time when calculating potential energy savings. All of the assumed run times, setbacks, 24-hour operations, etc. should be summarized to call attention to the fact that important decisions are based upon the validity of this information.

Each ECM should be calculated as if all ECMs have been completed in the following order; (1) project effect on building loads, (2) distribution system modifications, (3) primary equipment modification/replacements, and (4) energy management system installations (see Paragraph B, Calculation Methodology, of this section).

Variable speed drive installations have been a commonly recommended retrofit in recent years. Variation in the savings calculation methods has led to confusion and slowed the evaluation of the submitted reports. The ANSI/ASHRAE Standard 90.1-2010 Standard presents a recommended method for determining the savings from VSD installations (see Paragraph B, Calculation Methodology, of this section).

The primary goal of the Energy Assessment Report is the installation of sound retrofits which have an established payback track record. Because borrowers will be using the utility savings achieved by the projects to repay their loans, it is essential that paybacks be as accurate as possible. *In performing payback analyses, analysts should err on the conservative side.*

B. Calculation Methodology

1. Project Interaction

A common mistake made by analysts is overlooking the interaction between a load reduction project (such as adding insulation) and an equipment change (such as changing to a higher efficiency cooling system). Often the sum of the independent savings lead to an overly optimistic payback period. The correct way to handle these two dependent projects is illustrated on the following pages.

Example: Consider a school building that spends $8,000 per year for cooling energy only. Calculations based upon energy consumption records and manufacturer's data for the central air conditioning system indicate an annual consumption for an average weather year of about 160,000 kWh at 5¢/kWh. A technical analyst develops two projects to reduce total cooling costs. ECM-1 is a project to upgrade the ceiling insulation to R-30. Calculations show that this project will reduce the annual cooling load by 25%. A second project, ECM-2, is developed to replace the old cooling system (EER = 5) with a new high efficiency system (EER = 10). Determine the energy saved by this combination of two projects.

Independent Savings

ECM-1 savings (with old AC system in place)
Insulation will save 25% on cooling load*

Therefore, 25% of cooling energy = (0.25)(160,000 kWh)
Savings = 40,000 kWh

*Based upon detailed calculations shown in ECM-1 data.

ECM-2 savings (with no new insulation)
High efficiency cooling system will save:

Use = 160,000 kWh
(160,000 kWh)(5 EER/10 EER)
Savings = 80,000 kWh

Sum of Independent Savings = 120,000 kWh

Combined Savings (with Dependency)

Original heat load = 160,000 kWh x 5 Btu/Wh x 1,000
= 800×10^6 Btu/hr.

Modified heat load = $(1 - 0.25)\ 800 \times 10^6$ Btu/yr.

Energy to operate

the new High E cooling system $= \dfrac{600 \times 10^6 \text{ Btu/yr.}}{10 \text{ Btu/Wh} \times 1{,}000}$

$= 60{,}000$ kWh

Combined savings of ECM-1 & ECM-2 are:

Savings = kWh (before) - kWh (after)
Savings = 160,000 kWh - 60,000 kWh
= 100,000 kWh

For the preceding example the Energy Assessment Report will show a sequential implementation of projects; therefore, ECM-1 savings = 40,000 kWh and ECM-2 savings = 100,000 - 40,000 = 60,000 kWh.

NOTE: The combined savings of 100,000 kWh is less than the sum of the independent savings of 120,000 kWh.

2. Variable Speed Drive

For variable volume systems, fan input power should be adjusted as a function of air flow. The relationship is given by the following equation:

$$P_{in} @ (CFM) = P_{in} @ (CFM_{max}) \times \left[A + B\left[\frac{CFM}{CFM_{max}}\right] + C\left[\frac{CFM}{CFM_{max}}\right]^2 \right]$$

where P_{in} (cfm) = input power at the airflow rate,
P_{in} (cfm_{max}) = input power at the maximum scheduled airflow rate,
A, B, C = the constants from the following Table 4.1.

Table 4.1 - Fan Curve Constants

Fan Type - Control Type	A	B	C	Minimum Turndown (% cfm)	Minimum Input (% power)
Air-foil or backward-inclined - riding the curve	0.227143	1.178929	-0.410714	45%	68%
Air-foil or backward-inclined - inlet vanes	0.584345	-0.579167	0.970238	30%	48%
Forward-curved - riding the curve	0.190667	0.310000	0.500000	10%	22%
Forward-curved - inlet vanes	0.339619	-0.848139	1.495671	20%	22%
Vane-axial - variable pitch blades	0.212048	-0.569286	1.345238	20%	15%
Any – variable speed drive	0.219762	-0.874784	1.652597	10%	10%

The column entitled "Minimum Input (% power)" gives the minimum turndown for the fan as a percent of input power. For the variable speed case the fan can safely be turned down to a minimum of 10% full-load rated input power. Operations at air flows below this point should be simulated with a flat minimum power requirement equal to the minimum input in the above table.

C. Sample Electrical Rate Calculations for Cost Avoidance

(The following examples are provided by the Texas LoanSTAR revolving loan program after which U-Save is modeled. These examples reference Texas utility information and are included as examples only. The Texas utility data should not be used when making calculations for projects in Utah.)

The method of determining the avoided costs of electrical consumption and demand will be illustrated by an example from Texas Utilities Electric Company. **This is included only as an example of how to calculate avoided electrical costs.** Each utility company's rate structure will be different. Also, it will be impossible to determine how continuing deregulation will impact rate structures. This example uses historical rate schedules and is intended to illustrate a broad range of variables that must be considered in cost avoidance calculations. <u>The analyst must use current rate schedules, or those that will be in place when the ECMs are implemented, in preparing the Energy Assessment Report</u>.

The TUEC example has been used because it involves a more complex rate schedule that uses variable-size electrical consumption blocks, and more charges are included in the avoided costs of electrical energy and demand. It also depicts how demand has an implicit impact on the avoided cost of energy when the energy consumption block sizes are dependent upon demand. A "ratchet" clause is explained in the discussion of this example.

<u>Example - Texas Utilities Electric Company General Service Secondary Rate Schedule</u>

This example illustrates a determination of the avoided costs of electrical energy and demand for a complex rate structure from an investor-owned electric utility - Texas Utilities Electric Company (TUEC). A copy of the General Service Secondary rate schedule is included at the end of these calculations on page 33. Specific references will be made to portions of this rate schedule during the following discussion.

In the section labeled "Monthly Rate" the components of the utility costs are given. The consumption-based charges consist of an energy charge, a fuel charge, a power cost charge, and a cost of service charge. Other charges are a customer charge and a demand charge. The customer charge is not a consumption-based charge and does not affect the avoided costs of electrical energy or demand in any way. This facility pays no sales taxes on its utilities.

The TUEC General Service Secondary schedule does not have different energy charges for the summer and winter periods. However, the determination of billed demand illustrates an important rate schedule feature.

The following is excerpted from the "Demand Determination" section of the rate schedule:

a) Billed Demand is the smaller of:

- current month kW; or
- on-peak kW plus 25% of the current month kW in excess of the on-peak kW.

b) But is not less than the highest of:
- 80% of the on-peak kW;
- 50% of the contract kW; or
- 50% of the annual kW.

TUEC's definitions of these demand terms are given at the top of the second page of the rate schedule. It is Paragraph b, above, that sets a minimum demand to be charged as any of the three options listed. This is a prime example of the “ratchet” clause that is included within some utility rate schedules. Typically it is Sub-clause 1 that sets the minimum billed demand at 80% of the on-peak demand, which will trigger the ratchet. Therefore, during the off-peak period, the minimum demand that a facility will be billed for is usually equal to 80% of the maximum metered demand during the previous eleven months in the on-peak period.

Table 4.2 shows the electrical consumption of a facility within the TUEC service area that is on the General Services Secondary rate schedule. Refer to the columns for the actual and billed demands in the months of October 1992 and April and May 1993. Notice that the billed demand is larger than the actual demand in those months. The 80% ratchet was triggered in those months because the actual demands were less than the value of 80% of the on-peak during the June - September 1992 on-peak season. The billed demand of 554 kW allows us to calculate that the on-peak demand set during that period was:

$$= 554 \text{ kW} \div 0.80$$

$$= 693 \text{ kW}$$

Avoided Cost of Electrical Energy

The avoided cost of electrical energy will be composed of the energy charge, fuel charge, power cost charge, and a fuel refund. The fuel refund has been returned monthly by TUEC instead of in a lump sum. The power cost charge also changes every month.

