Department of Defense
Energy Manager's Handbook

Prepared for the

Office of Deputy Under Secretary of Defense (ODUSD)
Installations and Environment (I&E)
Washington, D.C.

In support of

Western Power Grid Peak Demand and
Energy Reduction Program

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Executive Summary

This handbook is designed to act as a useful tool and guide in assisting Department of Defense (DoD) installation and facility energy managers to effectively perform tasks associated with their jobs. It is not the intent of the Handbook to answer all questions on the subject of energy management, but rather to provide the energy manager enough of the basic information and reference to other resources in order to successfully conduct an energy management program. This Handbook is one of many resources to help energy managers meet the challenges of today's market.

The Handbook is divided into five parts. **Part I** is **"Organizing for Energy Management."** It includes an introduction and overview of the energy manager's professional responsibilities in addition to outlining the latest federal policies and the goals set by DoD in order to implement those policies.

Part II of the Handbook is "**Starting an Energy Management Program."** It defines those elements that lay the foundation of an energy management program such as installing a team, setting the goals and plans for implementation of those goals, creating an energy awareness campaign, and performing energy accounting and reporting.

Part III – "Energy and Water Conservation" provides the resources to assist in identifying, funding and executing measures that reduce energy consumption and cost. It provides recommendations for some of the latest strategies and technologies utilized in energy management today.

Part IV of the Handbook is **"Analyzing Energy Projects**.**"** Chapter 14 covers the techniques of Life Cycle Costing in assisting the energy manager in selecting the most cost effective energy and water projects. It also provides resources to support energy life cycle cost analyses. Chapter 15 identifies federally funded software in addition to that available commercially, for energy analysis.

Finally **Part V "Service Energy Programs,"** provides an overview of Army, Navy, and Air Force energy programs as well as those services provided by the Defense Energy Support Center and the Department of Energy's Federal Energy Management Program. Through information provided in the latest regulations, instructions, and procedural memorandum, the chapters define individual energy team member responsibilities and plans to meet federal energy and water use goals.

Appendices to the Handbook include a glossary of important terms and abbreviations, frequently asked questions, and resource and contact information for a variety of organizations both within the Federal government and outside that have common goals to the energy manager. Appendix E "Suggested Professional Library and Resources Guide" is a listing of publications that would be helpful to the facility energy manager. Appendix F includes references used in compiling the Handbook revision.

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The scope of this effort was to provide an update to the existing Handbook, to reflect the latest aspects of the DoD Instruction 4170.11 "Installation Energy Management," focusing mainly on implementation strategies shown in section 5.2. It also adds new information on some of the latest strategies and equipment being utilized in energy management today. Some of the information in the Handbook is retained and repeated verbatim of earlier editions.

Part I Organizing For Energy Management

1. Introduction to DoD Energy Management

1.1. Key Points

- Energy and water conservation deliver a wide range of benefits, including dollar savings, infrastructure improvements, reduced pollutant emissions, improved energy reliability and security, and in some cases, increased productivity.

- Each installation or facility energy manager (hereinafter referred to simply as "energy manager") faces the challenge of promoting energy and water efficiency as much as possible without jeopardizing mission capabilities or reducing the quality of life of DoD personnel.

- Because fully successful energy conservation programs need top Management support, DoD energy managers need to convince installation commanders or facility owners of the cost savings and benefits that can be realized through energy and water conservation.

- In order to establish and maintain a successful energy program, the energy manager needs a good understanding of both the technical and managerial aspects of energy management.

1.2. Energy Management Challenges

Executive Order (EO) 13123 "Greening the Government through Efficient Energy Management" set ambitious, but achievable energy management goals for the Federal Government. Efficient use of energy and water resources plays an important role in support of DoD's primary missions. The inefficient use of energy wastes limited defense funds, diverting those funds from other essential mission requirements. DoD installations are focused on improving efficiency, reducing demand, eliminating waste, and enhancing quality of life while meeting mission requirements.

1.3. Develop Integrated Conservation Program

DoD spends over $2.5 billion per year on facility energy consumption. They are the largest single energy consumer in the United States, representing 78% of the Federal sector. Conserving energy and investing in energy reduction measures makes good business sense. Research has shown that leaders in energy management are able to achieve superior financial performance.

A major challenge facing each DoD installation energy manager is to promote efficiency and reduce costs as much as possible without jeopardizing mission capabilities or reducing the quality of life for DoD personnel. The energy manager must develop and orchestrate the implementation of an integrated energy and water conservation program. That program must involve every energy user on an installation, from the commanding officer, down the chain of command to every person (and visitor) on the base. The program should include the following components, each of which are discussed in greater detail in succeeding chapters.

1.3.1. Baseline Energy Assessment

One of the initial steps in developing an effective energy cost control program is performing a baseline energy assessment. A baseline assessment will assist with evaluating the health of the existing energy program, or in identifying and documenting shortfalls if a program doesn't currently exist. It should serve as a starting and/or reference point to institute an integrated conservation program.

A baseline energy assessment will evaluate the facility's baseline energy use and performance. Benchmarking will then show a comparison of energy performance of similar facilities or for an established level of performance. That baseline assessment should be reviewed periodically, probably at a frequency of every 3 to 5 years. The assessment should identify the largest energy users, best opportunities for reduction, requirements for critical backup power, etc.

Various energy management and services companies can be contracted with to perform baseline energy assessments and audits. The ENERGY STAR web site lists numerous service and product providers to assist organizations with improving their total energy management. The ENERGY STAR web site address is: http://www.energystar.gov.

The Department of Energy's (DOE) Federal Energy Management Program (FEMP) supports agencies in need of technical assistance. Among other services, they perform screening for project opportunities in addition to providing feasibility studies. Reference Chapter 21 for a more in depth overview of FEMP's activities.

The Services each manage programs aimed at reducing energy and associated costs, and at improving energy systems. Specifics of their efforts including technical assistance provided and funding sources can be accessed through their associated web addresses:

http:hqda-energypolicy.pnl.gov/

http://www.nfesc.navy.mil/energy/
http://www.afcesa.af.mil/ces/cesm/energy/cesm_energy.asp

Reference Chapters 17 through 19 of this Handbook for further discussion on the Services' responsibilities related to energy programs.

1.3.2. Institute a Program Plan

Planning is an important part of an energy management program. That planning consists of initially performing an energy audit to identify how energy is currently being used in the facility, setting clear and measurable goals, then developing an action plan to implement those goals.

Energy audits as well as commissioning and re-commissioning of HVAC systems evaluate current energy usage and assist installations in determining the best locations to incorporate energy savings measures. EO 13123 requires Federal agencies to audit approximately 10 percent of their facilities each year. Chapter 9 provides additional information on performance of energy audits.

An additional component of the energy management program is to set goals and performance metrics which track progress towards those goals. The energy manager should estimate the installation's reasonable potential for energy savings and set goals consistent with that potential. Performance goals drive energy management activities and promote continuous improvement. Setting clear and measurable goals is critical for understanding intended results, developing effective strategies, and reaping financial gains. DoD's philosophy is to give the Defense Components the flexibility to manage their own energy programs to meet the goals of the Energy Policy Act of 2005 (EPAct) and Executive Order 13123.

Chapters 8 through 14 address such issues as identifying energy saving opportunities in both new and existing construction. The installation's energy manager needs to work with others to select the best conservation projects, since the application of conservation technologies and their payback and savings-to-investment ratio (SIR) can vary widely. Numerous conservation opportunities exist at DoD installations. To achieve the best energy and cost savings, those opportunities need to be ranked by appropriate life-cycle cost statistics. Poorly conceived projects often generate poor returns on investment and prevent DoD from properly applying limited funding to achieve maximum results.

1.3.3. Obtain Top Management Support

While some improved efficiency can be obtained at little or no cost, fully successful conservation programs need top management support. There are ways to obtain those needed resources, but to do so, energy managers must convince top management of the cost savings and benefits that can be realized through energy conservation. Taking full advantage of conservation opportunities requires that management place a priority on conservation projects and staffing. Convincing management to readjust resource priorities usually requires a well-planned program and effective salesmanship.

Most energy saving applications have high front end costs, however typically save money over the long run. DoD facilities should continue to use life-cycle cost analysis (Reference Chapter 15) in making decisions about investment in projects to reduce energy and water consumption. All projects within a 10 year or less simple payback and that fit within financial constraints shall be implemented.

1.3.4. Solicit Other Technical Support

Since the energy manager alone cannot do all of the work required in achieving conservation goals, he or she must learn to solicit support from other people where possible. Institution of an installation Energy Management Team (EMT) to share that workload would be ideal since only a few installations can afford to assign a dedicated, full-time energy manager. There are many conservation experts already available within existing base organizations. Spreading conservation work among various organizations mainstreams the conservation program and makes those organizations more energy and water conscious.

Unfortunately the possibility of a facility having the available manpower for pulling together a team for an energy management program is unlikely. The facility energy manager usually has sole responsibility to administer awareness campaigns and implement energy conservation measures. This includes the duty to track maintenance and repair work requests. Each energy manager should strive to add language to the base instruction and/or “facility manager” designation letters that add energy conservation responsibilities.

Another alternative to consider is obtaining the services of a Resource Efficiency Manager (REM) to assist the energy manager in meeting the facility’s energy conservation goals. A REM is a contractor that works on site at a federal facility and with existing installation staff to reduce energy, water, and fuel costs through improved practices, equipment modifications, and consumer awareness. The DOE Federal Energy Management Program (FEMP) sponsors the REM program. A premise of the program is that savings cover the REM's salary. Refer to Chapter 3 for additional information on the REM program and associated resources.

1.3.5. Provide Energy Awareness and Training

Awareness and training programs are important for DoD to achieve and sustain energy-efficient operations at the installation level. The purpose of an energy awareness program is to publicize energy conservation goals, disseminate information on energy matters and energy conservation techniques, and emphasize energy conservation at all command levels. Awareness is the essential foundation for an installation's energy program.

Awareness works through publicity and training. There is no substitute for a well-trained, competent, and dedicated installation energy manager and a network of aware, conscientious facility managers. Professional development of DoD energy managers is an important part of each installation's energy program. DoD personnel shall be trained through either commercially available or in-house generated technical courses, seminars, conferences, software, videos, and certifications.

Each DoD energy manager is strongly encouraged to attend the annual energy workshop sponsored by the Department of Energy and co-sponsored by the Department of Defense and General Services Administration. This workshop brings all Federal energy managers together, along with representatives of the commercial sector, for quality training and networking opportunities, and will satisfy the Congressionally-mandated requirement for annual training. For additional information regarding this workshop, visit the following OSD web site: http://www.acq.osd.mil/ie/irm/Energy/Energy.htm Additionally, each DoD energy manager is encouraged to pursue professional accreditation as a certified energy manager (CEM). Additional information can be found at the following web site: http://www.aeecenter.org

DoD energy managers should develop and implement a comprehensive training program for all facility managers and building occupants on their installation to raise awareness and provide education on energy saving ideas, habits, and methods.

1.3.6. Reporting

The Defense Utility Engineering Reporting System (DUERS) is essential for management reporting of required energy reduction goals called for in EPAct and other Executive Orders and Federal legislation. It is the Department's energy data collection and reporting system that generates recurring reports which are provided to different levels within their organization on a recurring frequency. It forms the basis for calculating (and subsequently validating) each installation's energy and energy cost savings. DUERS reporting is required of all DoD Agencies.

1.3.7. Obtain Project Funding

There are many different funding sources available to support energy conservation projects. These include Operations and Maintenance (O&M) funds, Defense Working Capital Funds (DWCF), the Energy Conservation Investment Program (ECIP), Federal Energy Management Program (FEMP) funds, Energy Savings Performance Contracts (ESPC), and Utility Energy Services Contracts (UESC).

Energy conservation projects can be funded with O&M funds. This is the same account that pays for core military operational needs such as fuel and bullets. Installation commanders have authority and flexibility in deciding how these funds are to be spent.

ECIP is a special MILCON-funded program for energy conservation retrofit or replacement construction projects. In general it can fund energy conservation projects at any DoD owned facility where DoD pays energy bills. For additional guidance on the ECIP program, see the OSD web site: http://www.acq.osd.mil/ie/irm/Energy/Energy.htm.

ESPC are contracts using an Energy Savings Company (ESCO) that use private sector investment to provide the up front capital to install or repair energy saving systems.

UESCs and DSM programs are public utility sponsored programs that encourage energy-efficiency improvements by offering financial incentives (rebates), subsidies, or other support to their customers for installation of energy-efficient technologies. DoD installations can and should take advantage of these type programs if their local utility offers them.

Partnerships with the private sector through UESC and ESPC are a crucial tool for alternatively financing energy efficiency measures and allow installations to improve their infrastructure. Increasingly projects with higher SIR should be first pursued using UESC and ESPC before consideration with ECIP, since these projects are typically more attractive to the commercial sector. Reference Chapter 14 for additional detail on DSM programs and UESC and ESPCs.

1.4. Benefits of Energy Conservation

The Federal Government is the largest energy user in the United States, and DoD is by far the largest consumer of energy in the Federal Government, accounting for nearly 80% of total Federal energy use. DoD's size provides it with a unique opportunity to shape the national energy conservation strategy. By providing leadership in this worthwhile effort, DoD installations can inspire the entire nation to follow their example.

1.4.1. Improved Use of Resources

Conservation is really improved management. Conservation does not mean simply turning off the switch and doing without. Rather, it means using resources more efficiently to provide the same or even an improved level of benefits at lower cost. Conservation helps installations deal with resource limitations without reducing mission capabilities, productivity, or the quality of life for DoD personnel. Resource-saving upgrades to facilities help provide needed improvements to infrastructure. Conservation also improves energy security and reduces the need for imported energy sources.

1.4.2. Cost Savings

The primary tangible benefit of energy conservation is the dollar savings resulting from improved operating efficiency. That savings accrues to the benefit of every American taxpayer. Congress has provided a model for a financial incentive to DoD for conserving facility resources used to run its installations by allowing the Services and Defense Agencies to retain all of their energy cost savings each year [see 10 United States Code (USC) 2865]. The Services must apply half of those retained energy savings to additional resource-saving projects or programs. The other retained half may be used for installation "quality-of-life" projects. With this quality-of-life money, which can be spent in the year following the savings, an installation can fund improvements to military housing; expand Morale, Welfare, and Recreation (MWR) facilities and services; and complete minor construction projects to improve the local quality of life. While this retention of savings model exists in principle, implementation of the model has not been very successful. In many cases, the resource savings may not be available as designed. Energy managers should contact their Major Commands (MAJCOMs) or Major Claimants for Service-specific information on energy costs savings retention.

1.4.3. Environmental Benefits

Energy efficiency directly benefits the environment, helping DoD installations meet their environmental goals. Reducing energy use reduces the amount of air pollutants resulting from the direct burning of fossil fuels and indirect burning when generating electricity. Less electricity consumption means less air pollution; a 10% reduction in US electricity use would cut annual carbon dioxide emissions by over 200 million tons, sulfur dioxide emissions by 1.7 million tons, and nitrogen oxide emissions by 900 thousand tons. Use of less fuel to produce steam on DoD installations means less worry about the cost of meeting legally permitted emissions levels.

2. DoD Energy Programs, Policies, and Goals

2.1. Key Points

- The Principal Deputy Under Secretary of Defense (Acquisition, Technology and Logistics) is the DoD Senior Agency Official responsible for meeting the goals of Executive Order 13123.

- The DoD Installations Capabilities Council (ICC), chaired by the Deputy Under Secretary of Defense (Installations & Environment) (DUSD (I&E)), is chartered to address a broad spectrum of installation issues, including energy management, and to identify and remove obstacles through improved policy and guidance.

- The Office of the Secretary of Defense (OSD) Energy Manager conducts a bi-weekly energy conference call to disseminate information and facilitate communication between the DoD Components. Service and Agency energy managers at the headquarters level are encouraged to pariticipate.

- There are several inter-agency working groups including the Inter-agency Energy Management Task Force, the Federal ESPC Steering Group, the Energy Efficient Products Working Group, the Renewable Working Group, and the Inter-agency Sustainable Design Working Group, all of which OSD and the Services attend regularly to coordinate energy issues and concerns on a Federal level.

- DoD's major energy efficiency goals are to reduce the energy consumption per gross square foot (1) in its standard buildings, (excluding facilities covered in section 203 of the order) by 30% (measured in BTUs per gross square foot) by 2005, and 35% by 2010 relative to 1985; and (2) in its industrial and laboratory facilities by 20% by 2005 and 25% by 2010 relative to the 1990 baseline.

2.2. Office of the Secretary of Defense (OSD)

The DUSD (AT&L) in OSD, is the highest energy policy-making authority within DoD. The USD (AT&L) has delegated authority for managing the installation energy program to the DUSD (I&E).

The DUSD (I&E) is to ascertain policies and provide guidance to the DoD Components for the management of facility energy resources in the DoD and serve as the primary adviser for facility energy policy matters. The DUSD (I&E) establishes Departmental energy conservation program goals and develops procedures to measure Components' energy conservation accomplishments; provides annual programming guidance and oversight for the achievement of energy goals and objectives; establishes criteria, program and budget for, and monitors the execution of the Military Construction – Energy Conservation Investment Program (ECIP). The DUSD (I&E) also develops policy guidance, consistent with current legislation and executive orders, to report energy use and results of energy conservation accomplishments against Federal energy conservation and management goals.

The DoD Installations Capabilities Council (ICC), chaired by the Deputy Under Secretary of Defense (I&E), is chartered to address a broad spectrum of installation issues including energy management. Membership includes a cross section of DoD senior leadership necessary to make decisions needed to remove obstacles hindering compliance with the energy program. Additionally Integrated Product Teams (IPT) are created as required to work specific issues with appropriate participation from the Defense Components.

An Interagency Energy Management Task Force (IEMTF) provides technical support to Federal agencies in efforts to meet the goals of EO 13123. The Director, Installations, Requirements and Management, ODUSD (I&E) (IRM), represents the Department of Defense on the IEMTF.

Interagency working groups with representatives from the Department, also support the Interagency Energy Management Task Force (IEMTF) and the IPB as necessary. These groups include but are not limited to renewable energy, sustainable design, and energy efficient products.

The Utilities Privatization Working Group and Energy Working group provide programmatic logistical and technical support to the utilities privatization effort. Its membership includes representatives from the OSD, the four Services, DLA/DESC and the other Defense Agencies.

2.3. Overview of DoD Energy Policies

DoD's policy is to ensure that DoD utility infrastructure is secure, safe, reliable, and efficient; that utility commodities are procured effectively and efficiently; and that DoD Components maximize energy and water conservation efforts. Despite successful energy reductions already experienced, the Department must make greater strides in energy efficiency and consumption reduction in order to meet the goals of providing reliable and cost effective utility services to the Warfighter. DoD will invest in cost-effective renewable energy sources, energy efficient construction designs, and aggregating bargaining power among regions and Services to get better energy deals.

Specific energy program implementation policies and goals are provided in DoD Directives (DoDDs), DoD Instructions (DoDIs), memoranda. A better understanding of these DoD policies allows energy managers to define their management responsibilities and the importance of energy conservation tasks.

The OSD Installation Energy Instruction, DoD Instruction 4170.11 dated October 13, 2004 is posted at the OSD energy web site: http://www.acq.osd.mil/ie/irm/Energy/Energy.htm.

The DoDDs and DoDIs mandate full compliance from subordinate organizations and provide the authority to issue additional detailed guidance using memoranda. All DoD policies are issued to DoD agencies and Military Services' headquarters; in turn, these subordinate DoD Components develop their own policies and regulations based on OSD policies.

In most cases, installation energy managers are not required to have detailed knowledge of DoD-level energy policies, since the Military Departments develop their own specific guidance and regulations that incorporate these policies. However, a few specific regulations apply directly to energy managers at all DoD installations.

