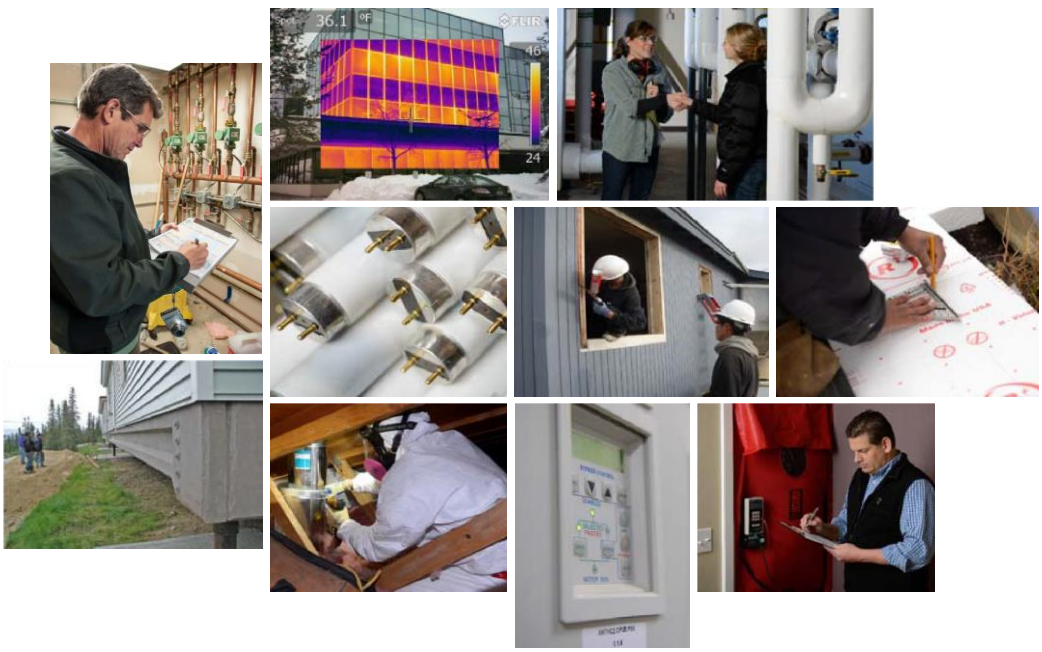
Strategic Energy Management Practices

January 2016

Alaska Housing Finance Corporation



Alaska Housing
FINANCE CORPORATION

Table of Contents

Index of Figures

Index of Tables

Forward

Purpose of this Guide

The purpose of the *Strategic Energy Management Practices* guide is to introduce public facility owners and managers to tools and resources that can be used to complete successful energy efficiency retrofit projects. The processes of procuring and implementing energy efficiency retrofit projects are complex; however when properly structured they can drive down costs and reduce inefficiencies for public entities. This guide will assist public facility owners and managers through the multidisciplinary nature of each step of the process, from energy auditing to public contracting to project financing. When applied holistically, the recommended practices and procurement strategies promote innovative design and recommend construction solutions that can achieve a wide range of energy saving goals. Procurement and budgeting practices may vary among public entities, so solutions should be carefully designed and adapted to fit local situations. It is assumed public entities have a basic capacity for contracting and legal requirements, evaluating proposals and selecting bidders, and oversight of construction processes. This guide is intended to provide industry best practices and does not address all circumstances or conditions.

Alaska Housing Finance Corporation would like to thank the US Department of Energy's (DOE) State Energy Program for providing funding for this guide, especially USDOE project manager John Winkel for his support throughout the project. Primary authors were Tim Leach, Carolyn Ramsey, and Scott Waterman, with Rob Jordan, Mike Spencer, Stacy Schubert, Jana Peirce, Katie Conway, Jessica Holden and Jimmy Ord acknowledged for editing, formatting, and layout.

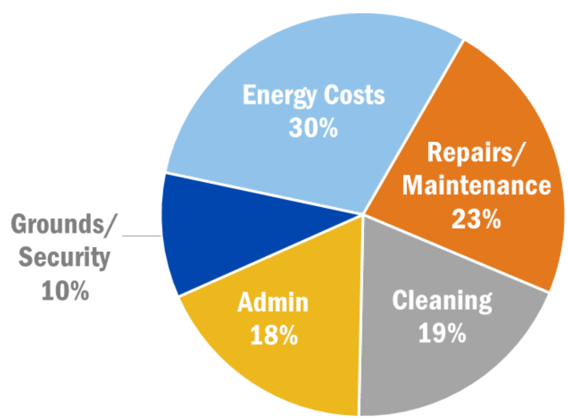
Introduction to Energy Efficiency

An energy efficiency retrofit is an investment in your building that can produce cost savings, increased durability of the structure, and a more comfortable and healthy environment for its occupants. For public facility managers, energy efficiency retrofits are a best practice for the stewardship of public funds. In an era when energy price volatility and reduced facility budgets are the norm, Alaska facility owners are well positioned to be proactive about minimizing energy costs to free money that can be focused on the mission of the organization. Government at all levels can reduce risk to energy price fluctuation and the associated negative impacts on programmatic goals by taking steps to construct or retrofit public buildings.

Energy costs typically represent the single largest controllable portion of the total operating budget for a building. Figure 1 from the Building Owners and Managers Association (BOMA) shows an average breakdown of operating costs for office buildings in the United States. Apart from fixed expenses (taxes and insurance), energy is the largest operating cost item and can represent up to 30-35 percent of total operating costs. This is particularly true in places like Alaska where energy prices are high. Costs in more remote parts of the state can reach up to $10 a gallon for heating fuel[i]. In addition, the U.S. Environmental Protection Agency (EPA) estimates that building owners can reduce energy use in buildings by up to 30 percent by adopting a comprehensive energy management strategy and by investing in cost-effective, energy efficiency technologies[ii].

Energy costs of state, municipal, and tribal buildings in Alaska can be significant burdens on a community, especially in more remote areas lacking large cash economies. High cost of inefficiency provides a tremendous opportunity to increase productivity of public dollars spent on facilities. A 2014 analysis of nearly 400 public building energy audits in Alaska showed that by implementing energy upgrades, public building owners could save an average of $21,800/year in energy savings per building, with an average simple payback of 4.5 years[iii]. While each building is unique and will vary from this average, these findings are illustrative of the savings potential available to the University of Alaska, school districts, municipal, tribal, and state agencies.

Figure 1: Typical operating costs for U.S. office buildings



A study conducted in 2012, proclaimed if energy efficiency retrofits were conducted at all of the estimated 5,000 public facilities across the state, Alaskans could save an estimated $125 million in energy costs each year[iv]. These utility cost savings could create fiscal space to allow governments to meet other critical infrastructure investment priorities. Decision makers in government who implement efficiency retrofits are practicing good stewardship of public funds while promoting community sustainability.

First Cost vs. Life-Cycle Cost

When evaluating products, new construction or retrofit projects owners typically rely heavily on the first cost or capital cost of the project as a means to select which parts to implement. This bias toward the least first cost can result in a project that provides lower value and higher operational cost to the owner during the life of the facility[v]. Project costs will always be important; however, as energy prices escalate, it is important to evaluate and compare project proposals on a life-cycle cost basis.

Life-cycle cost analysis (LCCA) is a method for assessing all costs of a product, system, or project over its useful life. Analysis includes acquisition, installation, operation, maintenance, and disposal costs, and it accounts for cost escalation. LCCA allows the user to analyze and compare two or more design or efficiency retrofit alternatives, not just on initial costs but also on all the costs (and benefits) incurred over the life of the proposed energy efficiency measures. All future costs are adjusted to present value so project decisions can be informed by capital costs and return on investment. Annual and cumulative cash flows can also be created as part of an LCCA. These projected cash flows can be a helpful planning tool for the project team as information collected regarding routine maintenance and planned replacements can influence the scope of work.

The types of expenses and savings used in LCCA traditionally only relate to direct costs of the product/systems/building that include utility costs (like water or energy bills) and operational costs/savings. Indirect costs can also be included in the analysis and might include things such as staff salaries, staff productivity, lost construction time, fire insurance, lost revenues due to downtime, and other costs that are not directly related to the cost of the building. While indirect costs are often more difficult to estimate, they are significant and should be considered.

Utilizing LCCA and managing a facility from an energy standpoint allows owners to have more control over operations and costs. There are many resources available that provide guidelines and tools for calculating life-cycle costs, including the National Institute of Standard and Technology's Life-Cycle Costing Manual[1], the Rocky Mountain Institute Microsoft Excel®-based LCC calculator called LCCAid[2] and the Alaska Department of Education and Early Development[3].

Some public entities in Alaska give preference to energy-efficient products or require life-cycle costs to be considered. All Alaska state agencies, the University of Alaska Board of Regents, the Legislative Council and the Supreme Court are all required by statute to consider life-cycle costs when evaluating proposals for leased space, lease-purchase agreements, bid acceptance and evaluation for construction projects[4]. Some municipalities and boroughs also have recommendations to use life-cycle costing. In practice, however, life-

[1] www.fire.nist.gov/bfrlpubs/build96/art121.html

[2] www.rmi.org/ModelingTools

[3] www.eed.state.ak.us/facilities/publications/LCCAHandbook1999.pdf

[4] A.S. §36.30.080, A.S. 36.30.085, A.S. 36.30.150 respectively.

cycle costs are not fully assessed or used for evaluation of project proposals and there is a bias toward least first cost for construction projects and product purchase.

Utilizing life-cycle costing to inform decision making is important for public facility owners because 1) they are often managing the properties in which they are making long-term investments, and 2) they are making investments with public dollars and whose constituents expect maximum value. Every time a building component reaches the end of its useful life, procurement officers have an opportunity to analyze life-cycle costs of the status quo option and the more efficient option to reduce long-term costs and increase overall productivity. Establishing a policy to ensure procurement decisions are informed by life-cycle cost analysis is an important step toward more efficient buildings. Where policy currently exists but execution of the policy is lacking, educating decision makers and procurement staff about the benefits and use of LCCA is a next step.

Energy efficiency investments in public facilities can stimulate local economies by creating jobs while lowering future operating costs. According to the U.S. Department of Energy (DOE), approximately 60% of the cost of efficiency investments goes to labor and half of all energy-efficient equipment is purchased from local suppliers[vi]. For every dollar spent in local economies, energy efficiency generates about $0.55 to $0.85 more economic activity than the payment of energy bills[vii]. Institute of Social and Economic Research (ISER) at the University of Alaska Anchorage determined that state spending of $110 million through the AHFC Home Energy Rebate program between April 2008 and September 2011 created 1,332 jobs. At time of the study, consumers saved an estimated $22 million/year as a result of the Home Energy Rebate program. These savings, if spent in Alaska, generate an additional 240 jobs per year[viii]. State spending on both residential and commercial energy efficiency has continued since then, and more jobs have likely been created as a result.

The U.S. Environmental Protection Agency (EPA) summarizes[ix] major benefits of energy efficiency as:

- **Reduced Energy Costs.** Energy-efficient products require less energy to operate than conventional products. Purchasing these products can reduce facility energy loads and peak demand charges, and achieve energy bill savings. Reduced energy use also decreases exposure to energy price volatility and associated challenges of budgeting with variable costs.
- **Reduced Maintenance Costs.** Because energy-efficient products, such as CFLs and light-emitting diode (LED), often have longer productive lifetimes than less efficient products, maintenance and replacement cost savings over their lifetimes can be significant.
- **Increased Economic Benefits through Job Creation and Market Development.** Energy efficiency programs in Alaska have contributed to job growth. Government units that implement energy efficiency improvements will support this market segment.
- **Increased Reliability.** When an energy-using product reaches the end of its usable life and fails, there is often a lag time of inactivity before the product is replaced. Energy-efficient products typically experience less frequent periods of inactivity because they have longer lifetimes than conventional products. This benefit is particularly relevant in areas where periods of product inactivity can have serious consequences, such as heating, sewer, and water systems during the prolonged cold of Alaska's winter.

- **Improved Occupant Health.** Some energy-efficient products remove sources of indoor air contaminants, such as moisture, mold, and chemicals. Energy recovery ventilation equipment, for example, can reduce infiltration of air contaminants from outdoors while significantly reducing a building's Heating, Ventilation and Air Conditioning (HVAC) system energy load[x]. One study of building performance found the average reduction in illness as a result of improving air quality in buildings is approximately 40 percent[xi]. The Lawrence Berkeley National Laboratory reports that poor indoor air quality in U.S. offices costs the economy more than $17-26 billion annually[xii]. Building owners and occupants have an opportunity to improve building and occupant performance.

Energy efficiency in buildings can improve indoor air quality and indirectly reduce emissions.

---

i (Alaska Department of Commerce, Alaska Fuel Price Report)
ii (U.S. EPA, 2011)
iii (Alaska Housing Finance Corporation, 2014)
iv (Alaska Housing Finance Corporation, 2012)
v (Barnes, Hodgin, Brew, & Karolides, 2013)
vi (U.S. DOE, 2004)
vii (Harris, et al., 2004)
viii (Goldsmith, Pathan, & Wiltse, 2012)
ix (U.S. EPA, 2011)
x (U.S. EPA, 2014)
xi (Kats, 2006)
xii (Fisk, Black, & Brunner, 2011)

Summary List of Best Practices

Planning and Feasibility

Policy. Develop an energy policy for public buildings to promote efficient energy use, occupant comfort, and high indoor air quality. An energy policy should include accountability, operation's schedules and setbacks, and procedures for occupancy and energy management education for operators and occupants. Effective energy policies frequently include rewards for good energy stewardship (see Chapter 6, **Strategies for Effective Program Implementation**).

Proper planning prevents poor performance.

Be Opportunistic. Take advantage of opportunities to incorporate energy efficiency measures into scheduled maintenance during the buildup to retrofit projects. If you have a heat plant that needs replacing, upgrade to a more efficient model. Too often opportunities are missed during the planning phases of an energy project (see page **6.16**).

Energy Manager Position. Create or hire an energy manager. Smaller organizations may want to consider contracting energy management services to a service provider (see Chapter 3, **What an Energy Manager Does**).

Project Management Team. Select initial team members with energy retrofit expertise who can find the maximum potential value of a retrofit and who can help ensure execution cost is not the only decision-making factor. Many local governments may not have existing energy retrofit expertise but would benefit from having their key decision-makers as part of the project management team (see Chapter 3, **Energy Management Team**).

Performance Benchmarks. Benchmark the overall energy performance through review of recent utility bills to better understand current energy usage. Install metering and data collection systems for all public buildings. Establish an energy usage baseline, and then monitor spikes and anomalies to aide in setting performance targets and comparing proposed energy management approaches (see Chapters 4 and 6, **Benefits of Benchmarking**).

Site Assessment and Project Feasibility. Conduct an energy audit to inspect the facility and collect detailed operation and performance data on specific building systems. An energy audit report will provide the owner with detailed analysis of the existing building and systems, recommend energy efficiency measures, and estimate energy savings. Preliminary upgrade costs and energy cost savings are included to inform return on investment per measure and allow the owner to asses cost effectiveness and overall project feasibility. (see Chapter 3, **Energy Assessment and Opportunity Identification** and Chapter 5 **Energy Audits**).

Evaluate Cost of Delay. Assess how delaying building improvements could raise costs through increased utility bills, erode occupant satisfaction, and exacerbate operational and enterprise risks. (see Chapter 15, **Evaluating Risk and Return**).

Contracts, Insurance, and Legal. Write contracts that align the team around a shared project vision, properly designating responsibilities and compensating performance. Ensure legal and insurance strategies are fully sensitive to the special considerations for your project (see Chapter 4, **Contract Types**).

Scoping and Design

Occupant and Manager Engagement. Incorporate occupants and building manager in the design process, and solicit their input on design and operation of the retrofitted building (see Chapter 6, **Involve Employees, Facility Managers, Maintenance Teams, and Other End-Users**).

Integrative Design. Emphasize integrative design principles to establish team dynamics and working relationships and reveal potential energy savings (see Chapters 6 and 7, **Integrative Design Process** (aka Integrated Project Delivery).

Reduce Loads and Improve Shell, Then Accurately Size Equipment. Reduce capital expenditures and minimize future operating costs by first reducing loads, and then installing efficient, optimally sized systems.

Design Options Assessment. Analyze using energy modeling and life-cycle cost analysis to find which combination of energy-efficiency measures provides the greatest value to the building's owner and occupants (see Chapter 6, **First Cost vs. Life-Cycle Cost**).

Project Phasing Phase a project over multiple stages and years, depending on efficiency and expected life of existing improvements, leasing situations, consideration of future technology/economic conditions that might make currently infeasible measures, and owner cash flow requirements (see Chapter 3, **What an Energy Manager Does**).

Measurement and Verification. Carefully think through measurement and verification (M&V) systems to ensure proper quantification and to verify project energy savings (see Chapter 12, **Measurement and Verification**).

Cost Estimation. Estimate gross and net costs of the retrofit. This is critical to determining its financial viability, and is most insightful when compared against a baseline and assessed using bundles of energy efficiency measures. Identifying factors that can undermine energy retrofits (short-term lower utility rates, contractor or equipment underperformance, warm weather, unexpected vacancies, operations staff changes, etc.) provides a complete picture of the potential cost.

Code Requirements. All new public facilities should comply with an Alaska specific minimum energy code such as Alaska Building Energy Efficiency Standard (BEES). BEES is based on the International Energy Conservation Code (IECC) and the American Society of Heating, Refrigerating, and Air-Conditioning Engineers (ASHRAE)

Standards and has Alaska-specific amendments to address unique cold climate requirements. Be aware of potential conflicts between codes, standards, and regulations stemming from an energy retrofit. Work with local and state officials to mitigate risks.

Equipment and Controls. The equipment should be variable and programmable for changing occupancy needs, yet simple enough to be effectively maintained and operated by local staff. Demand controlled ventilation that reduces outside ventilation air to the actual occupant load as opposed to building design load should be employed as a cost reduction strategy.

Consolidation/Modular Design. Consider offering unused or under-utilized space for post offices, clinics, city management offices, or other public uses. During periods of low occupancy, setback thermostats or controlling setback temperatures through Direct Digital Control (DDC) systems is an effective cost reduction strategy.

Finance

Finance Options Assessment. Consider the full array of financial options available as early in the execution process as possible. Compare alternatives considering all terms and conditions, including interest rates, financing amount, closing costs and timing, escrow and hold-back requirements, recourse, etc. (see Chapter 15, **Evaluating Risk and Return**).

Risk Management. Secure well-documented support for retrofit value. An Investment Grade Audit (IGA) complete with a life cycle cost analysis of recommended energy conservation and energy efficiency measures is necessary to evaluate economic benefit of any retrofit project. Identify and evaluate risk factors associated with the project, document whether the developer or owner bears the risk and the plan to minimize the risk. Due diligence may involve third-party reporting plus expert review similar to what is used in other complex risk situations (appraisal, Phase 1 Environmental Site Assessment, Property Condition Assessment engineering report) or new types of insurance (Energy Savings Warranty) (See Chapter 15, **Evaluating Risk and Return.**)

Life Cycle Cost Analysis (LCCA). Many retrofit loans and equity investments require economic analysis tools to quantify the differential costs of alternative investment options for a given project. LCCA can be used to develop rigorous well-supported assessment of retrofit value and risk, and is recommended to be considered at design, finance, and operations stages of retrofit projects. (see Chapter 6, **First Cost vs. Life-Cycle Cost**; Chapter 5, **ASHRAE Level I, ASHRAE Levels II and III**; and Chapter 15, **Evaluating Risk and Return**.)

Utilization of Subsidies. Take advantage of all government and utility tax, financial, and entitlement-related subsidies.

Select contractors with appropriate certifications and experience. Proper installation can impact energy use, safety and durability.

Construction

Contractor/Service Provider Selection. Utilize contractors (ideally early in the design) and service providers with requisite experience in deep energy and sustainability building retrofits.

Construction Management. Implement construction management techniques to keep the project on time and on budget. (see Chapter 3, **Energy Management Team** and Chapter 8, **Which Construction Management Services to Use?**).

Operation

Operations and Maintenance Plan. Involve maintenance personnel and facility operators in building upgrades from project conception. When maintenance personnel and facility operators are involved at the beginning of the project they can help establish energy reduction goals, understand the upgrades and be more engaged to help achieve them, and ensure they are able to manage the new systems effectively (see chapter 6, **Operation and Maintenance** and chapter 14, **Maintenance Management Plans**).

Seasonal Shutdown of Appliances. Refrigerators, freezers, and boilers that sit vacant for several months each year should be shutdown where possible. Schools offer the greatest opportunity.

Commissioning ensures that building controls are properly set. Staff will need additional training to operate the building efficiently

Commissioning. Implement commissioning during the design process, construction of the retrofit, and on an ongoing basis to ensure systems and equipment were installed and are operating according to design. (see Chapter 5, **ASHRAE Levels II and III**; Chapter 11, **Commissioning and Retro-commissioning**; and Chapter 12, **Steps to Determine and Verify Savings**).

Education. Create and offer building operator training, and building owner education about building energy use. This could include a resource of trained professionals assigned to regions or districts who act as trainers and mentors for building operators.

Building Monitoring System. Install a building monitoring system. It provides feedback on retrofit measures employed, assists operations and maintenance personnel, provides feedback to engineers to properly size systems, and helps to identify opportunities for future projects (see Chapter 6, **Building Monitoring System** and Chapter 13, **Building Monitoring**).

Periodic Review of Automation Strategy. On a seasonal basis, review automation system settings (see Chapter 3, **What an Energy Manager Does** and Chapter 1, **Introduction to Energy Efficiency**).

Continuous Energy Management Plan. Develop a commissioning plan with the express goal of maintaining and prolonging the energy savings from installed measures during the building retrofit (see Chapter 11, **Commissioning and Retro-commissioning**).

Overview

Energy management—employing an energy manager to help reduce operating and maintenance costs and increase building energy efficiency—can be one of the most cost-effective energy saving measures available to an organization. Based on two independent programs, findings show that facility owners with energy managers saved an average of 30 percent on energy-related costs[i]. Energy efficiency should be considered at all levels of managing a facility, from routine operations and maintenance to major renovations and system upgrades. Effective energy management also maintains and enhances occupant comfort by looking at measures such as indoor environmental quality, ventilation and lighting levels.

The US Department of Energy's Office of Energy Efficiency and Renewable Energy defines corporate energy management as an "integrated, company-wide effort that involves making business decisions about commercial and industrial equipment, establishing procedures that ensure greater energy and process efficiency, and encouraging behaviors that save energy and money"[ii]. Energy management should be a facility-wide effort that requires sustained management support at all levels of the organization. Without support, sustained energy efficiency results may be difficult.

Knowing where and how energy is used is a critical step in energy management.

Effective energy management involves identifying and understanding where and how energy is used in a facility, and using that information to measure, manage, and, minimize energy consumption while meeting performance standards[iii]. Impacts and interactions of building components, including building site; envelope (walls, windows, doors, and roof); heating; ventilation and air-conditioning (HVAC) systems; lighting; controls; equipment; occupant satisfaction and productivity; and maintenance schedules need to be taken into consideration. An energy manager will work closely with a client and members of a project team to develop strategies to achieve energy-related goals, improve energy efficiency, and optimize building performance while maintaining or improving building comfort and production levels.[iv]

The Alaska Legislature passed two bills in 2010 related to building energy efficiency. HB 306[5] mandated Alaska's energy policy of 15 percent energy efficiency on a per capita basis by 2020 and SB 220[6] mandated a minimum of 25 percent of all public facilities shall be retrofitted starting

---

[5] www.legis.state.ak.us/basis/get_bill_text.asp?hsid=HB0306Z&session=26

[6] www.legis.state.ak.us/basis/get_bill.asp?bill=SB%20220&session=26

with the least energy-efficient. Since passage of SB220 dozens of state buildings have completed energy efficiency retrofit projects and are seeing a decrease in energy consumption and energy costs.

Why an Energy Manager is Useful

An energy manager will frequently reduce costs, carbon emissions, and financial risk by providing leadership and accountability. They are also likely to set targets for energy reduction. Energy managers who understand effective energy management will enable those aggressive targets to be met.

An energy manager regulates how energy is used to increase energy cost savings. Primary duties of an energy manager are to monitor an organization's energy use. This is accomplished by monitoring, recording, and tracking monthly utility bills of each building in an organization's portfolio. Often, when an energy manager analyzes utility bills for the first time s/he will discover energy consuming events have been perpetuating for years, resulting in significantly higher energy costs. Energy managers also compare building energy use among similar buildings, investigate anomalies, and recommend corrections. S/he scrutinizes maintenance and operations for possible efficiency improvements, then will train operators about automation schedules, equipment maintenance, and operation schedules.

An energy manager often oversees a retro-commissioning project (see **Chapter 11**), which can yield a payback in one to two years and does not require large capital outlays. S/he may supervise a walk-through audit of each building to seek further opportunities for attention and study. If opportunities for further attention are identified, an energy manager can suggest a full-scale audit of each building.

When a full-scale audit is performed, the energy manager should review the results, perform life-cycle cost analysis of potential improvements, and determine what items recommended will be most beneficial. Once retrofits are complete the equipment is commissioned to ensure proper operation, then the measurement and verification process begins. The energy manager will continue to monitor the newly installed systems using long term measurement equipment, such as a whole building monitoring system.

What an Energy Manager Does

The position of energy manager is unfamiliar to many organizations. Hiring staff with energy management skills is not common in today's workplace. Why are energy managers necessary? What would they do? How would one justify such a position?

Energy managers work with all levels of facility staff to identify efficiency goals and opportunities.

An effective energy manager recognizes building operation best practices by understanding how, when and, where a facility consumes energy. An energy manager will meet with the building owner, maintenance staff, and occupants to determine and define energy efficiency goals. Preliminary data such as utility bills will be used to benchmark the building's current energy performance. Historical energy consumption and utility bill analysis will assist the energy manager in understanding the building's current energy usage, accurate billing, and rate information identifying future cost savings. Once the energy manager has completed the analysis, s/he will provide the building owner with potential energy-saving measures. This analysis may include upfront installation and or construction costs, and projected returns from energy savings. An implementation timeline should also be presented along with a strategic energy savings plan that includes an operations and maintenance plan, schedule, system upkeep manual, and measurement and verification implementation plans (see **Step 2: Develop a Project-Specific** M&V Plan).

An energy manager will create an energy management plan and oversee the implementation of recommended energy efficiency measures. S/he will arrange and implement operations and maintenance training for building staff as well as occupant energy efficiency training. An energy manager will ensure a building is retro-commissioned on schedule and benchmarked regularly. S/he will develop an energy management plan, which is updated regularly to ensure optimum energy efficiency is maintained. The multi-step process outlined below[v] provides a guideline for what the energy manager may require.

1. **Energy Use Assessment.** Involves facility owner/manager consultation, preliminary site assessment, and benchmarking. During this phase, the energy manager develops the client's goals and gauges a building's potential for reducing energy use and improving performance. The energy manager uses building energy data to perform detailed utility bill analyses of current and historical usage and cost patterns. These analyses are vital to determining the energy savings and cost reduction potential of any proposed measures.
2. **Site Assessment.** Requires the energy manager to perform a field inspection, which provides detailed operational data regarding specific building systems. Preliminary testing, adjusting, balancing, and functional testing provide the energy manager with valuable insight to further refine measures and facilitate existing building commissioning activities. The energy manager can then provide a detailed analysis of measures and existing building commissioning activities which will help quantify energy savings estimates and anticipated performance improvements.
3. **Project Feasibility.** The energy manager will work with facility management to determine how many suggested energy efficiency measures are financially feasible to implement, and when. These energy efficiency measures will be fitted into multiple categories: those to be implemented immediately or in the short term, those to be implemented in long term plans or over time, and those that are prohibitive for the existing building.
4. **Implementation.** The energy manager develops detailed plans for implementing measures and existing building commissioning. After measures are installed, the energy manager will assist with commissioning and installing measurement and verification equipment.
5. **Verification and Documentation.** This stage begins with functional testing to confirm newly-installed systems operate as designed, followed by measurement and verification. The energy manager will also compile a variety of documents related to commissioning, operations and maintenance, and building staff training. The documents will help the energy manager maintain a high level of building performance.
6. **Continuous Energy Management.** The energy manager will initiate an ongoing commissioning plan with the goal of maintaining and prolonging energy savings from installed measures and existing

building commissioning. The energy manager will work with the client to develop strategies for ongoing energy management activities, including enhanced operations and maintenance practices, regular benchmarking, and additional training opportunities.

Sharing Resources: Regional Energy Manager on Contract

A single energy manager or a team of individuals may be required to serve in an energy management capacity, depending on the size of the company or region. Small organizations may only need occasional contract energy management services allowing a single individual to cover multiple organizations in one area. There are times when the lead facility maintenance technician is also the energy manager; however, this situation is not considered optimal, due to workload.

Developing policies that govern measurement, monitoring, and maintenance standards can significantly reduce energy use and costs. A regional energy manager will set goals to evaluate and improve a buildings energy efficiency to enable optimal building system performance. Regional energy managers also oversee training of operations and maintenance staff and provide energy-saving recommendations to building occupants. They develop, implement, and use an ongoing commissioning plan to maintain optimum building energy efficiency. They also develop and implement building monitoring plans – to track energy use and help pinpoint energy-use irregularities – and explore new technologies and methods for building operations.

Responsibilities of each regional energy manager, specific to the communities' needs, will be drawn up and included in each contractual agreement.

Contracts can run, on average, from one to five years and will describe the type of energy management services needed for each building(s) or community. The energy manager contract should at least cover the energy management options of energy use assessment, site assessment, retro-commissioning, monthly utility bill and energy monitoring, maintenance and operations oversight and training, measurement and verifications plan, and benchmarking. The contract will show estimated project costs, capital costs, percentage financed, and simple payback years. Energy conservation measure options, such as mechanical system upgrades, controls, renewables, lighting, cogeneration, and or water conservation, will be listed on each contract. Everything may not fit neatly into one contract; therefore, attachments for facility/site plans, design drawings, payment provisions, historical data, design specifications, special requirements, utility usage history, certifications, and economic analysis may be added.

With energy management centralized among a few communities or within a region, fuel deliveries, construction materials, and services can be organized through one source saving the client time and money.

Qualifications

An energy manager should be proficient in planning, have excellent communication and interpersonal skills, and have a good understanding of[vi]:


Effective energy managers are competent in a variety of areas, from technical knowledge to team management.

Building and Facility Knowledge

- Energy measurement and verification techniques and protocols
- Building construction techniques
- Building envelope systems and design
- Facility and industrial processes
- Energy fundamentals
- Electrical systems
- System optimization fundamentals
- Traditional, new, and developing energy-related technologies
- Operation of energy-using equipment and systems
- Efficient use of energy in buildings
- Efficient use of energy in processes, systems, and equipment
- Operations and maintenance practices and requirements

Technical Knowledge

- Mechanical and electrical engineering principles
- Facility and industrial processes
- Operations and maintenance practices and requirements
- Awareness and understanding of new and existing technologies
- Building automation and interoperability
- Instrumentation and controls

Analysis

- Energy/mass balance diagrams and models
- Data collection and logging
- Metering, monitoring, measurement, and verification
- "Whole-of-systems" analysis
- Identifying creative solutions
- Identifying significant energy uses

Energy Assessment and Opportunity Identification

- Assessment/audit skills
- Understanding of factors influencing energy use or waste
- Understanding of the cost implications of wasting energy
- Building energy rating and simulation methodologies

- Implementation cost calculation
- Life-cycle cost analysis

Regulations, Standards, and Best Practices

- Federal, state, and local building regulations and codes
- National energy regulations and laws
- Heating, ventilation, and air conditioning (HVAC) and indoor air quality standards

Energy Management Team

An energy management team should involve the following departments: engineering, purchasing, operations and maintenance, building/facilities management, environmental health and safety, corporate real estate and leasing, construction management, contractors and suppliers, and utilities. The team will collectively possess knowledge and experience in[vii]:

Management

- Business decision-making fundamentals
- Business improvement skills
- Organizational and leadership skills
- Business case development
- Determining stakeholder roles
- Stakeholder engagement
- Developing multidisciplinary teams

Knowledge of Regulations, Standards, and Best Practices

- Federal, state, and local energy legislation and policies
- National energy reporting systems
- Federal, state, and local building energy efficiency standards (BEES) and programs
- Environmental regulations
- Energy management system concepts (e.g., ISO 50001)

Financial and Accounting

- Financial decision-making processes
- Risk management
- Economics of energy management

Technical Knowledge

- Facility and industrial processes
- Energy fundamentals
- Energy metrics
- Energy measurement and verification techniques and protocols

Other Knowledge and Skills

- Communication and interpersonal skills

Benefits of Energy Management

Even small organizations may benefit from the services of an energy manager. For example, the energy manager position could be contracted to a firm that specializes in energy management or one person within an organization could dedicate a portion of their time to energy manager duties. An energy manager may find ways for an organization to reduce energy costs. One way might be to incentivize maintenance and operations staff with a portion of the energy cost savings. This can often increase productivity and result in better maintenance.

---

i (Alaska Housing Finance Corporation, 2013)
ii (Machinchik, 2013)
iii (Energy Management Association, 2014)
iv (Energy Management Association, 2014)
v (Energy Management Association, 2014)
vi (Global Superior Energy Performance Partnership Energy Management Working Group, 2013)
vii (Global Superior Energy Performance Partnership Energy Management Working Group, 2013)

Benchmarking Tools

To manage energy use, one must first have a baseline against which to compare building changes. This baseline allows measurable progress in controlling a building's energy use. Benchmarking a building helps show how and when a building uses energy. Benchmarking can assist building owners and tenants in identifying poor-performing buildings by comparing energy use in similar buildings. Poor-performing buildings can then be targeted for energy efficiency improvements. Benchmarking also provides high-performing building owners with information to achieve greater occupancy rates, rents, and property values.

Benchmarking determines how much energy is used in a facility.

Benchmarking is the preliminary data collection and analysis that takes place before an energy audit. Typical benchmark data consists of building age, square footage, occupancy, building drawings (original and additions), and historical energy use (preferably a minimum of two years of fuel and electric bills, etc.). Facility staff is usually responsible for collecting this data. Once collected, an auditor can use it to determine the level of audit needed or whether or not undertake retro-commissioning (see **Chapter 11**).

If the capacity exists, an organization's staff can benchmark a facility. A Certified Energy Auditor (CEA) contractor can also benchmark the building during the energy audit (see **Chapter 4**). After benchmarking a facility's energy use, the building owner or manager can use the information to make decisions regarding which buildings to audit first.

Benchmarking should record basic information such as building name, location, square footage, facility use type, occupancy schedule, and utility usage and cost data. Benchmarking an existing building usually requires a minimum of two years of utilities data.