<u>Energy Charge</u>

Table 4.2 shows the electrical energy and demand usage by the facility that is the basis for this example. This facility is solidly in the third block of energy consumption. Therefore, the avoided energy charge is:

$$= \$0.007/\text{kWh}$$

<u>Fuel Charge</u>

The fuel charge from Rider FC is the avoided fuel charge:

$$= \$0.018926/\text{kWh}$$

Power Cost Charge

The power cost charge changes monthly so an average of the amounts from the last twelve monthly bills (not included in this document) will be used to calculate the avoided cost:

= [$0.000382/kWh + $0.000426/kWh + $0.000382/kWh + $0.000468/kWh +

$0.000496/kWh + $0.000530/kWh + $0.000537/kWh + $0.000510/kWh +

$0.000415/kWh + $0.000412/kWh + $0.000153/kWh + $0.000163] ÷ 12

= $0.000406/kWh

Table 4.2
Sample Utilities Summary of Electrical Consumption and Demand
Texas Electric Company General Service Secondary Rate Schedule

Billing Dates	Month	Days in Period	Plant Energy Consumption (kWh)	Guard Light Consumption (kWh)	Consumed in Block 1 (kWh)	Consumed in Block 2 (kWh)	Consumed in Block 3 (kWh)	Actual Demand (kW)	Billed Demand (kW)
09/21/92 - 10/20/92	October	30	215,376	1,350	2,500	95,980	116,896	399	554
10/20/92 - 11/18/92	November	30	258,240	1,350	2,500	111,620	144,120	646	646
11/18/92 - 12/18/92	December	30	226,368	1,350	2,500	109,070	114,798	631	631
12/18/92 - 01/20/93	January	33	327,840	1,350	2,500	118,930	206,410	689	689
01/20/93 - 02/17/93	February	28	199,248	1,350	2,500	117,060	79,688	678	678
02/17/93 - 03/18/93	March	30	190,272	1,350	2,500	111,620	76,152	646	646
03/18/93 - 04/12/93	April	25	183,216	1,125	2,500	95,980	84,736	504	554
04/12/93 - 05/11/93	May	29	229,488	1,350	2,500	95,980	131,008	544	554
05/11/93 - 06/10/93	June	30	260,784	1,350	2,500	91,050	167,234	525	525
06/10/93 - 07/12/93	July	32	230,256	1,350	2,500	104,650	123,106	605	605
07/12/93 - 08/10/93	August	29	249,312	1,350	2,500	121,105	125,707	557	557
08/10/93 - 09/09/93	September	30	241,776	1,350	2,500	119,600	119,676	550	550
		TOTALS	2,812,176	15,975	30,000	1,292,645	1,489,531	6,974	7,189
		AVERAGES	234,348	1,331	2,500	107,720	124,128	581	599

Fuel Refund

Fuel refunds are provided monthly to account for the variation in the price of fuel the utility purchases to produce electricity. The average of the amounts from the last twelve monthly bills (not included in this document) will be used to calculate the avoided cost:

= [$0.000240/kWh + $0.000486/kWh + $0.000464/kWh + $0.000439/kWh +

$0.000479/kWh + $0.000521/kWh + $0.000496/kWh + $0.000476/kWh +

$0.000401/kWh + $0.000405/kWh + $0.000379/kWh + $0.000349/kWh] ÷ 12

= $0.000428/kWh

Avoided Cost of Electrical Energy

= energy charge ($/kWh) + fuel charge ($/kWh) + power cost charge ($/kWh) -

fuel refund ($/kWh)

= $0.007/kWh + $0.018926/kWh + $0.000406/kWh - $0.000428/kWh

= $0.0259/kWh

Avoided Cost of Electrical Demand

The avoided cost of electrical demand is the fixed demand charge given in the rate schedule plus a block extender charge that is implicit in the variable energy consumption block that is dependent upon the demand.

Demand Charge

The fixed demand charge in the General Services Secondary rate schedule is $9.01/kW of billed demand in excess of 10 kW. Therefore, the fixed demand charge is

D_1 = $9.01/kW

Block Extender Charge

The first energy consumption block is fixed at 2,500 kWh, but the second block is extended by a multiplier of 215 kWh per kW of billed demand. The avoided demand associated with the second block is the block extender charge. If the electrical demand were reduced, the size of the second block would decrease. Since actual consumption does not change, this will cause more of the consumption to be charged at the lower-priced third block rate. This amounts to savings on energy consumption due to the reduction in the demand. This is termed the “block extender charge” and is computed as below:

D_2 = [second block price (\$/kWh) - third block price (\$/kWh)] × second block extender

= [\$0.0325/kWh - \$0.007/kWh] × 215 kWh/kW

D_2 = \$5.48/kW

Avoided Cost of Electrical Demand

D = $D_1 + D_2$

= fixed demand charge (\$/kW) + block extender charge (\$/kW)

D = \$9.01/kW + \$5.48/kW

D = \$14.49/kW

Simplified Electrical Avoided Cost

The simplified electrical avoided cost is essentially the same except that ratchets are not considered as a detriment to demand calculations. The actual demand is used in determining the avoided cost.

(SAMPLE)
Tariff for Electric Service
Texas Utilities Electric Company

3.2 General Service	Sheet: 1
Applicable: Entire System	Page 1 of 2
Effective Date:	Revision: Two

3.2.1 Rate GS - General Service Secondary

Application

Applicable to any customer for all of the electric service supplied at one point of delivery and measured through one meter at secondary voltage. East point of delivery is metered and billed separately and a demand meter is required when the expected maximum kW is 10 kW or higher.

Applicable to temporary, construction power, or warning siren service in conjunction with the appropriate rider.

not applicable to resale service, shared service, or where delivery voltage is other than secondary voltage.

Type of Service

Single or three phase, 60 hertz, at any one of the Company's available standard secondary service voltages as required by Customer. Where service of the type desired by Customer is not already available at the point of delivery, additional charges and special contract arrangements between the Company and Customer may be required prior to its being furnished.

Monthly Rate

Charge			**Amount**
Customer			$15.00
Demand	Demand in excess of 10 kW		$9.01 per kW
	Each current month kW in excess of the contract kW		$1.00 per kW
Energy	Customer without Metered Demand	First 2500 kWh	6.70¢ per kWh
		All additional kWh	3.25¢ per kWh
	Customer with Metered Demand	First 2500 kWh	6.70¢ per kWh
		Next 3500 kWh*	3.25¢ per kWh
		All additional kWh	0.70¢ per kWh
* Add 215 kWh per kW of demand in excess of 10 kW			

Fuel Cost: Plus an amount for fuel cost calculated in accordance with Rider FC.

Power Cost: Plus an amount for purchased power cost calculated in accordance with Rider PCR.

Payment: Bills are due when rendered and become past due if not paid within 16 days thereafter. Bills are increased by 5% if not paid within 20 days after being rendered.

Demand Determination

Demand for calculation of the monthly bill is determined in accordance with the following provisions:

a) Demand is the smaller of:

   1) current month kW;
   2) on-peak kW plus 25% of the current month kW in excess of the on-peak kW. This provision applies only if Customer has a stable, recurring, annual pattern of use, and at least one full month of actual on-peak history, or an estimate thereof, which is representative of such annual pattern of use.

b) But is not less than the highest of:

   1) 80% of on-peak kW;
   2) 50% of contract kW;
   3) 50% of annual kW.

Definitions

Current month kW is the highest 15-minute kW recorded at the point of delivery during the current month.

On-peak kW is the highest 15-minute kW recorded during the billing months of June through September in the 12-month period ended with the current month. For a customer contracting for new service, on-peak kW is the current month kW until Customer establishes such demand through on-peak use, unless, in Company's sole judgment, sufficient data exists for Company to estimate on-peak kW until Customer establishes on-peak history through actual use. Premise history may be used to estimate on-peak kW.

Contract kW is the maximum kW specified in the Agreement for Electric Service.

Annual kW is the highest 15-minute kW recorded at the point of delivery in the 12-month period ended with the current month.

Time-of-Day Option

At Customers option and after completion of necessary contract arrangements and installation of necessary metering equipment, the on-peak kW used in determining a billing demand is based upon the highest 15-minute kW recorded during the Company's on-peak hours in the 12-month period ended with the current month. On-peak hours are the eight hours between 12 noon and 8 p.m. each weekday (Monday-Friday), excluding July 4 and Labor Day, during the calendar months of June through September.

An additional monthly charge of $10.00 is made when Customer selects time-of-day option. On-peak kW must be established by actual use during Company's on-peak hours before billing under time-of-day option becomes effective. Service hereunder may be commenced only on the first regularly scheduled meter reading date after June 1, July 1, or August 1 containing at least 5 on-peak days. Company reserves the right to discontinue this option to additional customers if, in the Company's judgment, system load characteristics no longer warrant such option.

Special Conditions

Where Customer has another source of power which is connected, either electrically or mechanically, to equipment which may be concurrently operated by service provided by Company, Customer must install and maintain, at Customer's expense, such devices as may be necessary to protect Customer's and the Company's equipment and service.

Agreement

An Agreement for Electric Service with a term of not less than one year is required for customers having or expected to have maximum electrical loads of 500 kW or more, when special contract arrangements are involved, and may be required for loads under 500 kW. When Customer has a source of power available, not held solely for emergency use, for which the Company's service may be substituted, either directly or indirectly, or used as a standby, supplementary, or maintenance power supply, an Agreement for Electric Service is required and the maximum electrical load specified in the Agreement for Electric Service may not be less than the sum of Customer's normal load plus the load which may be carried all or part of the time by Customer's generator or prime mover or other source of energy.

Notice

Service hereunder is subject to the orders of regulatory bodies having jurisdiction and to the Company's Tariff for Electric Service.

3.4.2 Rider FC - Fuel Cost Factor

Application

Applicable to all rate schedules which provide for inclusion of fuel cost hereunder. The fuel cost factor is added to the amount due from charges of the rate schedules under which electric service is provided. The fuel cost factor is billed in proportion to the number of kWh used.

Net Monthly Bill

The fuel cost factor for each of the Company's rate schedules is as follows:

Major Rate Class	Rate Schedules	Fuel Component
Residential Service	R, RLU, RTU	1.8926¢ per kWh
General Service - Secondary	GS, OL (including all riders)	1.8926¢ per kWh
General Service - Primary	GP, SSC-T (including all riders)	1.8402¢ per kWh
General Service - Transmission	HV (including all riders)	1.8093¢ per kWh
Municipal Service - Secondary	MP-SEC, MS-SEC, SL-SEC	1.8926¢ per kWh
Municipal Service - Primary	MP-PRI, MS-PRI, SL-PRI	1.8402¢ per kWh
Wholesale Power Service - Primary	WP-PRI	1.8402¢ per kWh
Wholesale Power Service - Transmission	WP-TRAN	1.8093¢ per kWh

The amount to be billed is determined by multiplying the kWh used by the appropriate fuel cost factor and is rounded to the nearest cent.

SECTION VI – ENERGY ASSESSMENT REPORT (EAR) TEMPLATE

A. Energy Assessment Report Format

Energy Assessment Reports must be prepared in the format provided in the following pages of this publication. The prescribed format is intended to speed the review process as well as the report writing process. All numbers, titles, etc. should be in the location indicated in the format.