2.4. DoD Energy Consumption Reduction Goals

The DoD's energy consumption goals, based on EO 13123, are:

- Reduce Energy and Water Consumption:
    - Reduce the energy consumption per gross square foot in its standard buildings, (excluding facilities covered in section 203 of the order by 30% (measured in BTUs per gross square foot) by 2005, and 35% by 2010 relative to 1985.
    - Reduce energy consumption in its industrial and laboratory facilities by 20% by 2005 and 25% by 2010 relative to 1990.
    - Incorporate Water Management Plans with Best Management Practices on 30% of facilities by 2006, 50% by 2008, and 80% by 2010.
- Reduce Greenhouse Gas Emissions: Reduce greenhouse gas emissions attributed to facility energy use by 30% by 2010 compared to such emission levels in 1990.
- Conduct Facility Audits: Conduct audits for energy efficiency on 10% of all facilities annually.
- Reduce Petroleum Use: Through life-cycle cost-effective measures, reduce the use of petroleum within its facilities.
- Reduce Source Energy: Reduce total energy use as measured at the source.
- Expand Renewable Energy: Expand the use of renewable energy at all installations and facilities.
- Privatize Utility Systems: Privatize per DEPSECDEF memo of 9 September, 2002.
- Maintain Utility Infrastructure: Maintain utility infrastructure at a readiness rating of C2 by 2010.

Since program goals may change more frequently than other aspects of policy, OSD will convey program goals through memoranda vice an instruction. The latest energy program goal memorandum is posted on the OSD energy web site at: http://www.acq.osd.mil/ie/irm/Energy/Energy.htm.

2.4.1. Strategy for Achieving DoD Energy Reduction Goals

It is DoD's philosophy to give their Components the flexibility of managing their own energy programs to meet goals. The primary objectives are to improve energy efficiency and eliminate waste while maintaining reliability utility service. The following strategies should be incorporated into the Component's policies and programs.

2.4.1.1. Implement energy awareness programs and awards.

Energy awareness programs publicize energy conservation goals, disseminate information on energy matters and energy conservation techniques and emphasize energy conservation at all command levels. Employees much gain an awareness of energy and water conservation through formal training and employee information programs. They should be invited to participate in the process of developing an energy or water conservation program, and to submit definitive suggestions for conservation of energy and water.

Energy awards are to be presented to individuals, organizations, and installations in recognition of their efforts toward energy-savings and water conservation. In addition to recognition, awards provide motivation for continued energy-reduction achievements.

Showcase facilities demonstrate promising best commercial practices and the use of innovative techniques to improve energy and water efficiency. The DoD shall emphasize the benefit of these facilities, with a target of each Service developing at least one showcase facility per year for the federally sponsored program.

2.4.1.2. Implement training programs.

Training programs are important for DoD to achieve and sustain energy-efficient operations at the installation level. An energy management program will operate much more effectively with proper and thorough training. Personnel will be able to prioritize energy conservation measures and are aware of the latest technologies.

DoD personnel shall be trained through either commercially available or in-house generated technical courses, seminars, conferences, software, videos, and certifications. Defense Components will publicize program tools and progress at different organizational levels through web sites, reports, handbooks, and guidance. Additionally DoD will actively participate in annual energy conferences.

2.4.1.3. Increase Life-Cycle Cost Effective Capital Investment

DoD facilities shall continue to utilize life-cycle cost analysis in making decisions about their investment in products, services, construction, and other projects to lower the Federal Government's costs and to reduce energy and water consumption. All projects with 10 year or less simple payback that fit within financial constraints shall be implemented. The DoD Components shall consider the life-cycle-costs of combining projects, and encourage aggregating of energy efficiency projects with renewable energy projects, where active solar technologies are appropriate. The use of passive solar design shall be required when cost-effective over the life of the project. Sustainable development projects shall continue to use life-cycle costing methodology and should follow the Whole Building Design Guide.

2.4.1.4. Facility Energy Audits

Energy audits as well as commissioning and re-commissioning of HVAC systems evaluate current energy usage and assist installations in determining the best locations to incorporate energy savings measures. EO 13123 requires Federal agencies to audit approximately 10 percent of their facilities each year. Since auditing 10 percent of DoD facilities each year has been cost prohibitive in the past, Components are encouraged to use either appropriated funding or alternative financing through Utility Energy Service Contracts (UESC) and Energy Savings Performance Contracts (ESPC) projects to conduct their energy audits. In addition to facility audits, software such as Renewable and Energy Efficiency Planning and the Federal Energy Decision Screening system are utilized to assist this process by determining the investment required to meet energy reduction goals.

2.4.1.5. Financing Mechanisms

- The DoD Components shall insure that the energy efficiency measures are incorporated into repair and minor construction projects using available O&M funding.
- ECIP is an OSD-centrally managed, project-oriented, Defense-wide MILCON account which is programmed annually and represents the only direct DoD investment in conservation. Funds shall be allocated on a fair share based on the DoD Component's previous year reported facility energy use and factoring in the obligation rate for the previous 5 years. The DoD Components shall strive to obligate 100 percent of the ECIP funds provided by the end of third quarter in which the funds were issued. Each Component may program at least 10% of their target annual

amount against renewable energy projects that do not meet the specified Savings to Investment Ratio (SIR) of 1.25 and payback of 10 years or less.

- Partnerships with the private sector through UESC and ESPC are a crucial tool for financing energy efficiency measures and allow installations to improve their infrastructure and pay for the energy efficiency measures through the savings generated by the project over time. These contracts will include infrastructure upgrades and new equipment to help the installations reduce energy and water consumption. Projects may include new thermal storage systems, chillers, boilers, lights, motors, Energy Management Control Systems (EMCS) systems and water reducing devices and other energy saving devices and measures.

2.4.1.6. Procure Life Cycle Cost Effective, Energy Efficient Goods and Products

When life-cycle cost-effective, the Defense Components are encouraged to select ENERGY STAR and other energy-efficient products when acquiring energy-consuming products. Guidance generated by DOE, GSA and DLA for energy–efficient products are being incorporated into the sustainable design and development of new and renovated facilities. Defense components will invest in energy-efficient technologies, such as high efficiency lighting and ballasts, energy-efficient motors, and use of packaged heating and cooling equipment with energy efficiency ratios (EER) that meet or exceed Federal criteria for retrofitting existing buildings. Information technology hardware, computers and copying equipment will be acquired under the ENERGY STAR® Program using GSA Schedules, Government-wide contracts, or Service Contracts.

2.4.1.7. ENERGY STAR® Buildings

The DoD Components shall encourage participation in this program, developed by the U.S. Environmental Protection Agency, which promotes energy efficiency in buildings and requires measured building data and a comparison with archetypes in various regions of the country. ENERGY STAR® Building criteria are based on a five-stage implementation strategy consisting of lighting upgrades, building tune-up, load reductions, fan system upgrades, and heating and cooling system upgrades.

2.4.1.8. Use Alternative, Renewable, and Clean Energy

DoD Components will use alternative, renewable, and clean energy sources wherever such use is cost-effective over the life of the facility. All DoD Components are encouraged to participate in the DOE demonstration programs when participation is cost-effective and compatible with the installation mission. Passive solar designs, such as building orientation and window placement and sizing shall be implemented in a variety of building types and new facility construction.

2.4.1.9. Invest in Sustainable Building Design

Sustainability initiatives require an integrated design approach to the life-cycle of buildings and infrastructure. The concepts of sustainable development as applied to DoD installations will continue to be incorporated into the master planning process of each of the Services. All new facility construction and major renovations will use ASHRAE standard 90.1-2001 for design criteria and follow best value sustainable development principles. The Whole Building Design Guide provides sustainable design criteria and can be accessed at: http://www.wbdg.org/.

2.4.1.10. Electrical Load Reduction Measures

The DoD Components shall continue to identify load shedding techniques to cut electricity consumption in buildings and facilities during power emergencies. Examples of these techniques include: EMCS, sub-metering, cogeneration, thermal storage systems, duty cycling of air conditioning in military family housing by EMCS, alternative energy sources for air-conditioning, and turning off unneeded lights with timers, motion sensors and separate lighting circuits. In addition, the Department continues to focus its energy conservation program on measures that reduce electric consumption.

2.4.1.11. Water Conservation Measures

EO 13123 requires water efficiency improvement goals for Federal agencies, suggesting specific strategies that include development of a water management plan and adoption of at least four of the Federal Energy Management Program Water Efficiency Improvement Best Management Practices (BMP). The BMPs range from system-related (boiler/steam, cooling tower, faucets and showerheads, etc.) to public information and education programs. Installations will incorporate water management plans in their existing operation and maintenance plans and will focus on dissemination of information to all levels to educate personnel on water conservation practices.

2.4.1.12. Modernize Infrastructure

For utility systems that are not privatized, under current Defense Planning Guidance, the DoD Components are directed to achieve a 67-year recapitalization and sustainment rate in which the readiness of existing facilities is restored to a C-2 status, on average, by the end of FY 2008. The Military Services shall program sufficient funds to accomplish this goal.

Historically, military installations have been unable to maintain reliable utility systems due to inadequate funding and competing installation management priorities. Utilities privatization is the preferred method for modernizing and recapitalizing DoD utility systems. By allowing military installations to focus on core defense missions and functions instead of the responsibilities of utility ownership, this program shall transform how installations obtain utility services. By becoming smart buyers of utility services activities shall benefit from innovative industry practices, the reliability of systems kept at current industry standards and private sector financing and efficiencies.

Following the Deputy Secretary of Defense guidance issued on October 9 2002, DEPSECDEF Memorandum "Revised Guidance for the Utilities Privatization Program," the DoD Components shall complete privatization decisions on all electric, water, wastewater and natural gas systems by September 30, 2005. Except where the Secretary of the Military Department has certified that the systems are exempt due to security reasons or privatization is uneconomical, the Military Services shall privatize those types of utility systems at every Active and Reserve Component installation, within the United States and overseas, that is not designated for closure under a base closure law. Since upgrades are normally completed within 5 years after a privatization award is made, all privatized systems should reach a readiness level of at least C-2 prior to 2010. Services must program sufficient funds to support privatization contracts.

Part II Starting an Energy Management Program

3. DoD Installation Energy Management Team

3.1. Key Points

- Energy managers should recruit assistance for energy and water conservation tasks from other people. Organizing an installation Energy Management Team (EMT) is the first step in sharing workload.

- Before starting to actively recruit members for the EMT, the energy manager should study the responsibilities of base organizations and determine which organizations can be helpful to energy conservation.

- Energy managers need to establish informal lines of communication with key staff members whose assistance is critical in implementing energy conservation projects.

- When resources are not available to establish an EMT, the services of a Resource Efficiency Manager provides an option that should be considered.

3.2. Team Concept

Since the energy manager alone cannot do all of the work required in achieving conservation goals, he or she must learn to solicit support from other people. Organizing an installation EMT is the first step in sharing that workload. Knowing how best to use the team is very important since only a few installations can afford to assign a dedicated, full-time energy manager. Also, there are many conservation experts already available within existing base organizations. Spreading conservation work among various organizations mainstreams the conservation program and makes those organizations more energy and water conscious. Energy managers must learn how to orchestrate a successful energy conservation program using this team concept.

3.3. Installation Energy Manager

Selection of an energy manager is the first and most important step in building an installation EMT. Behind any successful conservation program there is usually one dynamic individual who takes the initiative to accomplish whatever is necessary with a "can do" attitude. Installation commanders have neither the time nor the knowledge to manage or oversee day-to-day activities. Installation energy managers must constantly keep track of the progress of all conservation activities and periodically inform the EMT. Under the installation commander's leadership, the energy manager develops a strategy for achieving energy reduction goals, assigns tasks to various organizations, and monitors goals and task progress. Table 3-1 lists some of the common tasks that are a part of the energy manager's job.

Energy management tasks are frequently assigned as additional duties to a junior engineer. Energy managers usually do not have staff of their own; therefore, they must rely on staff from various base organizations to perform specific conservation tasks. Because of resource constraints and limited authority, energy managers must gain strong support from installation commanders. Without their support, it is almost impossible to implement a successful installation-wide resource management program, because this requires broad participation from all organizations.

The installation energy manager’s job is to assist commanding officers and the sub organizations of the particular installation on all matters concerning energy conservation and awareness, fuel management, and the use of alternative energy sources. The energy manager must understand the required duties, organize an energy program, and determine what resources are available. The energy manager should be familiar with and understand the conservation measures applicable to all energy-using equipment, devices, buildings, or vehicles assigned to his or her installation so energy usage is improved. The energy manager will be responsible for evaluating energy conservation requirements, summarizing all energy-related statistical data for progress reporting and planning purposes, and initiating energy-awareness programs. The energy manager should also take the initiative to educate all members of the installation on energy-related issues and initiate actions to conserve energy in every possible way.

Table 3-1. Common Tasks for DoD Energy Managers

Category/Task
Planning and Organization: • Prepare a Facility Energy Plan. • Review and monitor energy-use trends and patterns. • Track progress toward meeting DoD energy goals. • Monitor monthly utility bills. • Identify and monitor high energy-use facilities. • Organize an installation Energy Management Team. • Prepare an energy contingency plan.
Budgeting and Project Programming: • Assist in preparing an installation energy budget. • Request funds for energy projects. • Calculate avoided energy costs.

- Keep track of energy projects funding status.

Program Management:

- Establish a peak load-shedding program.
- Establish and promote an energy awareness program.
- Manage an energy audit program.
- Monitor ECIP, Family Housing, and O&M energy projects.
- Monitor preventive maintenance programs.
- Initiate a base metering program.
- Participate in DSM programs.
- Procure energy-efficient supplies and equipment replacements.
- Implement ESPC and UESC.

Administrative:

- Prepare DUERS reports.
- Establish and communicate base energy policies.
- Serve as the Energy Management Team secretary.
- Prepare an annual point paper for facility energy program.
- Prepare an energy award program.
- Participate in utilities contract negotiations.
- Review and evaluate energy suggestions.

Because energy managers play a key role in the success of resource management for an installation, they must be familiar with the procurement, storage, distribution, and end use of all fuels, other forms of energy, and water. They should also maintain complete files of applicable energy policies, regulations, and instructions that might further the effective use of all forms of energy and water. The energy manager should be familiar with all current DoD and Service-specific directives relating to energy and water resource management. Formal planning is the means by which conservation efforts may be implemented, changed, and evaluated in an orderly and timely manner. Accordingly, the energy manager should maintain a formal long- and short-range conservation plan that includes performance-oriented goals for the command. These plans should specify reduction goals for both overall and elemental energy and water consumption. Once these goals are achieved, new and more demanding ones that are reasonably attainable should be established.

3.4. Installation Commander

The installation commander sets the tone for energy and water conservation. Although the energy manager is responsible for coordinating and orchestrating conservation efforts, the commander must make the sometimes difficult decisions to implement projects that will save energy and water. With the commander's approval, the resources of base organizations can be tapped. An installation commander's strong support for conservation efforts will make a big difference in setting budget priorities. Higher priority for conservation (over other mission needs) will ensure greater funding, more personnel, and more of the commander's personal attention.

The senior commander at the base should be informed and briefed about the resources management program. To gain support from installation commanders, energy managers must convince commanders of the benefits of conservation.

3.5. Installation Energy Management Team/Steering Group/Board

3.5.1. Function

Each installation has a clear chain-of-command structure that defines the authorities, spans of control, and responsibilities. Under that management structure, energy managers are at least four management levels from installation commanders. Having many layers of intermediate supervision does not help in keeping conservation issues visible to installation commanders. Conservation issues can often be deferred from being discussed at the command leadership level by intermediate supervisors.

Understanding an installation's organizational structure is important in communicating conservation program goals to the EMT because the energy manager must draw personnel from various organizations to support installation-wide energy programs. Members of the EMT should be senior representatives from various organizations that have different mission requirements; their differences will be reflected in their varying energy consumption patterns. Although they may not have technical knowledge about energy or water conservation, they can be instrumental in implementing a program for their own organization, and they serve as valuable points of contact for energy managers.

The function of the EMT should be an advisory one rather than a corporate decision-making one. The EMT is a good forum in which to propose and evaluate ideas. It acts as a kind of “sounding board" before decisions are made. Attempts to use the EMT as a decision-making body create an unnecessary administrative burden that will slow down energy conservation efforts. All major policy and budget decisions should be made by installation commanders or their designated deputies. Minor operational decisions should be made by installation energy managers. Through EMT channels, energy managers can have direct access to installation commanders to help manage conservation efforts.

3.5.2. Team Members

Energy managers must play a key role in organizing the installation Energy Management Team (EMT) and selecting its members. The effectiveness of the team will depend heavily on the talents and commitment of each representative. The energy manager must ensure that the EMT has capable representatives from those organizations that are critical to implementing installation conservation programs. The EMT should, at a minimum, consist of the following organizations:

- Chairperson: Installation Commander or a designated representative
- Secretary: Installation Energy Manager
- Core Members: Base Civil Engineer/Public Works Officer, Comptroller, Contracting Officer, Legal Counsel, Supply Officer, Utilities Manager, Transportation Officer, Director of Operations (or designee), Public Affairs Officer, and Fuel Management Officer or their representatives
- Optional Members: Representatives of the Security Police, Housing Officer, big energy-user organizations, and managers of the Base Exchange (BX), commissary, and clubs.

3.5.3. Meeting Agenda

The frequency of EMT meetings should be determined by the energy manager, with the approval of the chairperson, based on the activity's level of importance of energy and water issues. Most installations hold quarterly meetings. The meeting agenda should be designed to inform the installation commander of the status of conservation efforts and the progress being made toward established goals. The following issues should be included on the agenda:

a. Total energy costs and BTU consumption
b. Progress toward achieving energy goals
c. Reasons for not meeting established goals, if any
d. Status of major ongoing energy-related projects
e. Status of utilities funds and expected energy cost savings
f. New proposed energy projects
g. Recognition of key players and organizations for a job well done.

Meetings should last no longer than 2 hours. Make an effort to avoid any major discussions or problem solving during the meeting. If a problem arises, make note of the action items and assign appropriate individuals responsibility to address the problem and report back at the next meeting. If necessary, schedule follow-up meetings to address specific problems or issues.

3.6. Informal Working Relationships with Key Individuals

Besides having to involve various organizations by assigning energy and water conservation-related tasks during EMT meetings, managers need to establish informal lines of communication with key staff members whose assistance is critical in implementing conservation projects. It is important that these key staff members be responsive and able to give credible answers. These staff members are building managers from large facilities, utilities managers, plant supervisors, shop element leaders, contracting officers, design engineers, supply officers, project programmers, budget managers, major command energy conservation officers, utilities company representatives, and others. The roles of key individuals involved in implementing conservation projects are described below.

3.6.1. Building Managers

Building managers are normally responsible for calling the Civil Engineering (CE) Customer Service Office/Public Works (PW) Service Desk when their buildings are too hot or too cold. They also coordinate the CE/PW projects to be done at their buildings and serve as liaisons between the CE/PW maintenance group and building occupants. Building managers can describe how buildings are used and explain energy-use patterns. It is important that major energy users appoint a competent building manager who can actually help in the efforts to reduce energy consumption.

Although building managers may not be well-versed in energy technologies, they must understand the energy consumption patterns of their organization. Senior noncommissioned officers and junior officers are good candidates for this additional duty. Any appropriate technical education or training background would be very helpful to those selected.

Building managers' responsibilities are to provide energy auditing assistance, manage the energy awareness programs for their buildings, keep track of a preventive maintenance schedule, coordinate load-shedding activities, and provide user feedback on energy conservation projects. They can serve as the eyes and ears for the energy manager.

3.6.2. Utilities Managers

In some installations, the utilities manager is the energy manager. Since utilities managers are responsible for managing utilities contracts including contracts for utility-sponsored DSM programs and energy conservation services programs and for the operation and maintenance of energy systems, promoting energy conservation is normally assigned to them as an additional duty. If these functions are not performed by the same person, it is important to have a utilities manager closely involved in energy conservation efforts.

3.6.3. Design Engineers

The Engineering Branch (Air Force, Engineering Flight) has the capability to assist in energy management efforts. This office can help in conducting energy audits and developing engineering solutions to improve energy efficiency. However, the office is often understaffed and may have insufficient time to devote to energy conservation efforts. Be persistent in seeking their help. In order to keep design engineers informed about energy matters, energy managers should ensure that DoD and service energy publications and newsletters are distributed to them. Although most design engineers have little experience in energy management, they are responsible for managing major design modifications of energy systems and the construction of new facilities. Energy efficiency measures should be incorporated into the design process. For new construction, the minimum energy design standards outlined in 10 CFR, Part 435 must be addressed.