A variety of software programs are available that can track benchmarking information. The Retrofit Energy Assessment for Loan (REAL) spreadsheet form, the Energy Star Portfolio Manager (developed by the Environmental Protection Agency (EPA)), and AHFC's Alaska Retrofit Information System (ARIS) are among the most commonly used tools in Alaska. The tools generate an energy use index (EUI) and energy cost index (ECI). ARIS is a database containing information that is used to compare buildings of similar EUI/ECI, size, age, climate, etc., in Alaska. If a building owner has multiple buildings, it is possible to compare benchmarks across buildings. Both tools can track energy use and compare trends on a monthly or yearly basis. ARIS is free to use for any public facility. Contact AHFC Research & Rural Development for more information. www.ahfc.us

Figure 2: Screenshot of ARIS REAL Form

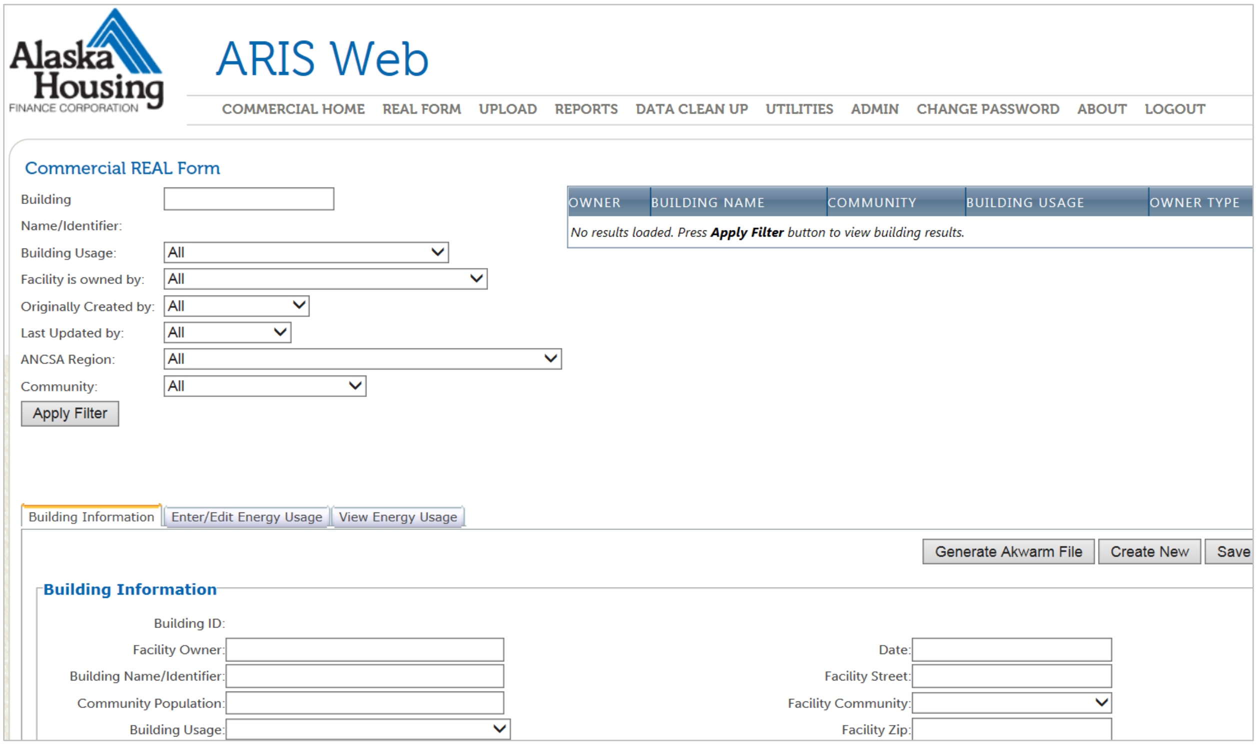


Figure 2 is a screenshot of ARIS. With ARIS, users can trend historical energy use, determine energy use per square foot, and compare energy use across facilities. ARIS is a building energy-use database that contains more than 1,000 buildings in Alaska. State agencies are required to track their energy use through ARIS and the system is available to schools, municipalities, and private building owners. The repository of energy-use information in ARIS allows users to compare their facilities to buildings of a similar type and use in the same region.

Facility owners may also use the stand-alone REAL benchmark form for their original benchmarking audits and to track energy data. If the building owner wants to track a single facility's energy usage, the REAL form will suffice. For comparisons to similar buildings, the REAL data will need to be entered into ARIS. An Excel® version of the REAL benchmark form[7] is available from AHFC's website. www.ahfc.us

The Energy Star system compares data on a national level. Building owners or staff can access Energy Star's Portfolio Manager by establishing an account through Energy Star. Find more information online[8].

---

[7] www.ahfc.us/efficiency/research-information-center/energy-efficiency-public-facilities

[8] www.energystar.gov/buildings

Understanding Audits

An energy audit will help determine what potential energy savings are in one or multiple buildings. This audit can include identification of changes to a building's structure, equipment, systems, and/or operational procedures that will result in less energy consumption, improved comfort, and provide sufficient cost savings to pay for improvements over a given time period. The audit can serve as a pre-feasibility study for an energy efficiency project by confirming cost-effective energy savings opportunities exist. The audit can also identify systems to be retrofitted and define project parameters which may then be stated in the building owner's Request for Proposal (RFP). Different types of energy audits offer varying levels of detail; efforts should be made to tailor every audit to each facility's needs.[i]

The American Society for Heating, Refrigeration and Air-Conditioning Engineers (ASHRAE) categorizes energy audits into three levels, summarized in detail:

ASHRAE Level I

An ASHRAE Level I audit is a walk-through visual assessment of energy systems and components in a building. The auditor completes a thorough analysis of benchmark data and compares the building to industry standards. This preliminary audit is used to gather additional information that can be used for more in-depth audits; it is not comprehensive. Level I is the lowest-cost audit and a first step to improving efficiency. This audit level involves refining systems and structure assumptions that were based on as-built drawings and utility data to identify low-cost or no-cost energy efficiency measures (EEMs) or retro-commissioning opportunities. The visual inspection can often identify other items that should be further investigated. Energy management and operations, and maintenance recommendations may also be identified. These will be simple recommendations, like whether the gym is still being heated and ventilated for Saturday open-gym periods that may have stopped five years ago. This is a great preliminary step to determine whether a more in-depth audit with energy modeling is required.

Walk-through audits identify low and no cost efficiency improvements, such as boiler set-points, and can identify options that need further investigation.

An ASHRAE Level I energy audit provides:

- A brief on-site survey of building
- Identification of key energy using systems
- Identification of no-cost/low-cost changes
- Identification of areas of further consideration/analysis
- Identification of potential capital improvements for consideration
- Basic system operational health

ASHRAE Levels II and III

If an ASHRAE level 1 audit indicates an energy efficiency retrofit project is potentially feasible, a more comprehensive energy audit with energy modeling is a prudent next step. If there is interest in a more comprehensive investigation and/or larger retrofit project for deeper savings, specify an ASHRAE Level II or Level III energy survey and engineering analysis. Before performing a Level II or Level III energy audit, the auditor may require:

- Automation system overview, set-points and sequence of operations
- Heating system, ventilation system, air conditioning
- Lighting
- Electrical equipment (motors, pumps, equipment, plug loads, appliances) and equipment update logs
- Specialized equipment
- Domestic water heating
- Building envelope
- Employee or building user behavior

And a report detailing:

- Energy consumption history
- Facility use
- Equipment list
- Equipment logs
- Existing conditions
- Current energy efficiency measures
- Life cycle cost analysis to proposed measures (including implementation cost, operational, and energy savings per measure)
- Description of methods of analysis
- Supporting calculations

An ASHRAE Level II audit is an energy survey and engineering analysis. It is a standard audit that evaluates how and where energy is used. It includes a detailed look at all building components. It takes into consideration occupants' behavior and operations and maintenance procedures to produce recommendations. The auditor performs in-depth on site measurement and testing to verify a building's efficiency and to calculate energy costs and savings. Energy

Energy Audit Types

ASHRAE Level 1 Audit provides:

- A brief on-site survey of building
- Identification of no-cost/low-cost changes
- Identification of potential capital improvements for consideration.

ASHRAE Level 2 Audit provides:

- A more detailed building survey
- Breakdown of energy use
- Savings and cost analysis on all energy efficiency measures (EEM)
- Identification of capital intensive EEMs requiring more thorough data collection and analysis

ASHRAE Level 3 Audit provides:

- The elements of a level 2 audit
- A more rigorous analysis and engineering for major capital improvements

modeling is also typical. This audit provides energy calculations and financial analysis of proposed EEMs. The analysis allows the facility owner to truly understand the financial benefits of installing the recommended EEMs listed in the audit. (See Chapter 15, **Life Cycle Cost Analysis**)

An **ASHRAE Level II** energy audit provides:

- A more detailed building survey
- Breakdown of energy use
- Savings and cost analysis on all EEMs
- Identification of capital-intensive EEMs requiring more thorough data collection and analysis

Thermal imaging can be part of energy audits. A thermal image camera may be one of the tools an auditor may bring.

An **ASHRAE Level III** audit is a detailed analysis or investment-grade audit. It is an expansion of the previous audit levels and is based on the facility representative's selection of measures to analyze further. Typically, auditors incorporate firm contractor costs and material prices to provide an accurate estimate of implementation costs. Energy savings calculations are more certain because they usually include actual building data. These savings combined with real construction costs result in reliable payback estimates for the targeted energy improvements.

An ASHRAE Level III energy audit provides:

- The elements of a Level II audit
- A more rigorous savings and cost estimate analysis and engineering for major capital improvements

An energy auditor who performs these assessments maintains Certified Energy Auditor (CEA), Certified Energy Manager (CEM) certification or an Association of Energy Engineers (AEE)—CBCP- Certified Building Commissioning Professional or Commissioning Agent (CX).

The energy auditor will consult with the operations and maintenance (O&M) team for design and operational considerations and review the buildings preventative maintenance schedule, capital improvement plan, and the list of known code deficiencies. These may present efficiency retrofit opportunities that would not be cost-effective without a previously scheduled or necessary major repair or replacement.

Tip: Look for Operations and Maintenance Opportunities

Example: If the preventative maintenance plan calls for a roof replacement or an unexpected leak forces a reroof, there is a prime opportunity to increase the insulation level. Mobilization costs required when upgrading the shell of the facility plus the added incremental cost of more insulation is offset by the energy cost savings it will generate over the life of the roof.

Consider bringing all parties to the table to gather input when developing the scope and requirements of the project. When an energy audit is combined with maintenance and renovation plans for a particular building, priorities can be arranged that are logical, cost effective, and an efficient.

When practical, direct the energy auditors to explore building-envelope improvements such as installation of new outside doors and windows, lighting fixtures and controls, heat recovery ventilator ventilation, and/or the reduction of air leakage or infiltration. These types of improvements should be explored prior to any replacement of major equipment.

Find a list of energy auditors online[9]

---

[i] (Energy Sector Management Assistance Program, The World Bank, 2010)

---

[9] www.akenergyefficiency.org/get-a-commercial-energy-assessment

Overview

Strategies for Effective Program Implementation

An energy efficiency retrofit is an investment in your building that can produce cost savings, increased durability of the structure, and a more comfortable and healthy environment for its occupants. For public facility managers, energy efficiency retrofits are a best practice for the stewardship of public funds. In an era when energy price volatility and reduced facility budgets are the norm, Alaska facility owners are well positioned to be proactive about minimizing energy costs to free money that can be focused on the mission of the organization. Government at all levels can reduce risk to energy price fluctuation and the associated negative impacts on programmatic goals by taking steps to construct or retrofit public buildings.

Government utilizes several mechanisms to establish energy-efficient procurement policies or modify existing procurement policies to include energy-efficient product and design specifications. Some governments use resolutions passed by governing bodies, while others use mayoral or executive initiative. Energy efficiency procurement policies should define desired outcomes and impacts. Provide clear direction to purchasing officers to procure energy efficient products, building designs, construction techniques, and operation and maintenance best practices.

Collect Baseline Information on Energy Consumption. Collecting baseline energy consumption information before establishing energy-efficient product procurement policies can help local governments identify their best opportunities for capturing energy cost savings.

Involve Employees, Facility Managers, Maintenance Teams, and Other End-Users. Involving these individuals in policy and project planning will ensure energy-efficient policy goals and retrofit projects account for the needs of those who use and maintain the facilities. Incorporating the needs of all parties involved will lead to increased collaboration and project buy-in. Information gathered from staff in the planning process will inform how an owner will schedule and phase the project to take advantage of expected repairs and replacements. In addition, training individuals who use and maintain energy-efficient products will ensure energy-efficient features are enabled, prolonging their product life and increasing energy cost savings.

Effective communication between individuals and departments will lead to more rapid progress toward efficiency goals.

Connect the Purchasing Department, Maintenance, Operations, Energy, Environment, and IT Departments. Fostering collaboration between these departments can significantly enhance the benefits of energy-efficient product procurement activities by bringing together individuals with technical expertise in complementary subjects.

To understand the financial impact of energy efficient products, it is necessary to compare first cost and life-cycle costs.

Develop a List of Pre-Approved or Priority Products. When vendors use different definitions of "energy-efficient," purchasers are required to spend time analyzing the relative attributes of each product. Some local governments have addressed this barrier and improved the effectiveness of their energy-efficient product procurement by establishing a list of pre-approved products. Streamlining the purchasing process, by establishing a list of pre-approved products and vendors, will enable purchasers to aggregate orders that can sometimes lead to lower costs.

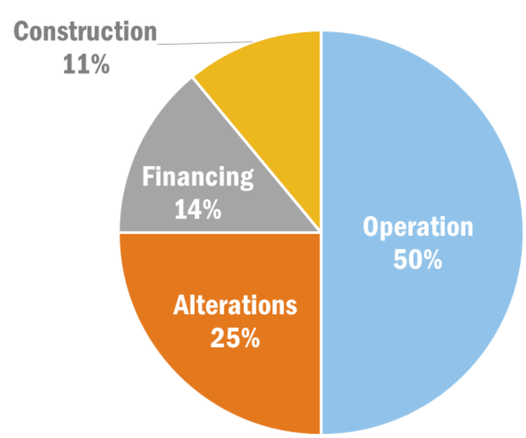
Borrow Sample Procurement Language. Local governments can use model contract language to specify energy-efficient products when making purchases. This can be borrowed from other local and state governments, federal government agencies, and non-government organizations.

Use Energy Efficiency Standards and Product Specification. Many government organizations specify a preference for energy efficient products. The Federal Energy Management Program (FEMP) has established purchasing specifications[10] and a list of ENERGY STAR[11] qualified products, both of which are useful for local government officials who set purchasing policy. Stating a preference for ENERGY STAR products can result in energy cost savings; however, to fully estimate the financial impact of procurement decisions a government organization should compare first cost and life-cycle cost.

First Cost vs. Life-Cycle Cost

When evaluating products, new construction, or retrofit projects, owners typically rely on the first cost or capital cost of the project as a means to select which project to implement or which firm to select. This bias towards the first cost can result in a project that provides lower value and higher operational cost to the owner during the life of the facility.[i] Project costs will always be important; however, as energy prices continue to escalate it is important to evaluate and compare project proposals on a life-cycle cost basis.

Figure 3: Costs over the life of a building



Source: ASHRAE

[10] http://energy.gov/eere/femp/energy-efficient-product-pro

[11] www.energystar.gov/index.cfm?fuseaction=find_a_produc

Life-cycle cost analysis (LCCA) is a method for assessing all costs of a product, system, or project over its useful life. Analysis includes acquisition, installation, operation, maintenance, and disposal costs, and it accounts for cost escalation. LCCA allows the user to analyze and compare two or more design or efficiency retrofit alternatives, not just on initial costs but also on all the costs (and benefits) incurred over the life of the proposed energy efficiency measures. All future costs are adjusted to present value so project decisions can be informed by capital costs and return on investment. Annual and cumulative cash flows can also be created as part of an LCCA. These projected cash flows can be a helpful planning tool for the project team as information collected regarding routine maintenance and planned replacements can influence the scope of work.

The types of expenses and savings used in LCCA traditionally only relate to direct costs of the product/systems/building that include utility costs (like water or energy bills) and operational costs/savings. Indirect costs can also be included in the analysis and might include things such as staff salaries, staff productivity, lost construction time, fire insurance, lost revenues due to downtime, and other costs that are not directly related to the cost of the building. While indirect costs are often more difficult to estimate, they are significant and should be considered.

Utilizing LCCA and managing a facility from an energy standpoint allows owners to have more control over operations and costs. There are many resources available that provide guidelines and tools for calculating life-cycle costs, including the National Institute of Standard and Technology's Life-Cycle Costing Manual[12], the Rocky Mountain Institute Microsoft Excel®-based LCC calculator called LCCAid[13] and the Alaska Department of Education and Early Development[14].

Some public entities in Alaska give preference to energy-efficient products or require life-cycle costs to be considered. All Alaska state agencies, the University of Alaska Board of Regents, the Legislative Council and the Supreme Court are all required by statute to consider life-cycle costs when evaluating

Life-Cycle Cost Analysis

Cost adjustments are necessary because the value of money changes over time. The value of a dollar received in the future is less than the value of a dollar on hand today. The change in value is driven by two primary factors: interest and inflation.

Interest is the return earned on money when it is used by another party.

Inflation in the economy causes a decrease in the purchasing power of money.

Life-cycle cost analysis sums the expenses and cost savings produced by a project throughout the life of energy efficiency measures. As these expenses and cost savings occur at different times, the values need to be adjusted for interest and inflation before being totaled.

[12] www.fire.nist.gov/bfrlpubs/build96/art121.html

[13] www.rmi.org/ModelingTools

[14] www.eed.state.ak.us/facilities/publications/LCCAHandbook1999.pdf

proposals for leased space, lease-purchase agreements, bid acceptance and evaluation for construction projects[15]. Some municipalities and boroughs also have recommendations to use life-cycle costing. In practice, however, life-cycle costs are not fully assessed or used for evaluation of project proposals and there is a bias toward least first cost for construction projects and product purchase.

Utilizing life-cycle costing to inform decision making is important for public facility owners because 1) they are often managing the properties in which they are making long-term investments, and 2) they are making investments with public dollars and whose constituents expect maximum value. Every time a building component reaches the end of its useful life, procurement officers have an opportunity to analyze life-cycle costs of the status quo option and the more efficient option to reduce long-term costs and increase overall productivity. Establishing a procurement policy to ensure decisions are informed by life-cycle cost analysis is an important step toward more efficient buildings. Where policy currently exists but execution of the policy is lacking, educating decision makers and procurement staff about the benefits and use of LCCA is a next step.

Contract Types

Contractors are necessary to accomplish many of the professional services described in this guide as many facility owners do not have staff capacity to conduct comprehensive energy retrofits. The contract type and procurement approach can have a large impact on project cost, schedule, and risk allocation. Facility owner's procurement staff should choose the procurement approach that best fits the performance goals of the project, and should write contracts with clear specifications for performance, designated responsibilities, and payment structures. This is an important step in clearly communicating the project vision from building owner to project team as it creates the legal basis to ensure work is completed as intended.

Contracting officers should work with personnel familiar with the technical requirements of the project to determine the best contract type and procurement approach.

The U.S. Department of Energy (USDOE) provides a helpful introduction to contract types in the *Acquisition Guide* Chapter 16.1: General Guide to Contract Types for Requirements Officials[16]. The following section is based on the USDOE resource.

[15] A.S. §36.30.080, A.S. 36.30.085, A.S. 36.30.150 respectively.

[16] http://energy.gov/sites/prod/files/16.1_General_Guide_to_Contract_Types_for_Requirements_Officials_0.pdf

Wide selections of contract types are available to public facility owners that provide flexibility in acquiring the variety and volume of supplies and services needed to support the missions of the public institutions. No single contract type is right for every contracting situation. Selection must be made on a case-by-case basis and consider many programmatic, performance, and financial factors. The goal is to select the contract type that will result in the optimum business arrangement between parties. Best practices show agencies should adopt their procurement regulations to allow the types of contracts and procurement approaches discussed below, even if not commonly used.

Design-Bid-Build

Pros

- Commonly used
- Roles are clear
- Easy to manage
- Defined requirements & fixed price

Cons

- Slow and can be more expensive than other procurement approaches
- Design suffers from lack of input from contractors
- Split accountability

The Selection of Contract Type

Public procurement units typically set out the type of contract in the terms and conditions of the solicitation. In non-competitive procurements and in a limited number of negotiated procurements, the contractor may be given an opportunity to propose different types of contracts than contemplated by the public procurement unit. The selection of the contract type should give the contractor an incentive to perform efficiently and effectively. Thus, selecting the appropriate contract type affects the public procurement unit's ability to obtain fair and reasonable prices.

Procurement Officer Responsibility for Selecting the Type of Contract

The procurement officer is responsible for selecting the appropriate contract type; however, in most instances their staff will be responsible for drafting the scope of work (SOW) and other technical/performance requirements. Personnel familiar with the technical requirements and degree of uncertainties in the SOW are in an important position to provide the Contracting Officer with information critical to the contract type selection and are an integral part of the procurement process. Expenditure for goods and services is seen not simply as the business of contracting personnel but also that of the requirement officials who initiate and use the goods and services obtained.

How the Scope of Work Influences the Contract Type

The scope of work (SOW) is critical in determining contract type and project delivery method (see **Contract Types**). Level of detail, clarity, and identification of performance objectives and expectations in the SOW drive all other conditions of the contract, from pricing structure to the contractor's entitlement to payment and to the level of contract administration. The greater the degree the government entity can articulate its needs accurately and clearly, the greater likelihood that the contractor will accept greater performance and cost risk associated with a particular type of contract. The contract type should be commensurate with the level of risk in performance of the SOW.

The objective in selection of contract type should be to establish the pricing arrangement that is most likely to produce a fair and reasonable price for performing a given SOW. Weighing cost and technical risks, and consciously assigning them to either the government entity or the contractor will achieve this.[ii]

Procurement Approaches

Three common procurement approaches will be discussed: Design-Bid-Build, Construction Manager/General Contractor (CM/GC), and Design-Build.

Design-Bid-Build

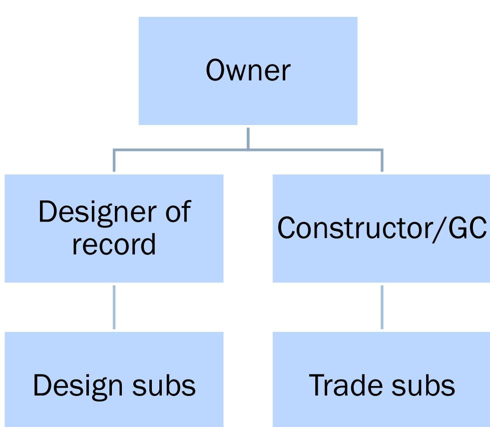
A large number of projects in the United States utilize the design-bid-build style of procurement. This is a common approach because many owners want to know exactly what they will get before they agree on the price or before they start construction. Architect and engineering firms define the owner's needs, design the building, prepare construction drawings and specifications for bid documents, and administer construction.

Drawings and specifications serve two purposes: They are guidelines for construction, and they are the contractual definition of what the contractor is to build. Contractors are prequalified and shortlisted, and usually provide a bond or bonds. Frequently two types of bonds are required, a performance bond, and a labor and materials bond. Typically the low bidder is awarded the work. The architect and engineer are at the agent end of the spectrum; the contractor is at the vendor end.

Pros of design-bid-build. Such an approach is commonly used and understood, thus, roles are clear and the process of design-bid-build is easy to manage. Since the owner has a defined requirement and a fixed price, this approach appears practical to them.

Cons of design-bid-build. Construction cannot start until design is complete. There is not a fixed price for construction until much work has been done. If bids are over budget, more time and money are lost to redesign. Design suffers from lack of input from contractors and subcontractors. This method creates split accountability between the two contractors. In the event the project does not perform as expected, neither contractor will accept fault, and are likely to blame the other.[iii]

Figure 4: Design-Bid-Build



Historically, most energy efficiency projects were done in two phases. Under the first phase, a consulting contract is used for an energy audit and project design.

This generally involves:

- Assessing the current energy consumption within the facility, documenting key energy-using equipment, facility age and function, floor space, review of 12–24 months of energy bills, etc.;
- Assessing energy efficiency potential and cost-effectiveness of various measures; and
- Proposal of a project design. Often this involves

having the consultant prepare technical specifications and bidding documents for equipment.

Under the second phase, a construction firm is hired to procure and install equipment.[iv]

Paul Tseng on Design-Bid-Build

Paul Tseng, another pioneer in the commissioning industry wrote in a 1998 trade journal, "The conventional plan-spec-bid [design-bid-build] process diffuses responsibility, muddies the performance measures, and does not [promote delivery of] a functioning, high performing building. The three main players—the owner, the design team, and the contractor team—are engaged in a triangular relationship that is contractually and inherently unstable. This relationship is also confrontational by its nature, blame-shifting by its practice, and actually rewards poor performance."

Construction Manager/General Contractor (CM/GC)

The construction manager/general contractor (CM/GC) procurement approach utilizes an integrated team approach, applying modern management techniques to planning, design, and construction of a project to control time and cost, and to assure quality for the project owner. The team consists of the public facility owner, an architect and engineer firm (retained by the public facility owner), and the CM/GC. The CM/GC method includes both pre-construction and construction phase services.

Typically, a construction manager and general contractor (CM/GC) will be hired during the design phase after an architect has been selected. The architect and engineer, and CM/GC will have separate contracts with the owner and work together through preconstruction and construction. The architect and engineer firm is selected utilizing the standard consultant selection process. The CM/GC is selected using a qualification-based, request for proposal (RFP) process.[v]

One of the benefits of the CM/GC delivery method is the development of a working partnership between the owner, architect, and contractor. The contractor is able to provide constructability reviews, cost estimating, and scheduling support, leading to accurate budgets and timetables and increased knowledge of the project before construction begins.

Construction manager/General contractor

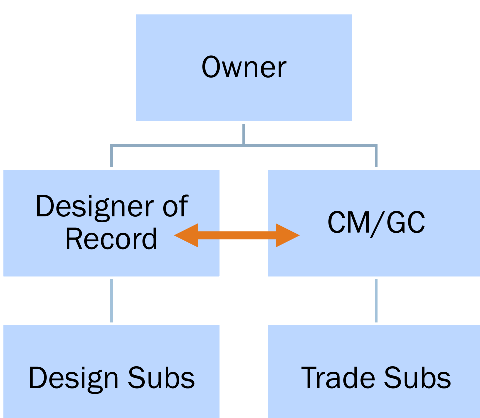
Pros

- Greater cost certainty due to collaboration
- Reduced design disputes
- Reduced time for project delivery
- Applied innovations
- Front end value engineering

Cons

- CM has normal GC conflict of

Figure 5: CM/GC



When managed effectively, this approach ensures a smoother process characterized by fewer requests for information (RFI) and change orders. Ultimately, the team is better positioned to deliver the project on schedule and on budget.[vi]

Design-Build

There has been strong interest to combine design and construction contracts to reduce the number of procurements, create clear lines of accountability, encourage more innovation at the design stage, and better link payments to performance; however, this creates some challenges for the procurement process, namely:

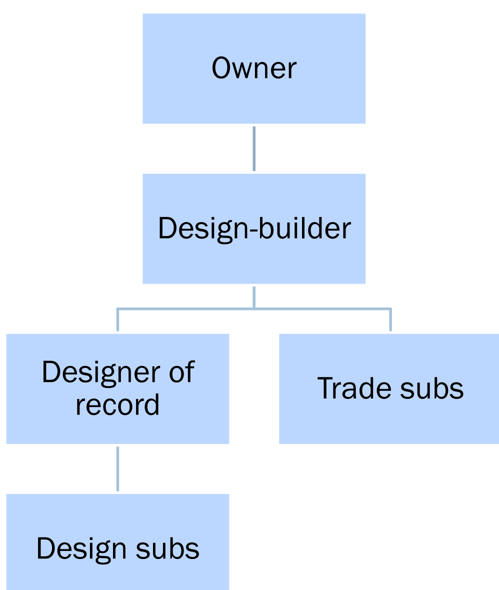
- Defining parameters of the project is tricky, since design has not yet taken place;
- Developing binding cost proposals for bidders is difficult without knowing the exact level of investment, equipment needs, etc.[vii]

Owners unfamiliar with this procurement approach who do not overcome these challenges can face cost overruns. An owner lacking experience with design-build but interested in pursuing this approach can use a separate project developer who is acting as an owner's representative to guide them through the process.

Design-build is a method of project delivery where engineering design and construction are combined into one solicitation and a firm or team of firms work together to deliver the project. The public facility owner retains oversight of the design-build contract. This type of contracting can be advantageous in a number of instances. One of its strengths is the ability of the public facility owner to effectively implement projects because construction activities can run concurrent with design activities, thus accelerating project delivery.[viii]

The contractor is selected based on qualifications, capabilities, experience, and price, thus avoiding some pitfalls from contract awards solely based on low price. Design and construction are performed by a single team under one contract. This reduces the owner's risk from

Figure 6: Design-Build



Design-Build

Pros

- Shortened timeframe
- Applied innovation
- Increased certainty of final cost
- Increased quality (design-build team has design and construction responsibility)
- Reduced owner staffing
- Less management effort
- Less conflict

Cons

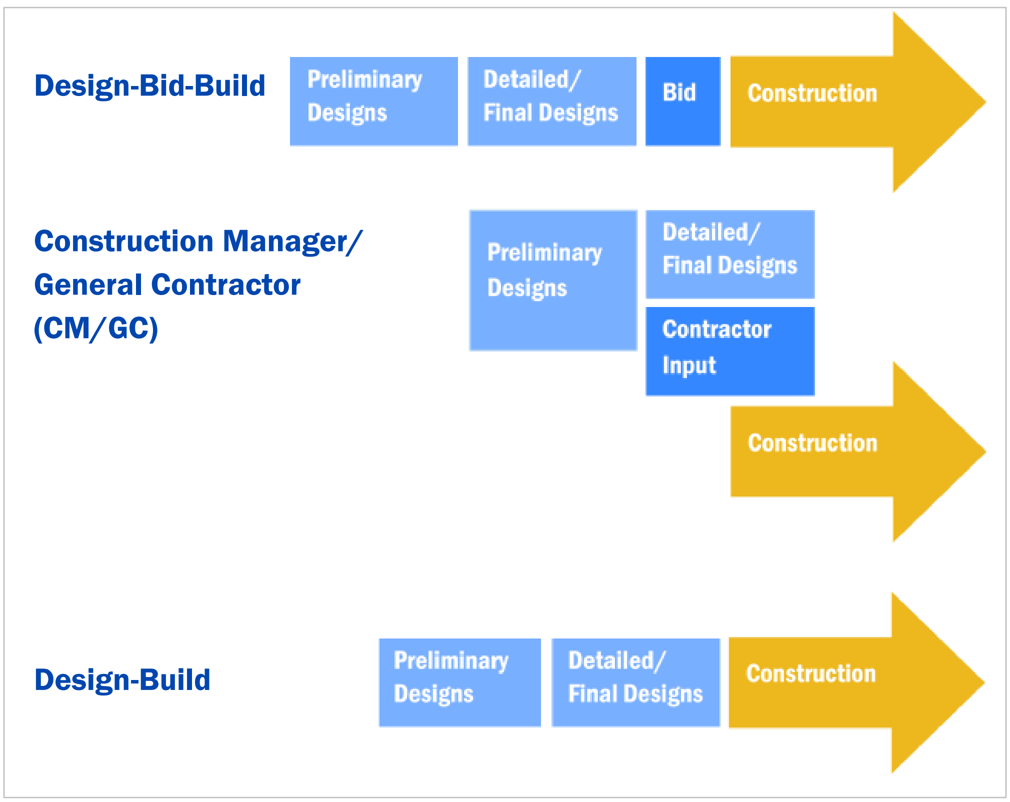
- Architect and engineer not acting as owners agent
- Owner has less control over design
- Potentially less competition

diffused responsibility for design and construction. Time can be saved because ordering of materials and site work can begin before total design is complete. There is a close contractual relationship between design and construction teams, resulting in fewer change orders by the owner that arise from occasional revisions in design by an owner's architect and engineering firm. Overall, design-build contracting has greater potential to save time and reduce cost.

There are disadvantages as well. The owner may not have security (and comfort) of having an architect and engineer firm act as his/her agent during the project. Even if the owner has an independent architect and engineer firm involved in project oversight, they do not have as much insight into the design details. As such, with design-build, the owner will lose some control of the design process.

Another disadvantage can be less competition in bidding firms. Not every company can put together an effective design-build team and it may be more difficult to secure performance and payment bonds on this type of project.[ix]

Figure 7: General Workflow for Procurement Approaches



Performance-Based Contracts

Energy savings performance contracts (ESPCs or EPCs) emphasize outputs of the project, rather than inputs typical in traditional contracts. The solicitation is structured around the purpose of the work to be performed in contrast to the manner the work is performed. The solicitation is designed to ensure contractors are given freedom to determine how to meet facility owner's performance objectives and that appropriate performance quality levels are achieved and payment is only made for services that meet these levels. Performance based contracts can be used with various types of contracts.

In an ESPC, the building owner typically contracts with one entity, an Energy Service Company (ESCO), for all services needed for an energy retrofit starting with investigation of the energy efficiency potential of the building and ending with measurement and verification of actual savings. Large ESCOs typically carry the upfront cost to develop a project until financing is established. Public facility owners do need to ensure funds are pre-allocated for development costs of a project so that the ESCO can be compensated in the event a project is identified but not pursued past the energy audit phase.

The Energy Sector Management Assistance Program publication, *Public Procurement of Energy Efficiency Services, Getting Started*[x] describes performance-based contracts as:

Lighting retrofits typically offer a quick payback and can be an important piece of a larger energy savings project.

- ESPCs typically involve:
    - **Goods** (e.g., appliances, windows, insulation);
    - **Works** (e.g., revamping existing systems, constructing stand-by power and cogeneration units);
    - **Services** (e.g., energy audits, project design, measurement and verification, operations and maintenance, training);
    - **Financing** (Performance contracts may also require the bidders to present a financing plan as part of their bid).
- Payments are based on performance rather than time-based or delivery-based contracts. Because contracts are based on outputs and not inputs, compensation is linked to verification of outputs rather than typical delivery-based schemes. This requires contracts include clear project baselines, pre-agreed performance indicators and measuring methodologies, contract terms long enough for outputs to accrue, procedures for payment disputes, etc.
- Energy savings performance contracting (ESPC) requires credible, upfront technical information. Since ESPCs are designed to solicit bids to improve operations of an existing facility or system from energy service companies, the need for reliable baseline data is critical. This can be accomplished through prefeasibility studies, audits, baseline surveys, or similar schemes—conducted by credible professionals.
- ESPCs are often finalized after contract signing. To reduce bidding costs for ESPCs, detailed energy audits or project designs are generally not required as part of initial bids; rather bidders are asked to propose their best estimate based on available information and their past experience. Once selected, an energy service company performs a detailed or investment grade energy audit (IGA) that establishes the project baseline and determines project scope and investment. This process does create risk because bidders may overpromise at the bidding stage, and then will have to reduce the

level of energy savings at the energy audit stage. It may, however, present opportunities for bidders to inflate project costs after the energy audit stage.[xi]

Where the project size and technical approach are not known, two-stage bidding can mitigate the cost inflation risk. To do this, a public facility owner can separate the contracts for the energy audit and the building retrofit. This provides the owner with an option of establishing a second competitive bid process for installation of the efficiency measures recommended in the energy audit.

The US Department of Energy presents the benefits and downsides to ESPCs in the *2010 Acquisition Guide*, Chapter 16.1: General Guide to Contract Types for Requirement Officials, as shown in Table 1. Facility owners may consider selective use of performance incentives when contracting with an ESCO. Performance incentives can be specified for positive or negative outcomes, or a combination.[xii]

Table 1: Cons and Pros of ESPCs

Cons	Pros
• Has an initial increase in up-front costs. • Increased time and costs associated with contract administration. • For a small dollar value procurement of less than approximately $500,000, the increase in time and cost for contract administration may not be worth the benefit in increased contractor performance. • Increased emphasis on contract administration is necessary.	• Clear expression of government's needs and how work will be judged. • Risk of performance shifted to the contractor. • Contractor is paid for successful completion of work. • Supports fixed price contracting when practical. • Helps correct problems commonly associated with service contracts including cost overruns, scheduling delays, and failure to achieve specified results. • Defined adjectives and adverbs. • Contractors clearly define how they will execute work. • Technical, schedule, and cost baselines are established.