Equipment and material descriptions should be sufficiently complete and clear for reviewers to verify the claimed ECM costs. For simple projects (lighting retrofits, for example) which could possibly be implemented by borrower's personnel, sufficient detail about equipment, material, and locations of the proposed installations should be given so that the borrower could accomplish the project based on information contained in the assessment report alone. Recommendations for additional design/engineering should be clearly indicated as a project cost as indicated in Section II, Paragraph I of these guidelines.

Final report copies must be bound on the left-hand side in three-ring binders with the title and date of the report on the spine.

Three copies of the Energy Assessment Report must be submitted with the loan application.

U-Save Energy Efficiency Fund

ENERGY ASSESSMENT REPORT

FOR

(Name of Facility)
(Street Address)
(City, UT, Zip)
(Agency # if applicable)

Conducted by:

(Name of Firm)
(Address, Phone Number)
(Date of Analysis)

Number of Buildings:

Total Gross Square Footage:

TABLE OF CONTENTS

PREFACE
BACKGROUND
SUMMARY NARRATIVE
ACKNOWLEDGMENTS

EXECUTIVE SUMMARY
BUILDINGS/FACILITIES ANALYZED
COMPOSITE PROJECT SUMMARY
SUMMARY OF PROJECT
SPECIAL CONSIDERATIONS
TABLE 1 - SUMMARY OF INDIVIDUAL ENERGY COST REDUCTION MEASURES

BASE YEAR ENERGY CONSUMPTION AND COSTS
TABLE 2 - BASE YEAR ENERGY CONSUMPTION DATA

METERING INFORMATION
TABLE 3 - METER DATA

UTILITY RATE SCHEDULE ANALYSIS
ELECTRIC UTILITY RATE SCHEDULE ANALYSIS
GAS UTILITY RATE SCHEDULE ANALYSIS
OTHER UTILITY RATE SCHEDULE ANALYSIS

FACILITY DESCRIPTIONS
FACILITY DESCRIPTION
BUILDING DESCRIPTIONS
TABLE 4 - BUILDING DATA
TABLE 5 - EQUIPMENT LIST

TECHNICAL ANALYSIS
ENERGY CONSERVATION MEASURES (ECMs)

ANALYST CERTIFICATION

APPENDIX
SUPPORTING DOCUMENTATION
OPERATION AND MAINTENANCE RECOMMENDATIONS

PREFACE

BACKGROUND

(Provide a brief narrative description of this program, note the location/description of the facilities studied and address any significant circumstances concerning the facilities which have a bearing on energy consumption).

SUMMARY NARRATIVE

This study was performed under the U-Save Energy Efficiency Fund guidelines as administered by the Governor's Office of Energy Development. The purpose is to identify Energy Conservation Measures (ECMs) which, when implemented, will result in significant utility cost savings for (the Borrower). The savings calculations are made using sound, accepted fundamentals of engineering and current utility rate schedules.

ACKNOWLEDGMENTS

The staff of ________________ would like to extend its thanks and appreciation to (the Borrower) and its staff for assistance on the procurement of building data and operation schedules. Special thanks to *(names and titles)* for devoting time, insight and resources. Further thanks are extended to other operation and maintenance personnel for their support and helpfulness.

(Note helpful individuals and mention areas where the Borrower's personnel are doing a good job in existing energy management and projects.)

U-Save Energy Efficiency Fund

Energy Assessment Report of
(Name of Borrower)
(Street Address)
(City, UT, Zip)
Contact Person: *(Project Manager, Title)*
Phone:

EXECUTIVE SUMMARY

BUILDINGS/FACILITIES ANALYZED
(Identify name(s) of building(s)/facilities analyzed and their use, type of construction and total square footage.)

COMPOSITE PROJECT SUMMARY
(Provide a summary listing of all recommended ECMs, along with the buildings to which they apply.)

SUMMARY OF PROJECT (including simplified report projects)					
	Cat. I	Cat. II	Cat. III	Total[1]	
kWh Savings:					kWh/yr.
Demand Savings:					kW/yr.
Gas Savings:					Mcf/yr.
Btu Savings:[2]					MMBtu/yr.
Cost Savings:					$/yr.
Base Year Cost Reduction:					%
Implementation Cost:					$
Simple Payback:					Yrs.

This report identifies capital-intensive projects which, if implemented in the form recommended, will result in the savings and costs summarized above. The savings for the recommended composite project listed above account for interdependence of savings of individual ECMs. Costs for the project likewise account for savings which accrue from installing several ECMs at once and for utility rebates which will lower project cost.

SPECIAL CONSIDERATIONS
(Provide a description of any special considerations for the Borrower's benefit, including possible utility rebates. Also, detail actions and costs the Borrower will likely incur in operating and maintaining all ECMs included in the Report.)

[1] Building O&M Savings identified in the appendix **should not** be included in the total.
[2] Btu savings should be calculated on the basis of source Btus (11,600 Btu/kWh and 1,030,000 Btu/Mcf). See Appendix D for a sample Btu savings calculation for Category I Projects.

TABLE 1. SUMMARY OF INDIVIDUAL ENERGY CONSERVATION MEASURES[1]

ECM No.	ECM Title	Annual Savings				Implementation Cost ($)	Simple Payback (yrs.)	Estimated Project Lifetime (yrs.)
		Electric Energy (kWh/yr.)	Demand (kW/yr.)	Natural Gas (Mcf/yr.)	Cost ($/yr.)			
TOTAL								

[1]Paybacks may reflect utility rebates which will lower the total project cost (Borrower's Option).

Bldg. ID: ______________________
Gross Square Footage: ______________
EUI: ___________
ECI: ___________

TABLE 2. BASE YEAR UTILITY CONSUMPTION DATA

For prior 12 month period beginning ________, _____ and ending _______, _______

	Electrical							Natural Gas		Other	
Month	Consumption (kWh)	Demand Metered (kW or kVA)	Demand Charged (kW or kVA)	Power Factor	Fuel Adjustment ($/kWh)	PCRF or Cogeneration ($/kWh)	*Total Cost ($)	Consumption (Mcf)	Cost ($)	Consumption Unit	Cost ($)
January											
February											
March											
April											
May											
June											
July											
August											
September											
October											
November											
December											
Total											

	Electricity	Natural Gas	Other
Company Name:			
Company Rate Schedule			

*Certification:

Charges have been recomputed and are correct_________________________________, P.E.

METERING INFORMATION

TABLE 3. METER DATA

Meter Number	Area Served
Electric	
Natural Gas	

UTILITY RATE SCHEDULE ANALYSIS

ELECTRIC UTILITY RATE SCHEDULE ANALYSIS

NAME OF UTILITY/PROVIDER:

RATE SCHEDULE ANALYZED:

SUMMARY OF BILLING COMPONENT CHARGES:

AVOIDED COST OF ENERGY TO BE USED IN CALCULATIONS:

AVOIDED COST OF DEMAND TO BE USED IN CALCULATIONS:

COMMENTS:

GAS UTILITY RATE SCHEDULE ANALYSIS

NAME OF UTILITY/PROVIDER:

RATE SCHEDULE ANALYZED:

SUMMARY OF BILLING COMPONENT CHARGES:

AVOIDED COST OF ENERGY TO BE USED IN CALCULATIONS:

AVOIDED COST OF DEMAND TO BE USED IN CALCULATIONS:

COMMENTS:

OTHER UTILITY RATE SCHEDULE ANALYSIS

NAME OF UTILITY/PROVIDER:

RATE SCHEDULE ANALYZED:

SUMMARY OF BILLING COMPONENT CHARGES:

AVOIDED COST OF ENERGY TO BE USED IN CALCULATIONS:

COMMENTS:

FACILITY DESCRIPTIONS

FACILITY DESCRIPTION

(Provide a limited description of the facility including its size and use. Include a suitable facility map indicating the location of buildings analyzed. A copy of an 8 1/2 x 11 layout obtained from facility personnel should be used or adapted. In the absence of such a layout a sketch should be used.)

BUILDING DESCRIPTIONS

(List the name and/or number of each building and, under the listing, provide the following information:

(1) *Building Construction Description - foundation, structure, walls, windows, roof, insulation, physical condition, etc.*

(2) *Building Use - general functions, operating hours, etc.*

(3) *Building Energy-Using Systems - types, sizes, and present condition of equipment such as boilers, hot water systems, chillers, cooling towers, air handling units, heat pumps, DX units, lighting, kitchen equipment, laboratory equipment, etc.*

(4) *Building Energy-Using System Controls - manual practices and/or condition and type of automatic controls, including thermostats (with setpoints), hot water setpoints, boiler pressures and controls, chilled water setpoints, lighting controls, ventilation controls, calibration conditions and practices, etc.*

For similar buildings provide the listing and, under the listing, indicate to which building it is similar and only provide exceptions to the similarity. Tables 4 and 5 should be used for compiling this information.)

TABLE 4. BUILDING DATA

Required for buildings implementing Category III ECMs. Optional for buildings implementing only Category I or II ECMs.

Building Name	Function	Conditioned Area (SF)	Gross Area (SF)	Number of Stories	Wall Construction Type	Roof Construction Type	Year of Construction	Estimated Remaining Life (Years)	Physical Condition

TABLE 5. EQUIPMENT LIST

Required for buildings implementing Category II ECMs. Optional for buildings implementing only Category I ECMs. **Include only the equipment that affects the calculations in the Energy Assessment Report**.

Building Name:______________________

Equipment Name	Quantity	Nameplate Data	Field Measurements	Efficiency	Load Factor	Annual Operation Hours	Area Served & Sq. Ft.

E = estimated, M = measured, D = from manufacturer's data. (Use E, M, or D as a suffix where needed, particularly to indicate estimated load factors or efficiencies where no other data exists.