3.6.4. Environmental Office

Energy and environmental initiatives have many common goals, problems, and solutions. Therefore, frequent communication and collaboration on major projects is important. Also, many energy upgrades may generate waste that must be properly handled, e.g., lamps and ballasts. Establish a close working relationship with appropriate contacts in the environmental office. See Chapter 7 for a more detailed discussion of energy and environmental issues.

3.6.5. Shop or Zone Element Leaders

Most low-cost/no-cost projects are accomplished by in-house personnel. Shop and zone element leaders are responsible for the completion of work. For example, Facility Maintenance or Infrastructure Support Elements are responsible for maintaining control devices for HVAC systems. Constant calibration of those devices is required to maintain peak energy efficiency. The element leaders have a wealth of hands-on experience and an excellent working knowledge of the technologies that work well. By establishing a good working relationship with these element leaders, the energy manager can tap into a knowledge base. Also, the element leaders can be made responsible for the implementation of preventive maintenance programs under the direction of a maintenance engineer.

3.6.6. Plant Supervisors

Plant supervisors are responsible for the day-to-day operation of major energy systems such as central heating and chiller plants. Plant supervisors often have many good ideas about how to make plant operations more efficient, but usually they do not know how to implement those ideas. The energy manager should visit those plants frequently to understand how they operate. In the case of establishing dual-fuel source capabilities, the possible operational modifications required to implement a fuel-switching option should be discussed with plant supervisors.

3.6.7. Project Programmer

For engineering projects exceeding a certain cost threshold, detailed project documentation is required. For example, to qualify for ECIP or FEMP funding, project documentation must meet the program protocol. The project programmer is normally the resident expert on how to prepare project documentation. Project programmers can also help develop a good strategy for obtaining funds for energy projects since they know the sources of funds that are available to finance various types of energy conservation projects.

3.6.8. Budget Officer

A budget officer's support is critical in establishing a separate account for retaining energy conservation funds. The budget officer is responsible for keeping track of the allocated energy budget and actual utilities expenses.

3.6.9. Contracting Officer

Since energy and water management-related needs are satisfied through contracting, obtaining the contracting officer's cooperation is very important. Once a contract is awarded, the contracting officer becomes the official Government representative for providing contract oversight. Energy managers must work through the contracting officer to affect the contractor's work performance. This working arrangement can be a very frustrating process for an energy manager if the contracting officer is not well-versed in conservation issues and if the contractor is not performing as expected. Spend time with the contracting officer to explain conservation requirements and to cultivate a good working relationship.

3.6.10. Legal Counsel

Many energy and water projects, especially those involving long-term contracts require careful structuring to avoid future legal problems. Legal counsel should review all contracts and be involved in development of ESPC, UESC, negotiation of DSM programs, and utility rate negotiation or litigation related to any energy issues. The contracting officer should interface with legal counsel on most issues.

3.6.11. Supply Officer

The base supply office provides many of the supplies and equipment needed to implement energy conservation efforts. Having an ally in the supply organization is invaluable.

3.6.12. Utilities Company Representatives

As a part of DSM efforts, some public utility companies may offer cash rebates or other incentives for implementing conservation projects such as lighting retrofits and motor replacements. To increase user participation in these rebate programs, utilities companies may offer free energy audits. As utility companies prepare for deregulation and resulting competition, stranded costs and other important issues are causing a reduction in rebates but an increase in interest in developing flexible assistance designed to foster a long-term customer relationship. A DoD energy manager should talk frequently with key utility company representatives and seek their help in accomplishing energy goals.

3.7. Additional Help From Other Organizations

Although installation energy managers are the principle architects of conservation programs, additional assistance and expertise are available from many other sources. The challenge is to identify those organizations that can best meet the needs of energy management programs. The sections below describe several that are most frequently used by DoD installations.

3.7.1. Major Command Staff

The major command staff should be a first stop in seeking additional help. One key responsibility for the major command staff is to provide assistance to installations. Major command counterparts should be contacted for assistance. Normally, major commands have more resources available to them and are in a better position to solve energy and water conservation problems that cannot be resolved at the installation level.

Some major commands have staff assistance teams that can provide technical help by pooling available resources from other installations or from within their headquarters staff. Temporary personnel can assist with and do whatever is necessary to meet the installation's energy and water reduction goals. If the major command does not have such a program, the energy manager may request that one be formed.

3.7.2. Technical Service Centers

3.7.2.1. Army

The Army Installation Management Agency (IMA) is responsible for executing the Army Energy and Water Management Program and provides technical assistance to installations for all aspects of the energy program. IMA has designated the Army Engineering Support Center Huntsville as the center for expertise for energy savings performance contracting (ESPC) and utilities energy services contracting (UESC). Additionally, the Engineer Research Development Center - Construction Engineering Research Laboratory (ERDC-CERL) provides assistance in the technology transfer and Research and Development (R&D) areas.

3.7.2.2. Navy

The Navy and Marine Corps technical centers of expertise are the Naval Facilities Engineering Command (NAVFAC) and the Naval Facilities Engineering Service Center (NFESC). These Service centers often require funding from the energy manager's installation budget. They also often contract the work to private architectural-engineering (A-E) firms that manage the contracts on behalf of the installation.

3.7.2.3. Air Force

The Air Force has two service centers that have expertise in providing technical support. The Air Force Civil Engineer Support Agency (AFCESA) is the primary technical expert on energy-related issues for the Air Force. The Air Force Center for Environmental Excellence (AFCEE) fills a supporting role when energy issues involve environmental concerns.

3.7.3. Other Federal and State Agencies

The expertise of other Federal and State agencies is available to assist energy and water conservation programs through the establishment of a Memorandum of Understanding (MOU) between the external agency and DoD installations. Many land-grants, State-supported universities have excellent extension technical services. DoD installations can obtain those university services without much administrative work and expense. The DOE Federal Energy

Management Program (FEMP) offers a variety of energy-related assistance. They can be reached at 1-800-DOE-EERE or via the Internet at http://www.eere.energy.gov. Some State energy offices can also provide help. See the Environmental Protection Agency's web page for links to State energy office contacts.

3.7.4. Professional Organizations

There are many nonprofit associations and institutions that promote energy and water efficiency and conservation. Contact information for many of those organizations is provided in Appendix C. Some of those organizations provide training and educational assistance on a fee-supported basis. They can also be a good place to exchange ideas about which energy conservation efforts work and which do not, the names of good contractors to use and the ones to avoid, so forth.

3.7.5. Architectural-Engineering and Energy Consulting Firms

Many A-E and energy consulting firms provide technical and managerial services related to various energy management and efficiency subjects. Those A-E and energy services must be procured through a competitive contract bidding process. There are also small businesses and individual consultants who specialize in energy management. Their credentials and references should be reviewed and evaluated before contracting with them.

3.8. Resource Efficiency Manager

Although an EMT provides an optimum solution to addressing energy conservation efforts at a facility, often only limited resources are available for sustaining an energy management program. Obtaining the services of a Resource Efficiency Manager (REM) provides one alternative to assisting the energy manager meet the installations energy conservation goals and objectives.

A REM is a contractor, rather than a federal employee, that works on site at federal facilities and champions your organization's commitment to saving energy, reducing environmental impact, and improving energy security. The REM works with the existing installation staff and has a working knowledge of day to day operations and maintenance practices, and focuses on practical, cost-effective, and sustainable energy conservation measures. A premise of the program is that savings realized will cover the REM's alary.

Past research has shown that a facility can expect to save 10% of what it normally spends on energy within a year of hiring a full time REM. It is not uncommon to save even 20% or more upon hiring a REM. However in order for a REM to succeed, it is necessary to have a consensus within the organization to make energy savings a priority.

REMs spend 100% of their time on energy issues and are motivated by the fact that their jobs are performance based. Continued employment depends on finding enough savings to cover their salary. One obstacle to hiring a REM may be in obtaining the upfront funds needed to sustain the position until savings can be realized. The guidebook referenced below also provides funding strategies. Additional resources, including case studies and fact sheets, to assist in convincing decision makers to hire a REM can be found online at: http://www.energy.wsu.edu/projects/rem/rem.cfm.

The U.S. Department of Energy Federal Energy Management Program (FEMP) sponsors the REM program. The program is administered by FEMP headquarters, its Western Regional Office, and the Pacific Northwest National Laboratory (PNNL). Washington State University Extension Energy Program further provides support necessary to maintain and expand the REM network. Case studies documenting programs that have been implemented successfully can be accessed at Washington State University's site at http://www.energy.wsu.edu/projects/rem/cases.cfm.

DOE publishes "Contracting for a Resource Efficiency Manager A Federal Energy Management Program, Operations & Maintenance Center of Excellence Guidebook," DOE/EE-0299 July 2004 which walks one through the process of making the decision to hire an REM, drafting the contract, and later assessing the REM's performance. The guidebook is available from the link http://www.energy.wsu.edu/projects/rem/guidebook.cfm.

4. Energy Conservation Program Planning

4.1. Key Points

- One way to start planning an energy program is to set goals and estimate the installation's reasonable potential for energy savings and set goals consistent with that potential.
- Almost all energy and water efficiency measures can be classified into six basic categories: awareness, maintenance, retrofit, replacement, new construction and load shifting.
- Energy security is also a part of energy management.

4.2. Planning

One way to start planning an energy program is to estimate the installation's reasonable potential for savings and set goals consistent with that potential. An audit is usually necessary for estimating energy- and water-savings potential and identifying no- or low-cost measures (see Chapter 9). An awareness program (Chapter 5) is helpful to achieve these measures. However, the installation will almost always need to go beyond no-cost and low-cost measures to achieve aggressive energy reduction goals. Potential sources of funding for these more costly measures are discussed in Chapter 14.

4.2.1. Types of Energy and Water Conservation Measures

There are numerous ways to increase energy and water efficiency. Specific strategies for existing systems are discussed in detail in Chapter 11. Most conservation measures can be classified into the following six basic categories:

a. *Awareness* measures are low-cost or no-cost measures that result from user education.
b. *Maintenance* measures are low-cost ways to ensure peak performance from existing systems and continued high performance from new systems.
c. *Retrofit* provides technological improvements to existing buildings and equipment.
d. *Replacement* is the installation of high-efficiency equipment when existing equipment reaches the end of its useful life. In addition, inefficient equipment should be replaced before its scheduled replacement time if economical.
e. *New construction,* offers an unparalleled opportunity to not only

install the most cost-effective HVAC, lighting and energy control equipment but also to install appropriate insulation, high-efficiency windows, and incorporate energy-saving design considerations such as site placement, window positioning, and passive solar features, and water efficient equipment.

f. *Load shifting* of electrical loads away from peak demand periods saves money when the local utility imposes "demand charges" based not just on total kilowatt-hours (kWh) of energy used but also on the highest kilowatt (kW) demand, or rate of use, over a certain period.

Four essential ingredients are needed to carry out measures in any of the categories listed above:

1. Accurate information
2. Audits and analysis
3. Project funding
4. Proper implementation.

Energy managers, energy users, and maintenance staff members need information on the latest energy-saving technologies. Even with such information, audits and accurate analysis of potential measures are needed to determine the technologies that are feasible and cost effective. Funding is needed to purchase the necessary materials, equipment, and installation. An installation can provide internal financing from O&M funding or it can opt for external funding via the FEMP or ECIP programs, ESPC, or a utility DSM rebate or subsidy. See Chapter 14 for more information about funding projects. Once purchased, the equipment or materials need to be properly installed, used, and maintained.

4.3. Establishing Energy and Water Savings Targets

Legislation and Executive Orders outline required energy reduction goals. However, energy savings beyond those goals may be cost-effective. It is helpful to understand the potential savings that may be achieved in specific areas of energy and water use. An energy audit, followed by economic analysis of all possible measures, can identify the savings potential in any specific facility. It is also helpful to have a good estimate of the potential savings at a particular installation. For installation-specific estimates of energy/water savings targets, use software tools such as Federal Energy Decision Screening (FEDS) or Renewable and Energy Efficient Planning (REEP). See Chapter 16 for a discussion of these and other useful software tools.

It is important to establish reasonable conservation targets. For example, energy experts typically project a potential cost-effective savings of 30-50%

in most existing facilities. In some specific end-use areas, savings of 75% or more are possible. While this is generally true based on average circumstances, the potential at a particular installation or facility may be much less. Site-specific energy costs, existing equipment type, and operating characteristics must be considered to establish accurate targets.

4.4. Programming, Designing, and Constructing Conservation Projects

Project programming requires following established budget and project approval processes to obtain the necessary funds. Each funding source has its own project approval procedures.

4.4.1. Project Programming

Findings from resource audits and resource consumption analyses will identify many good conservation ideas. These ideas should be submitted by Work Request (WR) forms for implementation. A copy of the audit, including the estimated energy saved and energy cost savings and payback period, should be included with the WR. The energy manager may have to provide detailed project information to clarify the project's scope. Most preventive maintenance and low-cost/no-cost projects can be approved on the spot at the time of submittal. Moderate-cost and more expensive projects may require higher installation level approval. ECIP and other MILCON projects cannot be approved at the installation level. These projects must be forwarded to higher headquarters for review and coordination. Only Congress has approval authority for those projects.

4.4.2. Project Execution

It is very important to "sell" good conservation ideas to project approval authorities so they do not blindly disapprove WRs. Since energy managers have little control over the WR approval process, they may need to lobby for projects. If the WR is disapproved, it should be resubmitted after making the necessary corrections.

An approved WR does not guarantee automatic funding for the project. Once a WR is approved, funding must be obtained before work starts. Most projects are funded from O&M funds. Since the installation commander decides how O&M funds are spent, his or her support for energy conservation efforts will be helpful in obtaining O&M funds. There are other sources of funds, and funds may become available from higher headquarters for planned energy projects.

Once a project is approved and funded, the work must be designed and scheduled for completion by in-house staff or by contractors. For contracted work, proper contractual procedures must be followed before a contract can be awarded. Writing a precise Statement of Work (SOW) is very important to insure that contracting can select an experienced, qualified contractor. Talk to other energy managers who have recently implemented a similar project to get insight into special requirements for the SOW. Once construction is started energy managers should visit work sites to check on the progress. Hidden factors may be discovered that require a revision of the original project scope, such as changes in cost/benefit calculations. After work is completed, perform a follow-up audit to determine whether the project is actually saving energy. The lessons learned from the project can be applied to subsequent projects.

4.5. Managing to Achieve DoD Energy Goals

Planning for energy programs begins with establishing realistic installation energy conservation goals. Once those goals are established, selling them to the installation commander and gaining his or her support are the first critical steps in implementing a successful energy conservation program. Since the Deputy Secretary of Defense has already set the minimum energy reduction goals for DoD installations, installation commanders will be required, at minimum, to achieve the DoD goals.

To determine whether DoD goals are being met, energy managers should monitor consumption data as reported through DUERS and perform energy trend analyses to determine whether actual consumption is on track with DoD's goals. Studying consumption trends reveals if past conservation efforts have worked and provides a basis for forecasting future consumption.

Achieving DoD's goals is the first priority. If analysis shows that the energy program is not on track to meet DoD's goals, a remedial course of action must be designed to reduce consumption. The energy manager must determine the resources required to implement additional energy conservation projects and should advise the installation commander that the installation is behind schedule in achieving the goals established by DoD.

Since DoD's goals are the minimum acceptable goals, installations should eventually set more ambitious goals based on the actual, cost-effective potential.

4.6. Developing Conservation Projects

To achieve energy reduction goals, energy conservation projects and an energy awareness campaign are needed. Conducting an energy audit identifies energy conservation opportunities. Details for conducting an energy audit are discussed in Chapter 9.

Reviewing past monthly energy consumption data helps determine installation energy-use patterns. Analyses of consumption data should consider, at a minimum, the following:

- The electricity use and demand profile
- Coal, natural gas, and fuel-oil consumption
- Energy consumed from renewable sources, e.g., solar, wind, and geothermal
- Fuel consumption by major energy systems, e.g., heating plants and chiller plants
- Energy consumption by end-user groups, e.g., family housing, process energy, street lighting, and administrative buildings
- Environmental, system design, human factor, and operational parameters that influence energy consumption original design requirements and the efficiency of energy systems.

Understanding energy-use patterns is critical in designing effective energy conservation projects. The credibility of any analysis will be based on the accuracy of consumption measurements.

Some sub-metering will be necessary to obtain actual consumption data. If sub metered consumption data are not available, there are several ways to estimate consumption and gauge energy efficiency. One is to calculate broad installation-wide energy efficiency factors by dividing total energy consumption by such factors as building square footage, population, family housing units, total O&M expenditures, etc. Much of this information is already reported through the DUERS system (see Chapter 6.) For example, energy managers can calculate average electricity consumption per family housing unit and compare the unit average to industry standards or to other higher headquarters' established command standards. Comparison between these two numbers will indicate how well your facilities are doing compared to similar facilities in the same industry.

Although such a comparison exercise will identify the relative standing of energy efficiency, detailed consumption data are still needed to help develop conservation projects. Further comprehensive energy audits by qualified engineers and technicians are the best way to develop a list of energy conservation opportunities. However, audit surveys are expensive and most often require expertise from outside the installation. The USACPW, NAVFAC, and AFCESA can provide assistance in arranging energy audits for DoD installations.

Another effective method for identifying energy conservation opportunities is to solicit ideas from energy users. They often have excellent suggestions on how to save energy since they are familiar with their own energy-use patterns. Offering rewards and incentives to energy users for good ideas that result in energy savings will encourage user participation.

4.7. Energy Security/Flexibility

Energy security is a part of energy management. The DoD Components shall develop strategies for short and long term outages, or run the risk of major problems.

4.7.1. Vulnerability Assessments

Installations shall perform periodic evaluation of the vulnerability of basic mission requirements to energy disruptions and assess the risk of such disruptions, implement remedial actions to remove unacceptable energy security risks and investigate off-base utility distribution and energy supply systems.

4.7.2. Critical Asset Assurance Program

Subject to findings of vulnerability assessments, critical nodes of assessed systems with unacceptable risk implications to mission achievement shall be nominated for inclusion in the Critical Asset Assurance Program under DoD Directive 5160.54 “Critical Asset Assurance Program (CAAP)” January 20, 1998.

5. Energy Awareness

5.1. Key Points

- Energy and water awareness programs attempt to eliminate waste by changing the attitudes of users and, through those changed attitudes, to change behaviors as well.

- An effective awareness program targets specific audiences and involves as many energy users as possible.

- The installation's public affairs office is a useful ally in an awareness program.

- Publicizing conservation information on a regular basis tends to increase the program's effectiveness by increasing and maintaining participation.

5.2. Program Purpose

The purpose of an energy awareness program is to publicize energy conservation goals, disseminate information on energy matters and energy conservation techniques, and emphasize energy conservation at all command levels. The program should additionally relate energy conservation to operational awareness. An awareness program attempts to alter the attitudes of energy users and, through those changed attitudes, modify behaviors as well.

It is important that DoD achieve and sustain energy-efficient operations at the installation level through awareness and training programs. An effective program targets specific audiences, involves as many energy users as possible, is widely publicized, and clearly defines energy-saving actions and goals. The DoD components shall increase awareness and publicize program goals, tools, and progress at different organizational levels through web sites, conferences, emails, displays, reports, newsletters, handbooks, and guidance. DoD personnel shall be trained through either commercially available or in-house generated technical courses, seminars, conferences, software, videos, and certifications.

Another important aspect of energy awareness is to keep the commander and staff informed. Energy managers should brief commanders once or twice a year or whenever there is a major change in the energy program. Providing short and concise reports periodically can also be an effective tool in educating management. Realistic installation savings goals should be set and the installation commander should be encouraged to endorse those goals.

Managing energy is a continuous need. It concentrates on reinforcing opinions that energy efficiency reduces pollution, it reduces dependence on oil imports, and it reduces costs. The program also provides information on exactly how to achieve those results. Energy awareness helps to increase the "persistence" of energy-savings projects so that they continue to reap savings year after year. A subsidiary, but important, message is that energy efficiency does not mean doing without energy; it means achieving the same results using less.