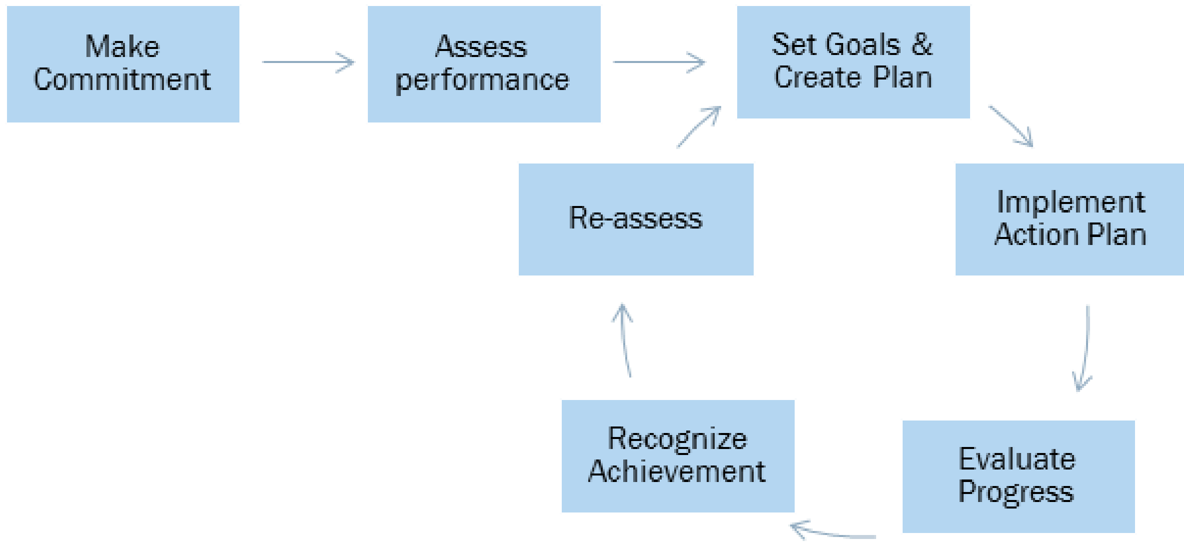
Procuring Retrofit Services

Implementation of an energy efficiency retrofit generally follows one of two procurement paths:

1. The ESPC path where an owner contracts with an energy service company to provide full service from initial development through construction, and measurement and verification, or
2. The non-ESPC path where an owner contracts with multiple entities or relies on internal staff capacity to accomplish all steps required to achieve and verify energy savings.

Elements below are critical to success of an energy project. Combing several elements into one contract depending on the procurement path chosen may be appropriate.

Figure 8: Elements of Successful Energy Projects



Benchmarking

Benchmarking helps identify and prioritize energy retrofit investments by comparing your facility's energy use and energy cost information to other similar buildings. It also provides the baseline to measure progress toward goals over time.

Benchmarking can be completed by staff if capacity exists. It can also be accomplished during the energy audit process, which typically is completed by a Certified Energy Auditor (CEA) contractor. The person benchmarking the building should record basic information such as building name, location, square footage, facility use type, occupancy schedule, utility usage, and cost data. A minimum of two years of utility data is recommended.

A variety of software programs are available that can be used to track benchmarking information. Microsoft Excel spreadsheet, ENERGY STAR Portfolio Manager[17] and AHFC's Alaska Retrofit Information System (ARIS)[18] are among the most common.

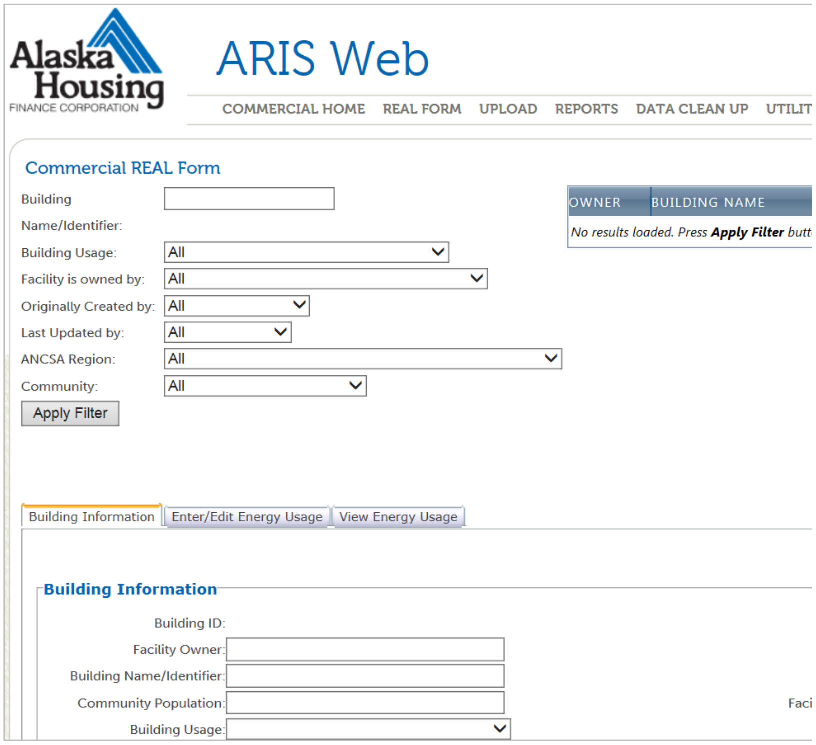
Figure 9 shows a screenshot of the ARIS system. Users can trend historical energy use, determine energy use per square foot, and compare energy use across facilities.

---

[17] www.energystar.gov/buildings/facility-owners-and-managers/existing-buildings/use-portfolio-manager

[18] For access to the Alaska Retrofit Information System (ARIS) please contact AFHC. www.ahfc.us

Figure 9: Screenshot of ARIS REAL Form



In addition to providing energy tracking services to individual users, ARIS contains building energy use data for the State of Alaska. State agencies are required to track their energy use through ARIS and the system is available to schools and municipalities. The large repository of energy use information allows users to compare their facility to similar buildings with comparable use in the same region. Once high energy use buildings are identified a decision can be made to determine which facilities to audit first.

Energy Audits

An *Energy audit* is an inspection and analysis of energy flows in a building, process, or system with the goal of identifying opportunities to improve energy efficiency. The activity should result in an objective standard-based technical report containing recommendations for improving energy efficiency. The report should also include an analysis of estimated benefits and costs of pursuing each efficiency recommendation and the simple payback period.

An energy audit will help determine potential energy savings in a building or buildings. This can include identification of changes to a building's structure, equipment, systems, and operational procedures that will result in less energy consumption and provide sufficient cost savings to pay for improvements over a given number of years.

Procurement Tip

Energy Auditor Criteria

Certified energy auditors for commercial and industrial energy efficiency improvements must meet one of the following criteria:

i. An individual possessing a current commercial or industrial energy auditor certification from a national, industry-recognized organization;
ii. A licensed professional engineer in Alaska with at least one year experience and who has completed at least two similar type energy audits;
iii. An individual with a four-year engineering or architectural degree with at least three years' experience and who has completed at least five similar type energy audits; or
iv. An energy auditor certification recognized by the Department of Energy through its Better Buildings Workforce Guidelines project.

This step can serve as a prefeasibility study for an energy efficiency project by confirming cost-effective energy savings opportunities exist, identifying target systems to be retrofitted, and defining the parameters of the project that will be stated in the RFP.

Walk through audits identify no and low-cost efficiency measures and can help an owner decide next steps.

Preliminary Energy Use Analysis, Level I Walk-through Assessment, and Investment Grade Audits should be completed by Certified Energy Auditors (CEA)[19] or Certified Energy Managers (CEM)[20], certified by the Association of Energy Engineers (AEE)[21] or other AHFC- approved equivalent certification body. In addition, the CEA or CEM must provide proof of completion of the following:

- Alaska Professional Engineer (P.E.) stamp, or,
- Board-approved Arctic Engineering Courses[22] for the Alaska P.E. stamp, or,
- AHFC-approved Cold Climate Building Science course(s).

Different types of energy audits go into varying levels of detail. Efforts should be made to tailor the audit to the specific needs of the host facility.[xiii]

When procuring the services of an energy auditor, include as a base requirement that they must be either a Certified Energy Auditor (CEA) or Certified Energy Manager (CEM).

Energy Audit Types

ASHRAE Level 1 Audit provides:

- A brief on-site building survey
- Identification of no-cost/low-cost changes
- Identification of potential capital improvements for consideration

ASHRAE Level 2 Audit provides:

- A more detailed building survey
- Breakdown of energy use
- Savings and cost analysis on all energy efficiency measures (EEM)
- Identification of capital intensive EEMs requiring more thorough data collection and analysis

ASHRAE Level 3 Audit provides:

- The elements of a level 2 audit
- A more rigorous analysis and engineering for major capital improvements

---

19 www.aeecenter.org/i4a/pages/index.cfm?pageid=3365

20 www.aeecenter.org/i4a/pages/index.cfm?pageid=3330

21 www.aeecenter.org/i4a/pages/index.cfm?pageid=1

22 www.commerce.alaska.gov/web/cbpl/professionallicensing/boardofarchitectsengineersandlandsurveyors/approvedcoursesinarcticengineering.aspx

The American Society for Heating, Refrigeration and Air-Conditioning Engineers (ASHRAE) categorizes energy audits into three levels:

A walk-through audit, or **ASHRAE Level 1** audit, conducted by a professional energy auditor is a preliminary step and can help determine if a more in-depth audit with energy modeling is required. The auditor will conduct benchmarking (if not already complete), visually inspect the facility and systems, and speak with the operator about areas for further investigation. This audit will look at how the building is being used versus how it is set up to be used. Simple things will be identified like whether the gym is still being heated and ventilated for Saturday open gyms that stopped five years ago.

If the walk-through audit indicates an energy efficiency retrofit project is potentially feasible, a more comprehensive energy audit with energy modeling is a prudent next step. If interested in a more comprehensive investigation and a larger retrofit project for deeper savings, specify an **ASHRAE Level 2 or Level 3** energy survey and engineering analysis. The term *Investment Grade Audit* can also be used for Level 2 or 3 audits.

The solicitation for level 2 or 3 energy audits requires:

The review of:

- Heating system, ventilation system, and air conditioning;
- Lighting;
- Electrical equipment (motors, pumps, equipment, plug loads, appliances);
- Specialized equipment;
- Domestic water heating;
- Building envelope; and
- Employee or building user behavior.

A report detailing:

- Energy consumption history;
- Facility use;
- Equipment list;
- Equipment logs;
- Existing conditions;
- Energy efficiency measures;
- Life-cycle cost analysis to proposed measures (including implementation cost, operational and energy savings per measure);
- Description of methods of analysis; and
- Supporting calculations.

A facility owner best practice is to require the energy auditor to consult with the operations and maintenance team for design and operational considerations, and to review the preventative maintenance schedule, capital improvement plan, and list of code deficiencies. These may present efficiency retrofit opportunities that would not be cost effective without a previously scheduled or necessary major repair or replacement.

Tip: Look for Operations and Maintenance Opportunities

Example: If the preventative maintenance plan calls for a roof replacement or an unexpected leak forces a reroof, there is a prime opportunity to increase the insulation level. Mobilization costs required when upgrading the shell of the facility plus the added incremental cost of more insulation is offset by the energy cost savings it will generate over the life of the roof.

A pre-design charrette is an effective means of gathering input when developing scope and requirements of the project. When an energy audit is combined with maintenance and renovation plans for a particular building, priorities can be arranged that are logical, cost effective and an efficient use of available resources.

Whenever practical, direct energy auditors to explore building envelope improvements such as new outside doors and windows, lighting fixtures and controls, heat recovery ventilation, reducing air leakage or infiltration, etc. These improvements should be explored prior to replacement of major equipment; the efficiency improvement of a new heating system will be marginalized if the building itself is inefficient.

Find a list of Alaska energy auditors[23] online.

Thermal image of AHFC headquarters in Anchorage.

Scope of Work

The scope of work (SOW) is a document that describes work required to complete a specific project. It is a formal document that must be agreed upon by all parties involved. To be effective, the SOW must contain an appropriate level of detail so all parties clearly understand what work is required, duration of work involved, what the deliverables are, and what is acceptable. This section should provide a general description of the project and highlight the project's background and what is to be gained. As the SOW often accompanies a request for proposal (RFP), the SOW introduction and background are necessary for bidding contractors to adequately familiarize their organizations with the project.

The breadth of work covered in the SOW will be determined by the procurement approach. The entire amount of work required by the owner is a key element in determining which project delivery method they choose. Once a delivery method is chosen it will inform the number and type of solicitations, and breadth of work covered by each of the SOWs required per solicitation. If an energy audit detailing recommended energy efficiency measures has not already been completed, a solicitation with a SOW limited to an IGA is the first step. If the

[23] www.akenergyefficiency.org/get-a-commercial-energy-assessment

intent is to solicit services of an energy service company (ESCO) to engage in an energy saving performance contract (ESPC) the scope an agency defines will be much broader than if choosing to solicit the services of multiple entities to complete your energy retrofit. This approach is typically split into a two tiered procurement, the first for the completion of the IGA and the second for completion of design, construction, and measurement and verification. If an agency is following a design-build approach without the performance guarantee, the agency will still include construction management and construction in the same solicitation as request for design.

In brief, the final SOW for a Non-ESPC should include:

- A description of facility, size, location, pre-existing equipment inventory (may be referenced from the current energy audit), and user requirements:
  - Maintainability, access, and operational requirements;
  - Temperature, humidity, ventilation, acoustics, pressure relationships;
  - Sustainability and efficiency goals, including specific design standards;
- A schedule of each energy efficiency measures (EEM), selected from those identified in the IGA and, if applicable, other capital improvements to be implemented;
- Estimated cost per EEM;
- Final list of buildings to be retrofitted;
- Request for the design and engineering of the energy efficiency measures;
- Request for cost assessment per EEM and for entire project

In brief, the final SOW for an ESPC should include:

- A description of facility, size, location, pre-existing equipment inventory (may be referenced from the current energy audit) and user requirements:
  - Maintainability, access, and operational requirements;
  - Temperature, humidity, ventilation, acoustics, and pressure relationships;
  - Sustainability and efficiency goals, including specific design standard;
- Final list of buildings to be retrofitted;
- Request for an investment grade energy audit (IGA) (see later section for description);
- Request for the design and engineering of the energy efficiency measures identified in the energy audit;
- Request for cost assessment per EEM and for entire project;
- Statement of cash flow, identifying savings and expense estimates, used to justify financing terms and conditions;
- Construction management and training for facility staff;
- Option for operation and maintenance of systems during the measurement and verification phase of the contract and per the contract terms, dependent on the skill level of the facility

Inform the scope of work with energy audit recommendations and discussions with operations and maintenance staff.

operations and maintenance team;

- Project measurement and verification, and trouble-shooting to ensure sustained savings:
  - Occupancy/operations schedules;
  - Training requirements;
  - Project schedule;
  - Project budget;
  - Performance guarantee or special requirements

Whichever procurement pathway is selected, non-ESPC or ESPC, a decision point is reached once the energy audit is received. After the auditor lists all the potential EEMs and provides basic cost and savings estimates, meet with the auditor to review the list measure by measure to determine which to implement in the near-term. From the audit report select EEMs that are cost effective, and for which there is a budget or financing. This list of EEMs will be used to direct the architect and engineering firm, whether handled by a separate team under the non-ESPC pathway or by the ESCO in the ESPC pathway, to finalize design and inform the construction contract. Owners should work with their operations and maintenance team to include the EEMs not pursued in the project in future preventative maintenance and capital improvement plans. Owners can phase projects over multiple stages and years depending on cash flow needs, equipment or structure life, leasing situations, and technological or economic conditions that might make marginally cost effective EEMs more attractive. It is recommended for owners to bundle as many EEMs into one project as possible to take advantage of economies of scale.

Procurement Tip

If the building automation system is an element of the scope of work, require the design team collaborate with operations and maintenance staff regarding access to and training for controls systems. The skill level of operations and maintenance staff will help determine what type of controls system to install, and whether access to the system is desirable. A non-proprietary, open-source system that can be managed by internal staff may be desirable. Staff training and system documentation are standard requirements. Additionally, include minimum environmental standards and required sequencing and set-points to ensure safety, occupant comfort, and efficiency requirements are specified.

Design

With a scope of work and contracting approach determined, appropriate construction documents with cost estimates are created. This is one of the more costly steps in the project development phase and can run 10-15 percent of construction costs. If a project scope requires some level of engineering and design, the next step is to prepare a solicitation for the services of an architect and engineering (A&E) firm. Soliciting services of an A&E firm may be part of design-build procurement.

Hiring a design professional who has experience in energy-efficient design and deep energy retrofits is crucial to achieving maximum energy efficiency for the least amount of money. Designers with extensive deep retrofit experience can save the project money in the short term due to proper sizing and integration of building systems and in the long term through diminished energy costs.[xiv]

Selection criteria for the A&E team should include:

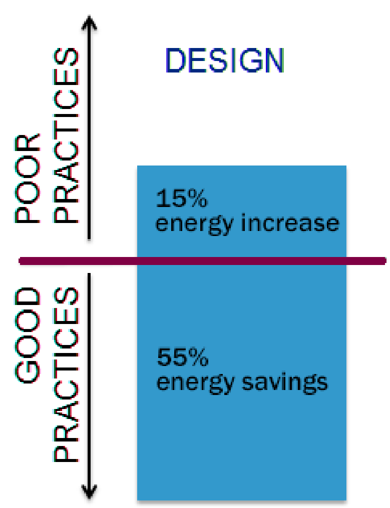
- Professional qualifications;
- Specialized experience and technical competence in energy conservation and passive energy design;
- Capacity to successfully accomplish the scope of work;
- Past performance;
- Location.

Establishing design guidelines gives designers and contractors a baseline of quality and energy efficiency for all projects, both new construction and renovation. While not all of the guidelines will apply to every project, simply having guidelines sets project priorities and helps designers understand the energy efficiency expectations.[xv]

Building design has a major impact on energy use. Certain elements of design such as envelope have a long lifespan, so it is important to compare the first cost of the component to the impact it has on life-cycle costs.

According to a 2011 report by the New Building Institute titled *Sensitivity Analysis: Comparing the Impact of Design, Operation and Tenant Behavior on Building Energy Performance*, which analyzed buildings in Fairbanks, AK and several locations throughout the U.S., the penalty of sub-optimal design can be significant, while the benefit of optimized design is impressive. Figure 10 from the report illustrates the impact of good and poor design practices on energy use.

Figure 10: Impact of Design on Energy Savings, Fairbanks offices



Building envelope improvements such as new outside doors and windows, lighting fixtures and controls, heat recovery ventilation, air leakage or infiltration reduction, etc., should be explored prior to replacement of major equipment. The efficiency improvement of a new heating system will be marginalized if the building itself is inefficient.

In addition to any general project requirements it is important to specify the design standard which will provide guidance to the A&E firms responding to the solicitation and serve as a metric for accountability through construction and after project completion. Choice in energy efficiency standards should align with the energy reduction commitment and goals set by organization leadership. Measureable performance goals should be explicit in the solicitation for design services if not referenced in statute, local ordinance, code, or design standard.

There are a variety of design standards. A performance based specification, such as ASHRAE 90.1 2010 or ASHRAE 50 percent Advanced Energy Design Guide (AEDG), provides clear direction as to how much energy reduction beyond the code minimum is required for a major retrofit project. The AHFC Building Energy

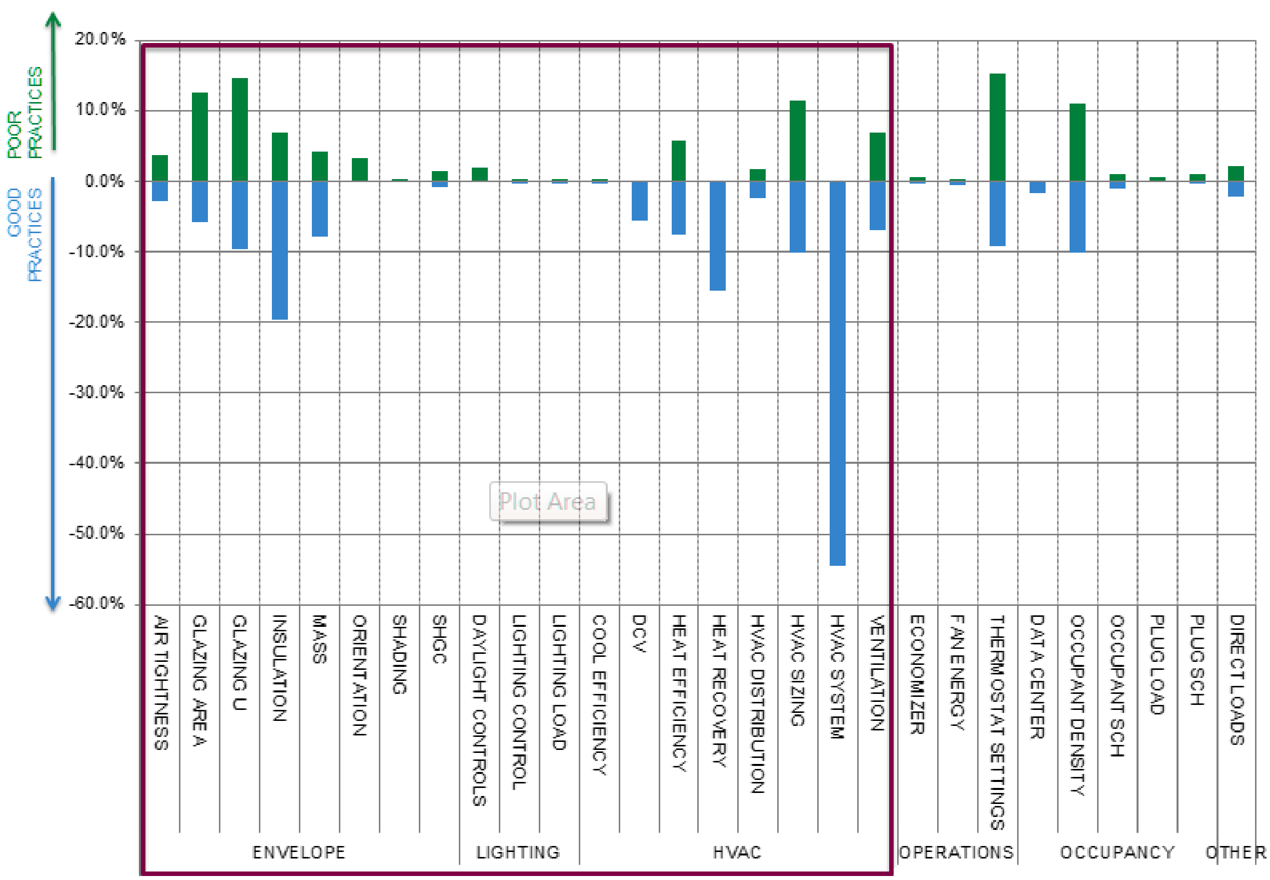
Efficiency Standard (BEES) (required for projects funded through AHFC) is a minimum, but striving for deeper energy reductions is encouraged.

Figure 11 from the *2011 New Building Institute Sensitivity Analysis* shows the results each individual building characteristic has on energy use for mid-size commercial office buildings in Fairbanks.

The Department of Energy/National Renewable Energy Lab mid-size office prototype was used to define the baseline. For each of the 28 characteristics identified in the prototype there were a range of performance values representing poor, baseline, and good practice. The values were determined using a range of published building characteristics studies, field research currently

Design considerations such as the amount of envelop insulation have a significant impact on building energy use.

Figure 11: Impact of Building Characteristics in Mid-size Commercial Buildings in Fairbanks

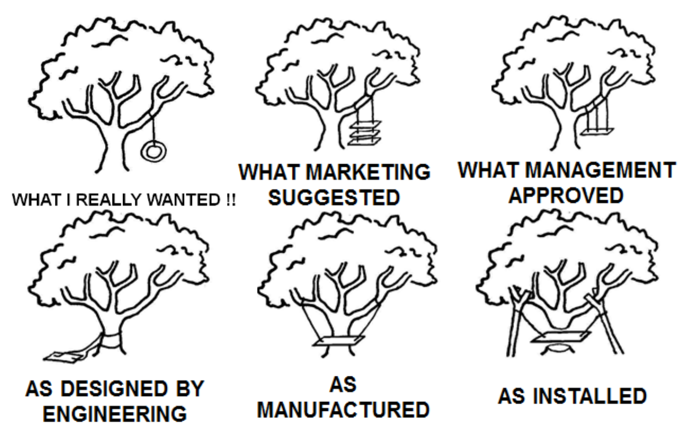


underway, and professional judgment. The impact on total building energy use was evaluated and each variable was modified from low to high performance, while all other characteristics were kept at the baseline performance level. To more accurately represent interactive effects, good and poor practice packages of measures were analyzed to represent various combinations. The analysis was conducted using weather data from 16 different cities to represent the range of climate types identified by DOE/ASHRAE for U.S. design criteria.

The study examined the role that design and operation of various building systems can play in energy use. It was not intended to suggest cost-effectiveness of any particular energy-saving actions, either in new construction or retrofit projects. For consistency the study includes only one building type as other building types may behave differently. Energy modeling and life-cycle cost analyses should be employed on a project-specific basis to determine which actions may be best. For instance, actions to improve air tightness can be implemented early on and at very low cost.

As is illustrated in Figure 11, envelope, lighting and HVAC options chosen during the design process can have a significant influence on a building's energy use. On this graph, values below zero (green bars) represent opportunities for reducing energy use from high-performance options for each variable. Values above zero (red bars) represent increased energy use associated with the low performance option. The graph depicts best practices for high performance envelope design that can reduce energy by as much as 20 percent, while poor practices can result in buildings that consume 15 percent more energy. For optimal energy performance in a building, proper design choices should be coupled with proper operations and maintenance.

Integrative Design Process (aka Integrated Project Delivery)



It's not easy to keep the project vision alive as it goes through all the hands it takes to make it a reality. The tree swing graphic to the right illustrates that at each step in the process project success can be revamped by poor product design or customer service, or failure to interpret customer's needs. The integrative design process establishes a system that promotes clear communication of project goals and collaboration on design, engineering, construction, and operational opportunities, and risk management from an early stage. When successfully applied, this approach can result in reduced project delivery time and costs, and a higher performance building. Hiring a design professional who understands the integrative design process will help ensure maximum energy savings and functionality are realized, and the project is within budget and on-time.

Efforts to incorporate good design practices that reduce energy use can be undermined by poor operation practices. The level of expertise of operations and maintenance teams varies greatly across public facilities in Alaska; therefore it is critical to design systems that meet the needs of the building and the capabilities of the staff. Early involvement of the operations and maintenance team may help design new mechanical systems appropriate for local conditions, and training staff to operate these mechanical systems is critical to project success. Research suggests specifying an integrative design process in the solicitation will ensure the outcome of the retrofit project meets user's needs.

Figure 12: Potential Stakeholders in an Integrative Design Process

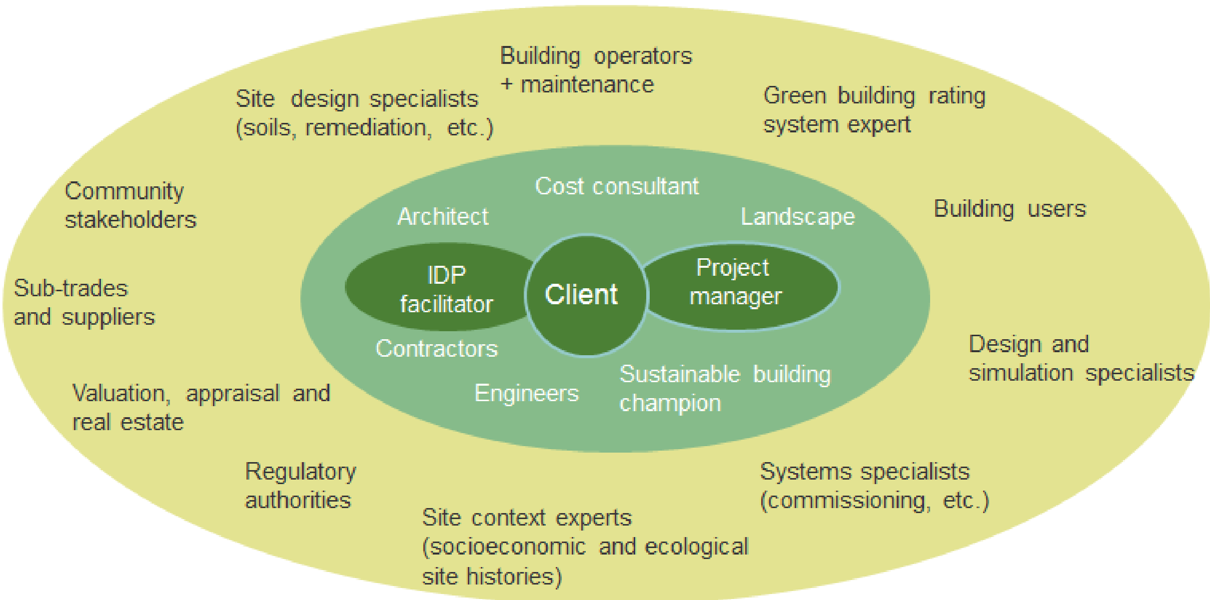


Figure 12 shows possible stakeholders who can be included. Another term commonly used with this concept is integrated project delivery. More information on the integrative design process and integrated project delivery can be accessed through the American Society for Heating, Refrigeration, and Air-Conditioning Engineers (ASHRAE)[24] and the American Institute of Architects (AIA)[25].

Construction

It is important to note that all job site contractors have a role in ensuring the ultimate energy efficiency of the building. In both new construction and renovations, contractors play a significant role helping Alaskan building owners reduce energy use through quality workmanship and attention to detail.

Figure 13: Communication within the project team is a key to a successful energy retrofit.

[24] http://aedg.ashrae.org

[25] www.aia.org/about/initiatives/AIAS078435?dvid=&recspi

Building owners should establish a procurement process that allows for a construction management firm to be evaluated on qualifications and price. While it may be obvious, ensure contractors have the required certifications and experience that matches the needs of the project. For example, in a glass building, the contractor should have expertise in glazing; with a building in a remote village, ensure the contractor has experience building in rural communities. Awarding contracts on price alone does not always achieve the best value.

Building retrofits can include specifications in the construction contract for:

1. Weekly meetings of all subcontractors to solicit feedback and identify potential issues affecting building energy use.
2. Regular inspections during construction of systems that impact energy use.

While project designers are responsible for design to reach a specified energy performance, they rely on the general contractor and the teams of building contractors to ensure proper standards are met. Also, the careful work of one contractor can be undone by the poor workmanship of a subsequent contractor.

Building commissioning can identify problems that result in poor energy performance, and fixing these problems can be costly for contractors in both time and reputation. A later chapter discussing construction management and contracting will discuss both of these further (**see Chapter 8**).

Commissioning

Commissioning is a best practice for ensuring a building is performing as expected. The *National Institute of Building Science* defines commissioning in the **Whole Building Design Guide** as a comprehensive and systematic process to verify that the building systems perform as designed to meet the owner's requirements. Commissioning during the design, construction, acceptance, and warranty phases is intended to achieve the following specific objectives:

- Ensure the owner's design intent is documented and pursued.
- Verify and document equipment is installed and started per manufacturer's recommendations, industry accepted minimum standards, and contract documents.
- Verify and document equipment and systems receive complete operational checkout by installing contractors.
- Verify and document equipment and system performance.
- Verify completeness of operations and maintenance materials.
- Ensure the owner's operating personnel are adequately trained on operation and maintenance of building equipment.

The commissioning process does not take away from or reduce responsibility of the system designers or installing contractors to provide a finished and fully functioning product. Nor does the commissioning process replace the need for measurement and verification, even though commissioning usually requires taking performance measurements to ensure systems are working properly. Because of overlap in commissioning and post-installation measurement and verification activities, some may confuse the two. Commissioning ensures systems are functioning properly; post-installation measurement and verification quantifies how the systems are working from an energy standpoint.

The commissioning approach should include regular meetings on and off site; program and legal commissioning (Cx) requirements, establishing and maintaining lines of communication with the building owner, design team, and contractor; thorough documentation; enforcement of specification provisions; identifying specialized tests; and creating a timeline for commissioning activities and reports.

Commissioning should be included in the project and is typically best performed by a third party, not the contractor in charge of the retrofit. Include the same basic building information and criteria in the solicitation for a commissioning agent as for an investment grade audit, but add criteria that the contractor must be a designated certified commissioning authority (CxA). Green building rating system compliance and other project requirements define goals for energy and water consuming equipment.[xvi] For design-build energy saving performance contracts (ESPC), the details of the commissioning activities are developed along with project scope rather than explicitly defined at the beginning of the project. In an ESPC, the commissioning activities are:

Case Studies from Coffman Engineers (Alaska Housing Finance Corporation, 2012)

AHFC's auditors who completed 327 public facility audits strongly advocated most buildings could benefit from retro-commissioning.

- A 90,000 sf office building in Anchorage had their air handling unit running 24 hours a day. The air was being heated and blown around with fans; both heat and electricity were being used in the building that was primarily empty 12 hours a day, and all weekend. By shutting down the air handlers during unoccupied times, they saved $41,000 a year.
- Kodiak Island Borough found that their research facility was using 100 percent outside air for no apparent reason. By changing this setting, they saved roughly 10,500 gallons of fuel for an economic recovery of $39,900. The problem was, it had been running that way for 10 years and had already cost the borough roughly $400,000.

- Specified in the contract;
- Defined explicitly after design;
- Implemented during construction;
- Completed prior to final project acceptance;
- Reviewed after project acceptance.

Retro-commissioning is an alternative pathway to energy savings for building owners. Instead of seeking an energy audit, an owner can have their building retro-commissioned. The result of the process is a report of recommended energy efficiency measures (similar to the IGA) and the correction of easily fixed building deficiencies. The energy cost savings and improvements to occupant health and comfort start to accrue immediately from the "low-hanging fruit" that is picked.

"Simple payback for a retro-commissioning project is typically less than two years and often less than one year." (Portland Energy Conservation, Inc, 2007)

A potential downside to retro-commissioning is the building owner will not pursue additional energy efficiency measures. This highlights a problem commonly found in public facilities, particularly schools. Many schools are ventilated for a number designers call "occupant load," it means the number of occupants the building was designed for. Designers have to assume worst case scenarios to ensure adequate capacity to provide fresh air if the building is fully loaded; however, the building may be over ventilated if there is declining enrollment. A solution for this is called demand-controlled ventilation where air is supplied according to how much carbon dioxide, what humans exhale when breathing, is measured in the return air ducts.

Commissioning can be a very cost effective step. The Lawrence Berkley National Laboratory studied commissioning in 560 buildings across the country in 2009. The average results are shown in Table 2.

Table 2: Commissioning Outcomes for 560 U.S. Buildings, 2009

Performance Metric	Average Outcome
Reduction in energy consumption	16 percent Savings
Annual energy cost savings	$0.29 per sf
Simple payback	1.1 year
Cash-on-cash returns (First year savings / Project cost)	91 percent
Benefit-cost ratio (Project lifetime benefits / Project cost)	4.5

See **Commissioning Flow Chart** in the Appendix.

Operation and Maintenance

Operations and maintenance (O&M) training are a critical component of energy retrofits. As discussed in the scope and design sections, it is important to include the O&M team in the retrofit project from the early stages of procurement to ensure their input is considered, and that appropriate training requirements are included.

Especially if including an energy performance guarantee in the project, maintenance specifics should be stated in the request for proposal and negotiated as a part of the energy saving performance contract. The preferred approach varies depending on the circumstances. If the facility O&M staff has limited technical skills, then the facility owner may require the energy service provider to either conduct the O&M for the contract period or provide O&M training to facility staff. Some training will be required in any case since eventually the equipment will be transferred to the facility owner.

The ESPC should include an outline of required training programs or a summary of what facilities managers and operators must do to achieve and maintain savings. Proper training and instruction are essential to assure savings achieved are sustainable during and beyond the contract term. Because energy saving performance contracts can span many years, provisions may be needed to deal with ongoing training needs, staff turnover, outsourcing, and the like.

Maintenance issues can be complicated by many factors, such as:

- Existing maintenance contracts with third parties;
- Risk that the facility's existing maintenance staff may be made redundant (or may need to be retrained and relocated) if the energy service provider takes over maintenance responsibilities; or
- Lack of incentive for the facility's existing maintenance staff to implement new procedures, undertake training, or take on additional work.

None of the previously stated items are deal-breakers and they can generally be addressed in a reasonable manner in the energy savings performance contract to the mutual satisfaction of both the public facility owner and energy service provider; however, these issues should be addressed upfront and provisions included in the energy savings performance contract, if not in the request for proposal.[xvii]

"Building operation and maintenance programs specifically designed to enhance operating efficiency of HVAC and lighting systems can save 5 to 20 percent on energy bills without significant capital investment."