ENERGY CONSERVATION MEASURES (ECMs)

(List the ECMs applicable to this facility.)

CATEGORY I ECMs - LIMITED CALCULATIONS

ECM NO.:

ECM NAME:

SUMMARY DATA

See Section II, Paragraph D and Appendix D for guidance.

kWh Savings:	$______________	kWh/yr.
Gas Savings:	$______________	Mcf/yr.
Cost Savings:	$______________	/yr.
Implementation Cost:	$______________	
Simple Payback:	_______________	yrs.

ECM DESCRIPTION

Provide a narrative stating what the ECM will accomplish, what buildings it applies to, and how it is to be implemented. ***This description must be provided in detail.*** *The operating hours, load on the equipment, methods of control, size and location of equipment, etc. must also be described. The analyst should keep in mind that the reviewer must be able to read the ECM description and understand the logic of the measure and the borrower must be able to implement the ECM without additional design documents if he so desires. Include clarifying sketches as necessary.*

ASSUMPTIONS

Summarize all assumptions which affect project implementation, cost estimates and cost savings. These assumptions will include, but not be limited to, the availability of the building for project completion, equipment run times and setbacks, and any extended hours of building operation. See Section III (General Instructions).

IMPLEMENTATION COSTS

Use the following format and refer to Section III, Paragraph I (Estimating Implementation Costs). These costs should be based on the amount of equipment to be replaced, modified, or removed.

Equipment:	$______________
Materials:	$______________
Labor:	$______________
Contractor Markup:	$______________
Additional design/engineering/administration:	$______________
Escalation 15%:	$______________
TOTAL	$______________

COST SAVINGS

Estimate the annual cost savings for Category I ECMs by dividing the Implementation Cost obtained above by the Simple Payback. Paybacks for Category I ECMs are found in *Section II, Paragraph D**.*

TECHNICAL ANALYSIS

CATEGORY II ECMs – DETAILED CALCULATIONS

ECM NO.:

ECM NAME:

SUMMARY DATA (DEPENDENT)

All projects are to be analyzed in the dependent mode and in the following sequence: building loads, distribution systems, primary equipment, energy management systems. All Simplified Report ECMs are assumed to be installed for dependency purposes.

kWh Savings:	________________	kWh/yr.
Demand Savings:	________________	kW/yr.
Gas Savings:	________________	Mcf/yr.
Cost Savings:	$_______________	/yr.
Implementation Cost:	$_______________	
Simple Payback:	________________	yrs.
Estimated Useful Life:	________________	yrs.

ECM DESCRIPTION

Provide a narrative stating what the ECM will accomplish; what buildings it applies to and how it is to be implemented. ***This description must be provided in detail.*** *The operating hours, load on the equipment, methods of control, size and location of equipment, etc. must also be described. The analyst should keep in mind that the reviewer must be able to read the ECM description and understand the logic of the measure. Include clarifying sketches as necessary.*

ASSUMPTIONS

Summarize all assumptions which affect project implementation, cost estimates and cost savings. These assumptions will include, but not be limited to, the availability of the building for project completion, equipment run times and setbacks, and any extended hours of building operation (see Section III, General Instructions).

EQUIPMENT & ENVIRONMENTAL DESCRIPTIONS

Provide narrative and/or listings of all pertinent existing conditions; including, as applicable, items such as: equipment/efficiency changes, light level readings, amperage readings, temperature readings, equipment efficiencies, operating hours, existing controls and/or operating procedures, estimated loads, estimated duty cycles, etc. In other words, backup equation inputs and provide assurance that codes, standards, and comfort will not be violated by implementation of this ECM.

COST SAVINGS CALCULATIONS

Show detailed utility cost savings calculations. Show all formulas, conversion factors and equations used to determine savings. All calculations must include units. Clearly state any assumptions. Use proper utility rates. If computer programs are used, refer to Section III, Paragraph A (Use of Computer Programs for Energy Savings Calculations).

IMPLEMENTATION COSTS

Use the following format.

Design & Administration:		$_______________
Material:		$_______________
Equipment:		$_______________
Labor:		$_______________
Contractor Mark-up:		$_______________
Escalation 15% max.:		$_______________
	TOTAL	$_______________

COST BACKUP

Provide unit pricing on all major pieces of equipment and material. Provide contractor estimates on all major installations that clearly break out material, equipment and labor. Where contractor estimates are not available use a reputable pricing source such as Means. Include all reasonable markups. Provide hours and rates for all labor not included in contractor estimates. Use state contract pricing of materials where applicable. Refer to Section III, Paragraph I (Estimating Implementation Costs).

SIMPLE PAYBACK

Provide simple payback calculation.

ANALYST CERTIFICATION

The undersigned certifies that this report has been conducted in accordance with the requirements of the U-Save Energy Efficiency Fund Technical Guidelines and Format as administered by the Governor's Office of Energy Development. The undersigned also certifies that the data and the cost reduction estimates presented are factual, accurate, reasonable, and in accordance with generally accepted engineering practices to the best of the analyst's knowledge and that this knowledge is based on the analyst's on-site investigation of the facilities involved. The undersigned further certifies that the analyst has no undisclosed, conflicting financial interest in the recommendations of this report.

The undersigned also agrees that if a recommendation of this or any other report generated under this program is implemented, that no company or association that the analyst owns or has a financial interest in, will provide products or construction for this project.

____________________________________ ____________________________________

Analyst's Signature Date

____

Title

(Affix Official P.E. Seal)

____

Utah P.E. Registration No.

APPENDIX

SUPPORTING DOCUMENTATION

(Include supporting documentation, equipment cut sheets, pricing backup, utility rate schedules, lighting readings, etc.)

OPERATION AND MAINTENANCE RECOMMENDATIONS

(Refer to *Section III, Paragraph B* *and* *Appendix C* *for further instructions.)*

APPENDIX A – Definitions of Terminology Used in this Manual

Actual or Measured Demand - The power or demand actually metered within a demand time period window. This figure appears on most utility bills that include demand charges.

Analyst or Technical Analyst - The individual performing the energy assessment for a facility.

Application Part-load Value (APLV) - A measure of part-load performance of a chiller based on ARI Standard 550 – 1998 calculation method. It is computed by defining four load points on the use spectrum of the equipment then calculating the efficiency of the equipment at those points. The four points used for analysis are 100%, 75%, 50%, and 25% of load. An average performance is then calculated using the individual performance values and the weighted seasonal use at those conditions. APLV is usually stated in kW/Ton. This measure is not interchangeable with EER, SEER, or IPLV.

Auxiliary Enterprises - Those spaces whose utilities are paid through generated income; e.g., student centers, cafeterias.

Billed Demand - The utility rate schedules state how the billed demand is determined. Some rate schedules state that there is a minimum billed demand that is some percentage of the contract demand. They may also specify that the billed demand is the greater of the minimum billed demand or some variation of the following:

- the current month actual demand,
- a percentage of the on-peak and/or off-peak demand experienced within the last twelve months, or
- the minimum demand level for which the rate schedule is effective.

The billed demand may be determined using a single demand window or an average of several. For example, a utility company may use the average of the four highest monthly demands to determine charges on some rate schedules. Care must be exercised when referring to the rate schedule to determine the billed demand because of the complexity of this feature. The section in the rate schedule that describes how the billed demand is determined is usually entitled "Determination of Demand." The billed demand will appear on all utility bills that include demand charges.

Borrower - The entity - state agency, university, school district, or hospital which is applying for a loan.

Buy Down a Payback - To fund a portion of a project(s) from another source for the express purpose of meeting an aggressive payback schedule. For example, the anticipated cost for three proposed projects is $300,000. The anticipated annual cost savings realized by the projects is $50,000. The composite payback is six years. To make the projects eligible for funding with a preferred 5 year payback, the borrower contributes $50,000 to the projects from another source, lowering the amount financed by U-Save to $250,000. Payback for the U-Save-funded portion is now five years.

Category I ECM – An Energy Cost Reduction Measure (ECM) for which there are simplified energy cost savings calculated or estimated. The implementation cost is based on the quantity or amount of material or equipment to be installed. The ECM savings are determined by dividing the implementation cost by a standard payback which depends on the type of retrofit.

Category II ECM - A complex ECM project for which detailed energy cost savings calculations and documentation are required. If a retrofit ECM is not, for calculation purposes, identified as a Category I, it must be treated as a Category II ECM.

Coefficient of Performance (COP) – The ratio of the rate of heat removal, or heat delivered, to the rate of energy input, in consistent units (e.g., Btu/h output / watts x 3.413 input).

Composite ECM Payback - The weighted average payback of a set of retrofit projects. It is calculated by dividing the combined implementation costs of all the retrofits by their total annual energy cost savings.

Composite Project - A summation of all individual recommended ECMs. The cost savings and implementation costs exhibited will be the sums of the savings and costs from the individual ECMs. A summary of the composite recommended ECM project shall appear in the executive summary of an Energy Assessment Report.

Conditioned Area - The total square footage of all the space enclosed within the exterior walls of the facility, including areas occupied by auxiliary enterprises, which are provided with heated or cooled air, or both, to maintain conditions for an acceptable indoor thermal environment.

Conditioned Space - An enclosed space that is cooled, heated, or indirectly conditioned. The U-Save program administrator should be contacted immediately if an assessment of unconditioned space is requested in areas other than power plants, stairwells, gymnasiums, vocational areas, and machine rooms.

Contract Demand - Some utilities define this as the maximum demand specified in the rate schedule or agreement for service. Others define it as a percentage of the highest demand, or some other peak demand, experienced by the facility. In some rate schedules the minimum billed demand is some percentage of the contract demand. This demand value does not usually appear on the bills.

Customer or Facilities Charge - The monthly utility bill amount paid by the customer that covers the costs for metering, meter reading, billing, and similar administrative functions. The fee is not dependent upon the demand or energy usage.