5.3. Awareness Basics

A good awareness program explains energy efficiency in simple terms -- not because installation personnel cannot understand more complex messages but because a simple message competes more effectively with the many other messages being broadcast. The awareness program must tell users what they can do and how to do it in the most direct way possible. Installation personnel are bombarded daily with an almost endless list of messages that include official regulations, advertisements, and even grocery lists. The energy awareness message must compete successfully with all of those other messages and it must not contradict other mission messages.

An energy awareness program has a high potential for success. Within DoD, successful awareness programs have already affected the attitudes of many installation energy users. In many cases, energy managers can build upon that existing foundation. Furthermore, the basic elements for a successful energy campaign either exist already or can be readily created. As identified by sociologists Kotler and Eduardo in *Social Marketing: Strategies for Changing Behavior*, those elements are:

- *Monopolization*. Almost everyone agrees that energy efficiency is worthwhile.
- *Canalization*. Existing installation personnel who already practice energy efficiency can be potential allies to the energy manager in spreading the message.
- *Supplementation.* The program must achieve contact with as many energy users as possible, including family members.
- *Channeling*. The necessary materials and equipment must be made available for efforts requiring an investment. Other awareness efforts, such as turning off lights and shutting windows, require little or no capital investment.
- *Universality*. Everyone can use energy more efficiently. However, the message must be tailored to appeal to various user groups.

5.4. Program Design

To develop an effective energy awareness campaign, the energy manager should start by defining the target audience. A different message is needed for family housing occupants than for maintenance workers. Once the target audiences are defined, the installation's public affairs office should be involved in the energy awareness program. This office has specific communications expertise, which can be effectively linked with the energy manager's technical expertise.

In addition to the public affairs office, energy managers should get as much help as possible from other installation personnel in developing an energy awareness program. It is especially important to have people who are required to implement the plan involved in the planning. Getting energy users and maintenance staff involved in the planning process not only increases their understanding of the program, it generates a greater sense of ownership, leading to greater participation. People feel a commitment to making things work if they have been a part of the design.

Having defined the audiences, the awareness program should suggest the specific actions that each user group should take that can save energy. For example, one promotional campaign could be directed to housing occupants, another to office workers, and another to maintenance workers. The energy manager may want to start with a general, overall awareness program; however, such overall programs tend to be more preachy, less action-oriented, and therefore, less effective than specifically focused action campaigns. They can, however, serve as a useful foundation for the more narrowly focused campaigns, which should follow the general campaign very quickly or parallel it.

Awards and recognition provide excellent opportunities for building an effective, highly motivating awareness program. Energy conservation awards shall be presented to individuals, organizations, and installations in recognition of their energy-savings and water conservation efforts. In addition to recognition, awards provide motivation for continued energy reduction achievements. DoD components shall establish and/or maintain their individual awards programs, and incorporate on-the-spot awards and incentives to recognize exceptional performance and participation in the energy management program.

Having developed a goal, the energy awareness program should publicize the specific actions that installation personnel can take to achieve that goal. It should also publicize the progress made toward achieving that goal in the same way that organizations publicize progress toward other goals, such as charitable contributions. In this way, energy savings provide a tangible reward in addition to the desirable but more abstract benefits of efficiency, reduced pollution, and lower operating costs.

Components are encouraged to participate in the Department of Energy's (DOE's) Federal Energy and Water Management Awards Program. This program recognizes organizations, small groups, and individuals for significant contributions to the efficient use of energy and water resources in within the Federal sector. Awards are provided in several energy-related categories including energy management, renewable energy, water conservations, Energy Saving Performance Contracts (ESPC), and beneficial landscaping. Each DoD component may also recognize one outstanding individual for overall contribution to the program. In addition to DOE and other Service energy award programs, the White House recognizes Leadership in Federal Energy Management with Presidential Awards.

Showcase facilities demonstrate promising best commercial practices and the use of innovative techniques to improve energy and water efficiency. Each service shall have a goal to develop at least one showcase facility for the federally sponsored program per year. For additional information on the Showcase Facilities program, reference the Federal Energy Management Program's web site at:
http://www.eere.energy.gov/femp/prodtech/fed_showcase.html.

5.5. Action-Oriented Messages

As mentioned above, the best awareness programs are those that can be distilled into short, action-oriented messages. The energy manager, working with the public affairs office, can then communicate those messages in many ways. For example, a message like "use energy wisely" is unlikely to achieve much savings by itself, although it can serve as a basis for more concrete messages. Slogans like "turn off the lights," and "switch it off when you leave" are more effective because they communicate a direct action that users can implement immediately. Such action-oriented messages have a greater potential to change behavior as well as attitudes. A message like "switch it off for the environment" may be even better because it combines an action with a generally desired consequence.

The awareness program should target those action-oriented messages toward specific audiences. Some examples of the kind of actions that an awareness program can emphasize are described below.

- "Turn off the lights (including fluorescent lights) when you leave the room."
- "Turn off computers, printers, and copiers overnight where possible."
- "Avoid the need for supplemental heaters (space heaters) by preventing drafts and properly maintaining heating systems."
- "Shut off sprinklers during rainy periods."
- "Don't let water run when brushing teeth or shaving."

An awareness program targeted toward maintenance workers can be particularly effective because this audience is generally responsible for upkeep of the most energy-intensive systems. Awareness messages can recommend the following (low-cost) actions:

- "Fix stuck dampers."
- "Clean steam traps."
- "Check for torn or missing insulation and fix it."
- "Clean condenser coils on cooling equipment."
- "Wash lighting lenses and luminaires on a regular basis."
- "Fix leaky faucets."

On installations with industrial activities, the energy manager should work with production and maintenance personnel to develop effective energy-savings actions that the awareness program can promote. Such actions are likely to be highly specific to particular activities but have the potential to save a lot of money because such industrial activities are usually the largest energy users at industrial installations.

The ideas presented above are only examples of the many possible messages that a good awareness program can promote. Consult DOE or other organizations listed in Appendix C for additional examples.

5.6. Publicity Tools and Techniques

Successful public outreach energy information programs continually present the "need for energy conservation" and "how to save energy" themes. Publicizing conservation information on a regular basis tends to increase the program's effectiveness by increasing and maintaining participation.

Posters, stickers, and other publicity materials get the message to the installation's personnel. Contact higher headquarters' energy offices and the Federal Energy Management Program (FEMP) Office to obtain the latest information and ideas. FEMP is eager to hear from people in the field. FEMP develops outreach materials to serve as "Resource Reminders" for federal agency and staff. This information will assist energy managers in communicating to their constituents the importance of using energy wisely. The package includes posters, bookmarks, calendars, etc. A compact disk (CD) containing high resolution graphic files is also available to those who would like to reproduce materials. To request information, contact:

Outreach Program
US Department of Energy
Federal Energy Management Program
202-586-4536

Use of stand-up displays at military exchanges, commissaries, front gates, and other high-traffic locations and on billboards is an effective way to reach a large number of energy users. In addition, stand-up displays are an excellent way to communicate progress toward energy reduction goals.

Films, videos, slide presentations, and publications on energy and environmental topics are available from sources listed in Appendix C. Almost all gas and electric utility companies have public outreach programs that make utility representatives available for presentations. Field divisions of the various engineering corps within each Military Service can provide both technical and more general energy information.

5.6.1. Energy Awareness Month

Energy Awareness Month is a nationwide program that recognizes the importance of energy conservation. This national event takes place every October.

Energy managers can leverage their own programs, especially in October, with the national attention generated by Energy Awareness Month. October provides a good opportunity to demonstrate to command management and installation energy users the installation's progress on existing energy reduction goals and to introduce any new goals. Also, October is a good month in which to recognize particular groups and individuals who have done outstanding jobs in energy conservation.

Articles in newspapers, billboard signs, award presentations, training seminars, family outings, "walk" or "hitch a ride to work" weeks, competitions, and other promotional activities occur during the month. Events such as a "run-for energy" race or a "bike-to-work" week encourage individual competition. Events that encourage individual participation and fun should be organized.

5.6.2. Youth Activities

Awareness programs can also involve schools and extra-curricular youth groups such as the Boy Scouts and the Girl Scouts. Children can be invaluable allies in spreading the energy conservation message to their parents and other adults. Young people can be helpful in areas such as recycling, energy conservation home surveys, handing out literature, and assisting at Energy Awareness Month activities. Children might enjoy field trips to base boiler plant facilities or other engineering-related educational activities. They should be taught how energy systems work and how they can conserve energy. Many elementary and intermediate schools, both on base and in the local community, welcome presentations on energy conservation and its effects on helping the environment. Science classes are ideal places to teach children the importance of preserving valuable resources. Similar to the Boy and Girl Scout programs, many classes can be encouraged to perform public service projects or assist at Energy Awareness Month activities.

5.6.3. Public Outreach

At many installations, the public affairs officer will publish energy conservation articles in the base newspaper. Daily energy conservation hints in the installation's "plan of the day" or equivalent are also useful.

Positive success stories about energy conservation achievements on the installation are often of interest to local news organizations. Not only are such stories good for public relations, but they set an example for the community. DoD personnel get positive reinforcement when they are recognized by the general public for their conservation activities, which can generate momentum for sustained, long-term conservation efforts.

5.7. Evaluating Program Effectiveness

Since the ultimate purpose of energy awareness is to use energy more efficiently, the most appropriate measure of success should be actual energy reduction. While it is difficult, if not impossible, to isolate those energy reductions resulting solely from energy awareness efforts, the installation should achieve some reductions in total energy consumption (or in BTUs per square foot).

One way to measure an awareness program's effectiveness is to develop a set of subjective assessment criteria to gauge changes in users' energy habits. Those criteria can include the number of incidents where lights are left on after duty hours, where windows are left open during heating/cooling seasons, and the number of unauthorized space heaters in use. Those subjective criteria can be measured during periodic "walk-through" inspections.

During facility inspections, the following actions should be completed:

- Find out whether posters and other awareness materials are visibly displayed.
- Conduct interviews to determine whether energy users are familiar with proper energy conservation procedures.
- Evaluate whether there is a general conservation ethic in the workplace.
- Encourage those not yet committed to the program to get more involved.

6. Energy Accounting and Management Reporting

6.1. Key Points

- The Defense Utility Energy Reporting System provides DoD with important energy-use and associated data.
- Energy accounting reporting through DUERS is required by DoD instruction.
- Individual Services compile data through their respective systems and submit data to OSD.

6.2. Defense Utility Energy Reporting System

The DUERS is an automated management information system DoD uses to monitor its supplies and consumption of energy. It was originally fielded in February 1974 as the Defense Energy Information System (DEIS) to respond to the need to manage DoD energy resources more closely in the aftermath of the 1973 Arab oil embargo. It is primarily an energy management tool, providing information about DoD's inventory and consumption of utility energy. DUERS reporting is required of all DoD agencies.

DUERS data is used for the following purposes:

- To analyze historical trends
- To measure progress toward DoD energy goals
- To report as mandated by Congress to DOE
- To provide Congressional support data.

DUERS is essential for management of required energy reduction goals called for in EPAct and other Executive Orders and Federal legislation. It forms the basis for calculating (and subsequently validating) each installation's energy and energy cost savings.

Refer to the DoD DUERS Manual (available on the CCB) for specific reporting requirements and energy conversion factors. The basic unit for DUERS reporting is the DoD Activity Address Code (DoDAAC). Some DoDAACs coincide with entire installations, while others comprise activities within an installation. Also, separate DoDAACs generally exist for family housing and for mission areas.

In the past, DUERS has been plagued by late and inaccurate submittals. To satisfy energy reporting goals, energy managers need to be certain that their energy-use data are reliable and that they are entered into the automated system in a timely manner. Facility energy-use data include not only consumption by energy type but also activity square footage, heating degree days, and cooling degree days. All of these data must be accurate for the installation to be able to calculate its energy savings and to retain its energy cost savings share. Because DUERS data will now form the basis for financial calculations, they are more likely to be subject to future audits.

6.3. Army Energy and Water Reporting System

All Army data submitted to DUERS will be input by installations through the Army Energy and Water Reporting System. This system is designed to facilitate energy management by providing timely, reliable, and accurate information on energy products used by the Army. This system provides essential energy management information to installations, Regions, Major Subordinate Commands (MSCs), major Army Commands (MACOMs), Department of the Army (DA), and DoD (through DUERS). This information is used to evaluate energy trends and to determine progress toward goals/targets. For more information on operation of this system, refer to the system web site at https://hqradds.hqda.pentagon.mil/.

The Army National Guard is considered to be the same as a MACOM with respect to reporting energy consumption. Each state is considered an installation and should report energy cost and consumption data into the Army Energy and Water Reporting System monthly, similar to Active Component and Army Reserve installations for which Federal funds are used to pay for utilities.

6.4. Navy Data Management

Navy data management consists of the Defense Utility Energy Reporting System (DUERS), the Energy Projects Status System (EPSS), and the Water data page. These are all located on the Department of the Navy's energy website. (https://energy.navy.mil).

a. DUERS. The Navy DUERS application facilitates the collection of energy cost, consumption and square footage data as directed in DoD 5126.46-M-2. Installations input monthly data on-line. Quarterly reports of progress are then created. The DUERS data provides essential energy management information to installations, Commander, Navy Installations, CNO, ASN, and and DoD. This information is used to evaluate energy trends and to determine progress toward goals/targets. For more information refer to the user's manuals available at https://energy.navy.mil, then select "Progress / Data / Projects.)

b. EPSS. The Navy EPSS application is used to view the status of energy projects submitted for Navy and Marine Corps installations. EPSS includes data on project costs, energy savings, economic information, and payment data for all energy projects.

c. Water. The Navy's water data page displays information on water consumption by installation and tracks implementation of Best Water Management Practices (See Chapter 13).

6.5. Air Force DUERS

The Air Force DUERS software facilitates the collection of energy cost and consumption data as directed in DoD 5126.46-M-2, Defense Utility Energy Reporting System. The Air Force database is maintained at AFCESA and contains data from the FY85 baseline forward. AFCESA has the responsibility of reporting the data to OSD annually. Air Force Policy Directive 23-3 states that compliance with energy management policy will be assessed by taking measurements using DUERS. The accuracy of this database is very important since it is the only metric used by the Air Force to report progress towards energy reduction goals.

Individual installations should ensure that their utility energy consumption, square footage, and cost are reported accurately. DUERS managers should ensure that base master meters are read and real property record indicators are current for the last calendar day of the month. A consolidated DUERS database should be prepared and submitted to the MAJCOM by the 30th day of the first month following the reporting period. Per Air Force Energy Program Procedural Memorandum 96-3, the DUERS database records are submitted quarterly. The Base Energy Steering Group should review DUERS reports at the end of each quarter to ensure continued progress toward energy efficiency goals.

MAJCOMs consolidate their individual installations' DUERS databases and ensure that their command's utility energy consumption, square footage, and cost are reported correctly. The MAJCOM DUERS database should be submitted to AFCESA by the 15th day of the second month following the quarterly reporting periods. AFCESA consolidates the MAJCOM data and ensures that Air Force data are reported accurately. Timely submissions by all responsible parties are key to the system's working smoothly and reliably for energy reporting at all levels of the chain of command.

6.6. Facility Energy Program Reporting Requirements

Energy managers must submit (at the least) an annual report describing the status of their facilities' energy programs each year. That report should be prepared in accordance with the requirements of their respective Military Department.

7. Energy and the Environment

7.1. Key Points

- Energy and environmental initiatives are closely related since energy conservation reduces emissions of atmospheric pollution including greenhouse gases.
- Water conservation not only saves energy but also reduces sewer volumes and protects natural resources.
- Energy and environmental managers can work together to accomplish common goals, achieving greater economic benefits greater than if working independently.
- US Environmental Protection Act (EPA) and DOE offer a variety of energy and environmental programs that can support and extend a DoD energy manager's program.
- Energy managers need to work closely with environmental offices when implementing retrofit projects that generate regulated wastes.
- Waste-to-energy technology solves an environmental problem while reducing energy costs by converting certain ingredients of municipal solid waste such as paper, plastics, and wood into energy.

7.2. The Energy and Environmental Connection

7.2.1. Background

The primary connection between energy conservation programs and environmental initiatives is the benefit to the environment of a reduction in energy consumption. When electricity is generated, three principle pollutants are emitted from the power plant: sulfur dioxide, nitrogen oxides, and carbon dioxide. In the US, electricity generation accounts for 35% of all US emissions of carbon dioxide, 38% of nitrogen oxides, and 75% of all sulfur dioxide. If less electrical energy is used, fewer emissions are produced.

7.2.2. Electric Power Plant Emissions

When sulfur dioxide and nitrogen oxides are emitted by power plants and automobiles, they mix with water vapor, turn into sulfuric and nitric acids, and fall to the ground in the form of rain, snow, fog, or acidic particles. “Acid rain” damages buildings, trees, and other vegetation and can harm aquatic life.

Smog is caused by various pollutants. Nitrogen oxides are a primary ingredient in this corrosive mixture that is harmful to humans. At best, smog irritates the eyes and lungs. At worst, it can intensify respiratory ailments, including asthma and bronchitis.

Sunlight passes through the atmosphere and is re-emitted as heat radiation from Earth’s surface. Certain gases block a portion of the outbound radiation, trapping heat much like a greenhouse. This interaction helps maintain Earth’s temperature at an average 60 degrees Fahrenheit. In the past 200 years, human activities have significantly increased concentrations of carbon dioxide and other “greenhouse” gases, accelerating the rate of global warming.

7.2.3. Estimating Emissions

The amount of emissions per kWh varies based on the fuel used and the operation of the generation plant. For reporting and estimating purposes, aggregate electric generation and emissions by State, region, or nation are used to compute average emission factors for the three pollutants.

7.2.4. Water Conservation Externalities

Water conservation measures not only reduce water use and cost, but also reduce energy consumption (for pumping) and sewage treatment costs. In every case, the principle of externality costs (and savings) is that reduction of use of one resource leads to savings and benefits in related areas. Water conservation externalities also include reduced quantities of wastewater treatment chemicals (most notably chlorine) being released to the environment, as well as reduced risk of drawing down aquifers or salt water intrusion into the aquifer.

7.2.5. Environmental Externality Costs

While the cost of damage done by these emissions is very difficult to estimate, numerous studies have been conducted to assess the potential environmental externality costs. These are costs that are not built-in to the cost of energy production but that may be borne by society in the future. Depending upon the fuel used to generate the electricity and the local electricity costs, the potential environmental costs can be as much or more than the actual purchase costs according to Pace Center for Environmental Law.

Regardless of the actual externality costs, it should be obvious that if energy conservation measures can be justified on a life-cycle cost basis alone, then the environmental benefits are an additional bonus. Conversely, for an organization charged with reducing environmental emissions, accomplishing this by providing energy and cost savings for client organizations provides a win-win win benefit. This is the principle behind numerous Government and non-profit programs based on energy/environmental initiatives. Despite the externality benefits, DoD energy managers must use only actual cost to the Government in conducting LCC analyses. Specific externality benefits should be identified, if appropriate, as an additional, intangible benefit and can advance potential projects in the funding priority list, if significant.

7.2.6. Environmental Protection Agency

7.2.6.1. Green Lights

The Green Lights Program, now incorporated within the ENERGY STAR®, is aimed at promoting energy efficiency through investment in energy-saving lighting. The program saves money for organizations and creates a cleaner environment by reducing pollutants released into the environment. The average Green Lights partner achieves rates of return of 30% on their lighting upgrades. For more information on Green Lights for Federal participants, access the site at http://www.epa.gov/Region7/p2/volprog/grnlight.htm.

7.2.6.2. ENERGY STAR® Buildings

Expanding on the success of the Green Lights program, EPA created the broader ENERGY STAR® Buildings program. This initiative focuses on profitable investment opportunities available in most commercial buildings using proven technologies. EPA through its ENERGY STAR® program offers a proven strategy for superior energy management by providing its partners with various tools and resources.

ENERGY STAR® has developed a set of guidelines to assist an organization in improving its energy and financial performance by lower operating costs and improving tenant comfort. Guidelines include the steps to:

- Make a commitment to energy management
- Assess performance and set goals
- Create/update an action plan
- Implement the action plan
- Evaluate progress
- Recognize achievements.

DoD Components shall encourage participation in this program. Visit http://www.energystar.gov and click on ENERGY STAR® Guidelines under Business Improvement to access detail on each of the above steps. Select other individual links for tools and resources that can assist at each step.