– 15 Best O & M Practices, Portland Energy Conservation, Inc., Tudi Haasl; funded by US EPA, Climate Protection Division, 1999

The **2011 New** *Building Institute Sensitivity Analysis*, discussed earlier in the design section, by New Buildings Institute (NBI) shows how various design, operation, and tenant behavior elements affect energy performance. This study demonstrated that building operations have a significant influence on energy use. Of all the operations variables examined, thermostat settings have the largest impact of any measure for heating-dominated climates. Poor building operation practices having the potential to increase energy use by about 15 percent—signaling the importance of education on the part of building operators, regardless of how efficiently a building has been designed. **Figure 11** illustrates the findings.

Further evidence from the certified energy auditors performing audits on public buildings across the state under AHFC's Retrofit Energy Assessment for Loan Program (REAL) program in 2011 and 2012 showed that poor HVAC practices are costing building owners significant amounts of money. A case study about two schools in Southeast Alaska that have identical design and essentially the same climate demonstrate this point. One school used 138,000 gallons of fuel oil per year and the other used 62,000 gallons per year. The difference in fuel usage resulted in roughly $300,000 cost saving per year. One difference was the set point temperature of the outside air; the higher set point of 62 degrees used significantly less fuel than the school with the set point of 55 degrees. Another difference was one building operator fine-tuned the system to reduce energy use, and then locked the system so it could not be overridden.

Figure 14 from the same 2011 NBI study shows the space heating requirements of office buildings in Fairbanks, AK are approximately 67% of overall building energy use. Buildings in Alaska have higher space heating requirements than similar building types in other parts of the country. As designers tighten buildings, they frequently install heat recovery ventilation systems to ensure adequate indoor air quality and reduce wasted energy. These systems have potential for large energy savings especially in climates with extreme winters and summers, and where fuel costs are high.


Performing M&V lowers risk to owners.

In especially cold temperatures these systems must be carefully maintained since very cold supply air can cause frost formation in the heat exchanger, reducing ventilation effectiveness. This factor underscores the importance of both good design and good operations in energy use.

Measurement and Verification

Measurement and verification (M&V) is an evaluation procedure that determines the actual performance impact of an energy efficiency retrofit project. The goal of M&V is to reduce the project risk to the building owner and ensure the energy and cost savings promised by the developer in the design were realized after construction. When owners use an energy saving performance contract (ESPC), one of the main functions of M&V is to validate payments or performance guarantees associated with contracted services. Even in non-ESPC projects, M&V can help minimize project risk by identifying performance issues that can be corrected. Including M&V in a contract allows the building owner to confirm actual performance of the retrofitted facility matches what was specified in the contract. This may sound similar to commissioning, the difference is commissioning ensures systems are functioning properly whereas post-installation M&V quantifies how well the systems are working from an energy standpoint. Facility owners will benefit from regular M&V activities that extend beyond a project or performance guarantee. M&V is an integral element of continuous energy management and provides energy managers or other decision makers with information to base ongoing energy management activities, including enhanced O&M practices, training opportunities, and future cost saving retrofits (see **Chapter 3**).

M&V Accuracy

The US DOE identifies factors that typically affect the cost and accuracy of M&V including:

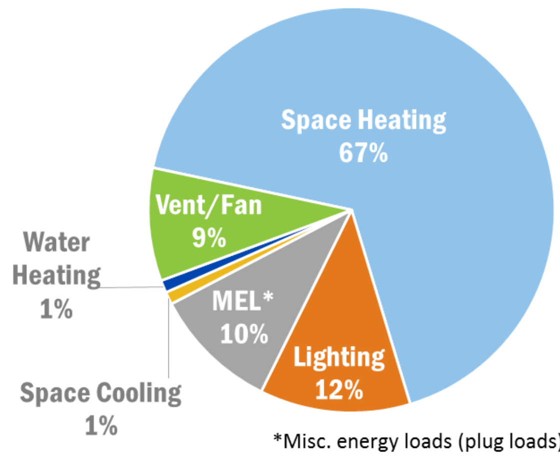
- Level of detail and effort associated with verifying baseline and performance period surveys
- Sample sizes (number of data points) used for metering representative equipment
- Duration and accuracy of metering activities
- Number and complexity of dependent and independent variables that are metered or accounted for in analyses
- Level of engineering required to conduct analyses
- Availability of existing data collecting systems (e.g., energy management systems)
- Contract term
- Level of accuracy needed in energy savings analyses

Energy savings are determined by comparing measured energy use before and after a retrofit project, while making appropriate adjustments for changes in conditions. The measurement and verification process includes engineering calculations, metering, utility billing analysis, and computer simulation.

Properly applied, M&V can:

- Accurately assess energy savings for a project;
- Allocate risks to the appropriate parties;
- Reduce uncertainties to reasonable levels;
- Monitor equipment performance;
- Find additional savings;
- Improve operations and maintenance (O&M);
- Verify that the cost savings guarantee is met;
- Allow for future adjustments, as needed.

Figure 14: Energy Use in Fairbanks Office Buildings



This section provides a basic overview of M&V for the procurement process. More detailed discussion of the M&V process can be found in **Chapter 12**. The Efficiency Valuation Organization (EVO) produces the International Performance Measurement and Verification Protocol (IPMVP[26]) that provides specific guidance for facility owners and project developers on the range of M&V options available and how the protocols may be applied. The US Department of Energy's M&V Guidelines: Measurement and Verification for Federal Energy Projects Version 3.0[27] that provides facility owners and project developers with direction on how M&V is applied in federal facilities is a useful resource for all public facility owners.

The Take Home

- M&V establishes impact of efficiency measures;
- M&V is a mechanism to confirm performance guarantee;
- M&V should be balanced with project size and complexity.

Cost and Rigor

The type of M&V required in a contract should be commensurate with the size and complexity of the project. This will balance the protection of the investment with the cost of detailed M&V. Careful consideration of the

[26] www.evo-world.org/index.php?option=com_content&view=article&id=272&Itemid=379

[27] www1.eere.energy.gov/femp/pdfs/mv_guidelines.pdf

M&V level, type, and rigor benefits both parties and can help mitigate potential problems during the performance period. M&V practices are on a spectrum from simple checks of isolated equipment to a full assessment of the facility. The International Performance Measurement and Verification Protocols (IPMVP)[28] define four main options for M&V, detailed in **Chapter 12**. The challenge of M&V is to balance costs with the value of increased certainty in cost savings achieved from the efficiency measures.

The cost of M&V should be less than the payment amount or guarantee at risk. Consequently, the objective of M&V should not be to produce a precise energy savings number but ensure energy services companies properly complete projects, and the resulting energy savings are reasonably close to the savings claimed. General estimates put overall annual M&V costs at 1 percent to 10 percent of typical project cost savings. Often, some energy efficiency measures (EEMs) will entail greater M&V costs; overall M&V costs are balanced by other EEMs which do not require substantial annual activities.[xviii]

Cost and Rigor Strategies

Strategies for keeping costs down while maintaining technical rigor:

- Use extensive metering during the baseline period and specify which values the ESCO has no control, such as set-points required for activities conducted in the facility.
- Verify key performance items using periodic data collection.
- Rely upon existing instrumentation, energy management systems, and energy management behavioral practices.
- Engage a third-party M&V expert to assist in development of the measurement and verification plan.

Specifications

M&V provisions are a very important part of an energy saving performance contract, since they determine payments made to the energy service provider under the performance guarantee. Even in non-ESPC projects, building owners benefit when M&V measures scaled to the scope of work are included in the contract. The M&V plan may be specified in the RFP but it may also be proposed by the bidder. In either case, the energy service provider must develop detailed M&V protocols by the completion of the energy audit and these must be agreed upon with the public facility owner. This final measurement and verification plan is then incorporated into the final energy savings performance contract.[xix] The duration of the M&V services are typically matched with the length of the performance guarantee.

Since the M&V approach calculates and documents energy savings, it is one of the most important activities associated with implementing performance contracts and is crucial in contract negotiations.

[28] www.evo-world.org/index.php?option=com_content&view=article&id=272&Itemid=379

Users wishing to specify use of International Performance Measurement and Verification Protocol (IPMVP) in an ESPC might use phrases such as, “The determination of actual energy and monetary savings will follow current best practice, as defined in IPMVP Volume I, EVO 10000 -1:2012.” Specification may go further to include, “The M&V plan shall adhere to IPMVP Volume I, EVO 10000 - 1:2012 and be approved by…” and may also, if known at the time of contract approval, add, “following IPMVP Option ….”[xx] See **Table 6** (Chapter 12) for a description of the IPMVP Options. Some financing may require M&V to be conducted by a third party, not by the energy services company (ESCO) completing the project. The owner should specify that the contractor performing the M&V be a Certified Measurement & Verification Professional (CMVP), or hold an equivalent certification.

Building Monitoring System

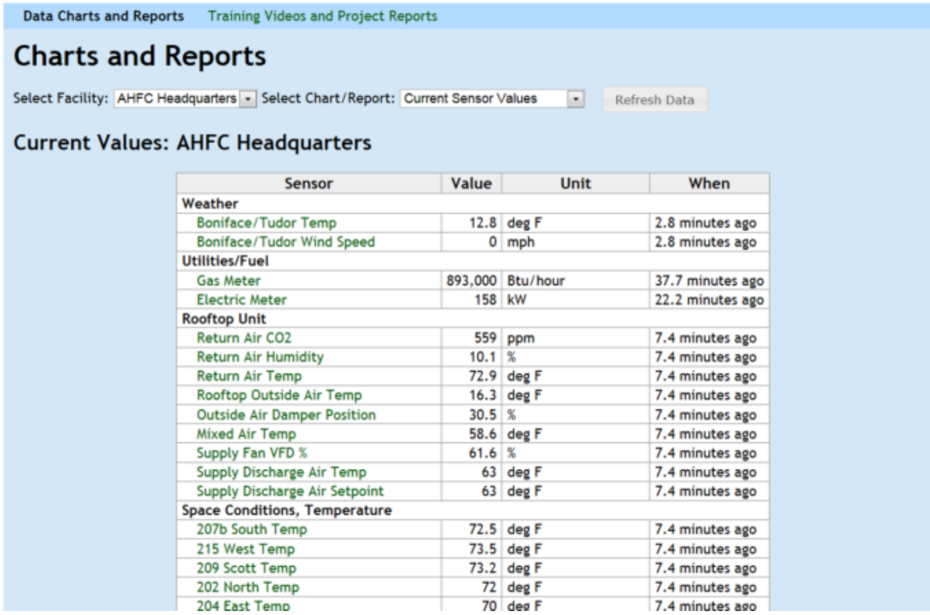
Metering and tracking energy is an important practice in lowering energy use and making sure a building is performing as designed. A common problem in commercial buildings, especially larger buildings or facilities with multiple buildings, is facility owners and managers have trouble identifying and tracking which building or systems dominate energy usage. Building monitoring systems are a helpful tool that can be used to establish a baseline from which post-retrofit performance improvements are measured.

Integrating metering and sub-metering with building automation systems can lead to substantial energy savings. Logging and monitoring energy use by building system allows building managers to respond to alerts when systems are not functioning properly. Energy dashboards provide building occupants with real time measured data about energy use at a glance, educating occupants on the relationship between their behaviors and the building’s energy performance. These monitoring systems are increasingly available and cost-effective, and worth considering.

AHFC developed a building monitoring system that incorporates near real-time readings for a facility from an array of sensors, a building automation system, local weather data, and more. The system is designed to provide detailed performance information about a building that can be used by facility managers and O&M staff to identify and act on cost saving opportunities. The system has been developed with open-source software but requires purchase of commonly available hardware sensors.

AHFC has installed this building monitoring system in eight buildings and has worked with Alaska Native Tribal Health Consortium (ANTHC) on installations in their buildings. A screenshot included in Figure 15 shows a portion of the sensors installed at the AHFC headquarters in Anchorage. With near real-time building monitoring, users are able to view up to date energy consumption that allows for almost instantaneous adjustments.

Figure 15: AHFC Building Monitoring



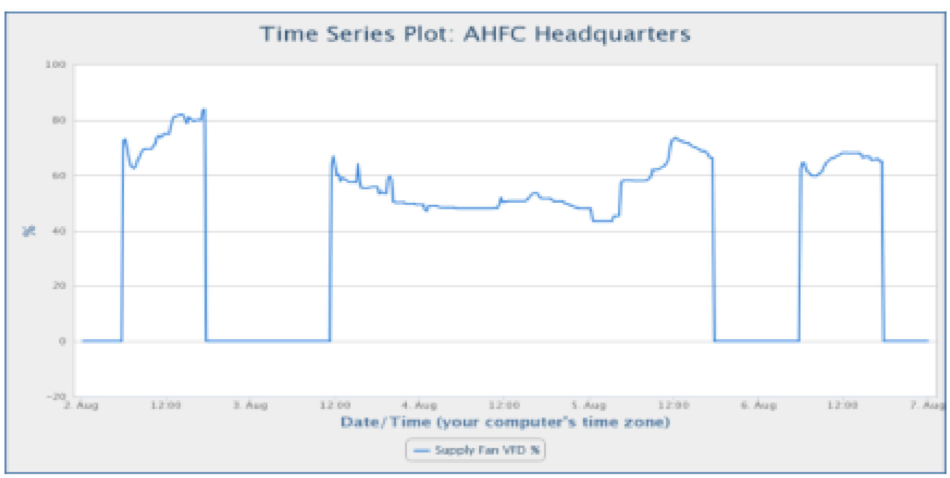
Sensor	Value	Unit	When
Weather			
Boniface/Tudor Temp	12.8	deg F	2.8 minutes ago
Boniface/Tudor Wind Speed	0	mph	2.8 minutes ago
Utilities/Fuel			
Gas Meter	893,000	Btu/hour	37.7 minutes ago
Electric Meter	158	kW	22.2 minutes ago
Rooftop Unit			
Return Air CO2	559	ppm	7.4 minutes ago
Return Air Humidity	10.1	%	7.4 minutes ago
Return Air Temp	72.9	deg F	7.4 minutes ago
Rooftop Outside Air Temp	16.3	deg F	7.4 minutes ago
Outside Air Damper Position	30.5	%	7.4 minutes ago
Mixed Air Temp	58.6	deg F	7.4 minutes ago
Supply Fan VFD %	61.6	%	7.4 minutes ago
Supply Discharge Air Temp	63	deg F	7.4 minutes ago
Supply Discharge Air Setpoint	63	deg F	7.4 minutes ago
Space Conditions, Temperature			
207b South Temp	72.5	deg F	7.4 minutes ago
215 West Temp	73.5	deg F	7.4 minutes ago
209 Scott Temp	73.2	deg F	7.4 minutes ago
202 North Temp	72	deg F	7.4 minutes ago
204 East Temp	70	deg F	7.4 minutes ago

The graph in Figure 16 shows the supply fan variable frequency drive (VFD) capacity in the summer of 2013. The fan continually ran from midday Saturday until the normal shutdown occurred on Monday evening. This pattern was observed to repeat every weekend.

Cause of the over-ventilation was tracked to a control schedule override made in the building automation system. This override was entered by AHFC staff to coincide with a carpet cleaning event that required additional fresh air for the building.

Resetting the controls schedule for the supply fan resulted in a reduced run time of approximately 34 hours per weekend. A separate analysis indicated saved fan power was about 55 kW. Reduction in fan use was associated with a reduction in electrical use of approximately 1,870 kWh per weekend or 97,240 kWh per year. This reduction did not affect the peak load of the building, since it occurred on the weekend. The electric rate at the time of the event was $0.082/kWh, not including peak demand charges. Cumulative electricity savings from the resetting of the ventilation schedule override were

Figure 16: Example of Supply Fan VFD capacity



$7,990/year.

Eliminating weekend fan runtime reduced annual gas usage by approximately 183 MMBtu for an annual savings of $1,280 per year. A total estimated energy savings of 515 MMBtu per year and cost savings of $9,270 per year was associated with resetting the ventilation control override at the AHFC Headquarters building.

The Bottom Line

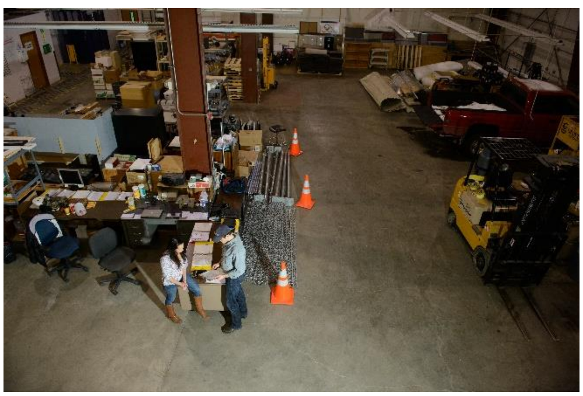
It pays to know how a building is operating, and a building monitoring system makes it easier to identify energy use, trends, and cost saving measures. Consider procuring a building monitoring system.

---

i (Barnes, Hodgin, Brew, & Karolides, 2013)
ii (US Department of Energy, 2010)
iii (Pressman, 1997)
iv (Singh, Limaye, Henderson, & Shi, 2010)
v (Oregon Department of Transportation, 2012)
vi (Schuler, 2012)
vii (Energy Sector Management Assistance Program, The World Bank, 2010)
viii (Pabor & Pennington, 2012)
ix (Pabor & Pennington, 2012)
x (Energy Sector Management Assistance Program, The World Bank, 2010)
xi (Energy Sector Management Assistance Program, The World Bank, 2010)
xii (US Department of Energy, 2010)
xiii (Energy Sector Management Assistance Program, The World Bank, 2010)
xiv (Barnes, Hodgin, Brew, & Karolides, 2013)
xv (Barnes, Hodgin, Brew, & Karolides, 2013)
xvi (National Institute of Building Sciences, 2014)
xvii (Singh, Limaye, Henderson, & Shi, 2010)
xviii (US DOE, 2008)
xix (Energy Sector Management Assistance Program, The World Bank, 2010)
xx (EVO, 2012)

Overview

The scope of work (SOW) is a document that describes work required to complete a specific project. It is a formal document and must be agreed upon by the building owner, architect and/or engineer, construction manager, project manager, and general contractor. To be effective, the SOW must contain an appropriate level of detail so that all parties clearly understand what work is required. State the objectives of the agreement or the deliverables, goals of the agreement, any administrative duties required, and the timeline for project completion. The SOW should provide a general description of the project, highlight the project's background, and explain what is to be gained. As the SOW may accompany a Request for Proposal (RFP), the SOW introduction and background are necessary for bidding subcontractors to familiarize their organizations with the project. A SOW is also needed if the project is not going out for bid.



A building's design can have major impacts on overall energy use.

After the auditor lists all the potential energy efficiency measures (EEMs) and provides basic cost savings estimates, the facility's project manager should meet with the auditor to review the list measure by measure to determine what to implement first. From the audit report, select EEMs that are cost-effective and will work within current budgets or with financing. Work with the O&M team to incorporate the EEMs that were not selected into preventative maintenance and capital improvement plans.

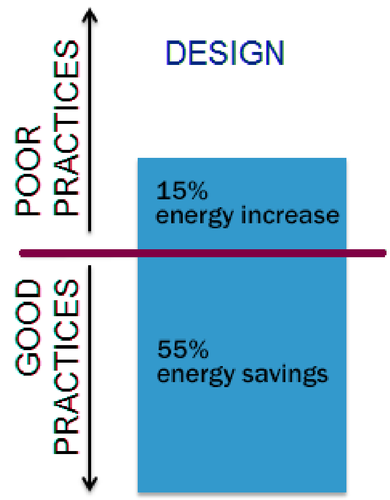
If the building automation system is within the scope of work, require the design team to collaborate with O&M staff regarding access to and training on the controls system. The skill level of O&M staff will help the design team determine what type of controls system to install and whether access to the system is desirable. A non-proprietary, open-source system that can be managed by the building's current O&M staff may be desirable.

Design

With a scope of work and contracting approach determined, the next step is to create appropriate construction documents with cost estimates. This is one of the more costly steps in the project-development phase and can constitute 10-15 percent of construction costs. If the project scope requires some level of engineering and design, the next step is to prepare a solicitation for services of an architecture and engineering (A&E) firm.

Hiring a design professional who has experience in energy-efficient design and deep energy retrofits is crucial to achieving the maximum amount of energy efficiency for the least amount of money. Designers with extensive deep-retrofit experience can save the project money in the short term by properly sizing and integrating building systems, and in the long term through diminished energy costs.

Figure 17: Impact of Design on Energy Savings, Fairbanks offices



Selection criteria for the A&E team should include:

- Professional qualifications;
- Specialized experience and technical competence in energy conservation and passive energy design;
- Capacity to successfully accomplish the scope of work;
- Past performance;
- Location where work will be performed.

Establishing design guidelines gives designers and contractors a baseline of quality and energy efficiency for new construction and renovation projects. While not all guidelines will apply to every project, they will set priorities for the project and help designers understand energy efficiency expectations for the project.[i]

A building's design has a major impact on energy use. Certain elements of design, such as envelope, have a long lifespan so it is important to compare the first cost to the impact on life cycle costs (see Chapter 6, **Procurement**).

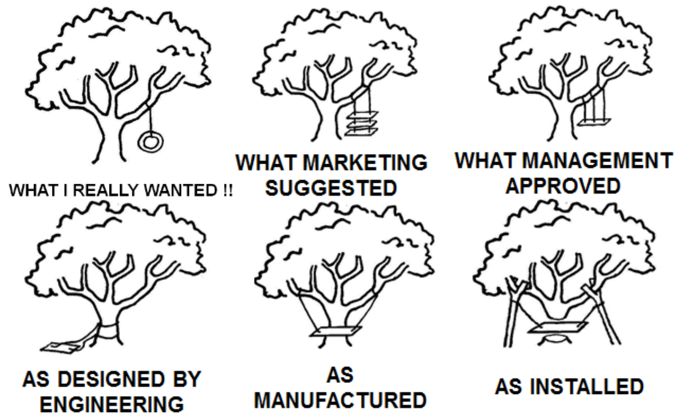
According to a 2011 report by the New Building Institute titled *Sensitivity Analysis: Comparing the Impact of Design, Operation and Tenant Behavior on Building Energy Performance*, which analyzed buildings in Fairbanks, AK and several locations throughout the U.S., the penalty of sub-optimal design can be significant.

Building envelope improvements such as new outside doors and windows, lighting fixtures and controls, heat recovery ventilation, air leakage or infiltration reduction, etc., should be explored prior to replacement of major equipment. The efficiency improvement of a new heating system will be marginalized if the building itself is inefficient.

In addition to any general project requirements it is important to specify the design standard which will provide guidance to the A&E firms responding to the solicitation and serve as a metric for accountability through construction and after project completion. Choice in energy efficiency standards should align with the energy reduction commitment and goals set by organization leadership. Measureable performance goals should be explicit in the solicitation for design services if not referenced in statute, local ordinance, code, or design standard.

There are a variety of design standards. A performance based specification, such as ASHRAE 90.1 2010 or ASHRAE 50 percent Advanced Energy Design Guide (AEDG), provides clear direction as to how much energy reduction beyond the code minimum is required for a major retrofit project. The AHFC Building Energy Efficiency Standard (BEES) (required for projects funded through AHFC) is a minimum, but striving for deeper energy reductions is encouraged.

Integrative Design Process (aka Integrated Project Delivery)



It's not easy to keep the project vision alive as it goes through all the hands it takes to make it a reality. The tree swing graphic to the right illustrates that at each step in the process project success can be revamped by poor product design or customer service, or failure to interpret customer's needs. The integrative design process establishes a system that promotes clear communication of project goals and collaboration on design, engineering, construction, and operational opportunities, and risk management from an early stage. When successfully applied, this approach can result in reduced project delivery time and costs, and a higher performance building. Hiring a design professional who understands the integrative design process will help ensure maximum energy savings and functionality are realized, and the project is within budget and on-time.

Efforts to incorporate good design practices that reduce energy use can be undermined by poor operation practices. The level of expertise of operations and maintenance teams varies greatly across public facilities in Alaska; therefore it is critical to design systems that meet the needs of the building and the capabilities of the staff. Early involvement of the operations and maintenance team may help design new mechanical systems appropriate for local conditions, and training staff to operate these mechanical systems is critical to project success. Research suggests specifying an integrative design process in the solicitation will ensure the outcome of the retrofit project meets user's needs.

Figure 18: Potential Stakeholders in an Integrative Design Process

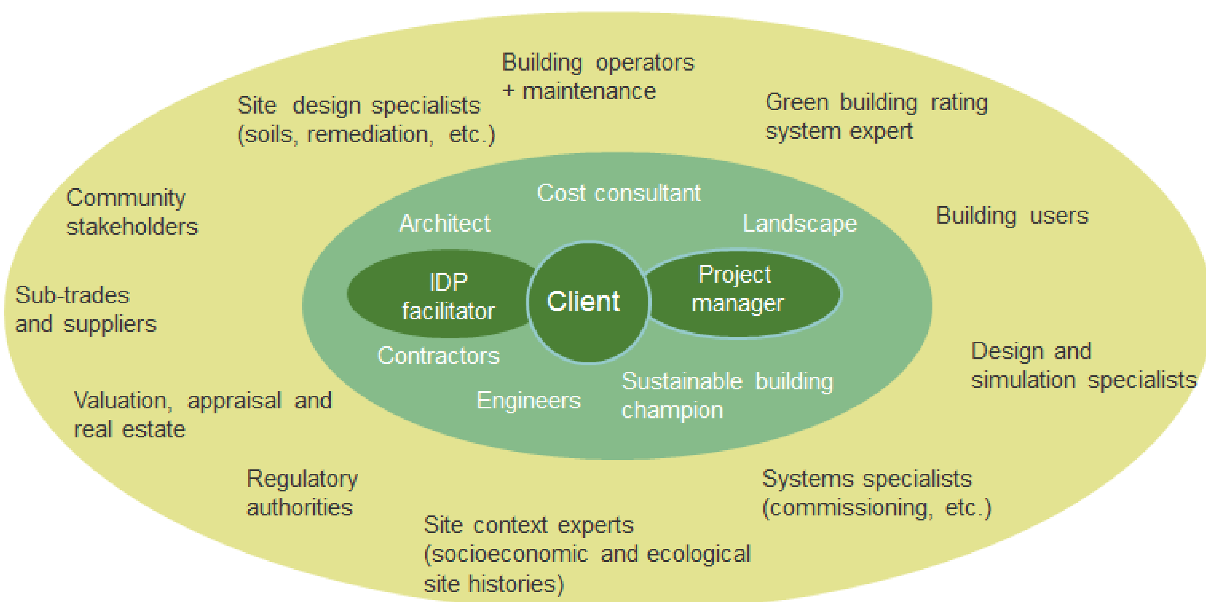


Figure 18 illustrates many of the possible stakeholders who can be included in the design process. Another term that is commonly used with this same concept is Integrated Project Delivery. More information on the Integrative Design Process and Integrated Project Delivery can be accessed through the American Society for Heating, Refrigeration, and Air-Conditioning Engineers (ASHRAE)[29] and the American Institute of Architects (AIA)[30].

---

i (Barnes, Hodgin, Brew, & Karolides, 2013)

---

[29] http://aedg.ashrae.org

[30] www.aia.org/about/initiatives/AIAS078435?dvid=&recspec=AIAS078435

Overview

Building or renovating to achieve good quality energy efficient buildings is not easy. Navigating building codes, technical specifications, construction regulations, building standards and practices, OSHA regulations, timelines, and budgets requires expertise and time. Having a construction manager (CM) on board can make the process easily navigable, streamline efforts, and lead to quality projects.

A construction manager (CM) can be an individual or a firm contracted to oversee the construction and installation of a project. A CM is classified as *not At-Risk* or *At-Risk*. A CM *Not At-Risk* uses specific project management methods for managing design and construction services. A CM could be used in conjunction with any project delivery method including Design-Bid-Build, multiple prime, or Design-Build. A CM *At-Risk* holds the trade contracts and is contractually responsible for the successful performance of the work. The existence of a guaranteed maximum price or a scheduled guarantee may affect the amount of risk the CM *At-Risk* has but they are still contractually responsible for the successful completion of the project.

The American National Standards Institute (ANSI) has accredited the Construction Manager Certification Institute's Construction Manager Certification program. Currently there are a few Certified Construction Managers (CCMs) in Alaska. At this time Alaska does not have licensing or regulatory requirements for CMs. The Energy Efficiency Division of the California Energy Commission has prepared a document that explains how to go about hiring a CM, titled "*How to Hire a Construction Manager for Your Energy Efficiency Projects.*"[i] Much of this chapter is credited to that document.

CMs are typically involved at the start of a project to assist the client with the initial planning and selection of an architect/engineer and general contractor. CMs may be engaged by the architect/engineer and general contractor or they may be directly hired by the client. Traditional general contractors are not usually involved in the building process until initial planning and design is complete. Depending on location within rural Alaska they may be involved in all aspects of the construction project.

A construction manager can assist the owner plan and procure a retrofit project, provide jobsite inspection, and ensure appropriate training is provided to operation staff.

When the CM is hired directly by the client he/she may be responsible for developing an overall approach for the project. The CM will write or oversee the writing of the construction contract, proposal specifications, technical specifications, and construction drawings or lists of bid items (including quantities). The CM determines the scope of work for each part of the project. They review contracts prior to bidding and manage the award process. The CM manages the request for information (RFI) process, subcontractors, procurement, scheduling of equipment, and material deliveries. The CM is responsible for determining the most cost-effective plans while developing, reviewing, and maintaining the construction schedule. The CM must also develop and/or ensure project testing, commissioning, and acceptance requirements are completed on schedule. The CM provides construction management and inspection services on site, ensuring all applicable environmental health and safety rules, regulations, building standards, and codes are complied with. The CM will submit progress reports to the client at regular predetermined stages throughout the duration of the project. They will also provide operation and maintenance manuals, procedures, and checklists. The CM should also create a recommended spare-parts-on-hand list for the owner, and ensure all operation and maintenance staff is properly trained on all aspects of the buildings systems and operations. A well-trained and experienced CM will identify potential problems before they happen. The CM will travel to jobsites when necessary to inspect the work of each contractor or sub-contractor, and confirm the quality and standard of work being done is in accordance with plans and specifications. Hiring a CM is typically five to ten percent of the project's construction budget.

Disruptions and Cost Considerations

During the planning phase, the CM considers disruptions to the occupants and their use of existing structures. Can the work be done during non-occupied hours, or done in stages so various parts of the building can be used while work is in process? If neither of these are options, other accomodations must be made available. These accomodations could mean anything from finding storage in the building for equipment to moving everything, including the building ocupants, to another suitable location. For example, if the work is broken up into sections or done during off hours, make sure no more than half of the restroom facilities in the buliding are renovated at a time. If there is only one restroom, then other alternatives must be considered. If the building is a medical clinic or requires a special ventilation system, the CM ensures that all safety measures are in place and any alternative steps are taken to ensure the building occupant's safety. If there are hazmat abatement issues, all safety measures must be taken into consideration and complied with. Other cost considerations that have the potential to drive up project costs are equipment costs, distance to the project, number of project locations, the flexibility of the schedule, the complexity of permitting requirements, and labor costs.

When to Hire a CM?

If an organization has knowledgeable and trained staff who are available and can handle all of the project oversight duties on top of their regular duties, hiring a CM is not necessary; however, in most cases, hiring a CM is the most expeditious and cost effective method of getting a project completed on time and within budget. Consider the worksheet in Table 3 to help evaluate options.

Weight each criterion from zero to five, with zero being unimportant and five being very important, and put that number in column A. In column B assign points from one to 10 based on how strongly the key questions are true, with zero being "not at all true." Multiply the numbers in columns A and B together, and then enter that number into column C. Add up the numbers in column C and place the total in cell “D”. Multiply the total of column A by 10 to get E. Dividing D by E will give you F. (D/E=F).

Table 3: Does My Project Need A Professional Construction Management Firm?

Criteria	Key Questions	A Weight (0-5)	B Points (0-10)	C Point Total (A x B)
1. Tight schedule	Does the project have a tight schedule?			
2. Staff unavailable	Is staff unavailable and/or committed to other projects?			
3. Lack of trained and experienced staff	Does the organization lack trained and experienced staff with construction management, contract administration, and inspection experience?			
4. Lack of project definition	Does the project need to be better defined before it starts? For example, is there a need to develop construction drawings or specifications, collect project data, take measurements, or develop an overall project approach?			
5. Need for careful project coordination	Will this project require careful coordination and management to minimize disruption of the facility? For example, is there a need to shut down essential systems such as electrical supplies, HVAC, or computer centers?			
6. Need for careful project management	Will this project require careful management to minimize indirect disruptions, such as noise, dust, or impeded traffic flow?			
7. Complicated/ multi-facility project	Is this a complex project that requires resolution of regulatory issues before it begins?			
8. Available funds	Are funds available to hire a CM?			
Total points in each column				D
Total maximum points				E
Percent of total points				F

After completing the table:

- If F is greater than 75 percent of the total points, it is strongly recommended a CM be hired for the project.
- If F is between 50 and 75 percent, then the owner may want to consider hiring a CM.

- If F is less than 50 percent the need to hire a CM for the entire project is reduced.

Which Construction Management Services to Use?

There are three phases to every project: pre-construction, construction, and post-construction, each with multiple steps. In the pre-construction phase, the most economical and reliable ways to accomplish the project should be identified. Will in-house staff and/or a contractor supply the necessary equipment for the project? Depending on the depth of the energy project, detailed construction documents and specialized tests could be required before and/or after installation requiring additional engineers or consultants. A detailed project installation plan will take into account specific quantities, location, access and scheduling constraints, hazardous or dangerous conditions, and the verification and commissioning process. Project documents must be dealt with such as pre-bid documents, contracts, construction documents and technical specifications, permits and inspections, budgets and schedules, and project team meetings must be managed. All contractors must meet minimum insurance/bonding requirements required by the State of Alaska and per the project contract. A health and safety orientation must also be addressed before the start of a project.

When considering CM services for the construction phase, the project size and any special requirements must be considered. If CM costs will exceed 10 percent of the project budget, an onsite project manager will move the project along. If the project is happening across several locations, a full time on-site construction manager who travels between locations will help ensure the project is moving along according to plans. A full time on-site CM is necessary for oversight if there are multiple contractors or subcontractors working on the project. The CM will take responsibility for verification of any contractors' or subcontractors' qualifications. The CM will oversee the inspection process and see that all required inspections are completed and recorded in a timely manner. Construction support services—such as change orders, schedule, budget updates, project meetings, and progress reports—will run through the CM. During the construction phase, the project engineer will develop criteria and performance tests that will be used during commissioning to determine whether energy efficiency improvements are correctly installed, and if measurement and verification standards are being met. New equipment can be installed correctly, but that doesn't mean the equipment is functioning within design parameters.

The size and complexity of the project will determine the level of construction management required.

The post-construction process will involve commissioning, operations and maintenance training, as-built drawings, and contract closeout. The equipment manufacturer or supplier will provide operations and maintenance (O&M) manuals for the installed equipment. O&M training is very important; the CM will ensure facility staff is trained on the proper O&M of the building. Training should be required per the contract signed with the equipment manufacturer or supplier.

Consider the following worksheet to help decide at what phase of construction to obtain CM services.

Table 4: Construction Management Services Worksheet

A. Pre-Construction Phase			
Requirements	**Service is needed**	**Service is not needed**	**Who will provide the service?**
1. Identify the most economic and reliable way to accomplish each project?			
2. Do you need engineers or other consultants?			
3. Create a project installation plan?			
4. Project documents:			
• Prepare bid documents for contractor?			
• Evaluate and select winning contractor?			
• Coordinate contract negotiations and preparation?			
• Manage preparation of construction documents?			
• Oversee permitting and other regulatory activities?			
• Develop and monitor budgets and schedules?			
• Conduct project meetings?			
• Provide health and safety orientation?			
• Ensure all contractors meet minimum insurance/bonding requirements?			

B. Construction Phase			
Requirements	**Service is needed**	**Service is not needed**	**Who will provide the service?**
1a. Is a full-time on-site construction manager needed?			
1b. Is a part-time on-site construction manager needed?			
2. Perform construction inspections:			
• Inspect mechanical systems and components?			
• Inspect electrical systems and components?			

B. Construction Phase			
• Inspect instrumentation and controls?			
3. Provide construction support:			
• Review data on construction equipment and materials?			
• Provide factory inspection of special equipment?			
• Review change orders?			
• Update construction schedules and budgets?			
• Conduct team meetings?			
• Prepare progress reports?			
4. Develop criteria for commissioning, final testing, and acceptance?			