Demand Charge - A charge paid by the electric utility customer based upon the rate that the energy is taken from the utility. The demand, which is also referred to as the power, is the energy rate measured during a 15 or 30-minute "demand window." There are many types of demand, which are defined below, that impact the utility bills. One or more of these will be shown on the bills, depending upon the method used to specify the billed demand. The demand charge is not a feature of residential and small commercial rate schedules, but is usually found on the larger commercial, general, and industrial rate schedules.

Demand Window - The time period over which power is averaged to determine the demand. Typical demand windows in the state vary from 15 to 30 minutes in length. The demand window travels continuously; thus, registered demand is a rolling average of the actual rate of power usage.

Dependent Measure - A retrofit measure is considered dependent if energy consumption or costs are affected by any other retrofit measure. In considering the effect of dependencies, technical analysts must use the following sequence: (1) building loads; (2) distribution systems; (3) primary equipment; and (4) energy management systems.

Electrical Consumption Blocks - A number of utility rate schedules specify that the electrical consumption be separated into "blocks" of varying size, and each block has a different price for the kWh consumed. Common methods include flat block sizes of a certain value of kWh. Other methods use a variable block size that is determined by a "block extender" multiplied by the billed demand.

Energy Assessment Report (EAR) - The technical report which identifies and documents energy projects submitted by potential U-Save borrowers for financing approval. The Energy Assessment Report is prepared by a professional engineer using the format provided in this manual.

Energy Charge - The charge for the quantity of energy consumed. This is the charge that is most familiar to users of electricity because it is common to residential, commercial, and industrial bills. This charge may vary in cost per kWh depending upon the type of service and the utility.

Energy Cost Index (ECI) - A reference expressing the total energy cost (electricity, natural gas, or other fuel costs) of operating a building over a given period (usually a year) in terms of cost/gross conditioned square feet. Units are \$/ (ft^2-yr).

Energy Conservation Measures (ECMs) – Individual retrofits/measures that are expected to conserve energy and reduce energy costs.

Energy Efficiency Ratio (EER) – A measure of the performance of a cooling system used to evaluate savings and is defined as the unit capacity in Btu/hr. divided by the power input to the unit in watts at the standard rating conditions. EER is not directly interchangeable with SEER.

Energy Utilization Index (EUI) - A reference expressing the total energy (electricity, natural gas, or other fuel source) used by a building over a given period (usually a year) in terms of source Btus/gross conditioned square feet.

Facility - Any major energy-using building (or buildings) or system which is owned or operated by the borrower, budgeted by the borrower, and billed by the local utility as one entity.

Franchise Fees - A charge to reimburse the utility for franchise fees paid to the municipalities in which it operates. Many utilities include this fee in their energy charges; i.e., not as a separate charge. However, some utilities do include it as a separate item on their bills.

Fuel Charge - The charge paid by the customer for the cost of fuel that was used by the utility to generate electricity. It is usually described in a rider to the rate schedules and may be entitled "Fuel Cost Rider." The charges for this expense are billed in cost per kWh.

Fuel Refund - A refund to the customer that is dependent upon the difference between the actual and forecasted fuel costs of the utility. Some utilities adjust their bills to include applicable refunds every month while others make lump sum refund adjustments every six or twelve months.

Gross Area - The total square footage of all the space enclosed within the exterior walls of the facility, including areas occupied by auxiliary enterprises, indoor parking facilities, basements, and penthouses. It includes all space such as hallways, lobbies, stairways, mechanical rooms, and elevator shafts.

Heating Seasonal Performance Factor (HSPF) – The ratio of the total heating output to the total seasonal input energy, usually applied to heat pumps.

Implementation Costs - All the costs directly associated with each measure. This includes direct labor to install the retrofit, supervisory labor, additional engineering beyond the initial energy retrofit recommendation, material, and equipment costs. Implementation costs do not include the EAR cost, cost to purchase and install any metering or monitoring equipment, or systems commissioning cost even though these costs may be included in U-Save loans through request of the borrower and approval by OED.

Independent Measures - A retrofit measure is considered independent if the energy consumption and cost is not affected by any other retrofit measure.

Integrated Part-load Value (IPLV) - A measure of the performance of larger water chilling equipment (greater than five tons) which is capable of significant unloading. IPLV is calculated by using ARI Standard 550/590 – 1998 for a defined set of conditions that closely reflect actual operating experience in the field for a single chiller. IPLV is usually given in kW/Ton, but it is also given in EER or COP by some manufacturers.

Net Area - The square footage of a building determined to be the net leasable or assignment area. The same as gross area except the following areas are **not** included: public restrooms, public stairwells, elevators, hallways, janitorial and other maintenance-related rooms or areas, mechanical rooms, and any other public areas determined as not assignable.

Non-standard Part-load Value (NPLV) – A measure of part-load performance of a chiller based on the ARI Standard 550/590 – 1998 calculation method. It is computed from a weighted average of the part-load energy efficiency at 100%, 75%, 50%, and 25% load points at conditions other than IPLV conditions (e.g., 42°F leaving water temperature). NPLV is usually stated in kW/Ton or EER but can also be stated in COP.

Off-peak Demand - The power or demand measured at the facility during the off-peak period. The off-peak period is defined as those months or hours when demand on a utility grid is commonly below peak levels.

On-peak Demand - The power or demand measured at the facility during the on-peak period. Depending upon the utility, the on-peak period for Utah electric utilities can be defined as May through September. However, some utilities define their on-peak period as certain hours of the day on Monday through Friday during any month in the year. These latter utilities define an annual on-peak as the highest on-peak demand during the last twelve months.

Operating and Maintenance Recommendations (O&Ms) - A recommended action that does not require loan financing and that the building staff can perform as part of their regular duties.

Power Cost Recovery Factor Charge (PCRF) - The charge to reimburse the utility for power that is purchased from cogeneration facilities. This charge is not a feature of all utility rate schedules in the State, but it is included in several. It is usually in rate schedule sections entitled "Power Cost" or in "Rider PCRF." Charges are quite variable depending upon the utility. This charge is also referred to as "Purchased Power Cost" and "Cogeneration Power Cost Recovery Factor."

Power Factor - This is the ratio of the actual power (kW) to the apparent power (kVA). The actual power, or the actual demand, is a measure of the metered power to the load. The apparent power is a measure of the actual power supplied by the utility to service the load. In resistance loads, such as incandescent lights, they are equal. However, in inductive loads such as motors, fluorescent and high intensity discharge lights, welding machines, etc. they are not equal. Most utilities have established a minimum power factor for their commercial and industrial customers. When a customer's power factor falls below this prescribed minimum value, the power factor adjustment clause of the rate schedule may be used to adjust their billing. The minimum power factor requirement by Rocky Mountain Power in the state of Utah is 90%.

Power Factor Adjustment - The power factor adjustment clause is used to increase the demand charge by the percentage that the actual power factor falls below the minimum power factor. For some utilities, if the minimum power factor is 90% and the actual measured power factor is 78%, the demand charge will be increased by 12%. Other methods of adjusting for power factor are also used.

Primary Demand - A concept used by an electric utility to determine "billing demand." If the off-peak demand is equal to or less than the annual on-peak demand, the primary demand is defined as the greatest of the following:

- the on-peak demand,
- the off-peak demand,
- 85% of the annual on-peak, or
- the minimum contract demand of the rate schedule.

If the off-peak demand is greater than the annual on-peak demand, the primary demand is defined as the annual on-peak demand.

Major Renovation - A complete renovation of 50% or greater of a defined space (usually a whole building, department, wing, etc.). The eligibility of any energy saving project proposed for funding will be based on the incremental savings and increased implementation costs beyond that necessary to meet the state energy code and other applicable codes.

Ratchet Clause - A feature of some utility rate schedules that specifies that the billed demand will be not less than some percentage of the peak demands experienced by the facility. The percentage may vary from 60 to 100%.

Regulatory Expense Surcharge - This is a feature of the rate schedules for a few utilities. The charges are billed in cost per kWh.

Retrofit Measure - A technique or technology designed to reduce utility costs at an existing facility.

Retrofit Project – The recommended ECMs for a single building or facility selected from the Composite Project list of ECMs. These recommended ECMs include design and installation of one or more measures for reduction of utility costs.

Secondary Demand - Some utilities offer this rate schedule feature when the off-peak demand is greater than the annual on-peak demand. Secondary demand is usually defined as the difference between the off-peak demand and the annual on-peak demand. The utility applies different rate charges for the primary and secondary demand.

Seasonal Energy Efficiency Ratio (SEER) – A measure of the performance of a cooling unit used to evaluate savings and is defined as the ratio of the total seasonal cooling output measured in Btu to the total seasonal watt-hours of input energy. Calculation of SEER recognizes that the cooling system operates at standard full-load conditions for a small part of its annual use. SEER is found generally on residential/commercial cooling equipment of five tons and less. Electric power is generally single phase. SEER is not directly interchangeable with EER. Also see EER, IPLV, and Section III, Special Instructions in this Guidebook.

Simple Payback - The cost of the project, including engineering, installation, and equipment, divided by the annual utility cost savings. Other savings or costs, such as reduced maintenance or operating costs, are not included.

Submittals – Technical data such as cut sheets and/or drawings as requested by the engineer to confirm products or methods of installation that the Contractor is proposing to use.

System Commissioning – The process of documenting, modifying, and verifying the performance of energy-related building systems to cause them to operate with optimum efficiency.

Technical Review - The process of reviewing the entire Energy Assessment Report prepared by the technical analyst and any other data or documents to ensure that the final report is technically correct, meets the program guidelines, and adheres to the report format requirements.