7.2.6.3. ENERGY STAR® Computers and Office Equipment

Computers are the fastest-growing electricity load in the business world. They account for 5% of commercial electricity consumption with the percentage contribution increasing. Research shows that most of the time computers are on, they are not in use. An estimated 30-40% is left running at night and on weekends. Contrary to popular belief, turning computers off at night does not decrease their life.

EPA has signed partnership agreements with industry-leading manufacturers of computers, monitors, printers/fax machines, and copiers. These partners have produced equipment that can automatically power-down or "sleep" when not being used. This feature can cut the energy use by half over a similar product without the feature. ENERGY STAR® computers use 70% less electricity than computers without power management features.

When acquiring energy-consuming products, DoD organizations are selecting ENERGY STAR® and other energy efficient products when life-cycle cost effective. These products do not usually cost more than competing products. Many products already in place have the capability of the sleep mode, but the feature is not enabled because of user awareness of the feature. An energy manager should incorporate publicity about these issues in their energy awareness activities (see Chapter 5).

7.2.6.4. Lighting Waste Disposal

Upgrading a lighting system will likely involve the removal and disposal of lamps and ballast. Some of this waste may be hazardous and must be managed in accordance with laws and regulations. State environmental laws regarding lamp and ballast disposal vary widely and, in some States, may not exist. Energy managers should work closely with environmental offices to ensure these issues are managed properly. Consult EPA or a State environmental office for more information.

7.2.6.5. EPA Program Information

For more information about any of EPA's pollution prevention programs, visit its Pollution Prevention Homepage. The web page provides general information about pollution prevention practices, the various source reduction programs and initiatives administered by EPA and other organizations. The site also provides contacts for further information. That web page address is:

http://www.epa.gov/ebtpages/pollutionprevention.html.

7.2.7. Department of Energy (DOE)

The US DOE Motor Challenge Program, launched in the fall of 1993, was managed by the Office of Industrial Technologies (OIT) in partnership with U.S. industry. In the winter of 1999-2000, all of OIT's Challenge programs became part of the BestPractices initiative. The Motor Challenge Program developed a set of project planning and preventive maintenance tools designed to help industry and industrial supply-chain vendors and consultants identify and cost-justify specific actions to reduce energy use in their motor systems. The most well known of these tools is the MotorMaster+ motor selection and management software, which has been distributed to thousands of industrial end users. Users can view the BestPractices Motors Web site and download the software at the site:

http://www.oit.doe.gov/bestpractices/motors/.

To contact a real person who is equipped with the knowledge to help you find information about any of the areas within the Industrial Technologies Program, can contact the EERE Information Center at 1-877-EERE-INF (877-337-3463).

DOE also supports numerous energy-related programs that are implemented through State energy offices that can be accessed from DOE’s web site.

7.2.8. Cool Communities

As urban areas have developed, increasing numbers of buildings have crowded out trees and other vegetation. The result has been that cities are typically 5-9 degree F warmer than the rural areas around them. In the summer, this “urban heat island” effect is estimated to cost US energy users an additional $1 million per hour in cooling costs. Compensating for this additional heat, accounts for 3-8% of electric demand.

To combat this “urban heat island,” the Cool Communities program was created as a cooperative effort of American Forests, DOE, EPA, US Department of Agriculture (USDA) Forest Service and other interested parties. The program develops voluntary partnerships for the purpose of educating the public about tree planting and care and implements and monitors programs designed to reduce urban heat island effect. According to Cool Communities, three well placed trees around homes can provide shade that will lower cooling costs by 10-50%. Additionally, tree planting and care are the least expensive ways to slow the build-up of carbon dioxide, since trees absorb carbon dioxide and release oxygen. For detailed information on strategies for energy and water reduction from tree planting, consult the publication *Cooling Our Communities: A Guidebook on Tree Planting and Light-Colored Surfacing*, US EPA, January 1992, ISBN 0-16-036034-X, which is available through the US Government Printing Office. Additional resources include http://www.americanforests.org/ or upon contacting The Heat Island Group at:

Berkeley Lab
Building 90, Room 2000
Berkeley, California 94720

Urban heat island research is summarized on the World Wide Web at http://eetd.lbl.gov/HeatIsland/.

7.3. Waste-to-Energy Technology

Waste-to-energy technology involves converting various elements of municipal solid waste such as paper, plastics, and wood to generate energy by either thermo chemical or biochemical processes. The thermo chemical techniques consist of combustion, gasification, and pyrolysis; these produce high heat in fast reaction times. The biochemical processes consist of anaerobic digestion, hydrolysis, and fermentation using enzymes that produce low heat in slow reaction times. Figure 7-1 illustrates many potential output energy technologies and the products that result from those processes.

7.3.1. Application of Waste-to-Energy Technology

Before considering any application of the waste-to-energy technologies, a comprehensive municipal solid waste management strategy must be developed. The most common application of waste-to-energy technology is combustion: the burning of municipal solid waste to produce steam for heating or to generate electricity. The combustion method (1) captures heat energy by generating steam that can be used for space heating and (2) provides process heat for industrial operations or electricity generation. DEPPM 91-3, Waste-to-Energy Projects, provides detailed information on the cost and risk assessment of waste-to-energy projects.

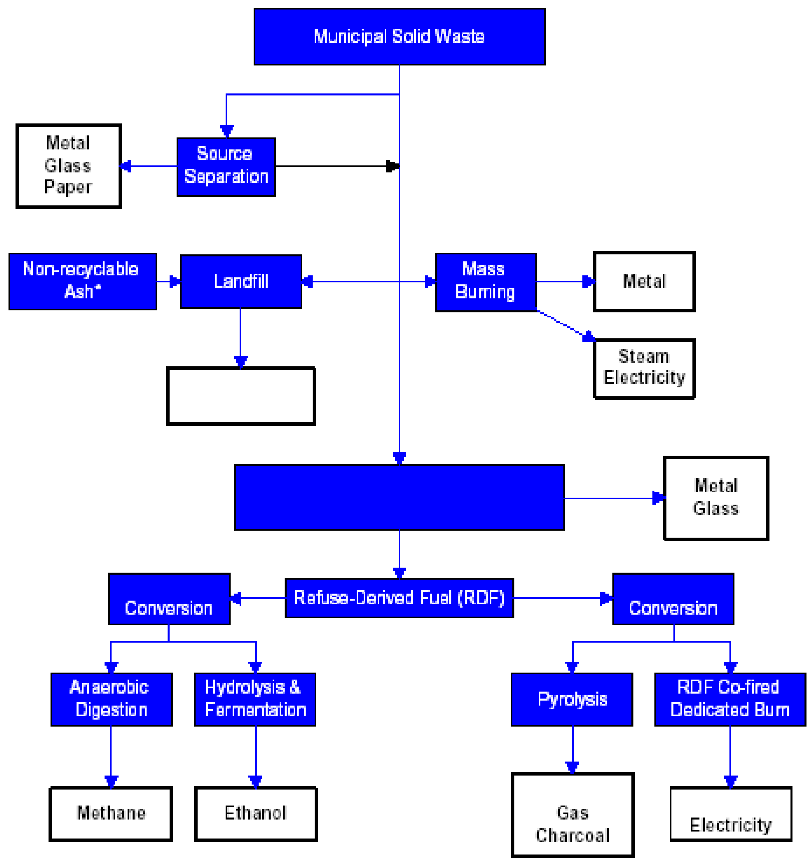
There are several types of combustion technology. The options are:

- *Mass burn*. A mass burn waste combustor has a single combustion chamber with an on-site energy-recovery mechanism. While an incinerator alone is not classified as a waste-to-energy technology, by attaching an additional heat recovery unit, it can be considered as waste-to-energy technology.

- *Modular*. A modular waste combustor has a two- (or more stage combustion unit and an energy-recovery unit. It is pre-fabricated and field erected for site construction.
- *Refuse-derived fuel*. A refuse-derived fuel system is an energy recovery facility with extensive front-end processing used to pretreat waste. Such a system has a dedicated boiler for combusting prepared fuel.

Eight DoD installations have modular waste-to-energy facilities. Table 7-1 shows their processing capacities, the type of combustion technology used the type of energy produced, and the startup year.

Figure 7-1. Waste-to-Energy Technology Options



Source: "Energy from Municipal Waste: Picking Up Where Recycling Leaves Off," Jonathan V.L. Kiser and B Kent Burton, Waste Age Magazine (November 1992).

* All technologies, including source separation, produce non-recyclable ash.

Outside of DoD, there are about 200 waste-to-energy facilities in the United States. Since 1980, the growth of those facilities has been dramatic. The technologies are advancing rapidly. Increasing public environmental concern over sanitary landfills and a legislative mandate [i.e., Public Utility Regulatory Policy Act (PURPA)] have created a social condition where it is economically feasible to offset plant construction and O&M costs from the savings earned from cost reductions for refuse disposal and the revenues incurred from generating energy. Increased public concern has forced the creation of tougher and more expensive environmental regulations on construction and the operation of landfills. The PURPA mandated that utilities companies buy the electricity generated by waste-to-energy plants.

Table 7-1. DoD Waste-to-Energy Plants

Service	*Installation, State*	*Capacity (tons/day)*	*Combustion Technology*	*Startup Year*
Air Force	Shemya, Alaska	20	Modular	1970s
Navy	Mayport, Florida	50	Modular	1979
Navy	Norfolk, Virginia	360	Modular	1990
Army	Aberdeen, Maryland *	360 and 125	Modular	1988/1992
Army	Ft. Detrick, Maryland	30	Modular	1996

* Aberdeen runs two separate waste-to energy plants

7.3.2. Solid Waste Management

The economic feasibility of a waste-to-energy plant depends on the volumes of waste generated and its waste management costs. The waste management cycle consists of collection, transportation, and disposal of the waste. The disposal method is pivotal since it influences how waste is collected and how far it must be transported. The costs of waste management can be substantial, in excess of millions of dollars per year for many installations.

Each year, the military generates millions of tons of trash in the form of wrappings, bottles, boxes, cans, grass clippings, furniture, etc. In our “throw away” society, it is easy to see why there is so much solid waste and too few acceptable places to put it.

For this reason, there is a compelling reason for Integrated Solid Waste Management (ISWM). ISWM planning is designed to minimize the initial input to the waste stream through source reduction, re-use, and recycling. The reduced solid waste stream is eventually disposed of through the effective combination of combustion (incineration), composting, and landfill disposal.

For most DoD installations, the land-filling option is still the most economical way to dispose of waste. In many parts of the United States, tipping fees are still relatively low and the distances to disposal sites are within reasonable ranges. Also, where there is no viable market for recycled waste materials except for aluminum, it does not make economic sense to establish a recycling program. Recycling programs must generate enough revenue to at least offset the additional refuse collection costs.

A waste-to-energy plant may be an economic alternative to developing a solid waste disposal plant if the landfill option becomes too expensive. A waste-to-energy plant can reduce the volume of waste by as much as 90%. If there is a rapid increase in refuse disposal costs to a point at which it is no longer cost effective to continue off-site land-filling, waste-to-energy application should be considered. By reducing the waste volume down to only 10% of the original volume, installations can save 90% of the disposal costs. However, since economics depend upon many years of successful operation, consider the possibility of future down-sizing or other impacts on the waste stream quantity when conducting an analysis.

To operate a waste-to-energy plant properly, installations must establish an effective waste management program that must consider recycling issues. Waste must be sorted, analyzed for its BTU heat content, and its flow of volume must be sufficiently steady to meet the plant's design criteria before it is fed into the combustion chamber. A recycling program can become part of the waste-sorting strategy.

7.3.2.1. Waste Stream Analysis

Over 70% of municipal solid waste consists of organic materials such as paper, food wastes, yard wastes, and plastic that have BTU combustion values. Table 7-2 shows the energy values for each waste element. Composition of the waste can shift with seasonal variations and unique local conditions over a period of time. For example, the proportion of paper and paperboard has grown from 32% in 1970 to 40% by 1988. An important initial check to make before conducting a waste-to-energy plant feasibility study is to complete an analysis of the composition and volume of the current waste stream and to forecast future trends. A commonly accepted industry "rule of thumb," which uses existing data, calls for the generation of at least 50 tons of waste per day to economically justify the development of a new plant. It takes a population of about 50,000 people to produce 100 tons of waste per day. On the basis of this estimate, a base population of at least 25,000 is needed before a waste-to-energy facility can be economically feasible.

Table 7-2 Energy Value of Various Wastes

Waste Element	*Energy Supplied if Burned*	*Energy for Virgin Manufacture*	*Energy for Recycle Manufacture*	*Energy Saved if Recycled*
Newsprint	8	27	22	5
Corrugated paper	7	17	17	0
Tissue paper	8	12	14	-2
Aluminum	0	100	5	95
Steel	0	48	23	25
Glass	0	10	7	3

Source: "Energy from Municipal Waste Program - Program Plan," Office of Industrial Technologies, Office of the Assistant Secretary for Conservation and Renewable Energy, US Department of Energy, May 5, 1992, p. 12

7.3.2.2. Regional Waste Management

In many cases, DoD installations may not generate enough waste to make construction of a waste-to-energy plant an economically viable option. In these situations, DoD installations may partner with local municipalities. Although the benefits of such cooperation can be many, negotiating a waste management arrangement with the local government can be very tedious and controversial. Major command counterparts and the installation's commander should be consulted to determine their related policies.

7.3.3. Economic And Financial Analyses

The financial attractiveness of a waste-to-energy facility hinges on many factors. Those factors include local landfill tipping fees, trash transportation costs, construction and operations costs of the plant purchase price of produced energy, recycling revenues, and interest rates. Figure 7-2 compares these factors to cost savings factors.

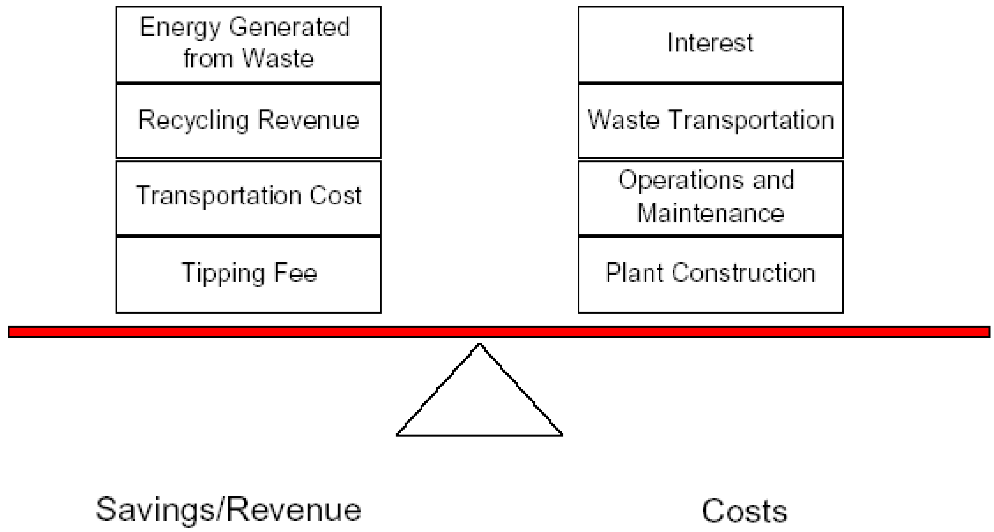


Figure 7-2. Balancing Financial Factors Affecting the Feasibility of a Waste-to-Energy Plant

7.3.3.1. Landfill Tipping Fee and Transportation Cost

Since 1982, the average landfill tipping fee in the United States rose from $12 per ton to $46 per ton in 1990. In some states with high population densities e.g., New Jersey), the average tipping fee ranges from $100 to $150 per ton. Most bases contract refuse collection and disposal services. The energy manager should review the service contracts to perform economic and financial analyses. For most bases, a refuse contract includes the transportation cost unless the base is using in-house capabilities to collect the trash. Refuse collection and disposal contracts are kept either by the base contracting office or by the civil engineering squadron/public works.

7.3.3.2. Construction and Operations Cost

The design criteria will ultimately drive the costs of both the construction and operation of a waste-to-energy plant. The design criteria must consider unique base-specific waste stream analyses. The energy manager should select a plant operation that will maximize the waste characteristics of the base. Energy managers should consult with major command counterparts and contact local vendors to obtain data for cost estimation.

7.3.3.3. Energy Generated from Waste

Under the PURPA, utilities companies are required to buy the energy generated from a waste-to-energy plant. The purchase price and conditions for sale should be negotiated. The prevailing market conditions will determine the utilities rate. The energy generated from a waste-to-energy plant could be used to supplement existing base energy needs. Steam produced from the plant can provide hot water or it can generate electricity. By generating a portion of their energy, installations can earn savings from their utilities budgets, savings which otherwise would have been spent to purchase that energy.

7.3.3.4. Recycling Revenue

Most waste-to-energy plants require some method of front-end waste handling to ensure that only combustible materials are fed to a combustion chamber. Waste handling can be accomplished by presorting the waste either manually, mechanically, or a combination of both techniques. Manually presorting waste can be integrated into the trash collection process. Several different trash bins can be provided to collect separated waste (e.g., aluminum, paper, and/or glass). Installation personnel must be trained to separate trash for disposal. Although this additional sorting effort requires some expense, recycling revenues can cover marginal increases in the waste collection costs.

7.3.4. Interest/Discount Rate

Under the MILCON program or ECIP, construction of a waste-to-energy plant must be economically feasible based on LCC analysis at current discount rates. A waste-to-energy plant can also be a good candidate for ESPC projects. For an ESPC project to be financially attractive, the private sector partner must have enough cash flow to cover interest rates on the initial capital investment.

7.3.5. Environmental Considerations

Reducing the volume of trash going to the landfill has many positive environmental benefits, so thorough environmental analyses and planning must be accomplished before considering construction of a waste-to-energy plant.

7.3.5.1. Environmental Assessment

The National Environmental Policy Act (NEPA) requires preparation of an Environmental Assessment (EA) or Environmental Impact Statement (EIS) as a part of the planning process before construction of a waste-to-energy plant. Energy managers should consult with the environmental coordinator to learn how to prepare an EA or EIS.

7.3.5.2. Environmental Permit

The combustion of municipal solid waste produces both an organic ash and airborne gases. The disposal of the ash is regulated under the Resource Conservation and Recovery Act (RCRA) and the emission gases are regulated under the Clean Air Act. Depending on the types of feed material, the burnt ash can be classified as hazardous waste. A careful waste stream analysis must be conducted to avoid a situation where the ash becomes hazardous waste. Under normal circumstances, the air emissions are lower than the State's allowable limits; however, preparation of an air permit application for the State is required. The base's environmental coordinator should be consulted learn how to prepare an application for an air permit and an ash disposal permit.

Part III Energy and Water Conservation

8. Energy Conservation in New Construction

8.1. Key Points

- New DoD buildings must be constructed to meet the minimum energy efficiency requirements established by the Department of Energy.
- Building commissioning is essential to ensure that systems operate as they were intended.

8.2. Federal Energy Codes for New Construction

8.2.1. Background

Energy and water conservation improvements are most cost-effective when they are implemented at the time of construction, rather than later as a retrofit or replacement project. Many opportunities for energy and water reduction are lost because efficiency and LCC are not appropriately considered in the design phase.

8.2.2. Basis for Federal Energy Code

The Energy Policy Act of 2005 establishes Federal building standards that require new Federal buildings to contain energy saving and renewable energy specifications that meet or exceed the energy saving and renewable energy specifications of current American Society of Heating, Refrigeration and Air-Conditioning Engineers/Illuminating Engineering Society (ASHRAE/IES) standards, "Energy Conservation in New Buildings Except Low-Rise Residential" (for commercial facilities). For residential facilities, UFC 3-400-01, Design: Energy Conservation, states for new or renovation housing projects that EPA's ENERGY STAR® Program is mandatory.

Metering is also an important factor in an energy management program because it provides the means necessary to establish the energy accounting system that is essential for control and evaluation of the program. The Energy Policy Act of 2005 requires metering of each distinct utility-provided energy service. The effective use of information generated by metering can result in savings of both energy and dollars. See Chapter 10 for additional information and pending legislation requiring metering in Federal facilities.