C. Post Construction Phase			
Requirements	**Service is needed**	**Service is not needed**	**Who will provide the service?**
1. Prepare operations and maintenance manuals?			
2. Provide training?			
3. Require the preparation of as-built, equipment list, or drawings?			
4. Close out construction contracts?			

How to Choose the Right Construction Manager?

There are many things to take into consideration when choosing a CM to hire. The list of questions below can help determine which CM is the best choice for a particular project.

- What is their experience?
- Have they completed similar projects, and if so, how many?
- How do their references look?
- Do they finish projects on time and within budget while delivering a quality product?
- What is their experience, and have they won any awards for their work?
- Is their approach to the project within parameters, including scheduling?
- Does the project fit within the CM abilities?
- What are their financial and bonding capacities, and insurance requirements?

- How do their costs line up with those of other CMs, including estimated project hours and average hourly rates? (Unless specified, CM services do not include the cost of building specialists, such as engineers and inspectors, even though the CM is usually overseeing their work.)
- Do they meet the criteria necessary for working on public sector projects, if applicable?

Conclusion

The worksheets in this chapter will help determine if hiring a construction manager is appropriate, regardless of the project size and/or stage of construction.

---

i Ketchum, et al., 2000

Overview

A general contractor (GC) differs from a construction manager (CM) in that GCs will usually have their own crews including foremen, superintendents, carpenters, or other skilled tradespeople, along with a contingent of subcontractors, with whom they usually work. GCs usually win their jobs through a competitive bidding process; all aspects of the project are built into the contract. If the GC manages to spend less than their bid to complete a project, then the GC makes a profit. A CM, in contrast, is hired directly by the owner to represent the owner. The CM is generally paid a set percentage of total project cost.

Aside from general contractors, there are electrical contractors, mechanical contractors, specialty contractors. There is also a subcategory of general contractor, “handyman,” that is usually used in residential applications. There are 37 different specialty contractor trades recognized by the Alaska Department of Commerce, Community, and Economic Development, e.g., carpentry, drywall, plumbing, masonry, commercial, residential, and roofing. According to Alaska Statutes and Regulations: Construction Contractors, January 2015, Sec. 08.18.024, “Specialty Contractors, (a) The department may authorize the limited use of specific construction techniques or materials that are defined by the department as part of one specialty trade by a specialty contractor licensed in a different specialty trade if those construction techniques or materials are a small but inseparable part of what is required to complete that specialty contractor’s work. (b) not withstanding (a) of this section, a specialty contractor may perform work that requires the use of not more than three trades.”

Select contractors with appropriate certifications and experience.

All contractors are required to be licensed and bonded. The bonding amount is different depending on the type of contractor. At time of publishing, the State of Alaska requires general contractors must be bonded for $25,000, mechanical, electrical, or specialty contractors require $10,000 bonds, and handyman contractors $5,000. “A handyman contractor will work on one project with an aggregate contract price of $10,000 or less, including all labor, materials and other items when the work is not part of a larger or major operation or otherwise divided into contracts of less than $10,000 to evade a higher bonding requirement.”[i]

Construction contractors in the State of Alaska are required to hold a certificate of registration. Statutes and regulations for construction contractors are issued annually each January. It is recommended to review the statutes and regulations[31] prior to hiring a contractor.

What to Know Before Hiring a Construction Contractor

Contractors can provide skilled services, hire trained and licensed subcontractors, and use reliable materials; however not every person who presents themselves as a contractor is skilled, experienced, and qualified. Due diligence is the best option to find the right contractor.

- Ensure the contractor is registered, bonded, and insured. Note: a business license and liability insurance are not the same as a professional license and bond.
- In addition to State of Alaska bonding requirements there are surety bonds. While not required by the State of Alaska, they are recommended especially for larger projects. A surety bond ensures contract completion in case a contractor defaults.
- "The surety bond holder (company) is obligated to find another contractor to complete the contract or financially compensate the project owner for the financial loss incurred. There are four types of surety bonds:
    - **Bid Bond**. Ensures the bidder will enter into the contract and furnish the required payment and performance bonds if awarded the contract
    - **Payment Bond**. Ensures suppliers and subcontractors are paid for work performed under the contract.
    - **Performance Bond**. Ensures the contract will be completed in accordance with its terms and conditions.
    - **Ancillary Bond**. Ensures requirements integral to the contract, but not directly performance related, are performed."ii
- Interview contractors, obtain bids, and check their references. Estimates will be presented in writing and include detailed specifications for labor, materials, the timeline, and total charges for the project.
- Check court records and the Better Business Bureau for any complaints against the contractor.
- Insist on a written contract outlining all work to be completed by the contractor, including materials to be used, any subcontractors, start and completion dates, and payment schedule. Do not pay a contractor in full prior to completion; most projects are paid in installments established at prearranged completion stages. Keep copies of all documents, including contracts and receipts.
- Know all project costs, including any interest or finance charges. Research all financing options to find the best fit.

When to Hire a Contractor

Consider hiring a contractor if the following requirements cannot be fulfilled:

---

[31] https://www.commerce.alaska.gov/web/portals/5/pub/contractorstatutes.pdf

- Skilled in construction;
- Fully versed in building codes, the Americans with Disabilities Act (ADA), building safety, and energy efficiency retrofits;
- Adequate time and ability to plan and successfully complete the job;
- Knowledge regarding materials required for the project, and their applications; and
- Knowledge of, and access to, a sufficient number of quality subcontractors.

Ensure contractors have appropriate certifications and experience.

Researching a Contractor

Before hiring any type of contractor or signing a contract, research and interview multiple contractors and consider multiple bids. It is standard practice to collect written estimates from at least three different contractors. Each written estimate must be based on the same set of specifications for comparison purposes, and request that the contractor provide specific detail that is measurable, action-oriented, realistic, and time-bound. Per Alaska law, Sec. 08.18.101[iii], any project with a total contract price including all labor, materials, and other items above $2,500 requires the contractor or specialty contractor to carry workers' compensation, public liability, and property damage insurance. Any legal history or registered complaints regarding contractors can be found at the following locations:

- Alaska state court records[32]
- Better Business Bureau or Local Consumer Affairs Agency[33]
- State License Revocation[34]
- Registered complaints[35]

What Kind of Contractor?

It is important to discuss specialty contractors with the general contractor. Per Alaska law, Sec. 08.18.024(b)[iv], a specialty contractor may perform work that requires the use of not more than three trades. A specialty contractor may only contract with a general contractor or subcontract with another specialty contractor. Both specialty contractors must have the trade(s) being bid on and subcontracted listed on their licenses, i.e., specialty with "drywall" may only bid on the "drywall" trade, and sub to another specialty that also has "drywall" on their license.

---

32 www.courtrecords.alaska.gov/pa/pa.urd/pamw6500.display

33 www.alaskaoregonwesternwashington.bbb.org

34 www.commerce.state.ak.us/occ/OccSearch/main.cfm

35 www.commerce.state.ak.us/occ/search3.htm

At time of publication there are 37 different specialty contractor trades under 12 AAC 21.200:

1. Access Flooring Contractor (12 AAC 21.210)
2. Acoustical and Insulation Contractor (12 AAC 21.220)
3. Asbestos Abatement Contractor (12 ACC 21.230)
4. Carpentry Contractor, Finish (12 ACC 21.240)
5. Carpentry Contractor, Rough (12 ACC 21.250)
6. Communications Contractor (12 AAC 21.260)
7. Concrete and Paving Contractor (12 AAC 21.270)
8. Demolition Contractor (12 ACC 21.280)
9. Drilling Contractor (12 ACC 21.290)
10. Drywall Contractor (12 AAC 21.300)
11. Electrical Contractor (12 AAC 21.310)
12. Elevator and Conveying System Contractor (12 AAC 21.320)
13. Excavation Contractor (12 AAC 21.330)
14. Fence & Guardrail Contractor (12 AAC 21.340)
15. Floor Covering Contractor (12 AAC 21.350)
16. Glazing Contractor (12 AAC 21.360)
17. Landscaping Contractor (12 AAC 21.370)
18. Liquid or Gas Storage Tank Contractor (12 AAC 21.380)
19. Low Voltage Alarm or Signaling Device Contractor (12 AAC 21.390)
20. Marine Contractor (12 AAC 21.400)
21. Masonry Contractor (12 AAC 21.410)
22. Mechanical Contractor, Exempt (12 AAC 21.420)
23. Painting Contractor (12 AAC 21.430)
24. Plaster Contractor (12 AAC 21.440)
25. Road Construction Contractor (12 AAC 21.450)
26. Roofing Contractor (12 AAC 21.460)
27. Security Systems Contractor (12 AAC 21.470)
28. Sheet Metal Contractor (12 AAC 21.480)
29. Sign Contractor (12 AAC 21.490)
30. Solid Fuel Appliance Contractor (12 AAC 21.500)
31. Steel Erection Contractor (12 AAC 21.510)
32. Tile and Terrazzo Contractor (12 AAC 21.520)
33. Wallcovering Contractor (12 AAC 21.530)
34. Water and Sewer Contractor (12 AAC 21.540)
35. Water System Contractor (12 AAC 21.550)
36. Welding Contractor (12 AAC 21.560)
37. Other Specialty Contractors (12 AAC 21.570)

i (Alaska Department of Commerce, Alaska Fuel Price Report)
ii (United States Small Business Administration)
iii (State of Alaska)
iv (State of Alaska)

Overview

Most projects sound simple when discussed; however, there is much to remember and consider before starting construction on any energy efficiency project. Timetables, permitting, space disruptions, inspections, codes, and quality assurance must all be taken into consideration.

Alaska weather limits the length of the construction season, for rural Alaska this makes the planning of equipment staging, construction supplies, materials, labor, food, lodging, travel time, and expenses more important. Coordination with the construction manager (CM) is paramount. If equipment, supplies, and materials are shipped early, staff must obtain a location for staging or storage. If outside labor will be traveling to the jobsite, accommodations for them and their vehicles (depending on the location) will be necessary.

Know going into a project that all construction is disruptive in some way. People, office supplies, and equipment will often need to be relocated. Whether this can be done on-site or by moving into other temporary facilities depends on the size of the project. Building occupants may need to plan for relocation even if the project does not initially call for it. If it is possible to keep building occupants on-site during construction, open communication—including progress reports—is very important. Construction inevitably produces dust, noise, and odors; giving occupants warning of this helps mitigate concerns and allows staff to plan for noise interruptions and address any health concerns. Accessibility of files, office equipment, and supplies must all be taken into consideration before the project starts.

Ensure construction workers and facility staff wear appropriate protection.

Before and during the energy-efficiency construction or renovation project, building owners and management should:

- Identify representatives to be primary points of contacts for building occupants and contractor(s), and schedule weekly update and planning meetings.
- Ensure appropriate personal protective equipment is worn by all individuals when in the construction area.[i]
- If possible, schedule work during low building-occupancy hours.[ii]
- Use containment barriers to help minimize dust. [iii]
- Use negative pressure within the construction area to help contain airborne particles and odors.[iv]
- During construction, ensure the construction area has been isolated and cut off from the building's HVAC system to keep airborne particles or noxious odors from being dispersed throughout the building.[v]

- Do not store construction equipment in HVAC mechanical rooms or next to fresh-air intakes.[vi]
- Ensure construction vehicles and equipment are not left running next to fresh-air intakes. [vii]
- Provide and maintain as much of a buffer zone as possible between the construction area and building occupants to allow for construction supplies and equipment to be moved around as needed.[viii]
- Ensure areas are roped off so building visitors or occupants do not inadvertently walk under or into a hazardous area.
- Maintain proper housekeeping to ensure construction dust is not spread around the building outside of the construction area.
- Have earplugs on hand for building occupants should they be necessary.

Safety-related issues to consider include open construction areas, ladders, falling objects, new and/or dangerous traffic patterns, unattended construction equipment, blocked exits, disabled fire detection systems, disabled fire alarms, disabled fire suppression systems, and emergency lights.

As construction progresses, ensure all building, code compliance, and quality assurance inspections are completed according to local regulations and contract specifications.

Projects often take longer than expected. Anticipating the needs of building occupants in advance will minimize the disruption of construction and may shorten the project timeline.

---

i CDC
ii CDC
iii CDC
iv CDC
v CDC
vi CDC
vii CDC
viii CDC

Commissioning and Retro-Commissioning

Overview

After a new ship is built, it must undergo sea trials to ensure it is seaworthy. Navigation systems are checked, captain and crew are trained, systems are tested to work as designed, and materials used are inspected for quality. Buildings follow a similar commissioning process after they are completed. The roof should be checked to ensure it does not leak; the foundation should be inspected to ensure it can support the building; the toilets should be tested to ensure they flush and drain completely into sewer lines; the lights are inspected to ensure they turn on when the switch is thrown; the building temperature should be monitored to ensure the thermostat is working properly; and maintenance crews should be trained to efficiently operate and repair the building. Building commissioning is a process similar to sea trials where the systems are inspected for the explicit purpose of ensuring everything works.

The building commissioning process ensures all systems are properly designed and installed, and operate within design parameters. It is a quality assurance process that should start with conceptual design of the building, continue through the construction and occupancy stages, and remain with building operations and maintenance departments throughout the life of the building.

Retro-commissioning is a similar process for existing buildings. A building that has had major systems replaced (like a boiler or a roof), has never been commissioned or is more than five years from the last commissioning is a prime candidate for retro-commissioning. The process inspects all systems in a building and verifies they are working properly. Systems adjustments can be made and maintenance can be done, or systems improvements can be identified for future attention. Sometimes components are recommended for replacement. Depending on the scope of retro-commissioning, it can collect much of the information needed for an energy audit. Cost savings may be realized by combining the two than if they were done separately.

Well-tuned mechanical systems only remain in tune over time with proper attention.

Well-tuned mechanical systems only remain in tune over time with proper attention. Building systems are no different. They should be inspected for hardware security, lubrication, range of motion, operational settings, and a host of other checks that keep them operating at peak performance. Retro-commissioning is more in depth than regular mechanical systems maintenance; it rebalances the building loads of heat, light, airflow, and water to their optimum operating parameters. A retro-commissioning project on an Anchorage school found an air damper constantly closed, even though the actuator was moving properly and the damper settings were reading open on the automation software. The retro-commissioning project identified a set screw had loosened and the damper remained shut while the actuator went through its proper cycles. This created discomfort for the teachers and students, and resulted in higher energy bills during the cooling seasons.

New buildings should be commissioned to ensure all systems are working as designed. Unfortunately, the commissioning budget is often one of the first items cut if the budget is higher than anticipated.

Commissioning during the construction, acceptance, and warranty phases is intended to:

- Verify and document equipment is installed and operated per manufacturer's recommendations, industry accepted minimum standards, and the contract documents;
- Verify and document equipment and systems receive complete operational checks;
- Verify and document equipment and system performance;
- Verify all operations and maintenance materials have been turned over to the facility manager;
- Ensure operations and maintenance staff has adequate training on the operation and maintenance of building equipment;
- Provide the facility owner with a manual on all systems including maintenance schedules, operating set points, sequence of operations, and replacement schedules.

The commissioning process does not reduce the responsibility of system designers or installation contractors to provide a finished and fully functioning building; it holds them responsible to ensure design and installation are what the facility owner paid for.

Commissioning agents verify systems operate as designed.

The commissioning process will ideally include regular meetings to ensure program and legal requirements are met. It should establish and maintain lines of communication with the building owner, design team, and contractor, and result in thorough documentation, enforcement of specification provisions, identification of specialized tests, and creation of a timeline for commissioning activities and reports.

Commissioning is an integral part of a construction or retrofit project, and is typically performed by a third party and not the contractor in charge. When procuring a commissioning agent, make sure they are qualified (see **Commissioning** and below) by checking their credentials and reviewing previous buildings they have commissioned. Ask for references or referrals from other building owners.

There are several organizations who offer commissioning and retro-commissioning certifications to professionals. Each certification requires significant education and professional experience related to building systems. Several organizations in Alaska are listed below:

- Building Commissioning Association (BCA) - Certified Commissioning Professional
- Association of Energy Engineers (AEE) - Certified Building Commissioning Professional or Commissioning Agent (CBCP)

- American Society of Heating, Refrigeration and Air conditioning Engineers. (ASHRAE) - Commissioning Process Management Professional Certification (CPMP)
- AABC Commissioning Group - Certified Commissioning Authority
- National Environmental Balancing Bureau (NEBB) - Commissioning Process Certification (CX-PC)

The scope of work in a commissioning process addresses the equipment to be commissioned, which can vary depending on needs or programs. Green building rating system compliance and other project requirements define goals for energy and water consuming equipment (National Institute of Building Sciences, 2014).

Retro-commissioning fine tunes the building system and typically results in immediate energy savings for building owners; however, when combined with an energy audit it will provide the building owner a long range energy saving plan. They will receive a report of recommended energy efficiency measures and immediate corrections on building deficiencies. The energy cost savings and improvements to occupant health and comfort should start to accrue immediately.

"Simple payback for a retro-commissioning project is typically less than two years and often less than one year." – Portland Energy Conservation, Inc. (PECI) and EPA

In 2010-12, the Alaska Housing Finance Corporation funded more than three hundred building audits across Alaska. Many of the audits were conducted on schools, and the majority of them were found to be over-ventilated. In these cases, the ventilation systems were operating at maximum capacity to ensure adequate fresh air when the building was fully occupied; however, the buildings were rarely at maximum capacity. Setting the ventilation system to operate at maximum levels resulted in over-ventilation and higher energy costs.

Low indoor humidity in the wintertime is one indication the building is over-ventilated. A solution to over-ventilation is "demand-controlled ventilation" where outside air is supplied according to carbon dioxide levels measured in the return air ducts. As building occupants exhale carbon dioxide, the system responds by increasing ventilation to meet the occupant load. Adjusting ventilation requirements based on current occupancy is an example of what might be found during retro-commissioning.

Benefits and Cost

Commissioning and retro-commissioning can be very cost effective. The Lawrence Berkley National Laboratory studied commissioning in 560 buildings across the country in 2009. The average results are shown in Table 5.

Table 5: Commissioning Outcomes for 560 U.S. Buildings, 2009

Performance Metric	Average Outcome
Reduction in energy consumption	16 percent
Annual energy cost savings	$0.29 per sf
Simple payback	1.1 year
Cash-on-cash returns (First year savings / Project cost)	91 percent
Benefit-cost ratio (Project lifetime benefits / Project cost)	4.5

See the ASHRAE **Commissioning Flow Chart**, Appendix 3.

Best Practices

An effective scope of work for designing a commissioning process will include:

Planning. Determine project requirements and objectives, and develop an owner's project requirement list. This list will include building issues that the commissioning agent (CxA) will inspect, test, and rectify or make improvement recommendations. These issues could be comfort problems, known maintenance deficiencies, high energy use, noises, or other building concerns. The owner's plan will identify which systems (HVAC, water, lighting, etc.) will be inspected and tested, who will make repairs, and what level of repairs will be made immediately and which may be deferred. Request the CxA provide their list of items they will check and any other documentation they will provide. Facility managers will be asked for equipment lists, maintenance logs, and perhaps hours of run time, if these are not available than a best practice is to have the CxA create them.

Investigation Phase. During the investigation phase, the CxA should document the operating conditions of the systems identified in the plan. Any deficiencies will be identified and solutions considered. The investigation phase consists of facility documentation, site assessment, testing, data gathering and analysis, development of an issues log, and overall documentation. Ideal documentation would include current as-built construction plans, design calculations, and specifications, energy consumption records (from benchmarking), testing, adjusting and balancing reports, operations and maintenance manuals, up to date computer renderings, operation control sequences, preventative maintenance, and service call information.

Site Assessment. The site assessment typically begins with an on-site meeting between the CxA and facility staff to introduce the commissioning or retro-commissioning process, verify occupancy and operating schedules, determine known occupant discomfort, and identify operations and maintenance complaints. The site visit should uncover specific issues that will receive greater attention during the project. If an energy audit is to be conducted in conjunction with the retro-commissioning, additional data will need to be gathered during the site assessment.

Testing. The testing plan is developed as part of the retro-commissioning plan, and is refined as experience with the facility's components is gained and operations and maintenance (O&M) issues are identified.

Equipment testing consists of pre-functional tests of individual components or equipment and functional performance tests of dynamic HVAC systems. Whole building electrical system monitoring and building automation system (BAS) trending of HVAC systems provides short term building monitoring.

Pre-functional tests include a visual inspection of equipment condition, pilot light, cycling control actuators, and spot measurements of flow rate, differential pressure, voltage, amperage, etc. Functional performance testing includes verification of building automation systems (BAS) set points, schedules and sequences, and operation of actuators, sensors, and alarms. System interactions are verified by modifying relevant control set points and observing how system components react. Functional performance tests are completed during the investigation phase and then repeated as required during the implementation phase to verify control programming changes and equipment repairs. The selection of systems for functional testing is based on system age and condition, and on areas identified from O&M issues or comfort complaints.

Data Analysis. Data is analyzed and compiled to identify low cost facility improvement measures and higher cost energy efficiency measures. Fan and pump performance is measured against the manufacturer's performance curves. Electrical use is observed for time of day consumption, possible efficiency improvements, changes in occupancy and scheduling, and reduction of demand charges. Building modeling is used to compare simulated energy consumption against actual performance. Recommended fixes are ranked by a savings to investment ratio and simple payback, and included in reports to owners.

Development of an Issues Log. Any issues discovered during the investigation phase are noted in the issues log. The issues log is a formal record of problems or concerns discovered during testing; it includes the issue's description, name of party responsible for resolving the issue, and the issue's final resolution. Each item in the issues log is discussed and recommendations considered are either approved, declined, or deferred. The issues log is continuously updated throughout the project as new issues are discovered and old issues are resolved. Resolutions are documented.

Results of investigation and testing should be documented, with specific problems flagged for follow-up.

Repair/Replacement. Issues identified as repair/ replacement items include minor adjustments and repairs to capital project recommendations. Typically repair/replacement issues are assigned to the building owner's maintenance staff for completion. Usually the maintenance department completes repairs immediately so results can be verified, and they will not interfere with further testing.

Implementation. Recommendations from the issues log are implemented by maintenance staff, and changes to controls programming are typically implemented by either the owner or owner's building automation contractor. Typical modifications include changes to occupancy schedules, pump delays, and heating set points to decrease equipment operating hours or improve occupant comfort.

Re-testing. Systems that did not operate properly during initial functional tests are re-tested after repairs have been completed or programming improvements implemented.

Hand-off Phase. The final phase of retro-commissioning process includes development of the retro-commissioning report, updates to the facility's O&M manual, a close-out meeting, and implementation of persistence strategies.

The retro-commissioning report includes:

- Summary of the retro-commissioning process;
- List findings identified (issues log);
- Descriptions of measures implemented;
- Recommendations for additional FIM/ECMs;
- O&M recommendations.

The revised O&M manual is provided to the O&M department. It typically is in an electronic format with book marks for easy navigation. It includes:

  - Equipment schedules;
  - Submittal and IOM documents for equipment where available;
  - Sequences of operations;
  - Necessary staff training on changes and updates to equipment, and best operating practices for efficiency.

At the completion of the scope of work, the owner is free to make plans on any remaining items to be incorporated into future renovations, replacements, or retrofit projects.

A finely tuned building performs better, lasts longer, has lower maintenance costs, and can have significantly reduced energy expenditures. Optimizing design, installation, and operation at startup or when major equipment is replaced is essential to ensuring the building continues to run smoothly. Commissioning and retro-commissioning are an essential part to managing a building's performance.

Measurement and Verification 12

Overview

Measurement and verification (M&V) is an evaluation procedure that determines the performance impact of an energy efficiency retrofit project. The goal of M&V is to reduce the project risk to the building owner and ensure energy and cost savings, promised by the developer, are realized after construction. When facility owners use an energy saving performance contract (ESPC), one of the main functions of the M&V step is to validate payments or performance guarantees associated with the contracted services. Even in non-ESPC projects, M&V can help minimize project risk by identifying performance issues. Regardless of whether or not the facility owner is engaged in a performance guarantee, they will benefit from regular M&V activities. M&V is integral to continuous energy management and provides energy managers or other decision makers with information to base ongoing energy management activities including operations and maintenance O(&M) practices, training opportunities, and future cost saving retrofits (see **What an Energy Manager Does**). This chapter provides an overview of M&V and how it can be applied during energy efficiency retrofits.

Measurement and verification assesses building system performance after energy improvements.

Energy savings are determined by comparing measured use before and after a retrofit project while making appropriate adjustments for changes in conditions. The measurement and verification process includes engineering calculations, metering, utility billing analysis, and computer simulation.

Properly applied, M&V can:

- Assess energy savings;
- Allocate risk to appropriate parties;
- Reduce uncertainties;
- Monitor equipment performance;
- Find additional energy savings;
- Improve O&M;
- Verify the cost savings guarantee is met;
- Allow for future adjustments.

The Efficiency Valuation Organization (EVO) produces the International Performance Measurement and Verification Protocol (IPMVP[36]) that provides detailed guidance for facility owners and project developers on how to apply M&V protocols. The US Department of Energy's M&V Guidelines: Measurement and Verification for Federal Energy Projects Version 3.0[37] provides facility owners and project developers direction on how M&V is applied in federal facilities, which is a useful resource for all public facility owners.

The M&V Plan

To establish the impact of an energy efficiency measure (EEM) on energy use after a retrofit project and to measure and verify savings, a set of rules should be agreed to at the outset. These rules are called the M&V plan and include records of baseline energy, measurement boundary and method, protocol for how adjustments will be made for changes in weather and operations, and a definition of how savings will be calculated.

In general, a project's specific M&V plan is based upon:

- Project costs and expected savings ;
- Complexity of the EEM;
- Interrelated EEMs at a single facility;
- Uncertainty or risk of savings being achieved;
- Risk allocation between the parties;
- Other uses for M&V data and systems.

The Efficiency Valuation Organization details four main M&V options in the IPMVP and provides a summary in the table below.

Table 6: Four Main M&V Options in the IPMVP

IPMVP Option	How Savings are Calculated	Typical Applications
A. Retrofit Isolation: Key Parameter Measurement		
Savings are determined by field measurement of key performance parameter(s) that define the *energy* use of the *EEM*'s affected system(s) and/or the success of the project. Measurement frequency ranges from short-term to continuous, depending on the expected variations in the measured parameter and the length of reporting	Engineering calculation of *baseline* and *reporting period energy* from: • Short-term or continuous measurements of key operating parameter(s); and • Estimated values.	A lighting retrofit where power draw is the key performance parameter that is measured periodically. Estimate operating hours of the lights based on *facility* schedules and occupant behavior.

[36] http://www.evo-world.org/index.php?option=com_content&view=article&id=272&Itemid=379&lang=en

[37] https://www1.eere.energy.gov/femp/pdfs/mv_guidelines.pdf

IPMVP Option	How Savings are Calculated	Typical Applications
period. Parameters not selected for field measurement are *estimated. Estimates* are based on historical data, manufacturer's specifications, or engineering judgment. Documentation of the source or justification of the *estimated* parameter is required. The plausible *savings* error arising from *estimation,* rather than measurement, is evaluated.	Routine and non-routine adjustments as required.	
B. Retrofit Isolation: All Parameter Measurement		
Savings are determined by field measurement of the *energy* use of the *EEM*-affected system. Measurement frequency ranges from short-term to continuous, depending on expected variations in *savings* and the length of the *reporting period*.	Short-term or continuous measurements of *baseline* and *reporting period energy*, and/or engineering computations using measurements of proxies of *energy* use. Routine and non-routine adjustments as required.	Application of a variable speed drive and controls to a motor to adjust pump flow. Measure electric power with a kW meter installed on the electrical supply to the motor that reads the power every minute. During the *baseline period* the meter is in place for a week to verify *constant* loading. The meter is in place throughout the *reporting period* to track variations in power use.
C. Whole Facility		
Savings are determined by measuring energy use at the whole facility or sub-facility level. Continuous measurements of the entire *facility's energy* use are taken throughout the *reporting period*.	Analysis of whole *facility baseline* and *reporting period* (utility) meter data. *Routine adjustments* as required, using techniques such as simple comparison or regression analysis. Non-routine adjustments as required.	Multifaceted energy management program affecting many systems in a *facility*. Measure energy use with the gas and electric utility meters for a twelve month *baseline period* and throughout the *reporting period*.

IPMVP Option	How Savings are Calculated	Typical Applications
D. Calibrated Simulation		
Savings are determined through simulation of the *energy* use of the whole *facility,* or of a sub-*facility*. Simulation routines are demonstrated to adequately model actual *energy* performance measured in the *facility*. This option usually requires considerable skill in calibrated simulation.	Energy use simulation, calibrated with hourly or monthly utility billing data. (Energy end use metering may be used to help refine input data.)	Multifaceted energy management program affecting many systems in a facility but where no meter existed in the *baseline* period. Energy use measurements, after installation of gas and electric meters are used to calibrate a simulation. *Baseline* energy use, determined using the calibrated simulation, is compared to a simulation of *reporting period* energy use.

Cost and Rigor

The type of M&V in a contract should be commensurate with the size and complexity of the project to balance investment with the cost of more detailed M&V. Careful consideration of the M&V level, type, and rigor benefits both parties and can help mitigate potential problems during the performance period. M&V practices range from simple checks of isolated equipment to a full assessment of the facility. The International Performance Measurement and Verification Protocol (IPMVP)[38] defined the four main options for M&V listed in Table 6. The challenge of M&V is to balance M&V costs with the value of increased certainty in the cost savings from the efficiency measures.

The cost of M&V should be less than the payment amount or guarantee that is at risk; however, M&V should not produce a precise energy savings number, but rather ensure energy service companies complete their projects and the measured energy savings are close to the savings claimed. Typically, overall annual M&V costs range between 1 percent and 10 percent of typical project cost savings. Some energy efficiency measures (EEMs) will entail greater M&V costs, but overall M&V costs for the project are balanced by other EEMs that do not require substantial annual activities.[i]

[38] The IPMVP is available at http://www.evo-world.org/index.php?option=com_content&view=article&id=272&Itemid=379&lang=en

Cost and Rigor Tip

Strategies for keeping costs down while maintaining technical rigor:

- Use extensive metering in the baseline period and stipulate values over which the ESCO has no control.
- Verify key performance items using periodic, rather than continuous, data collection to reduce data collection and management issues.
- Rely upon existing instrumentation, energy management systems, and energy management behavioral practices wherever possible.
- Engage a third-party M&V expert to assist in the development of the measurement and verification plan to ensure key building owner interests are protected and costs are minimized.

M&V Accuracy

The US Department of Energy identifies factors that typically affect the cost and accuracy of M&V:

- Level of detail and effort associated with verifying baseline and performance period surveys
- Sample sizes (number of data points) used for metering representative equipment
- Duration and accuracy of metering activities
- Number and complexity of dependent and independent variables that are metered or accounted for in analyses
- Level of engineering required to conduct analyses
- Availability of existing data collecting systems (e.g., energy management systems)
- Contract term
- Level of accuracy needed in energy savings analyses

Specifications

The M&V provisions are an important element of an energy saving performance contract because they determine payments made to the energy service provider. Even in non-ESPC projects, building owners benefit when M&V measures, scaled to the scope of work, are included in the contract. The M&V plan may be specified in the request for proposal, but it may also be proposed by the bidder. In either case the energy service provider must develop M&V protocols by completion of the energy audit, and they must be agreed upon with the public facility owner. The final measurement and verification plan is then incorporated into the energy savings performance contract.[ii] Since the M&V approach documents energy savings, it is one of the most important activities associated with implementing performance contracts and is crucial in contract negotiations.

Facility owners wishing to specify use of IPMVP in an Energy Saving Performance Contract may use phrases such as, "The determination of actual energy and monetary savings will follow current best practice, as defined in IPMVP Volume I, EVO 10000 -1:2012." Specification may further include, "The M&V plan shall adhere to IPMVP Volume I, EVO 10000 - 1:2012 and be approved by…" and may also, if known at the time of contract approval, add "following IPMVP option ...."[iii] Some types of financing may require M&V be conducted by a third party, not by the energy services company (ESCO) completing the project. The facility owner should specify that the contractor performing the M&V be a Certified Measurement & Verification Professional (CMVP) or hold an equivalent certification.

General Approach to M&V

The following section is adapted from the US Department of Energy's *M&V Guidelines: Measurement and Verification for Federal Energy Projects Version 3.0*.[iv]

Savings are determined by comparing the energy use before and then after the installation of conservation measure(s), while considering adjustments for changes in conditions. The "before" measurement is called the baseline. The "after" measurement is referred to as the post-installation or performance period. Determination of savings include adjusting for changes that affect energy use, not changes caused by conservation measure(s). Such adjustments may account for changes in weather, occupancy, or other factors between the baseline and performance periods. The equation below shows the general equation used to calculate savings.

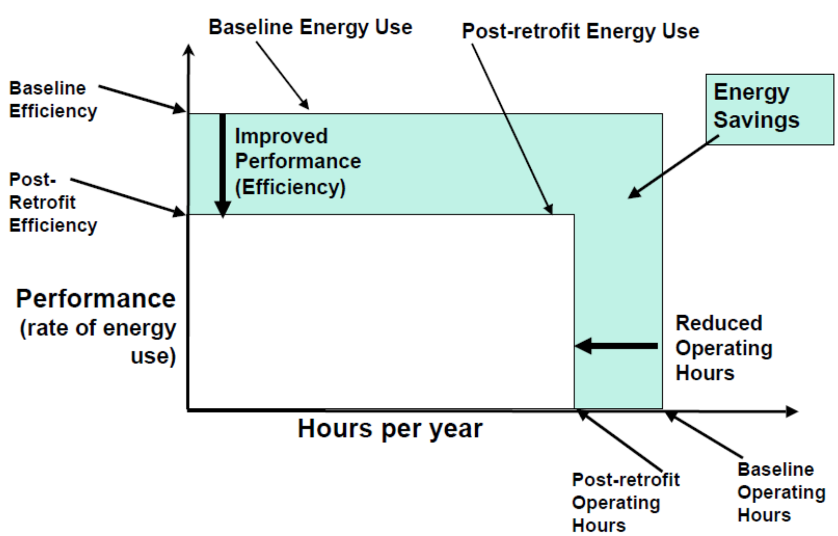
$$\text{Savings} = (\text{Baseline Energy} - \text{Post Installation Energy}) \pm \text{Adjustments}$$

Baseline and performance period energy use can be determined by using methods associated with several M&V approaches classified by the types of measurements performed. The four options, originating in the International Performance Measurement and Verification Protocol (IPMVP), are:

- Retrofit Isolation with Key Parameter Measurement
- Retrofit Isolation with all Parameter Measurement
- Whole Building
- Calibrated Simulation

These options enable application of a range of suitable techniques for a variety of applications. Tailoring a specific option to the facility owner's needs is determined by the level of M&V rigor required to obtain the desired accuracy level in the savings determination, and it is dependent on the complexity of the conservation measure, the potential for changes in performance, the measure's savings value, and the project's allocation of risk.

Figure 19: Determining Energy Savings



Performance and usage drive energy savings. Performance describes how much energy is used to accomplish a specific task and usage describes how much of the task is required. In the case of lighting, for example, performance is the power required to provide a specific amount of light and usage is the operating hours per year. For a more complex system like a chiller, performance is defined as the energy necessary to provide a specified amount of cooling, and usage is defined by the cooling load profile and the total amount of cooling required. Both performance and usage measurements should be known to determine savings.

Figure 19 further describes performance and usage. The large box represents total energy used in the baseline case. Reduction in the rate of energy use (increase in performance) or reductions in usage (decrease in operating hours) lead to reduced total energy use that is represented by the smaller box. The difference between the two boxes—the shaded area—represents the energy savings.

M&V activities include site surveys, metering of energy and independent variables, engineering calculations, and reporting. How these activities are applied to determine energy savings depends on the characteristics of the energy conservation measures being implemented, the accuracy in energy savings estimates, and the cost of conducting M&V.