Time-of-Day Option - Some utilities offer a time-of-day rate schedule option that defines the hours of the on-peak period in order to encourage usage during off-peak times. As an incentive to select this option, these utilities may reduce the demand and energy charges for consumption during off-peak times but increase them during on-peak times.

APPENDIX B – EXAMPLES OF EFFICIENCY IMPROVEMENT OPPORTUNITIES DISCOVERED THROUGH SYSTEM COMMISSIONING

A. Temperature Controls and Set Points

- Hot and cold deck temperature set points are not correct. Units are typically not in calibration. Numerous times cold deck temperatures below 55°F and hot deck temperatures above 110°F waste energy.

- When there is an outside air or zone reset on the decks, they must be operating properly. Many times when the outside temperature is quite warm, hot deck temperatures have been discovered that are still too high. If there are no reset schedules, they can be added.

- The room temperature set points are typically not where they are scheduled. Typical EMS projects call for summer temperatures of 75°F and winter temperatures of 72°F. These are usually adjusted by the occupants or the EMS operator in a way that consumes more energy.

- Vent cycle operation on double-duct units with a single fan are typically a problem. The energy savings associated with the free cooling (mixed air temperature of 55°F) causes a higher heating penalty. This occurs because the amount of hot deck air is usually higher than the cold deck air in these weather conditions. The heat required to raise 55°F air to 100°F is greater than with 75°F return (mixed air).

- Timed on and off schedules may be defeated since operators have found that they have trouble cooling down or warming up a space. Rather than spending time to adjust schedules, the schedules drop out of place. In some cases it is easier to set the fans to a slow roll condition (if they have a variable frequency drive) so that air is provided at all times, and the fans can be set to speed up if the space temperatures rise above or below a fixed set point. The fan would then slow back down when the space temperature drops back to within limits.

- There are many locations where damper or valve actuators are not operating. Damper actuators that have turned on the rod do not control properly. Actuators with bad diaphragms will not operate to their full capability. Dampers also are frequently discovered that are frozen in place and do not move. Multiple zone dampers are especially problematic.

B. Air and Water (Chilled or Hot) Flow

- There are some occasions when air handling units are oversized, and there is excess air. Many times sheaves and motors should be changed before installing VFDs for variable flow control. There are also cases where air handling units have been changed to variable volume, and the fans do not operate at greater than 80% speed at full-load conditions.

- When air handlers are changed to variable volume, there are many instances where the controls do not operate properly. The controls are not in calibration so the fans are operating at a greater speed than is really required.

- Chilled water and hot water pumps typically do not operate at the proper head. Sometimes pumps are grossly over designed and cannot operate efficiently at actual head. When this happens, the pumps operate on the far side of the pump curve and deliver higher flow than is required. This causes lower differential temperatures since as the flow increases the differential temperature drops at the same tonnage requirements. Sometimes this can be adjusted through partial valve closures or trimming the pump impeller.

- Return fans usually cause problems with air infiltration into a building if the fan is oversized. If the return fans have a VFD for variable flow and building pressure control, the controls have to stay in calibration and set points maintained to keep building over pressurization and infiltration to a minimum.

C. Outside Air Control

- There have been many instances where the outside air dampers are inoperable or closed by the maintenance crews due to other problems. If the outside air damper is closed too far and there are exhaust fans in the building, there could be infiltration problems. Exhaust air flow is sometimes greater than that required for the people load, and the building can be negatively pressurized. This is usually a good candidate for CO_2 or timed outside and exhaust air control when there are a limited number of people in the building. However, the outside air must be kept slightly greater than the exhaust air.

- Kitchens cause some interesting problems of their own since the kitchen exhaust hoods operate on a limited basis. When these fans are operating, the outside air must match these as well. Many times the building outside air volume does not take these units into account.

- There are many areas where there are high amounts of infiltration air because of leaks around doors and windows, in wall and roof lines where the ceiling plenum is the return air plenum, and excess outside air enters the building. These need to be sealed because the outside air, as needed, should enter air handling units for filtration and dehumidification control.

APPENDIX C – OPERATION AND MAINTENANCE PRACTICES

A. Introduction

Enormous amounts of energy are wasted in existing buildings through improper and unnecessary operation of the building and its energy-consuming equipment. Operation and Maintenance recommendations (O&Ms) are relatively inexpensive (low cost or no cost) measures that can improve campus or building efficiency without substantial modifications. Often O&Ms save hundreds and even thousands of dollars' worth of utilities after implementation. A detailed program to identify, implement, and maintain all the applicable and reasonable O&Ms is currently being developed and is described later. O&Ms are not eligible for U-Save funding.

An O&M program must have long-term commitment from both management and maintenance staff to produce a lasting increase in energy efficiency and cost savings. Frequently, periodic actions are required to maintain savings. A onetime effort, without establishing a continuing program, produces only small, temporary improvements. Many O&Ms should be included in the staff's preventive maintenance program because they aid in not only increased efficiency, but also in prolonging equipment life and reducing the amount of major capital expenditures spent on equipment and system failures. The O&M program should be a part of the staff's regular, overall maintenance program.

The quality of operation and maintenance is a key factor in influencing a building's energy costs. Historically, O&M energy conservation has focused on (1) fixing damaged parts, (2) reducing excessive operating hours, and (3) making appropriate nighttime setbacks. These traditional O&M measures can substantially reduce building energy consumption in poorly operated and maintained buildings and energy systems. However, building energy consumption can be further reduced even after these traditional O&M measures are applied. Extended O&M measures involve such things as optimal adjustment of the HVAC system by adjusting cold deck and hot deck settings according to the ambient temperature and controlling parameters like space temperature and humidity. The cold deck and hot deck settings can be adjusted continuously by an Energy Management Control System (EMCS) without additional investment. The optimized cold deck settings can be implemented manually or by an EMCS. These O&M measures reduce or even eliminate reheat by optimizing the whole system performance according to current weather conditions.

Traditionally, O&M strategies have been studied and discussed frequently, but in many instances, O&Ms have not been implemented to any large extent. Building facilities' staff are usually too busy "putting out fires" and have little time to study and implement O&M measures that will save energy.

The intent of these guidelines is to provide either the technical analyst or the facilities manager with a list of traditional O&Ms along with a methodology that can be applied to survey, identify, and implement extended O&M measures at their particular site. Several case studies of O&Ms identified through prior U-Save studies are presented in order to illustrate the benefits in terms of energy savings.

B. Identification of O&Ms

Some of the activities which analysts should do in order to identify O&M measures are listed below:

1. Daytime walk-throughs to determine:

    a. Number of PCs, printers, copiers
    b. Sample wattage of office machines
    c. Lighting
        - Foot-candle readings
        - Fixture counts
        - Controls
    d. Survey mechanical systems
        - System types and description
        - Record nameplate data
        - Temperature measurements
        - Verify controls operation
    e. Condition of the building envelope

2. Interview building operators to determine/obtain data on:

    a. Building operating hours - tenants
    b. Custodial operating hours
    c. Uninterruptible loads
    d. Current energy conservation practices
    e. Operating parameters - setpoints, etc.
    f. Energy consumption history - utility bills

3. Nighttime walk-throughs to determine:

    a. Number of office machines left on
    b. Number of lights left on
    c. Number of air handlers left on
    d. Space temperature & humidity measurements
    e. Verify controls operation

4. Short-term measurements

    a. Lighting levels
    b. Hot deck temperatures
    c. Cold deck temperatures
    d. Space temperatures
    e. Return air temperatures

C. Typical O&Ms

For commercial/office and institutional buildings, O&Ms can be separated into eight categories. They are:

1. Heating & cooling systems

   a. Turn off steam/hot water valves during summer.
   b. Turn off or setback domestic hot water temperature.
   c. Isolate off-line boilers and keep on-line boilers tuned.
   d. Use low temperature condenser water to increase chiller efficiency.
   e. Replace faulty steam traps.
   f. Insulate steam, hot water and chilled water lines.
   g. Ensure that pneumatic lines are not leaking and remain water proof.
   h. Ensure that compressed air systems are maintained and operated properly.
   i. Turn off fans and pumps when not in use.

2. Interior space conditions

   a. Locate temperature and humidity sensing devices away from drafts, supply air diffusers, outside walls, and direct sunlight. Consider purchasing wireless temperature sensors.
   b. Install locks on temperature and humidity sensing devices in areas where tampering is a problem.

3. HVAC Distribution System

   a. Check heating and cooling season setpoints to be sure that they are at design values.
   b. Install meters where cost effective to monitor trouble areas and document energy savings.
   c. Adjust temperature and humidity setpoints within comfort zones seasonally, higher in summer and lower in winter.
   d. Adjust thermostat settings based on occupancy (night setback).
   e. Adjust controls to prevent simultaneous operation of heating and cooling.
   f. Maintain proper shaft alignment on motors to reduce noise and vibration.
   g. Clean all system components (for example: ducts, humidifiers, condenser coil faces, chilled water and steam coils, and fan blades).
   h. Clean or replace filters regularly.
   i. Replace inaccurate gauges and thermometers.
   j. Ensure that dampers are tightly closed and repair dampers with loose or frozen linkages.
   k. Replace worn belts and bearings on fans and motors.
   l. Keep linkage and bearings lubricated.

4. Lighting System

a. Adjust schedule so that lights are on only when necessary. Install occupancy sensors.
b. Take advantage of natural lighting where possible. Use window films to reduce glare.
c. Encourage the use of fluorescent desk lamps or table lamps where practical.
d. Reduce outdoor, decorative, and display lighting where possible.
e. Schedule cleaning tasks for daylight hours. If this is not possible, instruct the custodial staff to use only necessary lighting, one room at a time, and to turn off lights after a room is cleaned.
f. Clean lamps, luminaires, diffusers, and interior surface of lighting fixtures on a regular schedule.
g. Delamp or reduce lighting levels.
h. Replace incandescent bulbs with screw-in fluorescent lamps.
i. Disconnect ballasts where delamping has occurred.