8.3. DOE Code Compliance Materials

DOE's Pacific Northwest Laboratory has developed simplified code compliance manuals, software, and training to support compliance with required Federal codes. EZCom is based on the 90.1 Standard and REScheck (formerly MECcheck) is based on the CABO Model Energy Code.

To request DOE publications, software, or user's guides in support of Federal energy codes contact:

US Department of Energy
Office of Codes and Standards
1000 Independence Avenue, SW
Forrestal Building, Room 5H04
Washington, DC 20585

Building Energy Standards Hotline
(800) 270-CODE
Internet: http://www.pnl.gov/buildings
Pacific Northwest National Laboratory
P.O. Box 999
Richland, WA 99352

8.4. Sustainable Building Design

Sustainability initiatives require an integrated design approach to life-cycle of buildings and infrastructure. The concepts of sustainable development as applied to DoD installations shall continue to be incorporated into the master planning process of each of the Services. MILCON and facility repair and/or sustainment projects shall include an energy analysis to show compliance to 10 CFR 434, relevant Executive Orders (EOs), and other Federal energy conservation requirements. All new facility construction and major renovations shall use ASHRAE standard 90.1-01 in accordance with Unified Facilities Criteria (UFC 3-400-01), Design: Energy Conservation, for design criteria and follow life-cycle cost (LCC) analysis for sustainable development principles. For all new or renovated MFH construction, the ENERGY STAR® criteria will be implemented as stated in UFC 3-400-01. Renewable energy systems may be considered when cost effective through LCC analysis.

The DoD Components shall strive to obtain U.S. Green Building Council's Leadership in Energy and Environmental Design (LEED) level of performance or equivalent. DoD Components are encouraged to approach land use planning and urban design in a holistic manner and integrate it with energy planning. The DD Form 1391, "Military Construction Project Data," shall be used to document sustainable development costs.

Additional information on “sustainable design” can be found in “The Whole Building Design Guide,” a DoD-sponsored, web based application. This internet based tool, located at http://www.wbdg.org, serves as a portal to the design principles and other resources needed to construct cost-effective, sustainable buildings.

8.5. Design, Installation, and Commissioning of Building Systems

Energy managers should participate in new construction projects from pre-design and design reviews through facility commissioning and acceptance to ensure the intent and requirements outlined in ASHRAE 90.1 are being met.

The builder or equipment manufacturer should provide proper training classes to familiarize energy operators and maintenance personnel with the installed HVAC equipment and controls. Note: Agencies shall select, where life-cycle cost-effective, ENERGY STAR® and other energy efficient products or equipment when acquiring energy-using products. For product groups where ENERGY STAR® labels are not yet available, agencies shall select products/equipment that are in the upper 25 percent of energy efficiency as designated by FEMP.

Energy managers must ensure that the builder has provided all of the necessary documentation and instructions of installed energy systems so that training modules can be developed. The energy manager should become involved in the final acceptance of new buildings. Building commissioning is a key strategy for ensuring that designed and installed systems perform as intended and minimize energy consumption.

Total Building Commissioning (TBC) is a process for achieving, validating and documenting that the performance of the total building and its systems meets the design needs and requirements of the client. The process ideally extends through all phases of a project, from concept to completion of warranty periods and beyond. Utilizing TBC principles in the planning and design phase can reduce costly rework and change orders during construction, and save limited funding by making changes and corrections on paper rather than in the field.

The Navy has issued Naval Facilities Engineering Command (NAVFAC) Instruction 12271.1, NAVFAC Total Building Commissioning Policy, to provide for incorporation of TBC principles into all phases of the acquisition process. It lists as its basic goals 1) to provide a well-documented design, 2) to verify through testing that all systems function as required, and 3) to provide adequate documentation and training for building operators. Achieving these goals will require development of quality-based commissioning plans, incorporating detailed testing requirements into contract documents, strict adherence to testing schedules during construction, warranty enforcement, and proper operation and maintenance documentation and training for the client.

9. Energy Auditing

9.1. Key Points

- Energy and water audits help form the foundation of an energy program by identifying energy conservation and cost-savings opportunities. EPAct requires DoD to audit 10% of its facilities annually for energy efficiency.

- It is important to set audit priorities among the many opportunities for energy savings.

- An important function of an energy audit is to inform installation decision makers about the findings and to convince them to allocate the necessary resources to correct any deficiencies.

- Audits should be performed only to the level needed for determination and justification of energy conservation measures. Energy conservation is achieved by the implementation of energy conservation measures.

9.2. Purpose of the Energy Audit

Energy audits evaluate current energy usage and assist facilities in determining the best locations to incorporate energy savings measures. The primary purpose is to determine how to reduce energy use and cost. “Energy survey,” “energy analysis,” and “energy conservation study” are similar terms that may refer to the same type study. An energy audit should answer the following four questions:

a. How much energy of each type is being used?
b. How much does the energy cost?
c. What is the energy being used for?
d. What opportunities exist for reducing energy use or cost?

Originally, the term “energy audit” was used in the *Federal Register* in 1977 to provide the requirements for states to implement energy conservation plans. Federal regulations outlined several levels of energy audits, which were offered to support specific energy conservation programs. As the energy conservation field has matured, “energy audit” has become the standard term for a site-specific energy analysis.

9.2.1. Background

Most DoD buildings were designed and constructed before the energy crisis of 1973 when there were sharp increases in energy prices and utility rates. Before those increases, architects and engineers lacked the incentive to use electricity and gas efficiently, particularly since energy-efficient equipment usually required greater initial capital investment. Also, little in the way of energy-efficient equipment or systems was available because of limited technology and market demand. Consequently, many old DoD buildings were designed to use lighting, HVAC equipment, and auxiliary fan motors that are inefficient by today's standards.

The EPAct and EOs require Federal agencies to audit approximately 10 percent of their facilities each year. Since auditing 10 percent of DoD facilities each year may be cost prohibitive, DoD Components are encouraged to use appropriated funding or alternative financing through Utility Energy Savings Contracts (UESC) and Energy Savings Performance Contracts (ESPC) projects to conduct their energy audits.

Although many DoD buildings have been improved over the years by retrofits, most old buildings still offer greater energy-saving and cost-saving opportunities. Retrofitting entire old energy systems can be an attractive investment because the simple payback for many of these projects is less than 2 years. However, the initial capital outlay is often substantial and may require the entire building to be vacated for some period of time. Initial capital requirements often kill good energy conservation proposals. To encourage good energy conservation projects, installation energy managers may have to compromise by implementing a partial or phased upgrade of energy systems.

An energy audit should also determine the performance and efficiency of each individual component of an energy system. Although the components of many energy systems have been replaced since they were first installed, many are still not energy efficient by today's standards. With advances in technology, more energy-efficient replacement components are available today. Most of those components can be replaced relatively easily. For example, replacing an entire HVAC system requires significant capital investment. However, numerous no-cost or low-cost opportunities can be identified through a productive energy audit program. For example, high-efficiency fluorescent lights with electronic ballasts can replace old-style fluorescent or incandescent lights without major modifications.

Many buildings have never been audited to determine energy efficiency. In addition, functional changes have taken place in many buildings that were audited in the past. As DoD downsizes its forces, deactivates or transfers military units, and consolidates bases, many of the remaining bases will have to readjust their energy use to accommodate those changes. It would be wise to determine if the original energy system designs have become obsolete.

9.2.2. Cost Savings vs. Energy Savings

Although many energy cost-saving measures can be identified during an energy audit, some measures will help reduce total energy cost but may not help reduce energy consumption, for example, shifting loads away from peak periods. By understanding energy requirements and alternative energy sources, energy managers can pick the most economical energy resources to save money. For example, switching an electric heater to a gas-fired heater may not reduce energy consumption, but this can save money since gas is cheaper than electricity. A comprehensive energy audit can identify the best cost-saving opportunities.

Energy audits can also follow up on operating energy conservation projects to determine if the expected savings have been achieved. This type of audit becomes increasingly important for Energy Savings Performance Contracts. Installing metering devices makes audit follow-up results more credible.

9.3. Types of Energy Audits

The Systems Energy Utilization Committee of ASHRAE, in an effort to promote improved reporting of energy use in commercial buildings, produced a *Guideline for Analyzing and Reporting Building Characteristics and Energy Use in Commercial Buildings, 1992.* Three levels of energy audits are defined, each one including a preliminary energy use evaluation. AHRAE has since issued Energy Assessment and Reporting Methodology, 1999, which provides a procedure for assessing the energy and systems performance of office buildings, banks, hotels, and mixed-use commercial/light industrial buildings. Water audits are discussed in Chapter 13.

9.3.1. Preliminary Energy Use Evaluation

Before beginning an energy analysis, determine the building's current energy use and cost efficiency relative to similar buildings. This effort should include at least 1 year of utility billing data as well as building size and function data. This information is used to determine how much energy is currently used at what cost. It is also used to calculate energy use per unit area for comparison with similar buildings and for comparison to energy targets. By comparing actual use to an energy target, you can determine energy savings potential.

9.3.2. Level 1 Audit

A Level 1 Audit is a walk-through assessment of the existing facility. Conduct a preliminary energy use evaluation followed by a brief survey of the building. In a Level 1 analysis, you identify low-cost/no-cost measures and provide cost and savings estimates of those measures. You should also identify and list potential capital improvements that merit further analysis and provide initial judgments about potential costs and savings.

9.3.3. Level 2 Audit

A Level 2 Audit is an energy survey and analysis. This level should include a more detailed facility survey and energy analysis. You should break down the energy use by end-use category. In a Level 2 analysis, you should identify and provide cost and savings estimates for all practical measures that meet the owner's constraints and economic criteria. Any potential measures that require more thorough data collection or analysis should be identified with initial judgments about cost and savings.

9.3.4. Level 3 Audit

A Level 3 audit is a detailed analysis of capital-intensive modifications. This level focuses on potential capital-intensive projects identified during Level 2 and requires more field data and engineering analysis. Detailed project cost and savings information suitable for making capital investment decisions should be provided.

9.3.5. Choose a Cost-Effective Level

The practical description of what an energy audit includes has to do with how much time will be spent and, therefore, how much the audit will cost. Generally, the more time and money spent, the greater the detail of the study and the more accurate and complete the savings recommendations. However, as in any energy conservation activity, there is a practical limit to how far the energy study should go. The challenge is to determine the level of effort that is most cost-effective. Depending on the objectives and circumstances of the energy audit, the energy manager should develop an audit strategy to maximize the use of time and resources. The usefulness of the different types of audits depends upon the purposes of those audits. The appropriate level of audit depends upon the type of economic justification required to obtain funding. Large-scale MILCON or ECIP projects require extensive economic analyses. Usually, a Level 2 or 3 audit is required to support MILCON and ECIP projects since they are closely scrutinized along the chain of command all the way to Congress.

DSM and ESPC programs usually require extensive audits to ensure accurate calculation of appropriate payments to DSM or ESPC contractors.

9.3.6. Cost of an Energy Audit

For small O&M projects where approval authority is within the scope of the installation, detailed economic justification is often unnecessary. For these projects, a Level 1 audit may be sufficient. Level 1 audits may be accomplished in 1 or 2 days, depending upon the size and complexity of the facility. As a result, they may be accomplished for as little as $500-2,000. Level 2 audits requiring outside assistance may cost $3,000-5,000 per building or more. Level 3 audits for larger facilities may cost $0.10-0.20 per square foot of facility area. More complex facilities (in terms of energy-using systems) will tend toward the higher numbers. Economies of scale make the area-based costs higher for smaller facilities.

9.4. Energy Audit Strategies

There are two different strategies for conducting an energy audit: the "system-based" approach and the "solution-based" approach. Each strategy has its advantages and disadvantages; the best strategy depends upon the audit objectives.

9.4.1. System-Based Audits

The system-based strategy requires the isolation of an entire energy system and its evaluation as a unit. Also, the efficiency of each element within the energy system must be evaluated. A Level 2 or 3 audit is usually required to obtain the needed data. Standard reference points are used for comparing energy system performance. For example, the system-based strategy for conducting an energy audit of a family housing unit would assess a building's "shell" for its insulation value, as well as lighting level, heating and cooling efficiency, kitchen appliances, washer and dryer, hot water, and other electrical equipment. The major standard reference points are temperature settings, e.g., hot water temperatures, lighting levels, and so forth. The system-based approach allows energy managers to minimize the total energy consumption of a house. The following are examples of results of system-based energy audits:

- Building a cogeneration plant based upon an installation's power needs and waste-to-heat recovery economic analysis
- Consolidating individual air-conditioning units into one centralized unit
- Installing Energy Management and Control Systems to maximize

energy efficiency
- Sizing appropriate heating and cooling units.

9.4.2. Solution-Based Audits

The solution-based strategy is relatively easy to implement. This strategy takes advantage of proven energy conservation techniques and applies those techniques where opportunities exist. Normally, Level 1 or 2 audits are sufficient to obtain the data needed. For example, in any building without adequate ceiling insulation, installation can be cost-effective and easy to implement. The solution-based strategy attempts to increase the energy efficiency of each energy-using system component. The following are examples of results of a solution-based approach:

- Replacing incandescent lights with more efficient lights, such as fluorescent, mercury vapor, metal halides, or high-pressure sodium lights
- Weather-stripping cracks and openings in the building's structure
- Insulating the building envelope by replacing single-pane glass windows with double-glazed windows or by adding a layer of insulation to exterior walls and ceilings
- Performing preventive maintenance in accordance with the manufacturer's recommendations.

One of the shortcomings of the solution-based approach is that sub-optimizing a piece of equipment does not necessarily optimize overall system efficiency. This is particularly important for doing HVAC audits. Energy managers should audit HVAC systems as a whole, rather than component by component.

Using a solution-based energy audit, energy managers can target specific energy conservation opportunities without the time-consuming task of preparing a trend analysis of base energy-consumption patterns. Energy managers can use the solution-based approach to start identifying the most attractive energy-saving options.

Certain energy conservation opportunities historically and consistently offer very attractive economic paybacks: fine-tuning HVAC equipment, properly-sizing electric power auxiliary equipment, and retrofitting lighting. Although economic paybacks from these projects depend on the cost of the projects, potential energy savings, and the cost of capital, a good portion of these projects will have a payback of less than 2 years.

Appendix D provides a more comprehensive list of solution-based energy conservation opportunities. Energy managers may need to conduct a Level 1 or 2 audit to calculate economic paybacks.

9.5. Preparing for an Energy Audit

One of the most difficult tasks for the energy manager is setting energy audit priorities among the many opportunities for energy savings. Reviewing past energy consumption patterns provides an historical trend that may identify where most energy is consumed, if the installation is sufficiently metered.

Gathering the necessary energy cost and consumption information can be tedious. However, to prioritize the energy systems audit schedule (based on highest potential energy and dollar savings), collection and analysis of that information is essential. The information analysis helps management to focus and prioritize the workload. Also, that information is needed for calculating the Savings-to-Investment Ratio for energy conservation projects. It is important to plan the contents of the final audit report before carrying out the audit to ensure that the audit gathers the data needed.

Many facilities were audited for energy conservation during the mid-1980s. Those old audit reports can provide good insight into the extent of prior energy conservation efforts, progress made to date and the remaining opportunities for conservation. If any projects were implemented as a result of those previous audits, those early audit reports become a good basis for conducting follow-up energy savings audits.

Higher headquarters energy management offices often issue specific directives and guidance for conducting energy audits. Along with those directives, the offices sometimes set up a separate fund for energy conservation projects and may have good ideas on where and how to conduct an energy audit. In addition, many utility companies offer free energy audits in conjunction with their DSM programs.

9.6. Organizing the Audit Team

Once the scope of an energy audit has been defined, the next crucial task is putting together a qualified energy audit team to perform the audit. It is often difficult to pull qualified engineers and technicians away from their full-time jobs to perform energy audits. This is where the installation commander's management commitment is paramount. If the installation commander is committed to energy conservation, organizing the team members will be easier. While a large audit team with broad experience provides a more comprehensive result, the additional price is time spent organizing and coordinating the team. Ideally, the audit team members should be assigned to the base energy office.

Although many installations contract energy audit tasks (for many different reasons), those contracting actions still take time and resources to manage.

Many utilities offer free or subsidized audits to their customers; however, installation personnel must still manage this process.

Selecting and training in-house qualified engineers and technicians to perform energy audits can pay off at project implementation. The personnel should be sent to energy training courses. Their ideas for developing energy conservation projects must be obtained. Also, ideas from other installations can be obtained by contacting higher headquarters counterparts.

Examples of areas where in-house staff members can participate on the audit team are as follows:

- Lighting analysis: The electrical shop foreman, staff electrical engineer, or technician can assist in conducting lighting surveys.
- HVAC systems and controls: This area is highly technical. Well-trained personnel are essential. The mechanical engineer can provide help, if available. If not, outside help from higher headquarters or contracting sources may be available.
- Building envelope: Civil engineers and architects can help in identifying potential energy savings opportunities.

9.7. Performing the Audit

An important requirement of an energy audit is for qualified personnel to physically inspect buildings and energy systems for inefficiencies. Audit teams should be organized based upon the types of energy systems being audited.

Checklists are effective for ensuring that an audit has obtained all of the necessary information. See Appendix D for checklists for various energy-using systems. The checklists can be modified to meet an installation's specific needs.

Building facilities managers should be part of the audit team. They should be familiar with the workings of different energy systems. More importantly, they must learn how to operate those systems at peak efficiency. Responsible maintenance staff members can also help conduct the audit.

Energy-user involvement is another important part of the energy audit. End users can provide useful information about the past performance of energy systems.

Outside consultants may be needed to provide needed technical depth and experience, especially for Level 2 and 3 audits. Also, contractors may offer the opportunity to complete the audit sooner, especially where existing personnel have limited time to devote to the task. Be sure to select contractors who will work with local personnel, since it is the building monitors, facility personnel, and engineers who know how the facilities are actually operated.

To ensure that energy consumption data are correct, quality control is critical when conducting an energy audit. The proper tools and instruments needed to help accurately evaluate energy systems must be purchased or rented.

9.8. Energy Audit Tools

The types of tools and equipment needed to conduct an energy audit depend upon the level of the data collection and analysis. However, for most audits, the tools are relatively simple and inexpensive. The more expensive equipment can be obtained by renting, if necessary.

9.8.1. Safety First

The primary consideration should always be for safety of the audit team and facility personnel. Never work alone around any energy-using equipment. Appropriate clothing, shoes, and safety glasses are essential. Hearing protectors may be needed in some industrial environments. Electrically insulated gloves will be needed when working with electrical equipment, and asbestos gloves should be worn when working with heated vessels, pipes and other equipment. A mask or respirator may be required in some environments. Energy auditors should be oriented in common environmental hazards and contaminants found in facilities. Exercise caution when working around rotating equipment or extreme temperatures and pressures. Of course, you should never work with or around equipment you are not trained for or familiar with, regardless of your safety equipment.

9.8.2. Field Data Collection

A well-prepared set of pre-printed audit forms may eliminate the need to return to the facility later to collect data that was forgotten. Many experienced auditors prefer to work with a blank notepad and collect only data pertinent to their analysis and recommendations. A tape recorder works well if you have to work alone or in small teams and where forms are not used. Cameras are useful for documenting situations you find. The client could be skeptical of some of the more bizarre discoveries so a picture can create needed awareness and confidence. Video cameras are also useful for follow-up briefings. Photos and videos are also useful in complex facilities for reminding the audit team of what they saw during the site visit, perhaps much earlier and several other projects ago. Some facilities may have security restrictions forbidding photographs or videos, so check before you shoot.

9.8.3. Building Envelope Assessment

Measuring devices such as tape measures, surveyor's measuring wheels, and ultrasonic measuring instruments are useful in taking building, room, vessel, and pipe dimensions. A set of scale drawings of the building or existing facility records may be an easier way to obtain needed building area data, although you should check them for reliability. Sometimes, square footage data are in error because of incorrect measurements or calculations. Flashlights, inspection mirrors and wiping cloths are useful for reading that old, dirty, hard-to-get-to nameplate. Binoculars or a monocular make it easier to see those distant details or that device near the ceiling.