Steps to Determine and Verify Savings

Determining actual energy savings achieved can be difficult and costly. In many performance contracts, it is important to verify the potential of the EEM to generate the predicted savings. Verifying the potential to perform requires confirming:

- The baseline conditions were accurately defined;
- The proper equipment/systems were installed and properly commissioned; and
- The equipment/systems are performing to specification.

Regardless of the M&V option used, similar steps can be taken to verify and determine the project's performance. These steps are outlined in Table 7.

Table 7: Common Steps in Measurement and Verification

Timing	Activity	
Before Project Implementation	Step 1	Allocate project responsibilities
	Step 2	Develop a project-specific M&V plan
	Step 3	Define the baseline
During Project Implementation	Step 4	Install and commission equipment and systems
	Step 5	Conduct post-installation verification activities
After Project Implementation	Step 6	Perform regular-interval verification activities during the performance period

The sections that follow provide an overview of M&V activities in each phase of the ESPC project.

Step 1: Allocate Project Responsibilities

The basis of any project-specific M&V plan is determined by the allocation of key project responsibilities between the contractor and the facility owner. On an ESPC project, a number of typical financial, operational, and performance issues must be considered when allocating risks and responsibilities. For a detailed discussion of risk, see 2012 IPMVP Volume I, Chapter 3[39]. For a non-ESPC project, a clear allocation of project responsibilities may improve overall outcomes. The distribution of responsibilities depends on the facility owner's resources and preferences, and the contractor's level of involvement.

Step 2: Develop a Project-Specific M&V Plan

The M&V plan is the single most important item in an energy savings guarantee. The plan defines how savings will be calculated and specifies any ongoing activities that will occur during the contract term.

The M&V plan is usually developed during contract negotiations. The agency and the contractor should agree upon general M&V approaches prior to starting the Investment Grade Audit (IGA). The M&V method(s) chosen should determine the activities conducted during the IGA, and the cost and duration of the IGA.

The project-specific M&V plan includes project-wide items and details for each EEM.

Project-wide items include:

- Overview of proposed energy and cost savings;
- Schedule for all M&V activities;
- Agency witnessing requirements;
- Utility rates and the method used to calculate cost savings; and
- O&M reporting responsibilities.

EEM-level items include:

- Details of baseline conditions and data collected;
- Documentation of all assumptions and sources of data;
- Details of engineering analysis performed;
- Energy savings calculation methods;
- Details of any O&M or other cost savings claimed;
- Details of proposed energy and cost savings;
- Details of post-installation verification activities;
- Details of any anticipated routine adjustments to baseline or reporting period energy; and
- Content and format of all M&V reports.

The level of M&V specified should be scaled to the scope of the project and the need to mitigate risk for the owner.

Step 3: Define the Baseline

When a facility owner engages the services of an ESCO, defining the baseline is a typical first step. If the facility owner is not working with an ESCO and is following a different procurement pathway, baselining the facility

[39] www.coned.com/energyefficiency/PDF/EVO%20-%20IPMVP%202012.pdf

should be done by the owner's staff or by a contracted energy auditor. Baseline physical conditions (such as equipment inventory and conditions, occupancy schedule, nameplate data, equipment operating schedules, energy consumption rate, current weather data, and control strategies) are determined during the IGA through surveys, inspections, spot measurements, and short-term metering activities. Utility bills are often used to verify the baseline has been accurately defined. Baseline conditions are established for the purpose of estimating savings by comparing the baseline energy use with the post-installation energy use. Baseline information is used to account for any changes that may occur during the performance period; this may require baseline energy use adjustments. The baseline information is included in the ESCO's final proposal. It is the agency's responsibility to ensure the baseline has been properly defined. If a whole building metering or calibrated simulation approach is used, it is important to document the baseline energy use of all end uses and not just those affected by the retrofit.

After the EEM has been implemented, it is impossible to reevaluate the baseline; therefore, it is important to properly define and document the baseline conditions. Deciding what needs to be monitored (and for how long) depends on such factors as the complexity of the EEM and the stability of the baseline, including the variability of equipment loads and operating hours, and other variables that affect the energy load.

Adequate documentation of baseline energy use is critical to resolving disagreements between the facility owner and the ESCO.

Step 4: Install and Commission Equipment and Systems

- Commissioning of equipment and systems is considered industry best-practice and should be considered by the owner whether a performance guarantee is incorporated in the contract or not. Commissioning ensures that systems are designed, installed, functionally tested in all modes of operation, and are capable of being operated and maintained in conformity with the design intent (appropriate lighting levels, cooling capacity, comfortable temperatures, etc.). Commissioning is generally completed by an independent third party, and witnessed by the facility owner, to verify the ESCOs work; however, in some cases it is completed by the ESCO.
- Commissioning activities include inspections and functional testing. These activities are specified in a commissioning plan, and their results are documented in a commissioning report. More specific information on commissioning is provided in the **Commissioning and Retro-commissioning** chapter.
- Commissioning usually requires performance measurements to ensure systems are working properly. Because of the overlap in commissioning and post-installation M&V activities, there may be some confusion. Commissioning ensures systems are functioning properly and post-installation M&V quantifies how well the systems are working from an energy standpoint. An additional difference is M&V services extend beyond project acceptance and are matched with the term of the performance guarantee.

Step 5: Conduct Post-Installation Verification Activities

Post-installation measurement and verification activities are conducted by the contractor and the public facility to ensure proper equipment/systems were installed and operating correctly, and have the potential to generate the predicted savings. Verification methods include surveys, inspections, spot measurements, and short-term metering.

The Post-Installation Report includes:

- Project description;
- List of installed equipment;
- Changes between the final proposal and as-built conditions, including any changes to estimated energy savings;
- Post-installation verification activities and performance measurements conducted;
- Performance verification criteria;
- Construction-period savings (if any);
- Status of rebates or incentives (if any); and
- Expected savings for the first year post improvements.

For facility owner's using certain M&V methods (Option A), see **Table 6**. The post-installation verification is the most important M&V step because measurements to substantiate the savings guarantee are made only once. When equipment performance and energy savings are not expected to vary significantly over time, post-installation measurements may be the primary source of data used in savings calculations.

Step 6: Perform Regular-Interval Verification Activities

Best practices suggest that at least once a year the public facility owner verify the energy performance of their building and retrofitted systems. When a retrofit project involves an energy performance guarantee, the contractor is typically required to conduct verification activities for a set duration of time. In Alaska a minimum requirement of three years of M&V is common. This includes, at minimum, verifying the installed equipment/systems have been properly maintained and continue to operate correctly, and continue to have the potential to generate the predicted savings. Building monitoring systems, such as those described in the **Building Monitoring** chapter, can greatly reduce the cost of some measurement activities.

The annual report from the ESCO to the facility owner documents annual M&V activities and the guaranteed savings for the year; however, in many cases more frequent verification activities are appropriate. More frequent monitoring and/or inspection ensures the M&V monitoring and reporting systems are working properly, allows fine-tuning of measures throughout the year based on operational feedback, avoids surprises at the end of the year, and installed equipment and systems are operating as intended throughout the year.

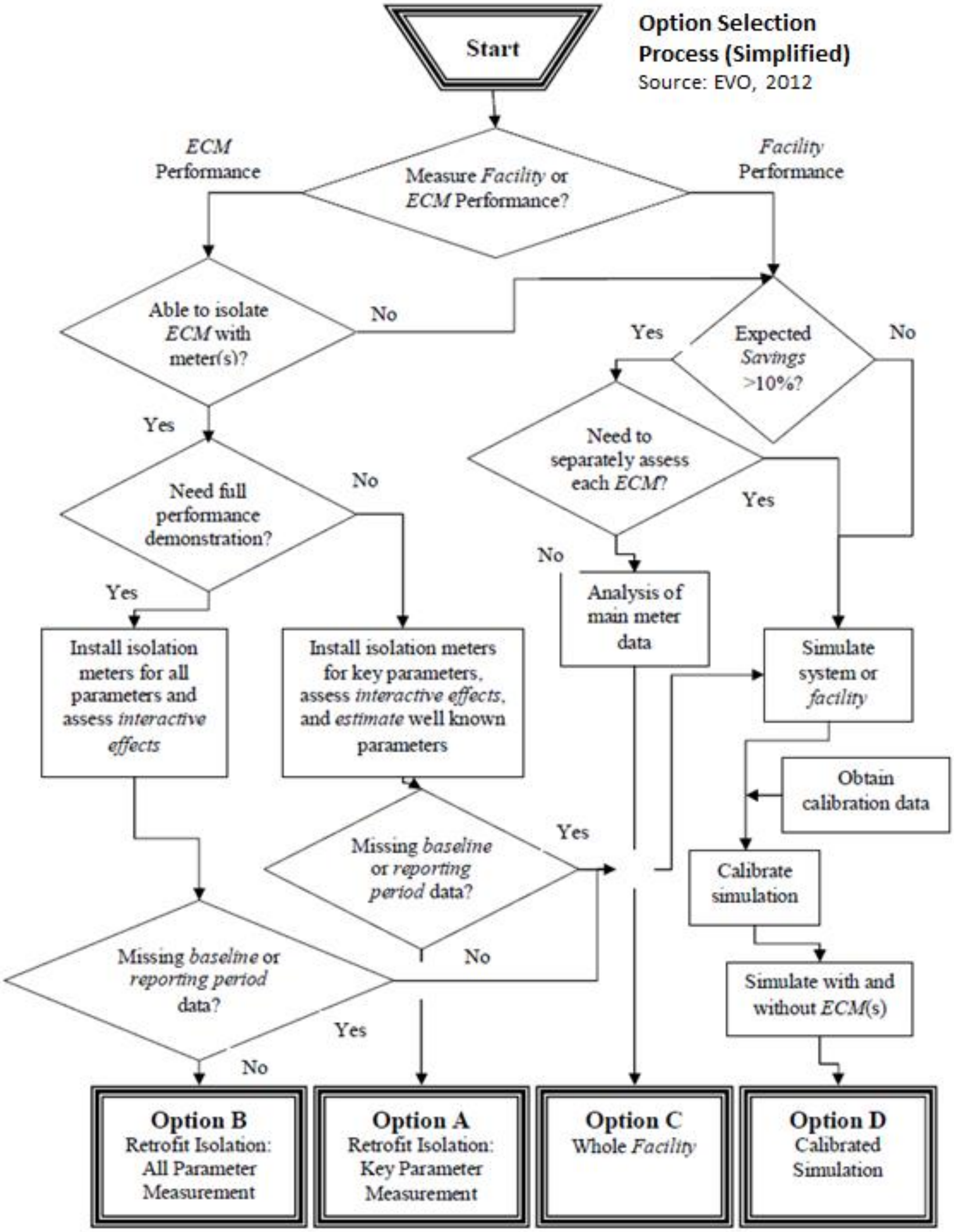
Annual reports include:

- Documentation of performance measurements and inspections;
- Verified savings for the year;
- Comparison of verified savings with the guaranteed amounts;
- Details of all analysis and savings calculations;
- Summary of operations and maintenance activities; and
- Details of any performance or O&M issues that require attention.

The Bottom Line

Measurement and verification is a critical tool. Facility owners should determine the level of M&V required by their project scope and risk tolerance, and specify M&V requirements in the construction contract. The level of M&V should be balanced with project size and complexity. Figure 20 provides a decision tree that highlights the four M&V pathways identified in the IPMVP.

Figure 20: M&V Decision Tree



---

i (US DOE, 2008)
ii (Singh, Limaye, Henderson, & Shi, 2010)
iii (EVO, 2012)
iv (US DOE, 2008)

Overview

Building monitoring has been around in some form or another for a long time. Technology has evolved from checking gauges, belt tensions, and on-off states manually; however, the reasons for monitoring remain the same. Building monitoring helps facility owners efficiently operate a building by ensuring systems perform as designed. It also provides maintenance and operations staff with up to the minute real-time data of building performance. A variety of building monitoring systems (BMS) are available for use. Some are proprietary systems created for manufacturer's control equipment and other systems are non-proprietary open-source.

The Alaska Housing Finance Corporation has developed a building monitoring technology that allows multiple users to view building performance in real time. The technology gathers data from multiple sources and graphically displays the outputs in easy to understand platforms. It is open source and available to anyone to adapt and use.

When considering a building monitoring system, creating a team for assessment and planning ensures buy-in from users and management. An appropriately assembled team is likely to develop the best approach to suit the needs of the users and their facility. The first step in the building monitoring process is to establish guidelines for the monitoring system and develop assessment criteria to determine which building systems offer the greatest monitoring benefits.

A building monitoring system can provide valuable information on a facility's heating requirements and can be used to tune systems.

Guidelines

The team designated to oversee the building monitoring system should establish guidelines for the BMS that best suits the facility's long-term goals and can derive the greatest benefit. The team ideally would consist of operations and maintenance, and financial and management staff.

System Approach

A building monitoring system can sometimes be part of building automation system; a downside to their integration is they are usually only seen by the maintenance staff that oversees the automation system. Stand-alone BMS's can be seen by multiple people, which is useful for organizations with buildings scattered over large geographic areas.

The building monitoring system developed by AHFC is a stand-alone system that communicates via the cellular network to web-based servers that compile and display the data. The system can gather data from weather stations, wired or wireless sensors, equipment controllers, and direct digital control (DDC) systems. All buildings are tied to the same user-interface to ease monitoring and allow display of multiple operational outputs simultaneously, which is valuable for efficient system operation.

Heating Systems

Heating loads often represent the largest energy cost in Alaskan buildings; most buildings lose heat through the building envelope. The building monitoring plan for buildings should focus on optimal operation of the heating plant.

Best practices include monitoring:

- Boiler lead/lag operation, runtimes, and temperatures to reduce standby and cycling losses by reducing boiler size, turning off unneeded boilers, or optimizing boiler lead/lag controls;
- Condensing operation for optimal efficiency;
- Proper zone control to preclude overheating;
- Bypass heating loads that may consume energy even during periods of warm weather;
- Normalized fuel use (per degree-day per sf) across buildings to determine high and low performing buildings; and
- Boiler seasonal efficiency.

Ventilation Systems

Ventilation systems often deliver excess ventilation air, operate with excessive reheat, or do not operate properly. This can cause high energy loads and represents considerable opportunity for optimization. Monitoring opportunities include:

- Focuses on air handling unit (AHU) runtimes and verification that systems are not over-ventilated by monitoring occupancy and CO2 levels in critical spaces; and
- Heat recovery ventilators (HRV) to improve HRV runtime, effectiveness, and defrost operation.

Domestic Hot Water Systems

Domestic hot water loads can contribute greatly to energy consumption in some buildings such as multi-family residential housing. The monitoring plan in this case should focus on proper operation of the hot water heater and gathering data on real-time hot water use, and standby and distribution losses. Actual hot water use can be used to properly size hot water systems.

Snowmelt Systems

Snowmelt systems can consume large amounts of energy. Monitoring these systems should focus on quantifying their energy use and verifying energy consumption during periods when snow and ice are not present. Through monitoring snowmelt systems, facility owners can improve the energy savings associated with optimizing the snowmelt controls or switching to manual control.

Lighting Systems

For common areas such as corridors, the monitoring system will observe occupancy levels to determine if occupancy sensors can reduce lighting energy. The system should monitor lighting in intermittently occupied spaces to verify lights are turned off when the areas are not in use. The monitoring findings may support a lighting energy policy or the use of occupancy sensors. Lighting monitoring can also focus on daylighting control opportunities by measuring light levels.

Electric Systems

The monitoring system can gather data on the building's electric consumption and demand. The data is useful to identify large energy loads that have optimization potential. It is also useful for quantifying energy use associated with a specific activity, such as engine block heaters.

For buildings that incur demand charges, demand data can show when the monthly peak occurs. The data is useful for determining which loads contribute to the peak demand, and helping facility owners decide if the loads should be turned off or reduced during periods of peak demand. The annual peak demand at the AHFC Headquarters occurs during summer months due to cooling loads. Since the peak demand establishes the demand charge for the entire year, there is incentive to reduce cooling to save demand charges.

Comparing electric use per square foot across similar buildings can help identify buildings to target for a more intensive electricity audit.

Building monitoring can provide detailed usage and cost information that can be used to identify efficiency opportunities.

Motivation

While it may be necessary to incorporate motivational strategies for staff into energy policies, a successful building monitoring plan can be used to motivate staff/tenants. If multiple buildings are monitored, energy use comparisons can motivate staff/tenants to decrease their building's energy consumption especially if savings benefit them directly.

Security Concerns

Information security concerns may arise during implementation of a BMS. Best practices suggest relevant staff, including information technology departments, coordinate prior to system implementation to settle any information security concerns. Accessing the internet in front of a facility's network firewall or isolating the BMS behind the firewall are two possible solutions to security concerns that may arise.

General Benefits

Building Performance

A BMS is a valuable tool for understanding and measuring building performance. A well designed BMS displays how a heating system, ventilation system, and terminal units work cooperatively to heat a building. This can offer insight into the operation and allows for fine-tuning the heating control sequence for optimal performance. BMS's can also capture the performance of equipment over time. In Alaska's unique climate, this can be valuable when used to measure heating or cooling system seasonal efficiency. Another benefit of a BMS is it measures energy flows within buildings. Understanding where energy flows is essential to identifying energy conservation opportunities and quantifying savings potential.

Quantifying Energy Use

Building monitoring systems quantify building energy flows in real-time, measuring peak loads and overall energy consumption. This information is can be valuable when sizing systems and identifying energy costs.

Troubleshooting

BMS data can be used to troubleshoot a system or piece of equipment that is not operating properly, and it can be used to identify issues with new heating plants or other equipment leading to resolution of design and equipment issues.

Improve Performance

A BMS offers a reliable and accurate method of gathering building data that is useful to facility managers when assessing energy system performance. The data is gathered at regular intervals and then archived to be analyzed. For example, a project team can use the data to evaluate the operation of the boilers to determine if there is an opportunity to modify the control sequence to improve performance.

Case Study: Glacierview Building in Seward, AK

The AHFC Glacierview building in Seward, AK used a building monitoring system to troubleshoot the domestic hot water system because it was not adequately supplying hot water to each residence. The hot water system temperature sensor was sensing super-hot water at the top of the tank. This caused the mixing valve to not function properly resulting in uncomfortable water temperatures for the residents. Using data from the BMS, facility managers decided to relocate the temperature sensor to a mid-level port in the tank. The mixing valve was then adjusted to regulate the temperature of outgoing water, and the situation was resolved. The BMS helped facility managers troubleshoot the water issue at Glacierview resulting in happy occupants.

Improve Energy Efficiency

Building monitoring has the capability to simultaneously display data from several buildings. The display can be used to compare the performance of multiple buildings against one another. Analysis of the building data can then be used to identify what is and what is not performing well.

Monitoring can save the most energy when applied to systems that have complicated and prone-to-fail control systems (e.g. sidewalk snowmelt), and systems where the facility manager can control the level and schedule (e.g. ventilation systems).

Reduce Maintenance Burden

Building monitoring systems have a web-based user interface that can be accessed from any computer and most mobile devices. This offers facility managers an opportunity to remotely check building performance, reducing travel and unnecessary on-site visits..

Design Benefits

A BMS provides valuable and relevant data on building loads and operating parameters. The data can be used to properly size control systems for lowest installed cost and maximum efficiency.

A building monitoring system can be valuable to system designers, providing actual heating and electrical usage that can be used to size mechanical systems.

Specific Benefits of the AHFC BMON system

AHFC facility managers installed a building monitoring system on several of their buildings throughout Alaska; this unique system is called BMON. The benefits of the AHFC BMON system can help facility managers and owners install and use a building monitoring system on their buildings.

Single Interface. AHFC's BMON is a dedicated system that can be accessed from any web-connected computer. Standardization of the user interface allows AHFC facility managers to view and trend data from different buildings, systems, etc.

Data Graphing. The data can be displayed in numerous ways: graphs and spreadsheets, plot over time, profiles, histograms, scatter plots, etc. The data is easy to manipulate and powerful for presenting building performance to others.

Programming. BMON is based on non-proprietary programming language. There are no proprietary limitations on its use. The system is open source and available to anyone. It is available as a download from the AHFC website[40].

Monitoring Dashboard. The BMON dashboard provides operators with different capabilities to monitor building operation. Its graphical display visually shows building operations that can help AHFC facility managers establish system operating parameters.

Energy Costs. The data from BMON offers an opportunity to understand real-time energy flows within AHFC buildings. The data can also help determine the energy costs of specific systems such as snowmelt. Energy costs tracked in other data bases, such as the Alaska Retrofit Information System (ARIS), can also be imported into the AHFC BMON.

---

[40] https://code.ahfc.us/energy/bmon

Building Systems Integration. An opportunity exists to interface building monitoring systems with building direct digital control (DDC) systems. DDC systems incorporate building sensors, including equipment controllers. By interfacing the DDC system with a BMS, building performance information can be obtained for lower cost, and can be archived and displayed through a common user interface. With AHFC building data exported from the DDC system to the AHFC BMON system, many users can view the building data from the automation system. This allows maintenance workers, managers, and other staff, who can benefit from the data, access to it.

In the AHFC Chugach Manor building, a large senior residential facility, a failed water heater system was up for replacement. The failed system was sized with two 35 gallon per minute instantaneous water heat exchangers. When total flows were analyzed with a BMS, facility managers found the peak water demand never exceeded 10 gallons per minute with averages of 3 gallons per minute. The analysis revealed a significantly smaller system could be used as a replacement, saving both first and energy costs over its lifetime. Lounges in this building were found to be lit and ventilated outside their measured occupancy times. Corridors were fully lit, even though occupancy was less than 30 percent. Snowmelt systems were operated at higher temperatures than needed, and they operated all winter rather than when snow and ice melt were necessary. Installing a BMS on the AHFC Chugach Manor senior facility provided AHFC facility managers with accurate building operations data allowing them to appropriately size replacement systems and fine-tune existing systems.

Overview

In Alaska, the median commercial building distribution of operating costs is approximately: 10 percent roads/grounds and security; 18 percent administrative; 19 percent cleaning; 23 percent repair and maintenance; and 30 percent utilities (BOMA Experience Exchange Report, based on Continental US average; data adjusted for +50% higher use of energy in Alaska buildings).[i] Operations and maintenance (O&M) practices can have a significant impact on building operating expenses, and are integral to the energy efficiency performance of a building. Poor operation and maintenance can lead to unhappy occupants, high vacancy rates, increased and unplanned capital expenses, and reduced profit. Good operation and maintenance can lead to energy efficient facilities, increased capital, and happy occupants.

O&M Best Practices

Best practices suggest facility administrative staff should collaboratively establish energy management goals and a baseline for building operations; it is particularly important to have the building owner and/or financial officer's buy-in. Effective O&M teams are usually the result of involved facility owners and finance officers. The owner and/or finance officer monitor the organization's bottom line, cost increases, and variances in energy bills, and they ensure invoices are paid and the budget is reconciled. Variances in energy bills should be closely observed; a four percent increase in one month may not be enough to send a warning flag, but a steady increase over time can be easily overlooked. Operations and maintenance staff should be notified if there are energy bill increases. This will prompt a building systems check to ensure the building is operating at optimum efficiency.

To develop energy management goals and establish a baseline for building operations, an O&M assessment should be completed; it should include review of the operating and capital budget, equipment, end-of-life replacement plans for equipment, and routine maintenance plans. It will help staff further understand how equipment and building systems are currently operated and maintained. Once energy management goals are developed and a building operation baseline established, then a measurement and verification plan should be created. It should include plans and procedures for equipment and building monitoring. Building monitoring systems can help facility owners and O&M teams identify building system abnormalities and optimize energy performance. When made available to staff, the building monitoring dashboards, which offer real-time monitoring of the building's systems, allow quicker identification of problems or abnormalities.

Facility owners and managers should share building energy expenses with O&M teams. Sharing energy expenses can show how the facility's operating costs are impacted by O&M practices, and it also provides accountability. If energy savings are realized, passing them to O&M teams can be an excellent incentive to seek further efficiencies.

Before purchasing new equipment, such as a heating /cooling system, a life-cycle cost analyses should be completed. A life-cycle cost analyses helps O&M teams determine the cost benefits over the life of the equipment as opposed to solely the upfront cost. Typically, once added up, the operational costs and life expectancy of energy efficient equipment equate to the most cost-efficient option over time.

O&M Benefits of Building Monitoring

At the AHFC headquarter building in Anchorage, the O&M team, through building monitoring, discovered a fan-system override switch had been turned to "on" to provide ventilation during a carpet cleaning event on a Saturday. The fan could have run continually every weekend if not identified. Through building monitoring the O&M team was able to identify the building operation abnormality, resulting in considerable energy savings.

Facility owners have found success by establishing an energy champion within O&M teams. The energy champion will promote, encourage, and facilitate energy-management best practices. This individual should ensure any new equipment meets the energy management goals and should track energy use through benchmarking and building-monitoring data. It is recommended monthly building reports are provided to facility owners and management. When energy usage spikes and/or anomalies are identified, the energy champion should investigate them.

Maintenance Management Plans

O&M teams should have maintenance schedules to ensure all preventative, routine, and deferred maintenance is completed in a timely manner. Adhering to these schedules keeps equipment functioning at optimum levels. It helps determine whether the frequency of preventive maintenance is effective or needs adjusting, and assists O&M teams in determining whether equipment is operating outside of established parameters. O&M teams may choose to defer maintenance of buildings and equipment to save costs. While this practice may save money in the short term, it has the potential to increase maintenance costs in the long term.

Maintenance management plans begin with an inspection schedule. Unless otherwise recommended by the manufacturer or installer, O&M teams should plan on inspecting every component of the building twice a year (usually in the spring and fall). Lack of proper maintenance and/or repairs may lead to increased repair costs. Some warranties might become invalid if documented inspections and timely repairs have not been completed.

A new roof was installed on a building with a 20-year warranty. Routine maintenance and inspections were not performed or documented as required by the O&M management plan. When there was a leak in the roofing membrane within two years of installation, it voided the roof warranty.

Preventative maintenance does not identify all potential building system failures; however, it is a best practice to ensure long equipment life and maximize building operating efficiency. Routine maintenance tasks, such as changing fluids and filters, should be done per the O&M management plan. In some cases, repair by replacement is the best and most cost-effective option; however, repair by replacement must not be used in place of preventative and routine maintenance. If the decision to replace is made, O&M teams should use life cycle cost analysis to determine the most efficient equipment replacement.

Unplanned Maintenance

Unplanned or reactive maintenance has overhead costs that can be avoided with proper planning. O&M teams that follow a maintenance schedule have spare parts and fluids on-hand; this reduces costs and eliminates equipment downtime. Having spare equipment on hand, such as a circulating pump and heat-exchanger parts, is also beneficial. Expedited shipping or unplanned delivery of parts increases O&M costs, causing a loss of revenue. Unplanned maintenance can increase labor costs; the facility owner may have to pay overtime for off-hours emergency maintenance. This usually can be avoided if O&M follow operations and maintenance schedules.

O&M teams should ensure settings, sequencing, and operating schedules are accurate for each piece of equipment.

A general checklist (Table 8) can be used as a guideline when creating building-specific checklists.

Table 8: Sample Building Maintenance Checklist

System	OK	N/A	Problem/Condition	Work Order #
Heating & hot water systems				
Ventilation				
Air conditioning system				
Automatic controls				
Electronic entry/security devices, door bells, intercom systems				
Interior lighting, electrical outlets, common areas				
Meter and breaker boxes – gas or electric				
Exterior lighting, electrical outlets, headbolt heaters				
Roofing, exterior walls				
Flashing, gutters				
Windows (including hardware and caulking)				
Porches, steps, handrails				
Landscaping, fencing, or other exterior equipment				
Drainage, sump pumps				
Fuel storage tanks				
Crawl space (leaks, moisture, sump pumps, vermin/animals, vents etc.)				
Other:				

[i] (Fowler, 2015)

Overview

The economic argument for efficiency retrofits in Alaska is very strong. High and volatile energy prices, high energy usage, and an aging building stock are a few reasons the argument is strong. Approximately 5,000 publicly owned buildings exist in the state; potential annual cost savings from energy efficiency retrofits are estimated to be more than $100 million in this sector. While the costs associated with undertaking building retrofits can be high, analysis of recent non-residential building retrofits revealed a statewide average simple payback of approximately four and a half years for these projects[i].

Making an impact with limited public funds can be challenging; however, public facility owners now have several government and private sector tools available to finance energy efficiency investments. Facility owners can accelerate energy efficiency investments in ways that improve community resilience and foster a competitive economic environment. Efficiency retrofits represent a significant investment and opportunity for cost savings, and have the potential to keep money circulating in the local economy while creating and sustaining local jobs.

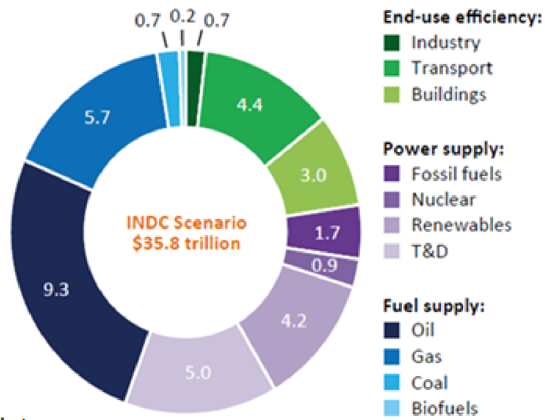
To achieve the full economic and environmental benefits of building energy upgrades, innovative project financing mechanisms deployed on large scales most likely will be required. This chapter summarizes the barriers and benefits of financing energy efficiency retrofits, and lists the assortment of funding and financing options available for public facility efficiency retrofits. Facility managers and owners are encouraged to use this manual as a starting point to guide further inquiry and analysis of specific projects and market conditions. Owners are further encouraged to take action and pursue an energy retrofit. There is a cost of delay associated with postponed efficiency projects. Facility owners who choose to pursue projects will improve their cash flow, increase building comfort, operability, and durability, and reduce long term costs.

Efficiency retrofits represent both a significant investment and cost saving opportunity. High return measures, such as lighting, should be paired with longer payback measures to maximize facility benefits.

Historic Action and Future Investment

Since 1987, Alaska state agencies have been discussing potential use of energy saving performance contracts. The Alaska Department of Transportation and Public Facilities (DOT&PF) and other state agencies have been working to reduce their building's energy consumption through the use of energy savings performance contracts or other means for many years. By the end of 2014, the state had executed energy savings performance projects in more than 50 facilities and invested more than $28 million to achieve a cumulative annual cost savings of greater than $2.4 Million, reflecting a payback of less than 12 years[ii].

Figure 21: Cumulative Global Energy Sector Investments in the INDC, 2015-2030 ($ trillion, 2013)



Note:
INDC is "Intended Nationally Determined Contributions"
T&D is transmission and distribution
Energy efficiency investment is defined as the additional expenditure made by energy users to improve the performance of their energy-using equipment above the average efficiency level of that equipment in 2012.
Source: (IEA, 2015)

After new technological advancements, there are early adopters and market leaders. Early adopters typically include institutions or property owners able to access conventional financing or self-fund efficiency projects. Arctic Wire Rope and Supply, an Anchorage based manufacturing company with a 22,000 sf warehouse, is one example of an early adopter of energy efficient building technology. After initiating energy retrofits in 2006, the business averaged an annual 34% reduction in energy usage. Commercial businesses like Arctic Wire Rope and Supply approach energy efficiency as an investment, with a very attractive return, rather than a capital cost of upgrading the facility. This change in how an efficiency retrofit is pitched to and perceived by the decision maker can have a significant influence in whether or not a project is prioritized and pursued.

Efficiency investments in Alaska are small in comparison to the amount spent elsewhere each year. Nationally, large corporations and developers take energy efficiency seriously. Fortune 500 companies such as Walgreens and McDonalds are investigating what it would take to create net zero energy retail spaces and quick-serve restaurants. "Zero energy buildings are definitely leading the future of the market," said Clayton Ulrich, Senior Vice President at Hines, a commercial real estate firm that has developed more than 275 million square feet in over 870 properties[iii]. Rockefeller and Deutsche Bank estimate in 2012, approximately $1.5 billion was spent in dedicated project financing for commercial building energy retrofits with turnkey project management by a service provider.[iv] While many facility owners in Alaska may include energy efficiency as an optional item in solicitations, states and governments around the world are committing significant resources to the pursuit of efficiency. The International Energy Administration reports in the 2015 World Energy Outlook Special Report that global cumulative investments in building energy efficiency are likely to be $3 trillion between 2015 and 2030. This is greater than the anticipated $2.8 trillion aggregate investment in fossil fuel and nuclear power plants during the same time period[v].

Some Alaskan communities pay some of the highest prices for energy in the nation. The price of electricity can exceed $1.00/Kwh in some of the most remote communities due to diesel powered generation. The price of heating oil, the predominant method of space heat for rural communities, can top $10 per gallon in the most expensive areas[vi]. A combination of an extremely cold climate (heating degree days ranging from 7,000 to more than 20,000 statewide) and high energy prices means Alaska has an inordinately high energy cost burden.

Energy expenditures cut into funds for critical public services and energy price volatility continues to be a significant challenge for government bodies and building owners. "The oil for which the U.S. pays $1 billion a day—and paid $2 billion a day until mid-2014, when $100+ per-barrel prices halved—comes with price risk and far bigger hidden costs that at least triple the real societal cost to upwards of $4 billion a day."[vii] Energy efficiency is a tool that will improve community resilience and reduce risk associated with energy price volatility.

Barriers

Though there is a strong economic argument for efficiency retrofits in Alaska, the retrofits are impeded by several barriers that need to be overcome to fully maximize the cost savings potential of building efficiency improvements. These barriers prevent owners from pursuing efficiency retrofits with cash reserves or loans from commercial or state lenders. Education on existing financing mechanisms and the introduction of new financing pathways will mitigate the barriers, and increase the uptake of efficiency retrofits. The Institute for Market Transformation (IMT) and Massachusetts Institute of Technology (MIT) CoLab published an excellent resource in 2015, the *Local Governments' Role in Energy Project Financing – A Guide to Financing Tools for the Commercial Real Estate Sector*[41]. Except where otherwise attributed, the barriers and solutions below have been selected or adapted from the IMT and MIT report[viii]

Knowledge, Time, and Motivation to Pursue Energy Project Financing

Minimizing buildings' energy costs are rarely building owners' top priority, despite the significant potential to improve cash flows and reduce budgets; they typically focus most of their attention on core services. Efficiency goals are not always clearly defined among state agencies, and regional and municipal governments. Even if targets are defined, sufficient knowledge and capacity may not exist to pursue the directives. Even when a community has the staff to develop and manage a project, energy retrofits may not be initiated due to a perceived lack of funding.

Some facility owners and managers report they simply do not have staff available to pursue an energy retrofit. The skill-set required for managing the complicated nuances of a retrofit project (audit interpretation, project scoping, obtaining a design, financing, procuring a contractor, and the measurement and verification process) are not often skill-sets they have easy, local access to. Other facility owners and managers might have enough staff to steward an energy efficiency project from concept to completion, but they do not always have the

---

[41] www.imt.org/resources/detail/local-governments-role-in-energy-project-financing

knowledge to develop their own energy efficiency (EE) project. Often it is easier, but not cheaper, in the short-term to just pay the energy bill.

Alaska has many options for public and private financing mechanisms targeting energy efficiency projects; however, many facility owners remain unaware of their existence or do not realize the cost of delay associated with waiting for a grant opportunity or legislative appropriation.

Perceived Lack of Capital

Few facility owners have capital allocated specifically for energy efficiency improvements. Efficiency improvements may often mean a significant up-front investment, even though they are followed by years of stable and predictable energy cost savings; a lack of available cash or financing can impede these types of investments. Due to perceived capital constraints, many facility owners only pursue energy efficiency measures with relatively short and simple pay back periods; many building owners across the country note they will only consider projects with a 2-3 year payback period. Larger savings and higher net-present value projects derived from deeper energy management measures are often “left on the table.”[ix]

A majority of public efficiency retrofits implemented in Alaska have relied on legislative appropriations. As of the time of publication the state budget forecast calls for deficits, meaning the likelihood of receiving an appropriation is greatly diminished. With state funding less abundant, public facility owners are beginning to explore financing options. New financing mechanisms, and the use of existing and emerging third party financing are key for facility owners to pursue comprehensive energy retrofit projects.