5. Building Envelope

a. Weather strip, caulk or seal doors, windows, penetrations, and other openings.
b. Replace worn weather stripping and missing putty or caulking around doors and window frames.
c. Seal openings in walls for piping, electrical conduit, through-wall units, and window frames.
d. Replace or repair faulty door latches and adjust uneven doors.
e. Maintain adequate insulation in walls, ceilings, and roofing.

6. Power Systems

a. Turn off elevators/escalators on weekends and after hours.
b. Turn off equipment manually or through time clocks.
c. Operate one boiler, chiller, or compressor at 90 percent capacity instead of two at 45 percent capacity.

7. Controls

a. Calibrate temperature and humidity sensing devices.
b. Calibrate controls and ensure that they operate as specified in the sequence of operation.
c. Turn on/off energy consuming equipment through existing control system.

8. Water-side Equipment

a. Clean or replace strainer screens in pumping systems periodically.
b. Ensure that air separators are operating properly and that no air is entering the system.
c. Flush system periodically.

d. Use proper water treatment procedures to reduce fouling of transfer surfaces and potential biological growth.
e. Clean coils, chillers, tubes, tanks, drain pans, heat exchanger surfaces, boilers, and/or furnaces regularly.

These guidelines include some of the more important O&Ms as part of its recommendations. However, it is expected that the analyst will be able to identify additional O&Ms.

D. O&M Case Studies and Methodology

As mentioned earlier, extended O&Ms can help identify energy saving measures which traditional O&Ms cannot do. This, however, requires more careful data gathering and analysis. If an EMCS exists at the facility and if it monitors energy and demand use data of the building, this data set can be a very valuable source of information. If not, a certain amount of effort to gather such data is required.

In this section, a methodology for O&M identification is described and some case histories are presented.

1. Methodology

During the daytime and nighttime site visits, the O&M opportunities are identified and necessary information for the O&M analysis is collected.

- The feasibility of candidate O&M measures can be determined by examining the physical conditions of the HVAC systems, examining the capacity of the HVAC control system, and discussing with the operation and management staff of the borrower.

- The possibility of delamping is determined by measuring the lighting levels at several selected places during a daytime walk-through. The potential savings in lighting and office equipment shut off is determined by a nighttime walk-through.

- The building envelope and occupancy information are collected by either visual assessment and examination or interviews with building operators, office workers, and custodial staff. The building energy systems, such as AHUs and their control systems, are examined very carefully. The most important operation parameters and control methods, such as cold deck setting, total air flow rate, fraction of outside air intake, are inspected and measured if possible. Submeter data measured by the borrower, if available, are also collected. These measurements provide sufficient information for a detailed O&M analysis.

2. O&M Case Studies *(Provided by Texas LoanSTAR, the program after which U-Save has been modeled)*

Case Study 1

Building:

Library, University of Texas, Austin
Floor area: 484,000 sq. ft.
Number of stories: Six (6)
HVAC system type: Single and dual-duct VAV system

O&M Recommendations:

a) Shutoff steam valves for all the single-duct air handling units.
b) Shutoff lights during unoccupied hours.

Measured Energy Savings:

Steam: 5,300 MMBtu/yr.
Chilled water: 5,000 MMBtu/yr.
Electricity: 1,162,500 kWh/yr.

Measured Annual Savings in Dollars:

$121,000

Cost to Implement:

No implementation cost.

Case Study 2

Building:

Classroom/Office, University of Texas, Austin
Floor Area: 94,800 sq. ft.
Number of stories: Five (5)

O&M Recommendations:

a) Disable economizer cycle (because it was not operating properly).

Measured Energy Savings:

Steam:	1,030 MMBtu/yr.
Chilled water:	-235 MMBtu/yr. (penalty)
Electricity:	52,300 kWh/yr.

Measured Annual Savings in Dollars:

$7,000

Cost to Implement:

No implementation cost.

Case Study 3

Building:

Office, State Capitol Complex, Austin

Floor Area:	470,000 sq. ft.
Number of stories:	Eleven (11)

O&M Recommendations:

a) Nighttime shutdown of air handling units.

Measured Energy Savings:

Steam:	8,000 MMBtu/yr.
Chilled water:	8,000 MMBtu/yr.
Electricity:	2,407,500 kWh/yr.

Measured Annual Savings in Dollars:

$122,000

Cost to Implement:

No implementation cost.

Case Study 4

Building:

Middle School, Fort Worth ISD, Fort Worth
Floor Area: 92,900 sq. ft.
Number of stories: Two (2)

O&M Recommendations:

a) Nighttime shutdown of nonessential equipment.

Measured Energy Savings:

Natural Gas: 320 MMBtu/yr.
Electricity: 337,000 kWh/yr.

Measured Annual Savings in Dollars:

$24,000

Cost to Implement:

No implementation cost.

Case Study 5

Building:

Classrooms/Office, Texas A&M University, College Station
Floor Area: 342,000 sq. ft.
Number of stories: Four (4)

O&M Recommendations:

a) Hot water pump shutoff.

Measured Energy Savings:

Electricity: 97,000 kWh/yr.

Measured Annual Savings in Dollars:

$2,700

Cost to Implement:

No implementation cost.

Case Study 6

Building:

Hospital/Office, UT Medical Branch, Galveston
Floor Area: 138,000 sq. ft.
Number of stories: Seven (7)

O&M Recommendations:

a) Change/optimize cold deck and hot deck schedules.

Measured Energy Savings:

Steam: 9,000 MMBtu/yr.
Chilled water: 10,500 MMBtu/yr.

Measured Annual Savings in Dollars:

$123,000

Cost to Implement:

No implementation cost.

APPENDIX D – BTU SAVINGS CALCULATION FOR CATEGORY I PROJECTS

Technical analysts should provide an approximation of source Btu savings for each Category I ECM specified in the Energy Assessment Report. Annual source Btu savings may be approximated by dividing annual cost savings by either electric utility rates, natural gas rates, or both if appropriate; then multiplying the results by either 11,600 Btu/kWh or 1,030,000 Btu/Mcf, respectively.

<u>Example</u>:

ECM: Install Programmable Thermostats

Estimated Project Cost = $25,000

Simple Payback (from Table 1) = 3 Yrs.

Annual Cost Savings = $25,000 ÷ 3 Yrs. = $8,333/Yr.

$8,333/yr. x 0.80 = $6,667/Yr. (approximate electric utility savings)

$8,333/yr. x 0.20 = $1,666/Yr. (approximate natural gas utility savings)

$6,667/yr. ÷ $0.08/kWh = 83,333 kWh/yr.

$1,666/yr. ÷ $ 4.50/Mcf = 370 Mcf/yr.

83,333 kWh/yr. x 11,600 Btu/kWh = 967 x 10^6 Btu

370 Mcf/yr. x 1,030,000 Btu/Mcf = 381 x 10^6 Btu

Total Annual Source Btu Savings = 1,348 x 10^6 Btu

APPENDIX E – ECM CASE STUDIES

Provided by Texas LoanSTAR, the program after which U-Save is modeled

ECM CASE STUDIES

A. Introduction

Several Energy Conservation Measures (ECMs) are reviewed in this section as a comparison between Energy Assessment Report estimated savings and actual measured savings. These case studies are summarized with respect to the ECM implemented, site description, savings comparisons, potential reasons for the differences that exist between the estimated and measured savings, and conclusions that suggest methods for improvement of the estimates.

B. Case Studies

Case Study 1: Variable Air Volume (VAV) Retrofit

An ECM for the University of Texas at Arlington Business Building was the conversion of the air handling units from constant volume to VAV. The dual-duct mixing boxes were replaced with VAV mixing boxes, and variable frequency drives (VFDs) were installed on fan motors. This retrofit was completed in July 1991.

<u>Building Description</u>

The Business Building is a two-section structure consisting of three floors in Area A and six floors in Area B. The building was constructed in 1976 and has a total area of 149,900 square feet. Area A houses classrooms, lecture halls, and computer labs with regular hours of 8:00 a.m. to 6:00 p.m. on Monday through Friday although some classrooms and computer labs are used until midnight. Because of the computer labs, one of the three air handlers runs 24 hours a day, seven days a week.

Chilled water and steam are supplied to the building from the campus central plant. Auxiliary equipment includes a 30 hp chilled water pump and three air handlers in the building. Each is a dual-duct system that has been retrofitted with VFD. Supply fan motor sizes are 100 hp, 50 hp and 40 hp, and each unit has a return air fan (one 10 hp and two 7 1/2 hp). The units are equipped with economizer cycles which, according to the building operators, are being used.

<u>Savings Compared</u>

The estimated annual savings by the audit were $70,278. Two years of monitored data shows that the total measured savings, $70,377, is 50% of the estimated annual savings. Some of the reasons for this difference are presented in the following section.

Differences Explained

A review of the original Energy Assessment Report showed differences in the run time used and the actual building operating schedule. Another difference noted was between the estimated kW by the audit and the maximum measured kW. Adjusting these two items gives an estimated saving of $38,671 per year, which results in a measured savings that is 90% of the predicted value.

A table of the usage hours used in the original Energy Assessment Report and the actual hours are shown in Table C.1. AHU #1 serves a computer lab that requires constant cooling, and the savings potential of a VAV is affected by the substantial increase in run time. AHU #2 and AHU #3 were specified to run 8,760 hours per year in the original Energy Assessment Report. However, the actual usage hours are 5,268 hours per year, which represents 60% of the specified run time, thus decreasing the potential savings.