Construction drawings should tell you what insulation was supposed to be put in that enclosed wall or ceiling structure. Infrared thermometers and imaging devices will help reveal heat loss paths in building envelopes and other equipment. In small structures, a blower door provides a means of quantifying infiltration, while a simple smoke generator can reveal air leaks but not quantify them.

9.8.4. HVAC System Assessment

For surveys of HVAC equipment and operation, temperature and humidity can be determined from a sling psychrometer or from digital instrumentation. Infrared thermometer "guns" are convenient for surface temperature measurements. Anemometers and velometers can determine air velocity from which you can estimate airflow rates. Flow hoods can directly measure airflow. Use portable dataloggers for short-term monitoring and diagnostics of HVAC system performance, and temperature and humidity conditions throughout a facility. Combustion analysis of furnaces and boilers can be conducted using a chemical (Orsat) analysis or an electronic tester. With appropriate training, you can assess the proper operation of steam traps using a special "wax crayon" type temperature indicator, stethoscope, or electronic "signature" tester designed for that purpose.

9.8.5. Electrical Assessment

A simple digital voltmeter and clamp-on ammeter should be adequate for most simple electric measurements. However, a wattmeter that takes into account power factor may be useful for more detailed measurements. A power/demand analyzer can provide single or multi-phase, single circuit or whole building data on electrical energy and demand. A power quality analyzer can add analysis of electric transients and harmonic distortion to the electrical data.

9.8.6. Lighting Assessment

For surveying lighting systems, a light meter (illuminance meter) is essential to determine current performance and to compare to IES recommended values. For most purposes, a handheld digital meter is adequate. A simple click counter device, obtainable at an office supply store, is handy for counting fixtures. Operating hour and occupancy monitors can verify lighting operating times and increase reliability of savings estimates which are highly dependent upon this data.

9.8.7. Domestic Hot Water Assessment

For checking domestic water heating systems, an immersible probe thermometer will provide water supply temperature and makeup data. A stopwatch and calibrated bucket provide an inexpensive means to assess flow rates of showerheads and faucet aerators.

9.8.8. Energy Analysis Software

Energy analysis software may be needed to support follow-up analysis of energy conservation opportunities. Level 1 and Level 2 analyses may require only hand calculation or spreadsheet analysis, while a Level 3 analysis may require a more detailed energy simulation tool. Economic analysis or LCC analysis software should be used to support Level 2 and Level 3 analyses. Software such as Federal Energy Decision Screening system may be utilized to assist this process by determining the investment required to meet energy reduction goals.

9.9. The Audit Report

To get the full potential from an energy audit, the results must be documented. At a minimum, the energy audit report should record the types of equipment used in the audit, energy consumption patterns, and potential areas for saving energy. This information will be useful in the future for calculating actual energy savings (by comparing historic consumption data with new data obtained after taking corrective actions). Preparing reports takes time, but it is necessary to ensure that good conservation projects are implemented.

9.9.1. Remember the Purpose

An important function of an energy audit report is to inform decision makers about the audit findings and to convince them to allocate the necessary resources to correct any deficiencies. Using briefing slides to show why the decision makers should commit resources to energy conservation is often an effective way to communicate audit findings.

Rather than on the audit itself, the energy manager should concentrate on the actions to take and explain deficiencies and proposed corrective actions, supporting them with an economic justification. The energy manager must present commanders with convincing and credible options to make it easier for the commander to make the necessary resource allocation decisions.

9.9.2. Characteristics of a Good Report

A good energy audit report will tell readers what they need to know about their current situation and what they should do differently in the future. While some data are interesting, useful, or even necessary to the report, these may not be needed to understand the recommended course of action. For that reason, it is helpful to tell the reader the pertinent information in the executive summary and body of the report and include supporting or potentially useful information in supplements or appendices. Write the report in a clear, concise style, as you would talk to the reader in a one-on-one conversation. Simple, understandable language is better than technical jargon. Use graphs and pictures to make points that would take too many words. A good general outline for an energy audit report is:

a. Executive Summary - Tell the story in a nutshell.
b. Current Situation - Describe current energy use and cost and compare to national/regional averages or energy targets to give an idea of the potential for savings. Describe the facility, its operation, and energy using systems.
c. Recommendations - Tell the reader what should be done differently and why. Give sufficient data or calculations (or reference appendices) to inspire confidence in the accuracy of the calculations and recommendations.
d. Appendices - Include utility histories, rate schedules, detailed calculations or computer printouts, product literature, cost estimating detail, lists of equipment -- anything too detailed for the body of the report but which provides supporting information or details that may be needed in the design or implementation phase or might be useful for future reanalysis.

9.9.3. Presenting the Report

Oral presentation of the audit findings to key personnel can be extremely valuable. Briefings to the commander and staff, engineers and technical personnel, and building monitors and other non-technical personnel can be structured to address each particular audience at an appropriate level. Briefings like these have been used successfully in the Army’s Energy Awareness Seminar program and can improve communication among members of the EMT and accelerate implementation of audit recommendations.

10. Metering

10.1. Key Points

- DoD directs the use of meters with remote metering capability or automatic meter reading (AMR) to manage electricity, water, natural gas steam, and other utilities' usage on all facilities where it is cost effective and practical. Remote metering or AMR should provide the ability for the user to receive at least 60 minute interval data, daily.
- Each Facility, Activity or Installation energy manager should:
    - Determine which facilities in their inventory are appropriate facilities. Appropriate facilities are defined as those for which the Component has determined metering would be cost effective and practical.
    - Justify and document all facilities determined to be exempt from the DoD metering policy.
    - Develop a plan to install a remotely readable meter data collection system for every facility deemed appropriate.
    - Ensure that meters are installed on all new construction and major renovation projects exceeding $200K.
    - Determine cost effectiveness based on when the cost of the meter, installation, and ongoing maintenance, data collection, and data management is less than 20% of the yearly cost of the utility being metered.
- Digital meters are preferred over analog meters.
- To minimize costs, each Component is encouraged to establish meter standards for all meter requirements and provide these to construction material procurement contracts. Established standards will reduce parts inventory, and calibration, maintenance and repair training.

10.2. Utility Metering at Federal Facilities

It is DoD’s policy to maximize energy conservation efforts by investing in products, services, and projects that will conserve energy and water thereby reduce utility costs. DoD fully supports the use of meters to manage energy usage when it is cost effective and practical.

While meters themselves do not constitute a direct energy conservation measure, it is expected that the management of data collected through metering will lead to energy and cost savings. Meter data should be collected, assimilated, interpreted, and made available to facility and energy program managers. This information should serve as the foundation to establishing facility energy efficiency relative to other facilities in the building inventory. It should also serve to identify and confirm opportunities for energy reduction or increased energy efficiency through improved operational procedures, best practices, or energy conservation and retrofit projects as described in chapters 4 and 5. In the event of limited direct appropriations, the metering information should be used to help prioritize projects for fiscal year funding and determine the most suitable means of financing, covered in chapter 14.

Meters are also used for utilities allocation and minimum recommended loads for these meters may be driven by customer requirements rather than energy management purposes. The metering guidelines below do not preclude installing additional meters or sub-meters should a business case analysis justify there use.

Adequate protection must be provided so that information on critical facilities is not compromised.

10.3. Policy Guidelines

By 2012, electricity, natural gas, and water shall be metered on appropriate facilities; steam will be metered at steam plants. Components shall develop an implementation plan to execute the DoD metering policy. Annually, installations should strive to install meters in at least 15 percent of facilities that are in noncompliance with this policy.

Provide utility meters equipped with remote metering capability or automatic meter reading (AMR) on all buildings where cost effective and practical. Remote metering or AMR must provide the ability for the user to receive at least 60 minute interval data, daily. Develop a plan to install a remotely readable meter data collection system and ensure that meters installed with new construction and renovation projects are capable of communicating with the installation’s planned or existing meter data collection system. Include safety switches with all new electrical meter installations to facilitate meter replacement and maintenance.

Cost effectiveness can be achieved where the cost of the meter, installation, and ongoing maintenance, data collection, and data management does not exceed 20% of the yearly cost of the utility being metered. This assumes that the average meter installation will result in at least 2% annual savings in the utility being measured by that meter. Typical utility cost thresholds for cost-effective metering are given below as a guide. Actual conditions will vary. For example, updating an existing meter to have Automatic Meter Reading capability may result in a lower utility cost threshold. The cost of the utilities is based on the utility/fuel rates billed by the utility company, not burdened rates that include government utility operations and maintenance charges.

The yearly cost of utilities at currently unmetered buildings may be estimated using Department of Energy's Energy Information Administration Commercial Buildings Energy Consumption Survey Data, Department of Energy's Facility Energy Decision System (FEDS) software, MIL-HDBK-1133 "Estimating Energy and Water Consumption for Shore Facilities and Cold Iron Support for Ships," tenant billing records, or an appropriate computer model.

The following economic guidance is provided to assist in a consistent determination of appropriate facilities:

Electric and Natural Gas Meters shall be installed in accordance with the following criteria:

Meter type--Digital meters are preferred over analog meters. Electric meters should provide data at least daily and should record at least hourly consumption of electricity.

- **For all new construction projects regardless of programmed cost, and for renovation or energy projects** with **an electrical or natural gas component programmed cost over $200,000—**at a minimum, provide all buildings or facilities with electric and/or natural gas meters equipped with remote metering capability or Automatic Meter Reading (AMR).
- For distribution systems – if daily download of at least 60 minute interval data is not available from utility company service entrance/interval meters, and if determined feasible, provide master meters and meters on the secondary side of sub-stations to enhance energy and utilities management on all utility feeds servicing the installation.
- **For existing buildings, and piers without existing meter sockets**--provide electric or natural gas meters on all **buildings** and piers (or groups of buildings/piers) that have an estimated or actual annual electric or natural gas bill of at least $35,000 per utility feed. It is estimated that the average meter installation will require some installation of a communications system and some labor effort to collect, analyze, interpret and act upon the measured data. It is estimated that the average new meter application will cost approximately $5,000. It is also estimated that the average meter installation will result in at least 2% annual savings. $35,000 per utility feed is the threshold at which the return on investment is predicted by engineering formula to be positive, and therefore economically beneficial for the average meter installation and subsequent effort associated with the collection, interpretation and management of data. For buildings and piers with existing meter sockets, but with meters that do not have remote reading capability, the minimum annual threshold for cost effective metering is $20,000 per utility feed. The estimated cost of retrofitting existing meter sockets for remote capability is $2,000-$3000.

- **Exemptions—**No exemptions will be made for new construction projects and major renovations. Existing buildings may be exempted from this policy provided justification is provided that demonstrates impracticality or an uneconomical determination.
- **Interval meters—**Utility companies use interval meters at the service entrance to an installation for billing purposes. With utility company permission, Defense components should establish a way to have access, on a real or near real time basis, to utility interval metered data to assist in energy management.

Water Meters shall be installed in accordance with the following criteria:

- **Meter type**--Digital meters are preferred over analog meters.
- **For all new construction** projects **regardless of programmed cost, and for renovation or energy projects with a water component programmed cost over $200,000—**at a minimum, provide all buildings or facilities with water meters equipped with remote metering capability or Automatic Meter Reading (AMR).
- **For existing buildings—**components are encouraged to provide meters equipped with remote metering capability or Automatic Meter Reading (AMR) for the following applications:
    - Master meters for all main water sources not metered by a utility company, and main distribution lines on the installation.
    - Central boiler or chilled water plants
    - Barracks, if sub-metering as a group is practical
    - Galleys/Kitchens
    - Golf courses
    - High water use mission infrastructure such as piers/dry docks and vehicle washing stations
    - Any building (or group of buildings)with an estimated annual water and water-consumption-based sewer bill of at least $50,000 per feed.
- **Exemptions—**No exemptions will be made for new construction projects and major renovations. Existing buildings may be exempted from this policy provided justification is provided that demonstrates impracticality or an uneconomical determination.

Steam meters shall be installed in accordance with the following criteria:

- **Meter type**--Digital meters are preferred over analog meters.
- **For all new construction heating or steam plant projects regardless of programmed cost and for renovation or energy projects** with **a steam system component programmed cost over $200,000—**at a minimum, provide central plant meters equipped with remote metering capability or Automatic Meter Reading (AMR).
- **Exemptions—**No exemptions will be made for new construction projects and major renovations. Existing buildings may be exempted

from this policy when justification is provided that demonstrates impracticality or an uneconomical determination. Steam meters may have high maintenance requirements, which will affect the economics.

Housing--Government owned military housing may be sub-metered as a group, rather than individually metered. For privatized housing, meter requirements are determined by the contractor and meters are owned by the contractor.

Meter reading-- Components should initiate maximum use of remote meter reading. All new meters shall be capable of remote meter reading. Components with meters unable to be converted to remote reading should establish a meter maintenance/replacement program to phase out the non-compliant meters over time.

Execution--Each Component should establish policy and specific criteria for installations to establish a metering program. Each policy should address the process to be used for the Component's approval of exemptions. Final approval should be at the Major Claimant or Major Command level.

Resources – The 2% annual meter savings may be used in the Life Cycle Cost Analysis (LCCA) of energy projects that contain meters. Components shall identify funding necessary to carry out their metering plan and report the amount in the Annual Energy Report and via the Planning Programming and Budget System (PPBS). Meter installation may be accomplished using installation utility operation and maintenance funding. Meter installation may also be included in Energy Conservation Investment Program (ECIP) projects where the economics are competitive with other projects being considered, and in Energy Savings Performance Contracts (ESPC) or Utility Energy Services Contracts (UESC).

10.4. Traditional Metering

Energy use metering is an essential component of an energy management program. It provides an energy manager with a wealth of information allowing implementation of measures to improve energy utilization efficiency and eliminate energy waste. While metering in itself does not save energy, it can be the basis for identifying energy waste resulting in energy and dollar savings. The most common type of metering is for electricity, but substantial benefit can also be realized for steam, water, and natural gas.

Traditionally utility metering has relied on analog meters. The result is the familiar round meter that attaches to a meter base using a locking ring. Utility revenue meters are designed to be robust in a variety of environments, resist vigorous attacks from customers, and thwart tampering. While useful for utility companies only concerned with billing, this provides little value for measuring or recording electricity use.

The most common meter, the residential meter, contains built in current transformers (CTs) and potential transformers (PTs), which convert actual current and voltage to a fraction that is within their sensing range. Residential meters are typically for single phase (120/240) voltage service. The accuracy of a CT-rated meter is dependent on the sizing of CTs and PTs.

Kilowatt ratings are recorded on a “register” visible through the meter cover. The traditional meter design uses a clock style register that consists of a number of rotating dials, driven by a small electric motor rotating in proportion to energy use.

Although the basic meter design is capable of more, historically they have mainly recorded cumulative energy use and for some, maximum demand. To add to the basic design’s capability, it is necessary to add registers. Provisions must be made however if they are set to record reoccurring events, such as maximum demand or cumulative use over a specified time interval. Interval metering is accomplished by separating the readings into appropriate intervals.

Although utility metering has been slow to adapt digital or solid state techniques, digital metering offers several advantages. One is that current and voltage measurements can be stored along with the wattage calculation. The advantage of doing the wattage calculation through software is that multiple voltage metering points can be measured using a single PT. A second advantage is the digital meters’ small size, as they can be installed in a space as small as a CT.

Digital meter designs in utility-grade meters allow utilities and users to implement interval metering and a large number of billing alternatives using the standard base and round meter configuration. Utility-grade digital meters with automatic meter reading (AMR) capability have a communication structure that can accommodate other digital inputs. A single digital meter can therefore record and transmit inputs from other sources such as water or natural gas meters, or can send alarms. AMR technology can be added to natural gas and water meters also, enabling them to perform the same function.

10.5. Advanced Metering

Advanced metering describes the use of “smart meters” and submeters that go beyond the basics of measuring demand and consumption but also have the capability of capturing power quality events such as transients, voltage disturbances and imbalances. They also allow queries in near real time and take interval measurements on an hourly or daily basis. Advanced metering is beneficial in determining accurate billing, performing diagnostic maintenance, and enhancing energy management by establishing baselines, developing demand profiles, ensuring accurate measurement for reporting, and providing feedback to users

Submeters within an installation provide additional information to facilitate energy reduction opportunities. Submeters are installed for the purpose of distinguishing between loads, such as buildings or specific zones. Information about the load among buildings or zones within a complex can be used to equitably allocate energy costs. This encourages tenants to be more efficient in their energy use since they are then billed directly for the utility.

Smart meters are invaluable tools in providing utilities and users with quality power monitoring and notification capabilities. An advanced metering system could be set to collect and present energy use information by an agency or facility and report progress toward goals set by legislation or the installation. Meters may also be set to provide emergency and condition alerts via phone, pager, or email.

Smart meters also offer opportunities in operations and maintenance efficiencies. Understanding the way energy is used in a building can lead to operational changes that reduce energy consumption. Data can be trended over time to assess increases in energy use signifying possible equipment running unnecessarily or equipment in need of service.

Advanced meters should be installed at installations where the energy being monitored justifies the cost of installation, maintenance, and reading the meter. Users should also maximize the use of meters capable of remote meter reading, which is available through software resident on an AMR system, Supervisory Control and Data Acquisition (SCADA) system, or Energy Monitoring and Control System (EMCS). Interval meters shall be used where "time of use" (interval) utility rate tariffs are in place or where building electric usage anomalies need to be reconciled.

10.6. Funding Resources

Per the metering policy, Components must determine funding necessary to implement their metering plan and report the amount in the Annual Energy Report via the Planning Programming and Budget System (PPBS). Components should take into account up front costs of metering components, installation, communication system, maintenance, and upgrades. Available funding options include the installation's utility operation and maintenance budget, or including meters and metering systems as part of broader scope Energy Conservation Investment Program (ECIP), Energy Savings Performance Contracts (ESPC), and Utility Energy Services Contracts (UESC).

10.7. Other Publications

In support of federal agencies considering establishment of metering programs, the U.S. DOE Federal Energy Management Program (FEMP) offers a publication on "Advanced Utility Metering." The document provides an overview of options in metering technology, system architecture, implementation, and relative costs. Access to this document and others, including workshops that provide further insight into advanced metering is provided through the FEMP web site at http://www.eere.energy.gov/femp/technologies/om_advmetering.cfm.

11. Energy Conservation in Existing Systems

11.1. Key Points

- To identify where to save energy in existing facilities, first identify where and how energy is currently used.
- There are four fundamental ways to reduce energy costs in existing systems: reduce price, operating hours, load or increase equipment operating efficiency.
- The search for energy savings opportunities is an ongoing task.
- Inadequate maintenance is a major cause of energy waste and the failure of energy conservation measures to achieve energy savings goals in both DoD and the private sector.

11.2. Reducing Energy Use and Cost

Significant energy and cost savings are available through energy management of existing systems. The implementation of new energy efficient technologies in materials and processes is also helping facilities to achieve improvements in productivity, environmental emissions, and quality of service.

Reducing energy use and cost in existing facilities is the primary method for achieving energy reduction goals. While energy goals are specified in terms of energy or BTU reduction, those goals must be met by taking measures that result in energy cost savings, thereby meeting the economic criteria for LCC effectiveness and for project funding. The process of searching for energy- and cost-saving measures is the focal point of an energy audit. However, this search for savings opportunities is an ongoing responsibility of the energy manager, not just a one-time action during an energy audit.

To know where to look for promising energy-saving opportunities in existing systems, it is important to understand how energy is currently purchased and consumed. Energy use and cost can be categorized by type and function. Ranking the end uses based on energy accounting data from most to least significant helps prioritize activities as time and budget constrain efforts to identify projects.

In every category of energy use, consider the four fundamental ways to reduce energy cost:

a. *Reduce the price* of the purchased energy

b. *Reduce operating hours* of the energy using equipment
c. *Reduce the load or the need* for energy
d. *Increase the operating efficiency* of the energy using equipment.

Savings opportunities may be low- or no-cost measures, typically operations and maintenance modifications that will pay back the implementation cost within a single budget year or capital-intensive measures that require multiple years to pay back. Energy system maintenance is specifically addressed later in this chapter. Methods for obtaining funding and for determining whether a measure is life cycle cost-effective are addressed in Chapters 14 and 15.