Capital and Operational Budgeting Barriers

Facility managers will often undertake projects with a 1–2 year simple payback. Beyond this threshold, however, it is necessary to coordinate with senior financial management. Senior financial managers have limited time to focus on energy management, as it is often not considered their core business. Likewise, facility managers may lack the financial literacy to present a compelling case to senior management for upgrades. This often results in communication breakdown between facilities management and ownership. Internal communication and cooperation is a critical component when identifying an energy retrofit project that provides the maximum benefit for the least cost.

Need for Non-debt Related Financing

Many private commercial, and some public facility owners, are highly leveraged and have limited capacity to take on additional debt even if energy cost savings are projected to balance out loan payments. Some public entities may be concerned about the potential credit rating impact if a payment is missed. Facility owners require a financing mechanism that does not appear on their balance sheets as debt. In 2015 the Alaska Department of Transportation and Public Facilities utilized a non-debt related financing arrangement with the Bank of America for an energy efficiency retrofit so the state’s credit rating would not be impacted if a payment was missed.

An operating lease, where payments are made from the operating budget and equipment is effectively rented by the building owner, allows for the asset and the liability to remain off the organization's balance sheet. A lease-purchase agreement is similar; in this case the asset may transfer to the facility owner at the end of the agreement term. The financing mechanisms that can meet off-balance sheet criteria are in flux. At the time of publishing, the US Financial Accounting Standards Board (FASB) allows equipment "operating leases" and other financing structures to be treated as off-balance sheet instruments. It is anticipated by 2016/17 any lease will be considered on-balance sheet. It is unknown if the US Government Accounting Standards Board (GASB) will adopt the change that FASB may make regarding operating leases. While the treatment of other financing mechanisms remains in doubt, service repayments through utility-initiated on-bill programs may be able to be structured as non-debt. Facility owners should consult their accountants and attorneys for the most up-to-date version of the accounting principles.

Financing Thresholds Too Large for Smaller Buildings and Projects

The capital required for project development (preparing an energy retrofit project for a loan and construction) is a barrier for many facility owners. Most facility owners do not have cash on hand to pay for pre-construction development work. Larger facilities, with annual utility budgets greater than $200,000, typically benefit from Energy Service Companies (ESCOs) that can carry the cost of pre-construction development activities until a project is financed. Many smaller facilities have not received the attention of the ESCOs and do not have cash reserves to pay for development activities. While pre-construction activities can be financed retroactively through programs, such as Alaska Housing Finance Corporation's (AHFC's) Alaska Energy Efficiency Revolving Loan Program (AEERLP), the challenge for many communities in accessing capital to forward fund this work remains. This funding gap, a small portion of the overall project cost, has been a significant hurdle to the owners of smaller facilities. To overcome this barrier, it may be possible to aggregate multiple projects to achieve the scale necessary to be cost-effective and attractive to an ESCO.

Facility owners with small retrofit projects may combine projects with other owners to take advantage of the economies of scale.

Utility and Regulator Buy-in

The traditional electric utility business model of selling power is rapidly evolving across the nation as more customers turn toward energy efficiency and distributed generation units to reduce cost and increase reliability and comfort. The mindset of utility managers in Alaska and across the nation has historically been that energy efficiency runs counter to one of the main purposes of the utility (to provide power), because it cuts revenue that supports profit and balances the cost of doing business.

Alaska state statute directs the Regulatory Commission of Alaska to "promote the conservation of resources used in the generation of electric energy,"[42] and Alaska Administrative Code 3 AAC 48.510 addresses primary objectives for the pricing of electricity[43] that include conservation and optimal use, including efficiency. A number of Alaska-based electric utilities promote energy efficiency to their customer base via new and traditional media platforms. Educational material, including tips on how to save energy, is frequently included on utility websites or in monthly billing statements. Chugach Electric Association, an Anchorage based utility, is piloting a program that allows building owners to track energy usage, build a personalized energy plan, and compare usage among neighbors. Beyond informational support, few utilities have ventured financial support. The Alaska Village Electric Cooperative, a rural electric utility, recently provided financial support through grants for energy audits. No utility in Alaska offers their customer base low-interest loans for efficiency upgrades.

Equipment leasing is common practice for most institutions, but the application of leases for financing efficiency retrofits, while common in other areas, is relatively new for Alaskans.

Utilities in many US locations play a central role in marketing and administering energy efficiency programs and brokering projects to be financed; however, many states' utility regulations do not reward utilities for facilitating the adoption of all available energy efficiency resources. The utility industry has voiced concern that its business model may be threatened by the growing adoption of efficiency and distributed generation, which reduces their revenue and limits opportunities for long-term expansion[x]. Financing mechanisms that rely on utility cooperation and entrepreneurship (such as on-bill financing agreements) may in some cases be hindered by reticent utilities and regulators. Some analysts suggest that financing strategies will have the greatest traction and scalability, ideally by allowing them to invest in projects via Power Purchase Agreements from which they can make a profit[xi].

Communities that own their utilities, as in many Alaska communities, are well positioned to influence the adoption of efficiency resources. In other Alaska communities, the city or borough may still be able to influence or at least start a conversation with the utility because they are the largest customer.

Evaluating Risk and Return

Public facility owners spend money on utilities that could otherwise be allocated to direct support of their mission, programs, and services, which benefit the public. When evaluating energy efficiency retrofit projects,

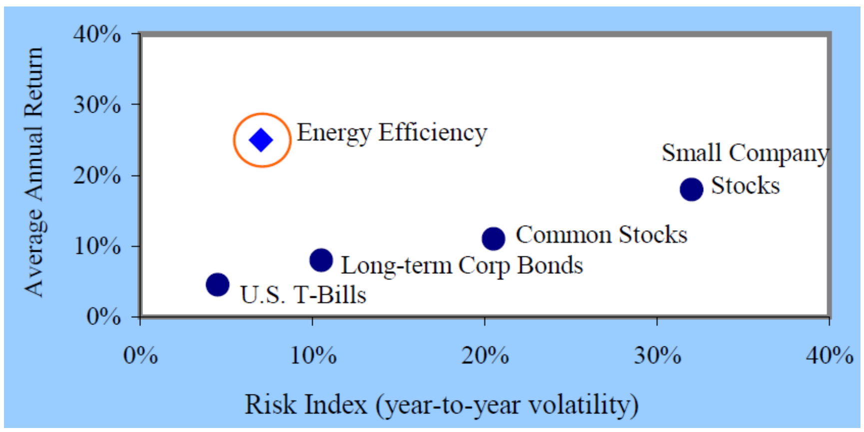
[42] AK Stat § 42.05.141 (c)

[43] www.legis.state.ak.us/basis/folioproxy.asp?url=http://www.legis.state.ak.us/cgi-bin/folioisa.dll/aac/query=%5BJUMP:%27Title3Chap48!2C+a!2E+4%27%5D/doc/%7B@1%7D?firsthit

facility owners should assess the costs, benefits, risks, and returns of conducting the project with variations in the scope, schedule, and source of capital. There are numerous economic methods for determining the effectiveness of an investment; however, not all methods are equal.

Public entities should utilize various economic assessment methodologies and evaluate various types of risk. This section introduces a few of the commonly used assessment methodologies and highlights energy price escalation risk. For an in-depth discussion of risk see the AHFC REAL Manual[44]. When risk is measured in terms of volatility, the risk of energy efficiency investments is approximately the same as U.S. T-bills; while the return on investment is greater than small company stocks as is demonstrated by the matrix in Figure 22[xii].

Figure 22: Efficiency Investment Risks and Returns



Savings to Investment Ratio

Savings to investment ratio (SIR or benefit to cost ratio) is used to determine if a project is economically viable. The ratio compares cumulative operational cost savings expected over the life of the energy efficiency measures to increased capital costs related to the energy retrofit.

$$SIR = \frac{Cost\ Savings\ per\ Year * Expected\ life\ of\ efficiency\ measures\ in\ years}{Total\ Project\ Cost}$$

The savings to investment ratio offers a good snapshot of “bang for the buck.” An SIR greater than 1 generally means the project is life-cycle cost effective; however, it is only an appropriate measure in certain situations. This metric is useful when prioritizing projects or determining whether to accept or reject a project. Facility owners can use SIR as a means of determining whether to accept or reject a project. The calculation can also be helpful in prioritizing projects, e.g., a project with a larger SIR could result in larger savings. SIR is not as helpful in selecting a level of efficiency or selecting a single system EEM or combination of interdependent systems EEMs. These decisions should be based on total life cycle costs calculations.

44 https://www.ahfc.us/files/8213/5716/1275/real_program_manual_r1_1.pdf

Return on Investment

Return on investment (ROI) is another common metric used to evaluate energy improvement decisions. To calculate ROI, the return is divided by the investment and the result is expressed as a percentage. For energy efficiency retrofits this means the annual operational cost savings are divided by the project costs.

$$ROI = \frac{(Annual\ operational\ cost\ savings)}{(Cost\ of\ investment)}$$

Return on investment is a popular metric due to its simplicity and versatility. ROI is a commonly used metric for evaluating financial investment performance in the stock market. The Standard & Poor's 500®, for the 10 years ending July 31, 2015, had an annual return on investment of 5.48 percent[xiii]. By comparison, energy efficiency retrofits produce much higher rates of return. From a review of energy audits performed on nearly 400 public buildings across Alaska, the Alaska Housing Finance Corporation reported building owners could save an average of $21,800/year in energy costs per building for an average investment, or project cost, of $82,000[xiv]. The average return on investment for these public buildings was 27 percent.

If an owner's decision to initiate a project is purely financial, then a project that does not have a positive ROI should not be initiated; projects with higher ROIs, as compared to other projects, should be prioritized accordingly. When calculating ROI an owner should make the decision whether to include savings other than energy cost savings. In a lighting retrofit, for example, there may be significant cost savings (in addition to the energy cost savings) related to labor and replacement bulbs that are not required if an owner decides to install LED fixtures instead of high pressure sodium fixtures. ROI does not inherently account for the amount of time the savings will be realized by the owner, nor does it account for the time value of money. A life cycle cost analysis will assist the facility owner in evaluating and comparing the full value of projects.

Life Cycle Cost Analysis

A life cycle cost analysis (LCCA), as typically completed in an investment grade energy audit and is also described in **First Cost** vs. Life-Cycle Cost of this manual, is an effective method for assessing present values of all costs of a product, system, or retrofit project over the useful life of the elements within the project. This includes acquisition, installation, operation, maintenance, and disposal, and can account for cost escalation. LCCA allows the facility owner or other user to analyze different retrofit project scopes, not on initial costs but on all the costs (and benefits) incurred over the life of the proposed energy efficiency measures. The methodology is beneficial because it addresses not only first costs (including design and construction costs) of a product or system, but also takes into account the future costs of energy, maintenance, operation, and replacement over the life of the facility owner's assets. Once the calculations are made to bring future costs back to present value, decisions can then be made that take into account capital costs balanced by payback periods and return on investments.

The expenses and savings used in LCCA traditionally relate to the direct costs of the proposed building retrofit, including utility costs such as water or energy bills and operational costs/savings. Indirect costs can be included in the analysis, e.g., salaries, staff productivity, lost construction time, fire insurance, and lost revenues due to downtime. These indirect costs are often more difficult to estimate, and can be significant and should be considered in the decision-making process even if a direct value is not included in the LCCA.

There are many resources available that provide guidelines and tools for calculating life-cycle cost, including the National Institute of Standard and Technology's Life-Cycle Costing Manual[45], the Rocky Mountain Institute Microsoft Excel®-based LCCA calculator called LCCAid[46] and the Alaska Department of Education and Early Development[47]. A simplified tool for life cycle cost analysis, AHFC's cash flow calculator, is presented in the section below.

Financing energy efficiency retrofits will keep more money in the operating budget, and reduce the demand for money in the capital budget that may be directed toward other priorities.

Cost of Delay

It can be easy to overlook the high cost of utilities as the cost of doing business. It may be very tempting for facility owners to seek "free money" from the public treasury for projects. As discussed earlier, the likelihood of receiving a state appropriation is declining. Waiting for a state appropriation or equivalent can be more costly than financing a project immediately. Whatever the reason for the delay of an energy project, there are real costs associated with the delay that can be avoided by initiating an energy saving project. Some risks associated with delaying improvements can include increased utility cost, occupant dissatisfaction, and increased operational risk.

To assist facility owners in determining what funding or financing path

Life Cycle Cost Analysis

Cost adjustments are necessary because the value of money changes over time. The value of a dollar received in the future is less than the value of a dollar received today. The change in value is driven by two primary factors: interest and inflation.

Interest is the return earned on money lent.

Inflation in the economy causes a decrease in the purchasing power of money.

Life cycle cost analysis sums the expenses and costs savings produced by a project throughout the life of energy efficiency measures. As expenses and cost savings occur at different times, the values are adjusted for interest and inflation before being totaled.

---

[45] www.fire.nist.gov/bfrlpubs/build96/art121.html

[46] www.rmi.org/ModelingTools

[47] www.eed.state.ak.us/facilities/publications/LCCAHandbook1999.pdf

is best, AHFC developed a cash flow comparison calculator (calculator) that compares cash flows of an energy project utilizing different funding sources and start dates. The calculator is intended to be used by project developers, facility managers, and others who communicate with facility owners about implementing energy saving projects and the cost of delayed action and inaction. Information from an energy audit is entered into the calculator such as existing expenditures on energy (both thermal and electric), projected energy cost savings, cost for proposed improvements, and loan terms and interest rate available on the market that would best match the owner's needs. From the inputs the calculator determines projected life cycle cost savings, rate of return, cash flows, and net present value of the proposed project. Additionally, the calculator graphs cumulative cash flows of four implementation scenarios that demonstrate the cost of delay by comparing cash flows immediate action to delayed action. This free tool is available on AHFC's website.

Figure 23 shows one of the screens from the cash flow calculator and presents a hypothetical scenario with inputs based on real energy audit data from 2012. The estimated cost of the project is $720,640 and annual savings are projected to be $143,000. The economic metrics indicate the project has the potential to save significant amounts of public dollars over the life of the project; cost savings associated with the lower energy consumption can be used to offset loan payments. After payments are complete the increased cash flow can be redirected to other priorities.

If state appropriation funding is sought to fund a project, several years may pass before funds are received and the project initiated. Facility owners should consider the full range of costs and benefits when evaluating different courses of action, including the likelihood of receiving an appropriation and the cost of delay if the appropriation is not received.

Each year of delay can be costly. In the example presented in Figure 23, whatever the source of funds, a five year delay in the project can result in an avoidable cost of more than $780,000.

Figure 24 is a screenshot of the cash flow calculator that depicts a hypothetical project with an implementation cost of $55,000. Even with a conservative energy escalation rate of 1.4 percent, the project still produces a good internal rate of return of 23 percent.

Figure 23: Cash Flow Calculator (larger project)

Cash Flow Calculator

Energy Project - Cost Comparison

This Cash Flow Calculator is for Demonstration Purposes ONLY. No guarantees to the accuracy of this analysis are made or implied. All Facility Owners and Borrowers should complete their own financial analysis before committing to a project.

INPUTS & OUTPUTS

Pre-Retrofit Annual Energy Expenditure	$460,000	Cost for Improvements	$ 563,000	Loan Term (yrs.)	6
Post-Retrofit Annual Energy Expenditure	$317,000	Design/Engineering	$ 84,450	Interest Rate	2.500%
Post Retrofit Annual Energy Cost Savings	$143,000	Project Management	$ 16,890	Number of Payments per year	12
Post Retrofit Annual Energy Savings %	31%	Contingency	$ 56,300	Down Payment	$ -
Energy Cost Annual Escalation Rate	2.0%	Project Costs - Down Payment	$ 720,640	Discount Rate	8.0%
Assumed Project Life	15				

KEY

Value Description
User Inputs Required
Outputs from calculations

ECONOMIC SUMMARY (Assuming Loan)

Cumulative Project Savings

$1,739,051

Assumed Project Life: 15 years

Gross Project Cost	Avg. Ann. Savings	Simple Payback	Savings to Inv. Ratio
$ 720,640	$ 168,161	5.04	1.94
Avg. Ann. Cashflow	**IRR**	**Adj. Rate of Return***	**NPV**
$ 115,937	21%	13%	$678,954
Discount Rate: 8.0%	Term: 6 years	Utility Esc. Rate: 2.0%	Annual Payment: $130,561

* *Where AIRR = [(1+Discount Rate)*[(SIR)^(1/Life)]]- 1*
AIRR assumes interim proceeds can be invested at the discount rate.

Figure 24: Cash Flow Calculator (smaller project)

Cash Flow Calculator

Energy Project - Cost Comparison

This Cash Flow Calculator is for Demonstration Purposes ONLY. No guarantees to the accuracy of this analysis are made or implied. All Facility Owners and Borrowers should complete their own financial analysis before committing to a project.

INPUTS & OUTPUTS

Pre-Retrofit Annual Energy Expenditure	$41,200	Cost for Improvements	$ 50,000	Loan Term (yrs.)	4
Post-Retrofit Annual Energy Expenditure	$27,500	Design/Engineering	$ -	Interest Rate	2.125%
Post Retrofit Annual Energy Cost Savings	$13,700	Project Management	$ -	Number of Payments per year	12
Post Retrofit Annual Energy Savings %	33%	Contingency	$ 5,000	Down Payment	$ -
Energy Cost Annual Escalation Rate	1.5%	Project Costs - Down Payment	$ 55,000	Discount Rate	8.0%
Assumed Project Life	10				

KEY

Value Description
User Inputs Required
Outputs from calculations

ECONOMIC SUMMARY (Assuming Loan)

Cumulative Project Savings

$88,510

Assumed Project Life: 10 years

Gross Project Cost	Avg. Ann. Savings	Simple Payback	Savings to Inv. Ratio
$ 55,000	$ 15,465	4.01	1.80
Avg. Ann. Cashflow	**IRR**	**Adj. Rate of Return***	**NPV**
$ 11,444	23%	15%	$43,931
Discount Rate: 8.0%	Term: 4 years	Utility Esc. Rate: 1.5%	Annual Payment: $15,079

* *Where AIRR = [(1+Discount Rate)*[(SIR)^(1/Life)]]- 1*
AIRR assumes interim proceeds can be invested at the discount rate.

Energy Price Escalation

Energy cost volatility presents risk to all facility owners. Reducing energy usage can reduce the impact of volatility on operating budgets. Owners evaluating energy efficiency retrofits need to make some determination on how to handle energy price volatility. Energy cost escalation factors are used when calculating the cost-effectiveness of energy efficiency measures and projects and in energy saving performance contracts. As noted in **The ESPC** path where an owner contracts with an energy service company to provide full service from initial development through construction, and measurement and verification, orperformance guaranteed projects are measured by energy savings and not cost savings.

Energy price escalation factors can be taken from the most recent version of the National Institute of Standards and Technology's *Energy Price Indices and Discount Factors for Life-Cycle Cost Analysis: Table Ca-4*. Escalation rates can also be calculated with the US Department of Energy's Energy Escalation Rate Calculator[48] or derived from local historical utility data. It is important for facility owners to realize that past energy pricing trends do not guarantee future price escalation. There is risk in assuming any energy price escalation rate, whether negative, zero, or positive. If the escalation rate used in modeling is lower than what is realized, underestimating the future cost of energy, an owner risks decreasing the scope of the project and missing potential cost savings. If the modelled escalation rate used is higher than what is realized, overestimating the future cost of energy, an owner risks having loan payments larger than the energy cost savings.

Solutions: Funding and Financing Tools Overview

In recent years, market participants across the nation have developed a variety of energy project financing tools. Alaskan facility owners can take advantage of these beneficial tools. This overview is not intended to be comprehensive; rather, it provides a broad look at the functionality of historic funding options and emerging financing mechanisms that can support energy upgrades in public and commercial buildings. The Alaska Specific Programs and Funds section will provide more detail on the capital sources currently available. Facility owners should carefully consider the costs, timing, and risks associated with available sources of capital and utilize AHFC's Cash Flow Calculator[49] to help illustrate the economic impacts of various funding alternatives.

Sources of funding and financing for energy efficiency projects include:

Government Appropriation

Public facility owners in Alaska have historically relied on government appropriations for building energy retrofits. Appropriations, today, may be less available than they once were. Projects may not receive appropriations when first requested, if at all. Facility owners who decide to delay a project and wait for an appropriation for several years or more incur a significant cost of delay. Depending on the total cost of the project and the amount of time before funds are received, the cost of delay can outweigh the cost of financing.

[48] http://energy.gov/eere/femp/building-life-cycle-cost-programs

[49] AHFC's Cash Flow Calculator will be available on online once completed

Energy Conservation Savings

Local governments can use a "paid from savings" approach to fund purchases of energy-efficient products and the procurement of energy efficiency retrofits, that have cost premiums by reserving energy cost savings generated from energy efficiency activities, to pay for future expenditures.

Equipment Lease Financing

An equipment lease or lease-purchase agreement allows public entities to finance installation and purchases over long-term periods using operating budget funds rather than capital budget funds. With an equipment lease, a lessor will own the energy efficiency equipment in a building, and the lessee (typically the owner or tenant) will make periodic payments to them. The lessee benefits from using energy savings equipment through lower energy costs. A lease-purchase agreement will include clauses allowing the lessee to acquire the equipment at the end of the lease term.

Energy equipment manufacturers may provide lease financing. Likewise, equipment lease companies may have relationships with contractors and/or equipment manufacturers. Equipment lease companies will agree to purchase and lease equipment for projects matching certain conditions, e.g., the credit of the lessee, the technology being implemented.

Under current FASB rules, depending on their repayment terms and how ownership of the equipment is ultimately transferred to the lessee, leases are considered either:

- **Capital leases**. The lease is considered debt, and the lessee must report liability on their balance sheet.
- **Operating leases**. Lease payments are considered operating expenses, and the lessor holds liability on their balance sheet.

Operating lease agreements utilized in the public sector typically include "non-appropriation" language that limits obligations to the current operating budget period. If a local government decides not to appropriate funds for any year throughout the term, the equipment is returned to the lessor and the agreement is terminated. Because of this non-appropriation language, lease agreements typically do not constitute debt;[xv] however, it is expected that FASB will eliminate the non-debt treatment of operating leases in the future. Facility owners are encouraged to consult with their accountant for the most up-to-date rules and standards that apply for their projects.

Equipment leasing is common practice for most institutions, but the application of leases for financing efficiency retrofits, while common in other areas, is relatively new for Alaskans.

Energy Saving Performance Contracting (ESPCs) With Facility-Owner Borrowing

Energy Saving Performance Contracts (ESPCs) are used by Energy Service Companies (ESCOs) to provide turnkey energy improvements. The ESCO typically provides design, build, commissioning, and in some cases operations services for a client facility.

ESCOs will frequently partner with lending institutions to provide building owners with financing, typically loans or leases. Alternately, owners may provide funding from other sources or use cash reserves. Figure 25 shows a visual representation of the relationship between the parties involved with an ESPC. The capital costs of equipment, the ESCO's design and project management fees, and the cost of performance bonds are paid from this financing.

Advantages and Limitations of Leases

Lease structures advantages:

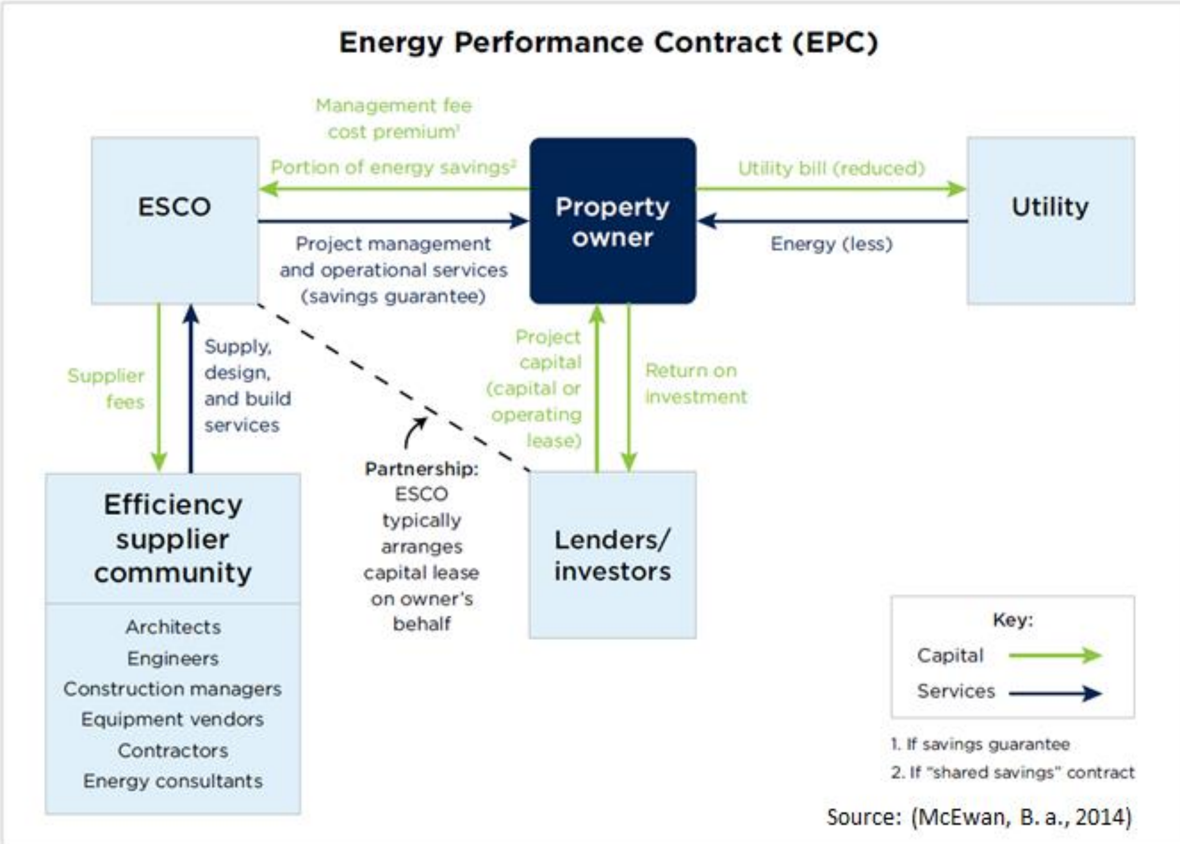
- Many facility owners are familiar with lease structures and are comfortable using them to finance equipment. Many businesses have experience using leases; in contrast, more novel energy financing mechanisms may be unfamiliar and met with skepticism.
- Some lease companies will serve small projects. Some emerging energy upgrade equipment leases have proven to serve very small projects, providing financing options for smaller facilities.
- There is no need for capital budget appropriation.
- There is no delay for voter referendum because public debt is not being incurred.
- Monetary obligation is limited to the current budget period because of a non-appropriation clause.
- There are reduced interest rates.

Limitations of leases:

- There is difficulty in transferring leases to future lessees.
- FASB may eliminate operating leases' off-balance sheet treatment.

Initiating a lease-purchase agreement does not require a voter referendum to approve public debt, a process that can delay energy efficiency improvements. Tax-exempt lease-purchase agreements typically require only internal approval and an attorney's letter, which often takes a week (as opposed to months or years for bonds). Local governments can expedite the process by adding energy efficiency projects to existing tax-exempt lease-purchase agreements. Many local governments have master lease-purchase agreements in place to finance capital investment projects. Energy-efficient product procurement can often be added to the agreements without difficulty (U.S. DOE, 2004).

Figure 25: Energy Saving Performance Contract (ESPC)



ESCOs frequently provide a customer some form of an energy savings guarantee. The ESPC may guarantee a level of energy or dollar savings below a "baseline" building energy use projection[50]. The performance guarantee will have a cost premium that the ESCO will integrate into its fee. The performance bond is attractive to most clients because it reduces the risk that the project will not result in sufficient energy savings. In this case, an ESCO only guarantees a set level of energy savings and not the cost of energy. The ESCO has incentive to achieve the guaranteed level of savings, but no incentive to achieve deeper savings. Many ESPCs offered in states other than Alaska are structured as "shared savings" arrangements, wherein ESCOs receive an agreed upon percentage of the savings customers achieve. In this case, ESCOs have an incentive to pursue energy savings above and beyond the guarantee.

---

[50] The Efficiency Valuation Organization publishes the International Performance Measurement and Verification Protocol (IPMVP), which provides criteria for establishing such a baseline and measuring performance relative to it; the ASTM E 2797-11 Building Energy Performance Assessment Standards, provides prescriptive guidelines for meeting the IPMVP.

Advantages and Limitations of the ESCO/ESPC Model

Government buildings and institutional owner-occupied properties comprise the large majority of ESCO clients, and for the Municipal-University-School-Hospital (MUSH) sector the ESPC model is often an attractive option. The ESCO/ESPC model, however, may be of limited availability when applied to smaller individual public facilities. Aggregating small facility projects into one larger project and ESPC may allow an owner to overcome this barrier.

Additionally ESPCs have limited prospects to achieve “off-balance sheet” status. While some ESCO/ESPC models currently use operations lease financing to achieve off-balance sheet treatment, in the coming years FASB may eliminate off-balance sheet leasing. ESCOs can and do service facility owners with smaller retrofit and energy management projects; however, performance guarantees and ESPCs are not typically offered with smaller dollar value contracts.

Given their use of performance guarantees, ESCOs have incentive to specify low-risk but perhaps not innovative strategies. There is perception in the industry in other parts of the country that ESCOs may sometimes pursue more capital-intensive, higher-cost options, and/or measures with quick paybacks. Such practices may be most profitable for ESCOs, but typically do not realize all cost-effective efficiency improvements for the facility owner. The practices do not usually realize the highest value for facility owners because the holistic building approach is usually ignored. This may take away the cost advantages of blending a shorter payback with a longer payback that ultimately saves more energy.

Energy Efficiency Loan Program

An energy efficiency loan program offers loans to local facility owners to implement efficiency projects. Typically, the loan has standard size limits and defined borrower eligibility terms. A loan program will require a reliable and regular source of capital to fund loans. Loan programs often use a “revolving” loan structure to manage funds. After the initial capital is disbursed in loans, new loans would only be made when earlier loan principal is paid back into the fund. Available sources of funds include initial capitalization from federal, state, city, and philanthropic sources; a regular stream of funds from utility systems benefits charges; other customer funds available for investing in efficiency; and in local general obligation bonds. Public entities typically must have the authority to take a loan and service debt. In a memo dated November 21, 2014, the Alaska Office of Management and Budget (OMB) clarified that state agencies may enter into third party financing arrangements for energy efficiency with the approval of the State Debt Manager and the OMB. Typically, public entities are required to obtain legislative approval through the budget process in order to spend money. See **OMB Third Party Financing Memo** and the **OMB Third Party Financing Request Form** in the Appendix.

Advantages and Limitations of the Energy Efficiency Loan Programs

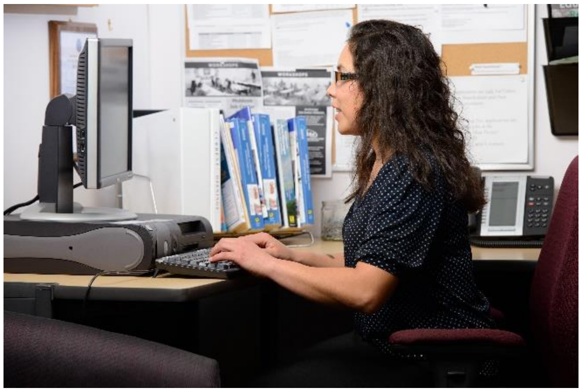
Energy Efficiency Loan Programs typically offer low interest rates and favorable terms. The programs were developed to recognize energy cost savings as a means of balancing debt payments. Origination costs may be a potential limitation, as costs are established by the lender and may need to be paid prior to loan funding. Some loan programs may allow costs to be financed.

Credit Enhancements

A credit enhancement is a general term for funds or assurance provided to a lender, which adds security to a loan. In contrast to a direct loan program, a credit enhancement is specifically designed to leverage private lending. The issuer of the credit enhancement (in this case a city) typically provides a lender with a promise to cover certain losses in the event a borrower defaults. As a result of the credit enhancement, private lenders lower borrowing costs (such as the interest rate) below the rate that would apply to borrowers and projects that might be deemed risky for the lender. A credit enhancement can be used to reach a larger group and magnify an investment to create five or ten times the total amount of capital lent for efficiency measures, compared to a direct loan program.

Credit enhancements can be conveyed in a variety of forms:

- **Loan loss reserves.** A loan loss reserve specifies a certain amount of capital (e.g., 10 percent of the balance of a pool of loans) is held in escrow by the local government to be available to private lenders (up to the predetermined portion of their loan portfolio) to repay in case of default on the loans. Alternately, funds could be advanced to the lender upfront and held for a designated period. In this scenario, unused funds would be returned.
- **Interest rate buy-downs.** An interest rate buy-down delivers a lump sum up-front payment to a lender at the beginning of a loan term as additional security. The buy-down, unlike a loan loss reserve, is retained by the lender at the end of the loan term.
- **Loan guarantees.** Loan guarantees are often rendered by a creditworthy institution—such as the federal, state, or local government. A loan guarantee may be the strongest of all three types, but requires the institution extend the guarantee to record the potential loss as an operating expense.



Credit enhancements can lessen the risk to the lender which, in some cases, can reduce the cost of financing to the borrower.

A credit enhancement program will require a source of funding to support the guarantee that is extended to lenders; grant, ratepayer, bond, and philanthropic funds could be used. One option with a loan guarantee is to implement it through an institution with a strong credit rating, such as a city or state treasury department or a state housing finance agency. For any credit enhancement program to succeed, a partnership with a financial institution (such as a national or regional bank, or a CDFI) is required. A credit enhancement program will require a trusted institution to manage and extend the credit enhancement for eligible projects, and an existing entity with treasury back-office experience, such as a state treasury department or other loan authority, to operate it.

On-Bill Repayment (OBR) and Financing (OBF)

On-bill programs are when a utility or lender extends financing to a utility customer (such as an owner-occupant), and the utility then collects loan payments through regular monthly utility bills that repay the investment or third party. One benefit is the potential to reach a group of customers including tenants with multi-year leases, city-owned properties, schools, and others, because the entities often have substantially greater latitude to incur financing if the repayment is part of the utility bill.

In most current on-bill programs in non-rural areas, funding for loans is provided by utility customer funds such as a utility systems benefits charge. In rural areas, another source of funding for loans is the US Department of Agriculture (USDA) Rural Utility Service (RUS) that provides loans and loan guarantees to electric cooperatives and other entities. When funds are provided by the utility, the repayment structure is termed on-bill financing (OBF). See the diagram in Figure 26. At the time of publication, several states appear to be exploring whether a private financial institution might extend loans to customers and then rely on the utility's customer bill for repayment; a variant known commonly as on-bill repayment (OBR). See the diagram in Figure 27. As the programs develop a utility could potentially extend the loans and then immediately turn to sell the loans to an investor, such as a bank, recouping funds and facilitating additional lending. The utility then passes on the monthly payments to the investor when they are received through their monthly billing process.

An on-bill program is only realistic with the cooperation of the utility and the utility regulator, even if loans are funded by external sources via OBR. Additionally a source of funds for the loans is required and may include, a utility systems benefits charge, funds from a federal program such as USDA RUS, funds from a city or state treasury, a lender interested in making loans, or an investor ready to purchase the loans.

Alaska Specific Programs and Funds

Alaska has a variety of options in place for facility owners to fund or finance energy efficiency retrofits. Private commercial lenders, community development institutions, and state and federal agencies stand ready to support efficiency projects. The institutions below are the Alaska Energy Authority (AEA), the Alaska Housing Finance Corporation (AHFC), the Alaska Industrial Development and Export Authority (AIDEA), the Alaska Department of Community Commerce and Economic Development (DCCED), the Rural Community Assistance Corporation (RCAC), and the United States Department of Agriculture (USDA). Details of commercial lending programs and government appropriation options have not been described do to the range of possibilities and the time sensitive nature of those programs. Building owners should evaluate all options available to them to determine if the option allows a project to be initiated quickly and produce a reasonable rate of return.