A comparison of the presumed air handler kW to the actual measured kW was made. In order to predict savings for each of the air handling units in the building, the Energy Assessment Report estimated a kW demand multiplied by usage hours to obtain kWh consumption. The building has been monitored since January 1991, and maximum kW demand for the monitored AHUs from January 1991 to June 1993 is less than the audit estimates. The results are summarized in Table C.2. When these kW differences are applied to the differences between Energy Assessment Report estimated usage hours and scheduled usage hours, as presented in Table C.1, the resultant kWh consumption data is greatly affected. The reader should also note that AHUs #2 and #3 are displayed as a combination because the U-Save metering combines them in the field.

Table E.1 - Energy Assessment Report Estimated Usage Hours Compared with Actual Usage Hours

Air Handler No.	Energy Assessment Report Estimated Usage Hours	Actual Usage Hours Pre & Post Retrofit	Actual/ Energy Assessment Report Estimate (%)
AHU #1	Occupied 5,840	Occupied 8,760	150
	Unoccupied 2,920	Unoccupied -0-	—
AHU #2	Occupied 8,760	Occupied 5,268	60
	Unoccupied -0-	Unoccupied 3,492	—
AHU #3	Occupied 8,760	Occupied 5,268	60
	Unoccupied -0-	Unoccupied 3,492	—

Table E.2 - Comparison of Energy Assessment Report Estimated kW and Maximum Measured kW

Air Handler	Audit Assumed kW	Measured kW	Measured/Audit (%)
1	96	50	52
2 & 3	93	75	81

On the basis of the information presented in both Tables E.1 and E.2, an analysis was done to relate these kWh consumption differences to dollars saved per year. The adjusted estimated savings, $38,671 per year, results in a measured savings that is 90% of the predicted annual value.

Conclusions

The above problems could have been avoided by the following:

- Verify the occupancy hours with building personnel.
- Use measured values rather than nameplate data.

Verify the occupancy hours throughout the buildings noting which pieces of equipment serve that area so that appropriate run times are used in the calculations. A one-time measurement of the actual load would have indicated a difference between actual load and nameplate data.

Case Study 2: Diversity

An ECM implemented in 1991 at Sims Elementary School and Dunbar Middle School in the Fort Worth Independent School District converted the fluorescent light fixtures from a 2×4 four-lamp to a 1×4 two-lamp configuration.

Building Descriptions

Sims Elementary School

Sims Elementary School is a one-story structure. Erected in 1989, the 62,400 square foot building contains classrooms, offices, and an auditorium-cafeteria. The building operates from 7:00 a.m. to 5:00 p.m., five days a week. Prior to the 1992-1993 school year, the school had a three-month summer break, but then went to a full-year schedule. Electricity is supplied to the building from a municipal power plant. The building has two 270,000 Btu/hr. hot water boilers.

Dunbar Middle School

Dunbar Middle School has a two-story main structure and a one-story activity building. The main building was erected in 1982, and the activity building was constructed in 1989. The 51,693 square foot main building contains classrooms, offices, an auditorium, a cafeteria, a library, and a gymnasium. The activity building is 6,128 square feet. The school operates from 6:30 a.m. to 7:00 p.m., five days a week. Prior to the 1992-1993 school year, the school had a three-month summer break, but then went to a full-year schedule. Electricity is supplied to the building from a municipal power plant. The building has two 110-Ton chillers, two 3,150,000 Btu/hr. hot water boilers, and a variable volume chilled water pump.

Savings Compared

The estimated annual savings by the Energy Assessment Report were $18,641. Twenty-nine months of monitored data shows that the total measured savings are $32,859. The annualized amount is $13,600, which is 73% of the estimated annual savings. This difference is explained in the following section.

Differences Explained

A review of the original Energy Assessment Report showed the diversity factor was assumed to be unity for the lighting fixtures. Several walk-throughs after the retrofit showed that the diversity was 0.75 resulting in a difference of 25%. When the corrected diversity factor is used to estimate savings, the estimated and measured savings are within 5%.

Conclusions

Several walk-throughs during the energy assessment process would give a reasonable diversity factor to be used in the Energy Assessment Report calculations. This simple procedure would not overstate the estimated savings.

Case Study 3: Motor Sizes

An ECM at the University of Texas at Austin Education Building was the conversion of the air handling units from constant volume to variable air volume. The dual-duct mixing boxes were replaced with VAV mixing boxes, and variable frequency drives were installed on fan motors. The original Energy Assessment Report made no recommendation concerning changing the original motors. However, the motors were downsized to half the original horsepower (hp) in the retrofit, completed in May 1991.

Building Description

The Education Building (EDB) is a five-story structure. Erected in 1973, the 251,161 square foot building contains classrooms and administration offices. The building is primarily occupied Monday through Friday from 8:00 a.m. to 5:00 p.m., with some occupancy at other times. Air handlers are run 24 hours a day, seven days a week. Currently, EDB has eight 50 hp variable volume dual-duct AHUs and three constant volume (7.5 hp, 7.5 hp and 5 hp) AHUs serving the building.

The retrofits implemented at the EDB were a variable volume dual-duct air handling system, variable speed pumping, and energy efficient fluorescent lights. An economizer cycle has been added as a part of the retrofit. The retrofits were completed at the end of May 1991.

Savings Compared

The estimated annual energy savings for the VAV conversion were 1,195,530 kWh, resulting in an annual cost savings of $54,397. Three years of monitored data shows that the average energy savings for the VAV conversion with the downsized motors is 1,665,049 kWh annually, which results in a cost savings of $75,760. The measured savings are 40% greater than the estimated savings. This difference is the result of the downsized motors.

Differences Explained

Originally the eight 100-hp (total 800 hp) dual-duct AHUs were included in the Energy Assessment Report for VAV conversion without downsizing. However, measurements made prior to the retrofit by physical plant personnel indicated that motor loads never exceed 50 hp per motor. Therefore, smaller 50-hp motors were installed in the retrofit with variable frequency drives, resulting in greater savings.

Conclusions

Technical Analysts should investigate the actual motor load for the equipment being considered for retrofit. A simple one-time clamp-on measurement would have identified that the actual load was different than the nameplate load. Using actual field measurements results in greater accuracy in the estimated savings.

Case Study 4: Complete VAV Retrofit

An ECM for the Perry-Castaneda Library at the University of Texas at Austin was the conversion of the air handling units from constant volume to variable air volume. The dual-duct mixing boxes were replaced with VAV mixing boxes, and variable frequency drives were installed on fan motors. The original Energy Assessment Report considered only dual-duct units; however, physical plant personnel also included the single-duct units in the retrofit, completed in December 1990.

Building Description

Perry-Castaneda Library (PCL) is a six-story building with a floor area of 483,895 square feet. Constructed in 1977, the library contains an open-stack library, offices, and computer facilities. The building is open seven days a week, Monday through Friday from 8 a.m. to 12 p.m., Saturday from 8 a.m. to 5 p.m., and Sunday from noon to 10 p.m. The air handling system runs 24 hours a day. There are eight 75-hp variable volume single-duct AHUs and four 100-hp variable volume dual-duct AHUs serving PCL.

The retrofits implemented at PCL were occupancy sensors (completed in November 1990), variable air volume air handling units (completed in December 1990), and variable speed pumping (completed in August 1990).

Savings Compared

The estimated annual energy savings by the Energy Assessment Report for the dual-duct VAV conversion were 1,319,180 kWh, which results in a cost savings of $60,023. Three and one-half years of monitored data shows that the measured energy savings for the complete VAV conversion (both single and dual ducts) are 3,271,993 kWh annually, which results in a cost savings of $148,876. The measured annual savings are 2.5 times the estimated savings. This difference is the result of including all AHUs in the VAV conversion.

Differences Explained

A review of the original Energy Assessment Report showed that only the dual ducts were considered for a VAV retrofit. The facility personnel decided to include all the AHU units in the building which resulted in higher savings.

Originally, the four 100-hp (total 400 hp) dual-duct AHUs were included in the Energy Assessment Report for VAV conversion. The inclusion of eight additional 75-hp (total 600) single-duct AHUs increases the overall converted hp from 400 hp to 1,000 hp. This increase in hp of 2.5 times is reflected in a similar increase in estimated savings and was well worth the additional cost of this change in scope.

<u>Conclusions</u>

Technical Analysts should consider both dual-duct and single-duct units in the Energy Assessment Report for further consideration.

APPENDIX F – U-SAVE ENERGY EFFICIENCY FUND APPLICATION FORM

Formal Loan Request

1. AGENCY DATA

Agency/Institution Name | State Agency # | Federal ID #

Mailing Address

City | County | State | Zip Code

2. LOAN CONTACT PERSON

Name | Title

Phone # | Email | Fax #

3. ENERGY CONTACT PERSON

Name | Title

Phone # | Email | Fax #

4. LOAN DETAILS

Total Loan Amount Requested	÷	Estimated Annual Savings	=	Simple Payback
	÷		=	

5. AGENCY CERTIFICATION

I do hereby certify that I am duly authorized to submit this application to the Comptroller of Public Accounts, State Energy Conservation Office for a loan to be approved on the basis of economic and technical grounds on behalf of the submitting agency/institution. I further certify that the information presented is true, correct and accurate to the best of my knowledge.

Name of Person Certifying | Title of Person Certifying | Submitting Agency Name

MAIL APPLICATION MATERIALS TO:
Governor's Office of Energy Development
60 South Temple, 3rd Floor, Salt Lake City, Utah 84111

6. FACILITY INFORMATION

Facility Name | Mailing Address

City | State | Zip Code

Firm Name | Mailing Address

City | State | Zip Code

Date of Audit Report

7. ECM Description

ECM Number	Building Name	ECM Description	Construction Time	Costs			Estimated Annual Savings	Payback
				Eng./Design	Construction	Total		
			TOTALS					
					EAR Cost*			
					Metering Cost**			
					Monitoring Cost**			
					Total Loan			

________________*Costs for the EAR, metering, and monitoring may be included in the loan at borrower's option.
**Maximum metering cost is 3% of ECM costs and monitoring cost is 7%. Contact OED for additional information