Figure 26: On-Bill Financing (OBF)

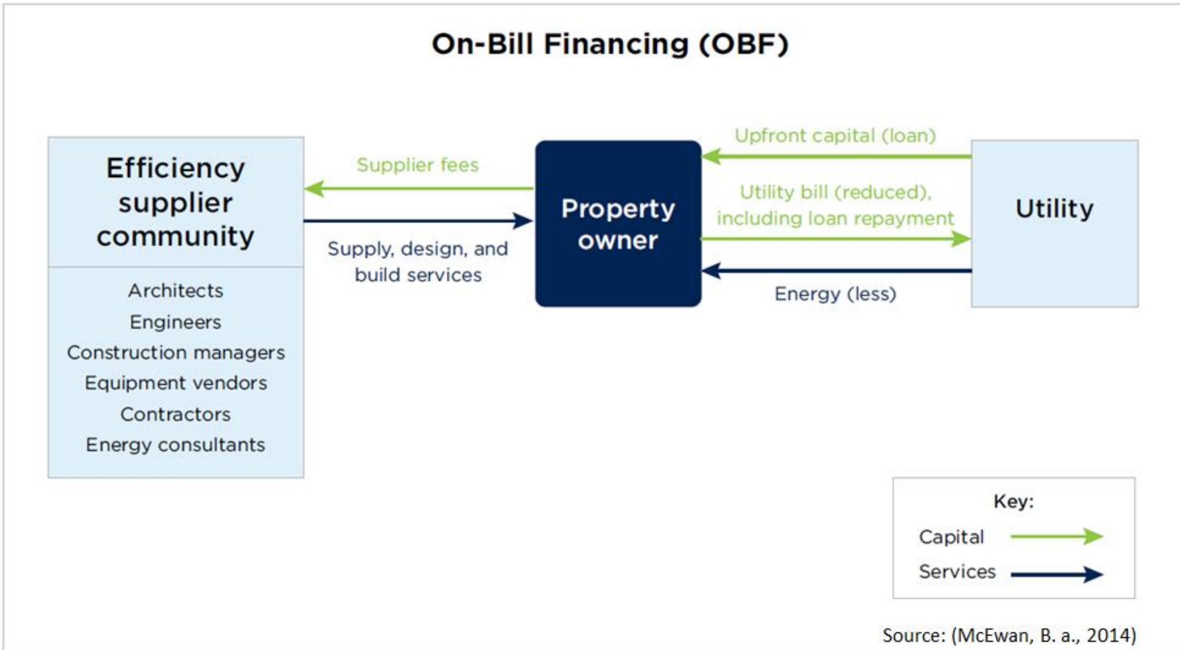
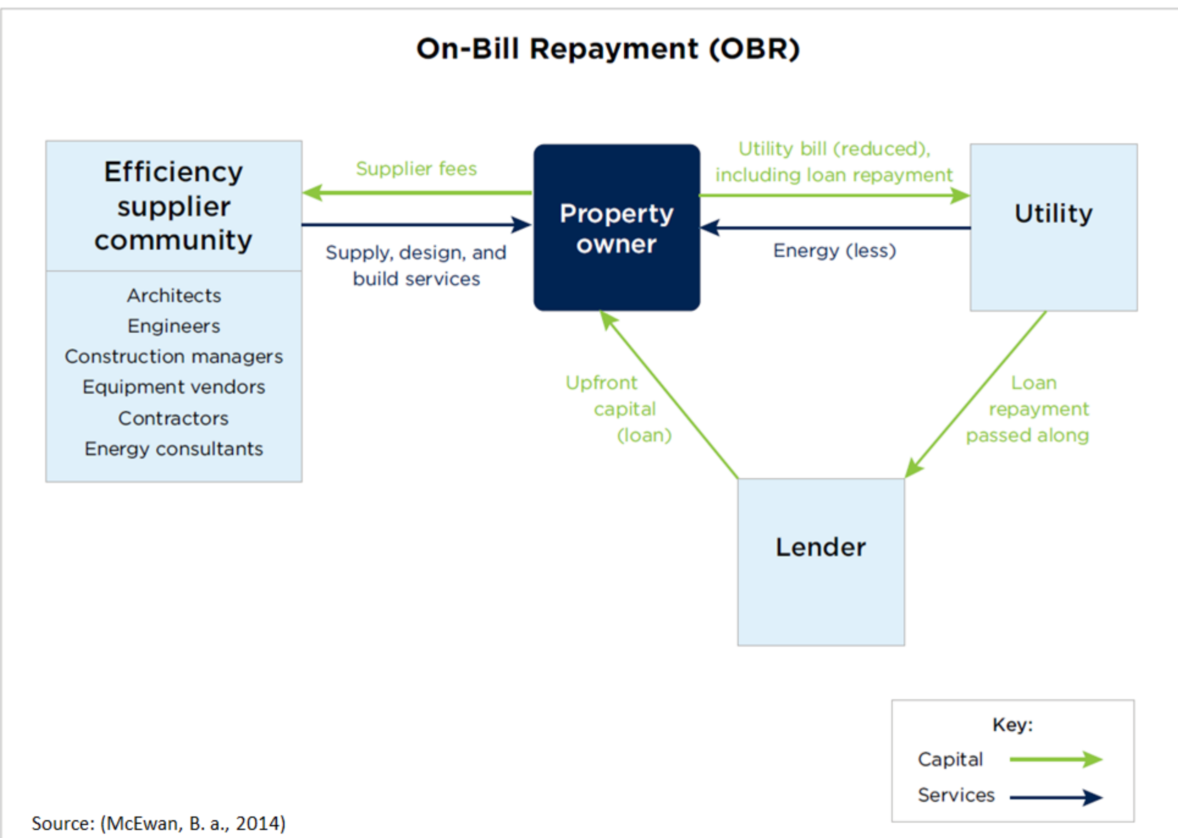


Figure 27: On-Bill Repayment (OBR)



1. **AEA Village Energy Efficiency Program (VEEP).** Funding is available to small, high energy cost communities in Alaska with a population no greater than 8,000 residents. Eligible applicants include municipalities, cities, school districts, unincorporated villages, Alaska Native regional and village corporations, 501(c)3 tribal consortiums, regional housing authorities, councils organized under 25 U.S.C 476 and traditional councils. Learn more[51].
2. **AHFC Alaska Energy Efficiency Revolving Loan Program (AEERLP)**. Loans made through the revolving loan fund are currently available for energy saving building retrofit projects to local governments, school districts, University of Alaska, and buildings owned by State of Alaska agencies. There is no minimum or maximum loan amount. Loans can be repaid by energy savings. Learn more[52].
3. **AIDEA Loan Participations for Qualified Energy Developments**. Under AIDEA's loan participation program, an entity seeking a loan works with an eligible financial institution such as a bank or credit union. A financial institution will conduct its own underwriting and may submit an application to AIDEA on behalf of the borrower(s). Under AIDEA's loan participation program for qualified energy development, the program is expanded to cover energy projects including energy efficiency measures for reducing building energy consumption. AIDEA can purchase up to 90 percent of a participating loan up to a maximum of $25 million. This program offers permanent financing to borrowers through a qualified originator for the purpose of financing a "qualified energy development" project. Learn more[53].
4. **AIDEA Sustainable Energy transmission and Supply (SETS)**. This program is currently available to provide loans for larger qualified energy development projects. Up to one third of project costs are eligible for qualified energy development, defined as a project that involves transmission, generation, conservation, storage, or distribution of heat or electricity. The other two thirds of funding for the project must come from other sources such as private equity, debt, or grant funds. Eligible applicants include sole proprietorship, cooperative, corporation, firm, partnership, or other association of persons organized in any manner, for any credit worthy business purpose. Learn more[54].
5. **DCCED Alternative Energy Conservation Loan Fund**. Loans may be made to purchase, construct, and install alternative energy systems or energy conservation improvements in commercial buildings. Loans must result in alternative energy production or energy conservation. The maximum loan amount is $50,000.00. Loan requests more than $30,000 require a letter of denial from a financial institution, stating the reason(s) for denial, or confirmation that a loan from a financial institution is contingent on the applicant receiving a loan from the fund. Eligible applicants include Alaskans with a minimum of 12 months residency required. Learn more[55].

---

[51] www.akenergyauthority.org/Efficiency/VEEP

[52] www.ahfc.us/efficiency/energy-programs/energy-efficiency-revolving-loan-fund-aeerlp

[53] www.aidea.org/Programs/LoanParticipation.aspx

[54] www.aidea.org/Programs/EnergyDevelopment.aspx

[55] www.commerce.alaska.gov/web/ded/FIN/LoanPrograms/AlternativeEnergyLoanProgram.aspx

6. **RCAC loan fund.** The RCAC loan fund offers a comprehensive array of loan products for affordable housing development, environmental infrastructure, community facilities and businesses in rural locations. Each RCAC loan product is designed to meet the unique loan structure needs of the applicant. Eligible applicants to the loan fund are nonprofit organizations, public bodies, and tribal governments. For profit entities and sole proprietorships as well as nonprofit organizations, and tribes or tribal designated entities, may qualify for business loans. Learn more[56].
7. **USDA Business and Industry Loan Guarantee.** By guaranteeing loans for rural businesses, this program allows private lenders to extend more credit than they would typically be able to. Lenders with legal authority, sufficient experience, and financial strength to operate a successful lending program may request a guarantee for public bodies among many other borrower types. Loan guarantees up to 90 percent are offered, depending on project size and location. Learn more[57].
8. **USDA Community Facilities Direct Loan & Grant.** This program provides affordable funding to develop essential community facilities in rural areas including cities, villages, townships, and towns including federally recognized tribal lands with no more than 20,000 residents. Funds can be used to purchase, construct, and/or improve essential community facilities, purchase equipment, and pay related project expenses. Low interest direct loans and grants are available through the program and may be used in combination and with other programs and commercial financing. Learn more[58].
9. **USDA Community Facilities Loan Guarantee.** This program provides loan guarantees to eligible private lenders to help build essential community facilities in rural areas including cities, villages, townships, and towns including federally recognized tribal lands with no more than 20,000 residents. Funds can be used to purchase, construct, and/or improve essential community facilities; purchase equipment; and pay related project expenses. The program offers a maximum guarantee of 90 percent of the eligible loss. Learn more[59].
10. **USDA Energy Efficiency and Conservation Loan (EECLP).** This program provides low-cost federal financing for energy efficiency and conservation projects for commercial, industrial, and residential consumers. With the EECLP, eligible utilities including existing rural utilities service borrowers can borrow money tied to treasury rates of interest and re-lend the money to develop new and diverse energy service products within their service territories. Borrowers could set up on-bill financing programs whereby customers in their service territories implement energy efficiency measures behind the meter and repay the loan to the distribution utility through electric bills. Learn more[60].
11. **USDA Rural Economic Development Loan & Grant.** This program provides funding for rural projects through local utility organizations. Under the REDLoan program, USDA offers zero interest loans to

---

[56] www.rcac.org/pages/82

[57] www.rd.usda.gov/programs-services/business-industry-loan-guarantees

[58] www.rd.usda.gov/programs-services/community-facilities-direct-loan-grant-program

[59] www.rd.usda.gov/programs-services/community-facilities-guaranteed-loan-program

[60] www.rd.usda.gov/programs-services/energy-efficiency-and-conservation-loan-program

local utilities that pass through to local businesses (ultimate recipients) for projects that will create and retain employment in rural areas. Under the REDGrant program, USDA offers grant funds to local utility organizations that use the funding to establish revolving loan funds (RLF). Financing is made available from the revolving loan funds for projects that will create or retain rural jobs. Public entities can be the ultimate recipient of the RLF proceeds. Up to $300,000 in grants may be requested for establishment of the RLF. When the revolving loan fund is terminated, the grant is repaid. Learn more[61].

12. **Commercial lenders**. Commercial lenders may have an interest in financing energy efficiency retrofits. Facility owners are encouraged to investigate loans available through commercial lenders in Alaska.

The Bottom Line

Facility owners considering an energy efficiency retrofit for their building should inform decision makers by collecting data on the building, conducting analyses, and reviewing the full array of funding and financing options available. Decision makers should consider life cycle costs and savings, and other harder to monetize benefits and costs associated with different courses of action to determine the option that provides the best value proposition.

Facility owners should conduct a financial options assessment as early as possible. Compare all terms and conditions including interest rate, financing amount, closing costs and timing, hold-back requirements, and recourse. Evaluate all cost-effective and appropriate subsidies and grant sources. Assess the impact of delaying the project by determining to seek subsidies, cheaper financing, or another approach. Many projects can be implemented with financing to reduce energy costs, produce positive cash flow, improve the durability of the structure, and the health, comfort, and safety of the work environment.

Investing in energy efficient projects will usually result in future energy cost savings that can be reinvested in programs or projects and may increase productivity. Conversely, the cost of delaying implementation of an energy efficiency project results in lost savings—savings that may have been available for other uses.

---

i (Dodge, Wiltse, & Madden, 2014)
ii (Alaska Department of Transportation and Public Facilities, 2015
iii Chatto, 2015
iv (Rockefeller Foundation and Deuchtsche Bank Climate Change Advisors, 2012

---

[61] www.rd.usda.gov/programs-services/rural-economic-development-loan-grant-program

v International Energy Agency, 2015
vi Alaska Department of Commerce
vii Lovins, 2015
viii (McEwen & Miller, 2014)
ix (McEwen & Miller, 2014)
x Kind, 2013
xi PGL and NBI, 2013
xii Nadel, 2011
xiii S&P 500
xiv (Dodge, Wiltse, & Madden, 2014)
xv US EPA, 2004

Closing Summary 16

Managing facilities in arctic and sub-arctic environments can be challenging. The environment is changing, existing buildings are aging, and building systems are becoming more complicated. Pursuing energy efficiency retrofits can lead to decreased operating expenses, increased occupant comfort, improved worker productivity, extended facility life, streamlined building systems, and a sustainable built environment in Alaska. Hopefully, this manual has provided several resources and opportunities to overcome the barriers to managing public facilities and implementing energy efficiency retrofits. If you have comments or suggestions, please contact Alaska Housing Finance Corporation at efficiency@ahfc.us.

Alaska Department of Commerce, C. a. (n.d.). *Alaska Fuel Price Report*. Retrieved November 24, 2014, from http://commerce.state.ak.us/dnn/Portals/4/pub/Fuel_Price_Report_Jan_2014.pdf

Alaska Department of Commerce, C. a. (n.d.). *Alaska Fuel Price Report*. Retrieved November 24, 2014, from http://commerce.state.ak.us/dnn/Portals/4/pub/Fuel_Price_Report_Jan_2014.pdf

Alaska Department of Transportation and Public Facilities. (2015). *Alaska Sustainable Energy Act Annual Report - 2014 Progress Report.* Anchorage: AKDOT&PF.

Alaska Housing Finance Corporation. (2012, November 7). *A White Paper on Energy Use in Alaska's Public Facilities.* Anchorage: Alaska Housing Finance Corporation. Retrieved from https://www.ahfc.us/files/3313/5769/3854/public_facilities_whitepaper_102212.pdf

Alaska Housing Finance Corporation. (2013). *ahfc.us.* Retrieved from Introduction to Energy Efficiency: http://www.ahfc.us/files/4213/6330/7361/AHFC_

Alaska Housing Finance Corporation. (2014). *Energy Efficiency of Public Buildings in Alaska: Metrics and Analysis.* Anchorage.

ASHRAE and WBDG. (2015, August 4). *Owner's Role and Responsbilities in the Commissioning Process*. Retrieved from Whole Building Design Guide: http://www.wbdg.org/project/plan_comm_process.php

Barnes, C., Hodgin, S., Brew, J., & Karolides, A. (2013, March). Retrieved May 14, 2015, from Rocky Mountain Institute: http://www.rmi.org/Knowledge-Center%2fLibrary%2f2013-03_SHISolutionsToHurdles

Chatto, H. F. (2015, March 31). *Five Reasons Why Zero Energy Buildings are the Real Deal*. Retrieved July 6, 2015, from New Building Institute: http://newbuildings.org/blog/five-reasons-why-zero-energy-buildings-are-real-deal

Dodge, K., Wiltse, N., & Madden, D. (2014, November 21). *Potential Paybacks from Retrofitting Alaska's Public Buildings*. Retrieved July 6, 2015, from Alaska Housing Finance Corporation: https://www.ahfc.us/files/9614/1866/9905/Potential_Paybacks_from_Retrofitting_Alaskas_Public_Buildings.pdf

Energy Management Association. (2014). *EMA Energy Management Guideline.* Retrieved from http://energymanagementassociation.org/

Energy Sector Management Assistance Program, The World Bank. (2010). *Public Procurement of Energy Efficiency Services: Getting Started.* Retrieved May 15, 2015, from Energy Sector Management Assistance Program: http://www.esmap.org/sites/esmap.org/files/PublicProcurement_GettingStarted_2013pdf.pdf

EVO. (2012). *IPMVP Public Library of Documents*. Retrieved August 11, 2015, from Efficiency Valuation Organization : http://www.evo-world.org/index.php?option=com_content&view=article&id=272&Itemid=379&lang=en

Fisk, W., Black, D., & Brunner, G. (2011). *Benefits and Costs of Improved IEQ in U.S. Offices*. Retrieved July 23, 2015, from Lawrence Berkeley National Laboratory: http://www.iaqscience.lbl.gov/pdfs/benefits-1.pdf

Fowler, J. (2015). *The Role of Building Maintenance in Energy Efficiency and Building Operations.* Anchorage. Retrieved from www.ahfc.us/files/1114/2592/5859/11_Jim_Fowler_The_Role_of_Building_Maintenance_in_Energy_Efficiency_030415.pdf

Global Superior Energy Performance Partnership Energy Management Working Group. (2013). Knowledge and Skills Needed to Implement Energy Management Systems in Industry and Commercial Buildings.

Goldsmith, S., Pathan, S., & Wiltse, N. (2012). *Snapshot: The Home Energy Rebate Program.* Anchorage: Institute of Social and Economic Research.

Harris, J., Brown, M., Deakin, J., Jurovics, S., Khan, A., Wisniewski, J., . . . Thomas, A. (2004). *Energy-Efficient Purchasing by State and Local Government Triggering a Landslide Down the Slippery Slope to Market Transformation.* Retrieved 12 1, 2009, from http://www.pepsonline.org/ publications/Energy%20Efficient%20Purchasing%20 By%20State%20and%20Local%20Government.pdf

International Energy Agency. (2015, June 15). *WEO 2015 Special Report on Energy and Climate Change*. Retrieved July 6, 2015, from World Energy Outlook: http://www.worldenergyoutlook.org/

Kats, G. (2006). *Greening America's Schools: Costs and Benefits*. Retrieved November 26, 2014, from Greend Building Pages: http://www.greenbuildingpages.com/KatzGreenSchools.pdf

Key Bank. (2015). *Equipment Buy or Lease Calculator*. Retrieved July 29, 2015, from Key Bank: https://www.key.com/personal/calculators/equipment-buy-versus-lease-calculator.jsp

Kind, P. (2013, January). *Disruptive Implications and Strategic Responses to a Changing Retail Electric Business*. Retrieved July 10, 2015, from Edison Electric Institute: http://www.eei.org/ourissues/finance/Documents/disruptivechallenges.pdf

Lovins, A. (2015). *The Oil Price Roller Coaster*. Retrieved July 2, 2015, from Rocky Mountain Institute: https://medium.com/solutions-journal-summer-2015/the-oil-price-roller-coaster-abafecb1ffb9

Machinchik, T. (2013). *An Introduction to Energy Management Systems.* Retrieved from https://www.noesisenergy.com/site/content/introduction-energy-management-systems-0?utm_source=AEE&utm_medium=Newsletter

McEwen, B., & Miller, J. (2014). *Local Governments' Role in Energy Project Financing - A Guide to Financing Tools for the Commercial Real Estate Sector*. Retrieved July 2, 2015, from Institute for Market Transformation: http://www.imt.org/uploads/resources/files/energy_finance_06.pdf

Nadel, S. (2011, July). *Energy Efficiency and Finance: Opportunities and Approaches*. Retrieved July 31, 2015, from National Conference of State Legislatures: http://www.ncsl.org/documents/energy/SteveNadel.pdf

National Institute of Building Sciences. (2014, October 30). *Planning the Commissioning Process*. Retrieved May 15, 2015, from Whole Building Design Guide: http://www.wbdg.org/project/plan_comm_process.php

Oregon Department of Transportation. (2012). *Office of Project-Letting, What is CM/GC*. Retrieved May 15, 2015, from Oregon Department of Transportation: http://www.oregon.gov/ODOT/HWY/OPL/Pages/CMGC.aspx

Oregon Department of Transportation. (2012). *Office of Project-Letting, What is Design-Build*. Retrieved May 15, 2015, from Oregon Department of Transportation: http://www.oregon.gov/ODOT/HWY/OPL/Pages/Design-Build.aspx

Pabor, E. J., & Pennington, R. (2012). *The growth (and growing pains) of design-build construction*. Retrieved May 15, 2015 , from Amerian City & Country: http://americancityandcounty.com/contracts/growth-and-growing-pains-design-build-construction

PGL and NBI. (2013, June). *Realizing the Energy Efficiency Potential of Small Buildings*. Retrieved July 10, 2015, from National Trust for Historic Preservation: http://www.preservationnation.org/information-center/sustainable-communities/green-lab/small-buildings/130604_NTHP_report_sm.pdf

Portland Energy Conservation, Inc. (2007). *A Retrocommissioning guide for building owners.* Portland: Portland Energy Conservation, Inc. Retrieved from http://www.sandiegorcx.com/docs/epa-rcx-guide-building-owners.pdf

Pressman, A. (1997). *Professional Practice 101: A Compendium of Business and Management Strategies in Architecture.* John Wiley & Sons.

Rockefeller Foundation and Deuchtsche Bank Climate Change Advisors. (2012). *United States Building Energy Efficiency Retrofits: Market Sizing and Financial Models.*

S&P 500. (n.d.). *S&P Dow Jones Indices, McGraw Hill Financial*. Retrieved July 31, 2015, from S&P 500: http://us.spindices.com/indices/equity/sp-500/

Schuler, G. (2012). *Where's the Risk in Construction Management at-Risk*. Retrieved May 15, 2015, from Boyd Jones Construction: http://www.boydjones.biz/news-events/2012/10/18/wherestherisk

Singh, J., Limaye, D. R., Henderson, B., & Shi, X. (2010). *Public Procurement of Energy Efficiency Services: Lessons from International Experience*. Retrieved May 15, 2015, from Energy Sector Management Assistance Program: http://www.esmap.org/node/270

State of Alaska. (n.d.). *Statutes and Regulations Construction Contractors, Division of Corporations, Business and Professional Licensing*. Retrieved from http://commerce.state.ak.us/dnn/portals/5/pub/ContractorStatutes.pdf

U.S. DOE. (2004). *Additinal Financing Sources and Considerations*. Retrieved 12 1, 2009, from http://www1.eere.energy. gov/buildings/financial_opportunities.html

U.S. EPA. (2011). *Energy-Efficient Product Procurement, A Guide to Developing and Implementing Greenhouse Gas Reduction Programs*. Retrieved November 26, 2014, from U.S. EPA: http://www.epa.gov/statelocalclimate/documents/pdf/energyefficientpurchasing.pdf

U.S. EPA. (2014). *Integrating indoor air quality protections and energy efficiency improvements*. Retrieved November 26, 2014, from U.S. EPA: http://www.epa.gov/iaq/schools/energy_savings_plus_health.html

United States Small Business Administration. (n.d.). *Surety Bonds: The Basics*. Retrieved from https://www.sba.gov/content/surety-bonds-basics

US Department of Energy. (2010). *Acquisition Guide Chapter 16.1: General Guide To Contract Types For Requirements Officials.* Retrieved May 15, 2015, from US Department of Energy: http://energy.gov/sites/prod/files/16.1_General_Guide_to_Contract_Types_for_Requirements_Officials_0.pdf

US DOE. (2008, April). *M&V Guidelines: Measurement and Verification for Federal Energy Projects Version 3.0*. Retrieved August 10, 2015, from US DOE - Energy Efficiency and Renewable Energy - Federal Energy Management Plan: https://www1.eere.energy.gov/femp/pdfs/mv_guidelines.pdf

US EPA. (2004, November). *Innovative Financeing Solutions: Finding Money For Your Energy Efficiency Projects*. Retrieved July 10, 2015, from Energy Star: http://www.energystar.gov/ia/business/COO-CFO_Paper_final.pdf

US EPA. (2008). *Building Upgrade Manual*. Retrieved November 26, 2014, from Energy Star: http://www.energystar.gov/ia/business/EPA_BUM_Full.pdf

US EPA. (2011). *Energy Efficiency in Local Government Operations - A Guide to Developing and Implementing Greenhouse Gas Reduction Programs*. Retrieved July 31, 2015, from US Environmental Protection Agency: http://www.epa.gov/statelocalclimate/documents/pdf/ee_municipal_operations.pdf

Whole Building Design Guide. (n.d.). Retrieved from https://www.wbdg.org/

Appendices

1. **OMB Third Party Financing Memo**
2. **OMB Third Party Financing Request Form**
3. **Commissioning Flow Chart**

OMB Third Party Financing Memo

THE STATE *of* ALASKA
GOVERNOR SEAN PARNELL

Office of the Governor

OFFICE OF MANAGEMENT AND BUDGET
Karen Rehfeld, Director

Court Plaza Building
240 Main Street, Suite 802
Juneau, Alaska 99811-0020
Main: 907.465.4660
Fax: 907.465.2090

MEMORANDUM

To: Administrative Services Directors

Date: November 21, 2014

From: Karen Rehfeld, Director
Office of Management and Budget

Subject: Process for Third Party Financing

PURPOSE
As a tool to manage its budget, State agencies may enter into a third party financing arrangement. When entering into such a financial arrangement, an agency may commit to long term repayment with the agency's operating funds, subject to annual appropriation. In some instances, the savings resulting from the project or acquisition can be used to repay the indebtedness.

The purpose of this third party financing policy is to identify the process and required steps for a State agency when proposing to finance equipment acquisition and energy efficiency projects. A loan, or line of credit, can be entered into by a State agency for personal property, equipment acquisition (including systems furniture), performance based contract, or other energy efficiency project. Regardless of the means of financing used, the financing should be structured to ensure that there is no potential for the fractionalization and securitization and public sale to third party investors as a State of Alaska obligation. Acceptable loan options include the State Master Lease Line of Credit, the Alaska Energy Efficiency Revolving Loan Fund Program (AEERLF), or through other lenders. Private financing should only be used if there is a significant advantage for the agency to do so, and only with approval of the Department of Revenue to ensure that no potential for a negative impact on the State's credit rating is being created.

BACKGROUND
As pressure on the State's budget continues to increase, State agencies, including the University of Alaska and the Alaska Court System, are finding alternative methods for purchasing equipment and funding energy efficiency projects that do not require a capital appropriation. There are two types of projects that readily lend themselves to financing since the savings from such projects can be used to service the debt.

1. Personal Property and Equipment, including furniture resulting from implementation of the universal space standards; and

2. Energy efficiency projects.

It can be advantageous for agencies to finance equipment over a period of time, especially when interest rates are extremely low, or even at zero. Such low interest rates are often available through certain office and copier supply vendors. This financing method allows agencies to spread the cost over the life of the equipment/project and not have to commit to a large, one-time cost, within a single budget year.

The State has implemented universal space standards across agencies when there is a move within State owned space or a move from private lease into State owned space. The new space standards reduce the amount of lease space, and thus cost, by having staff work in smaller, closely associated working groups, and the elimination of private offices. The savings that is realized can be directed to paying down the cost of purchasing the new systems furniture. Loan payments can be structured so that the payment is comparable to the annual savings.

Similarly, Energy Efficiency (EE) projects can result in significant savings from reduced utility usage. To complete EE projects, agencies must first complete an investment grade audit using an Energy Service Company. Based on the anticipated savings, agencies would then secure a loan to complete the construction project. The construction loan can be serviced by using the utility savings from the project.

AUTHORITY

AS 36.30.086 Lease-Purchase of Personal Property

> (a) To perform its duties and statutory functions, an agency, the Board of Regents of the University of Alaska, the legislative council, the Legislative Budget and Audit Committee, the office of victims' rights, the office of the ombudsman, or the supreme court may enter into lease-purchase agreements for the acquisition of equipment or other personal property. The government entity is the lessee under the agreement.
>
> (b) If a government entity enters into a lease-purchase agreement under (a) of this section that exceeds $100,000 in payments by the state, the government entity shall provide notice to the presiding officers and finance committee chairs of the house and senate. The notice must describe the property that is the subject of the agreement and must set out the terms of the lease-purchase.

In accordance with AS 36.30.086(b), the Office of Management and Budget (OMB) will provide notice through the annual report that OMB prepares for the Legislature. This report includes a summary of all lease purchase agreements that were entered into during the preceding fiscal year, which are reported to OMB by the agencies.

PROCEDURE

Equipment and Personal Property with Total Payments of $100,000 or Less

For equipment and personal property acquisition that will result in less than $100,000 in payments, State agencies may utilize the Master Lease Line of Credit through the Department of Revenue without advance approval from OMB.

Equipment/Personal Property with Total Payments that Exceed $100,000

For equipment/personal property acquisition that will result in total payments of $100,000 or more, OMB approval is required. Agencies must follow the existing process established through the Department of Revenue's State Debt Manager for using the Master Lease Line of Credit, or obtain granted through the *OMB Approval for Third Party Financing* form (Attached). If the Debt Manager approves, the Debt Manager will forward to OMB for review.

Energy Efficiency Projects
All third party financing arrangements for energy efficiency improvements must be approved by the State Debt Manager and OMB.

1. Complete, sign and submit the *OMB Approval for Third Party Financing* request form to the Department of Revenue, Debt Manager, along with other information that the Debt Manager will need in order to properly analyze the loan and to assure the state's credit rating is protected.

2. The Debt Manager will either approve or not approve. If approved, the request form will be forwarded to OMB for review. If not approved, it will be returned to the agency along with the analysis as to why it is not approved, with a copy to OMB.

3. If approved by the Debt Manager, then OMB will review and either approve or not approve, and return the request form to the requesting agency.

Legislative Authorization
As part of the budget submission, agencies must include in their operating budget detail the funds that will be used to service debt, and the reason. By doing so, agencies will show the authorization needed to service debt with operating funds.

Any questions regarding this process or procedure should be directed to Arnold Liebelt, Senior Policy Analyst, Office of Management and Budget.

Attachment

cc: Deven Mitchell, Debt Manager, Tax Division, Department of Revenue
Marjorie Vandor, Chief Assistant Attorney General, Department of Law
Mary Ellen Beardsley, Assistant Attorney General, Department of Law
Scott Waterman, Energy Specialist, Alaska Housing Finance Corporation
Tom Mayer, Director, Division of General Services, Department of Administration
David Kemp, Statewide Facilities, Department of Transportation & Public Facilities
Arnold Liebelt, Senior Policy Analyst, Office of Management and Budget

OMB Third Party Financing Request Form

OMB Approval for Third Party Financing

Department/Agency/Division: ______

Type of Project:
- ○ Energy Efficiency
- ○ Equipment/Furniture
- ○ Other ______

Loan Agency (*See Note):
- ○ Master Lease (Key Bank)
- ○ AK Energy Efficiency Revolving Loan fund (AHFC)
- ○ Other ______

*When Selecting Energy Efficiency & Other Financing, Please Attach The Terms of Financing to This Form

Amount of Loan: ______

Interest Rate: ______

Duration of Loan: ______

Loan Payment Amount: ______

Payment Interval:
- ☐ Monthly ☐ Quarterly
- ☐ Annually
- ☐ Other ______

Debt will be serviced by the following:
- **Results Delivery Unit:** ______
- **OMB Component Name:** ______
- **OMB Component Number:** ______

Fund Sources & Amounts:

Fund Code & Name	Fund Amount

Will This Loan Result in an Increment to Agency Budget?
- ☐ Yes
- ☐ No

Estimated Amount if Yes ______

Expected Date of First Payment: ______

Expected Date of Final Payment: ______

Total Expected Amount of Interest: ______

Office of Management and Budget
Revised November 20, 2014

Page 1 of 3

Description of Financing
Explain why this project is needed now and how it will result in cost savings.

Contact Completing This Form

Date

Administrative Services Director or Commissioner

Date

Analysis & Recommendation: To Be Completed By The State Debt Manager

Analysis & Recommendation: To Be Completed By OMB

Approved

☐ Yes

☐ No

Approval - State Debt Manager, Treasury Division | Date

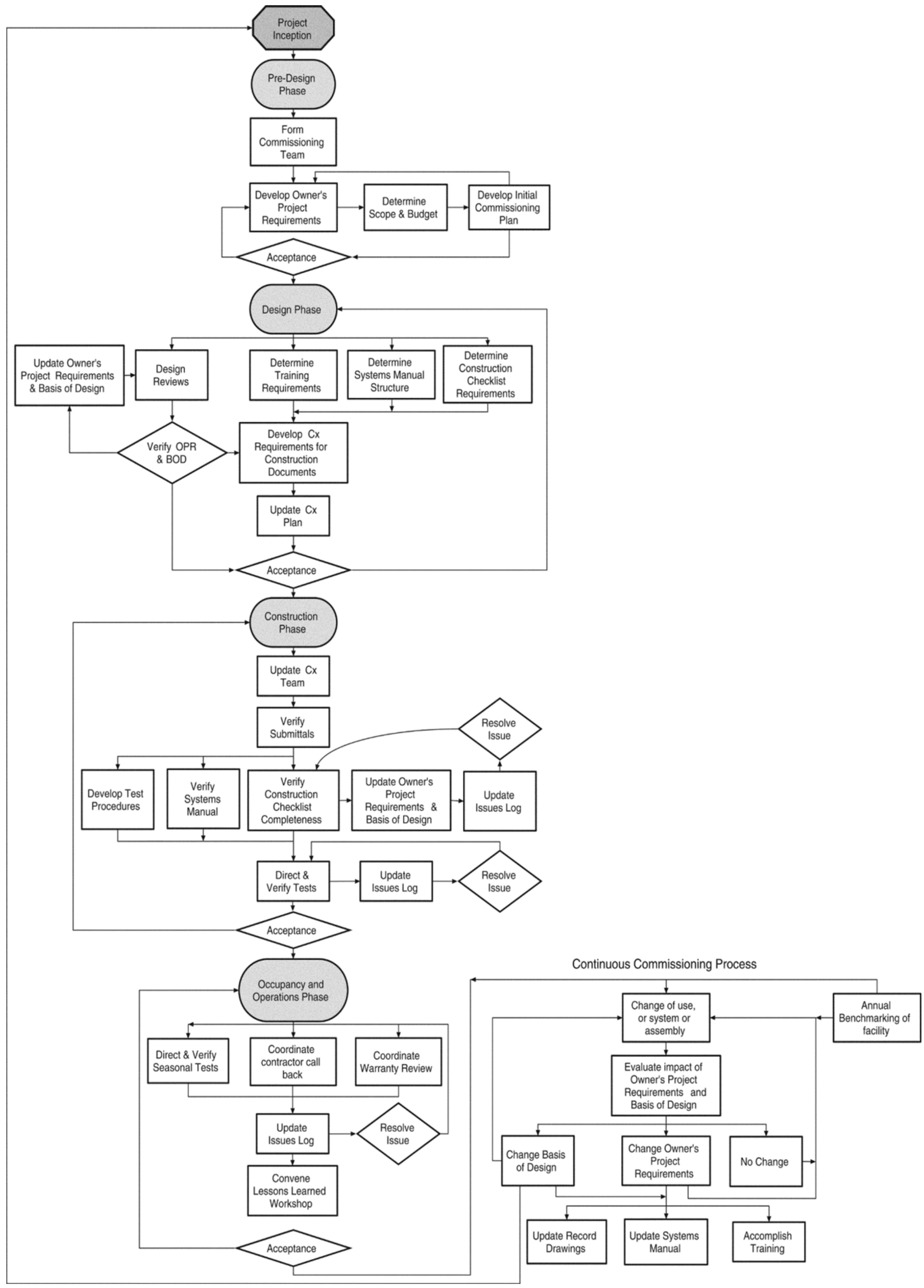
Approved

☐ Yes

☐ No

Approval - Director, Office of Management & Budget | Date

Commissioning Flow Chart



(ASHRAE and WBDG, 2015)