11.3. Utilities

11.3.1. Primary Utilities

Primary utilities are usually purchased from a utility company: electricity, natural gas, fuel oil, or water. They may also include renewable energy sources like solar, wind, or biomass fuels. Even though not energy utilities, water and sewer utilities are the responsibility of the DoD energy manager and may impact the cost of operating energy-using systems.

One of the first tasks to be accomplished by the energy manager is to look at how a facility uses energy and what it pays for each utility consumed. The performance of an energy audit, as discussed in Chapter 9, will uncover this as well as other factors such as use patterns and peak demand periods. The results of this assessment will lead to recommendations for energy conservation opportunities that reduce both energy and costs. These might include opportunities such as:

- Reduced utility costs through alternate rate schedules or suppliers
- Changes to use patterns or operating hours of equipment
- Use of more energy efficient equipment
- Resizing equipment or distribution systems.

The DoD Components are encouraged to partner with Defense Energy Support Center (DESC) and aggregate regional electricity requirements (including renewable energy) to competitively procure electricity, and ancillary and incidental services needed to meet the identified requirements. Award determinations shall be based on best value compared to the applicable utility tariff available under a Utility Services Contract.

The Department of Defense’s policy also is to competitively acquire Direct Supply Natural Gas (DSNG) under the DSNG Program, managed by DESC, when cost effective and the DSNG has the same degree of supply reliability as other practical alternative energy sources. The DoD Instruction 4170.11 "Installation Energy Management" provides guidance when the DESC and the DoD Components may mutually agree to exclude an installation from a DSNG contract. Reference Chapter 20 of this handbook for other services provided by DESC.

11.3.2 Secondary Utilities

Secondary utilities are energy sources such as steam, chilled water, or compressed air that may be centrally generated using a primary utility and distributed throughout the facility to supply energy to end-use equipment. The following section discusses energy reduction and conservation measures for these secondary utility systems. Maintenance procedures to keep the systems at optimum operating efficiency are also discussed.

11.4. Energy Conservation Measures

It is DoD's policy to maximize energy conservation efforts by investing in products, services, and projects to reduce energy and water consumption. The following provides information on equipment and a number of strategies to assist in achieving Federal goals.

11.4.1. Metering

For DoD, the application of meters and/or sub meters are encouraged as a management enhancement tool to identify energy cost savings attributed to conservation projects, energy systems maintenance activities, energy load management, command leadership or other specific, discrete measures implemented during the year. Usage shall be determined through engineering estimates only when metering proves to be cost prohibitive.

Energy use metering is an essential component of an energy management program. Metering can provide the energy manager a wealth of information that is necessary to effectively track and manage energy use. It can be the basis for identifying energy waste and can result in savings of both energy and dollars. The most common type of metering is for electricity, but substantial benefit can also be realized for steam, high temperature water, and natural gas.

Pending legislation directs the Department of Energy and other Federal agencies to draft a Federal metering policy to increase energy consumption awareness and energy conservation efforts. In support of federal agencies considering establishment of a metering program, the U.S. Department of Energy Federal Energy Management Program has a publication on "Advanced Utility Metering." This publication provides an overview of options in metering technology, system architecture, implementation, and relative costs. Consult Chapter 10 for further detail on this topic.

11.4.2. Building Envelope

The building envelope includes the ceilings, walls, windows (glazing, fenestration), doors, floors, etc., that separate the outside from the inside environment. Note the type of construction, insulation levels, and condition of the building envelope components. Note those components that separate the conditioned from the unconditioned environment. Look for opportunities to r*educe the load or need* for HVAC conditioning by minimizing thermal induction and air infiltration. Energy managers should do careful hourly load analysis and life cycle cost analysis before purchasing and installing any products that claim to reduce heating and cooling loads on the building envelope.

- Are there leaks or openings in the building envelope that could be sealed?
- Should additional insulation be added?
- Can single-glazed windows be replaced with double or triple glazing, or can storm windows be added?
- Can windows and walls be shielded from direct solar radiation by trees, overhangs, or shading devices?
- Are doors and windows properly caulked and weather-stripped? Do they operate properly?
- Could vestibule entrances or revolving doors be added to frequently used entrances to reduce infiltration?
- Are conditioned areas separated from unconditioned areas with doors, plastic strip curtains, or air curtains?
- Should the roof be better insulated?
- Could the roof color be lightened or roof spray cooling be used to reduce solar heat gain through the roof structure? Reducing roof temperature also reduces the air temperature around rooftop HVAC equipment.

The accurate assessment of the building envelope's performance is essential to the success of an energy management program. The "Energy Management Handbook 4th Edition" by Wayne C. Turner provides additional information on quantifying building envelope performance. More comprehensive information is included in the "ASHRAE Handbook of Fundamentals, American Society of Heating, Refrigerating and Air Conditioning Engineers, Inc., 1997."

11.4.3. HVAC System

Heating and cooling systems are the largest consumers of energy in buildings. The primary purpose of the heating, ventilating, and air-conditioning system is to regulate the dry-bulb air temperature, humidity and air quality by adding or removing heat energy. Energy managers accordingly should evaluate the many alternatives available in developing HVAC systems that optimize energy efficiency.

In addressing energy conversation opportunities, it is best to assess what equipment and control systems exist in your facilities. Heating and cooling systems mainly consist of chillers, boilers, cooling towers, and pumps. Although the conventional approach to addressing system upgrades is to look at each component, using an integrated systems approach to address the interaction between components results in a more energy efficient system.

11.4.3.1 Boilers

Boilers and other fired systems, such as furnaces and ovens, are the most significant energy consumers. Over 68% of electricity generated in the U.S. is produced through the combustion of coal, fuel oil, and natural gas. The combustion efficiency of older boilers is generally between 65 and 75 percent, although for inefficient boilers this could be even lower. Energy efficient gas or oil fired boilers can have efficiencies that range between 85 and 95 percent.

Opportunities for reducing the energy consumption include load reduction, waste heat recovery, operating efficiency improvement, energy fuel cost reduction, or combinations thereof. By category, energy conservation measures include, but are not limited to, the following:

Load Reduction

- Insulation of steam lines and distribution system, condensate lines and return system, heat exchangers, and boilers or furnaces
- Repair of steam leaks
- Repair of failed steam traps
- Reduce boiler blowdown
- Repair condensate leaks.

Waste Heat Recovery

- Utilize flash steam
- Preheat feedwater and/or makeup water with an economizer
- Recover waste heat from some other system to preheat boiler make-up or feedwater
- Install condensation heat recovery system.

Efficiency Improvement

- Reduce excess air
- Optimize loading of multiple boilers
- Shutoff unnecessary boilers
- Install more efficient boiler or furnace system
- Clean heat transfer surfaces to reduce fouling and scale
- Improve feedwater and make-up water treatment to reduce scaling.

Energy Fuel Cost Reduction

- Switch to alternate utility rate schedule (i.e. interruptible rate schedule)
- Purchase natural gas from alternate source
- Fuel switching
    - Switch between alternate fuel sources
    - Install multiple fuel burning capacity
    - Replace electric boiler with a fuel-fired boiler
- Switch to a heat pump (for baseline or supplemental heat requirements).

Additional opportunities for boiler energy and cost reduction are discussed in more detail in resources included at the end of this chapter and in Appendix E. The ENERGY STAR® web site at http://www.energystar.gov/products provides a list of energy efficient products, including boilers, as well as other resource information. ENERGY STAR® boilers use about 10% less energy than a standard boiler.

11.4.3.2 Chillers/Cooling Towers

Cooling systems may use as much as a third of the electricity consumed in a building. Optimizing the energy use of the cooling tower/chiller system is one example of using an integrated systems approach to reducing energy consumption. Proper design and operation of these systems can translate into significant savings. Cooling systems for large non-residential type buildings typically employ chilled water as the medium which transfers heat from occupied spaces to the outdoors through the use of chillers and cooling towers.

Chillers. Recent years have seen a lot of improvements in chiller technology, partly because of the demand for higher efficiency (enlarged condensers, enhanced controls, improved compressors) and partly because of better sizing and applications. The minimum efficiency recommended by AHRAE for chillers over 300 ton capacity is 0.68 kW/ton, while the minimum recommended by the Federal Energy Management Program (FEMP) is 0.56 kW/ton. The best available efficiencies available are in the range of 0.47 kW/ton.

There are four types of mechanical compression chillers – centrifugal, screw, scroll, and reciprocating. The most common type of water chiller for large buildings is the centrifugal chiller. Generally older chillers consume twice the energy of newer, more efficient chillers. Existing chillers 10 years and older can have efficiencies less than 0.8 kW/ton and those operating more than a couple thousand hours per year may provide excellent opportunities for energy savings.

In examining HVAC systems for energy conservation opportunities, the less efficient a system is the greater potential for significant energy conservation. Some of the best energy conservation opportunities include chiller retrofitting, resizing, or upgrade.

The operating fluid used may be either a CFC or HCFC type refrigerant. CFC refrigerant production was phased out of law in 1996. Price of CFC refrigerants increase as existing stockpiles reduce. If your existing chiller is less than 10 years old, retrofitting the chiller to operate on non-CFC refrigerants will likely be the most cost effective option. The first step in implementing an integrated chiller retrofit is a preliminary energy audit to assess the savings potential of various efficiency measures. Many chiller manufacturers offer retrofit kits and should be contacted to determine your chiller's requirements.

Chillers are frequently oversized and cost more to operate due to substantial energy losses from excessive cycling. Appropriate sizing is critical to achieving maximum energy savings. Those in poor condition result in significant downtime and increased operating and maintenance costs. Replacing your existing chiller with a smaller, energy-efficient one that matches the newly reduced loads and uses compliant non-CFC refrigerants may be more cost effective. The FEMP web site contains information on how to buy energy-efficient air cooled and water-cooled chillers.

In some cases, replacing components of a chiller system will result in improved system efficiency and increased cooling cost savings. Consider cooling tower improvements and a free cooling or water side economizer system.

Cooling Towers. Heat generated from central cooling systems must be rejected outside the building. Cooling towers, which are specialized heat exchangers, function to transfer heat from the condenser side of the chiller to the outside air by spraying the hot water through a flow of outside air. Forced draft and induced draft cooling towers utilize a surface contact medium or fill to increase contact surface and improve the transfer of heat between hot water from the chiller and the outside air.

An improperly maintained cooling tower will produce warmer cooling water, resulting in higher condenser temperatures. This in turn reduces the efficiency of the chiller, wastes energy, and increases costs. The chiller will consume 2.5% to 3.5% more energy for each degree increase in the condenser temperature.

Scaling, corrosion, and biological growth also impede cooling tower efficiency and increase maintenance costs from the resultant condenser fouling and loss of heat transfer. In the past, chemical treatment has been used to mitigate these type problems. However new non-chemical treatment technologies such as ozone generators, magnetic systems and ultraviolet irradiation, are available.

11.4.3.3 Variable Speed Drives (VSDs)

Centrifugal chillers are typically driven by fixed speed electric motors. Chillers that utilize variable speed drives have greater efficiencies than single speed chillers. Chiller efficiency can be further enhanced if in addition to variable speed the system can also change the temperature of the condensing water depending on the load on the chiller. Two-speed and three-speed fan motors, in combination with fan cycling, provide an improvement in control and efficiency over fan cycling alone.

Variable speed drives (VSDs) provide the most efficient method of control to reduce power consumption and provide adequate water cooling capacity. Cooling tower fans also offer similar energy saving opportunities. Fan power is proportional to the cube of the airflow rate; thus a reduction of 20 percent in fan airflow and speed will correspond to a reduction of 49 percent in fan power.

11.4.3.4 Free Cooling/Water Side Economizers

Under the right conditions, a free cooling system can generate significant energy savings. Free cooling is using the cooling tower water to cool supply air or chilled water is referred to as a water side economizer system. In cooler, drier climates, water side economizers can provide over 75% of cooling requirements; in warmer climates, they may provide only 20%. This energy saving technique is a potential retrofit for existing older buildings.

There are several methods of free cooling available. The most common method of free cooling is indirect free cooling which uses a separate heat exchanger. It allows a total bypass of the chiller, transferring heat directly from the chilled water circuit to the condenser water loop. A less common method is direct free cooling, where the condenser and chilled water circuits are linked directly without the use of a separate heat exchanger. Facilities that require year round cooling from high sensible heat gains would mostly benefit from direct free cooling.

When ambient outdoor conditions are ideal, the chiller can be shut off and cooling load may be carried exclusively by the cooling tower. When the outside air is cooler than the cooling temperature set point, only distribution energy is required to provide cooling. Dramatic results in energy consumption can be produced by this measure.

11.4.3.5 Pumps

For buildings that use pumps to transport chiller or condenser water, an integrated systems approach can reduce pumping system energy by 50 percent or more. Energy efficient measures include:

- Replacing oversized impellers, pumps, and motors with correctly sized pumps and smaller more energy efficient motors
- Installing variable speed drives (VSDs) on pump motors
- Converting single-loop configurations to primary-secondary loop configurations.

Operated at less than design flow rates, conventional single-speed pump and throttling valve systems waste energy. Pressure drop losses can be avoided by driving pumps at variable speeds and those powered by VSDs can operate without incurring an energy penalty of the conventional arrangement. Variable speed drives are normally suited for pump ratings of 20 to 500 Hp and larger.

Other HVAC energy conservation opportunities that can be implemented include:

- Raising chilled water temperature – The energy input required for any liquid chiller increases as the temperature lift between the evaporator and the condenser increases. Raising the chilled water temperature will cause a corresponding increase in the evaporator temperature and thus decrease the required temperature lift.
- Reducing condenser water temperature – Reducing condenser water temperature can produce a similar effect as raising chilled water temperature, namely reducing the temperature lift that must be supplied by the chiller.
- Reducing auxiliary power requirements – Since energy cost is not limited to chiller cost operation only, reducing the requirements for cooling tower fans, condenser water circulating pumps, and chilled water pumps as much as possible should also be considered.

Look for ways to *reduce operating hours, reduce the load or need* for space conditioning, and *increase the operating efficiency* of the

HVAC equipment. Other general considerations for HVAC systems include asking the questions:

- Does the operating schedule of the system correspond to the occupancy of the facility?
- Are time clocks used and are they properly functioning and coordinated to the schedule?
- Are thermostat settings proper to maintain productivity and comfort while minimizing energy?
- Is the proper amount of ventilation air provided to meet ASHRAE standards for indoor air quality?
- Can ventilation air quantity be varied based on comparison of indoor and outdoor conditions to minimize the energy required to condition the air (airside economizer)?
- Is reheat energy used only where necessary?
- Is the system sized properly for the load?
- Does the system deliver the conditioned air where intended?
- Are ducts adequately sealed and in the conditioned environment where possible?
- Is the system properly balanced and maintained?
- Could a variable volume system be used to reduce energy use?
- Are filters changed regularly and heat transfer surfaces clean and unrestricted?

11.4.4. Lighting System

The lighting system consists of the lamps, ballasts, fixtures, and controls necessary to provide adequate illumination for the visual task. Skylights, windows, and building interior surfaces all interact with the lighting system and affect its performance in some way. Inventory lighting equipment space by space, noting the type of fixture, lamp type, and wattage; ballast type, if appropriate; and type of control. Record the operating hours, state of maintenance, and characteristics of the space that affect performance of the lighting system. Calculate the Unit Power Density (UPD) of the existing lighting system in watts per square foot and compare to current ASHRAE/IES standards for energy-efficient buildings. Current technology allows UPDs of 1.0-1.5 watts per square foot in commercial buildings while maintaining IES recommended illuminance. Measure illuminance at task locations and note for comparison with IES recommended illuminance. Interview occupants, if possible, to assess their reaction to the existing lighting system.

Look for opportunities to *reduce the operating hours*, *reduce the load or need* for artificial light, and to *increase the operating efficiency* of the lighting equipment. Consider the following:

- Are lights turned off when the space is unoccupied?

- Could occupancy sensors, timers, photocells, or other control systems be used to ensure lights are only on when needed?
- Is illumination excessive compared to IES recommendations for current use of the space?
- Is available day lighting used effectively to displace artificial lighting?
- Could task lighting be used to reduce the need for general (ambient) lighting?
- Could the existing lamps/ballasts/fixtures be replaced with more efficient components or systems to supply the need for lighting with less energy? Consider the quality of light (uniformity, visual comfort/glare, color temperature, color rendition) when making recommendations for change.
- Is the system properly cleaned and maintained to ensure operation at peak efficiency?
- Could group re-lamping be combined with a scheduled maintenance program to reduce maintenance costs and maximize overall energy efficiency?

Studies reveal that 20-30% of energy consumed in commercial building is related to lighting systems. An energy efficient lighting system can reduce excess heat and energy and can also improve lighting quality and employee productivity. Numerous options are available for consideration when designing lighting system retrofits or when designing new buildings.

Because nearly all buildings have lights, opportunities for lighting retrofits are very common and generally offer an attractive return on investment. Due to substantial advances in lighting technologies, lighting retrofits can reduce energy expenses while improving lighting quality and worker productivity. Various energy-efficient retrofit options are presented below:

- Incandescent Lamps are the oldest lighting technology but are considered the least energy-efficient. They are also the least efficacious (have the lowest lumens per watt) and have the shortest life. Consumers purchase incandescent bulbs due to their low initial cost, however if life cycle cost analysis is performed, these lamps are usually more expensive than other lighting systems with higher efficacies.
- Compact Fluorescent Lamps (CFLs) are energy-efficient, long lasting substitutes for incandescent lamps. CFL technology improvements have been occurring consistently since they became available commercially, and in most applications they are excellent replacements for incandescent lamps. They can last up to 10 times longer, typically providing an attractive return on investment. Typical applications for CFLs are outdoor lighting and security lighting where they run steadily for extended periods.

- Fluorescent Lamps are the predominant type used in commercial and industrial spaces in the U.S. They are relatively efficient, have long lamp lives, and are available in a variety of styles. The four foot T-12 lamp is the most common fluorescent lamp used in offices today, but they are being rapidly replaced by T-10 and T-8 lamps. Energy efficient T-8 lamps are more expensive than the T-12 lamps, however they provide 98% as much light and use about 40% less energy when installed with an electronic ballast.
- Electronic Ballasts - When replacing standard fluorescents with the more energy efficient T-8s, it is necessary to replace the existing electromagnetic ballasts with the electronic ballasts, which operate at higher frequencies and convert power to light more efficiently. Energy saving electromagnetic ballasts can cut fluorescent lighting energy consumption by as much as 10%. The life of these ballasts is approximately twice that of their conventional counterparts.
- High Intensity Discharge (HID) refers to lighting provided by mercury vapor, metal halide, and high-pressure sodium lamps. Although originally designed for outdoor and industrial uses, HIDs are also used in offices and other indoor application. The principal advantage of mercury vapor HID lamps is their long life, although they are only slightly more efficient than incandescent lamps.
- Reflectors – Highly polished retrofit reflectors are being marketed for use with existing luminaries (light fixtures) and can achieve a 50% reduction per fixture. Installing reflectors in most luminaries can improve its efficiency because light leaving the lamp is more likely to reflect off interior walls and exit the luminaire. Although the luminaire efficiency is improved, the overall light output from each is likely to be reduced, which will result in reduced light levels. To ensure acceptable performance from reflectors, measure “before” and “after” light levels at various locations in the room to determine adequacy.
- Lighting Controls – Maximum energy efficiency cannot be achieved without effective controls. Modern lighting controls provide benefits ranging from energy savings and electrical demand, to better support of the functions from which the lighting is needed. Manual controls should be used in spaces that accommodate different tasks or that have access to daylight. Occupants should be encouraged to shut lights off when they are not needed. Automatic controls such as occupancy sensors are available for turning off lights in unoccupied areas, while auto-dimming controls adjust light levels to existing daylight. Scheduling controls activate, extinguish, or adjust according to a predetermined schedule.
- LED Lighting - Light Emitting Diodes (LEDs) is one of today’s fastest evolving lighting technologies. LED light sources are more efficient than incandescent and most halogen light sources.

White LEDS today can deliver more than 20 lumens per Watt, and are predicted to achieve greater than 50 lumens per Watt by 2005. Other inherent features of LEDs include very low power consumption and virtually no heating effect, making it ideal for a wide range of new and existing applications. Due to the decrease in energy used for the lighting of a building, air handling costs drop, generating both additional initial and ongoing investment savings. Another advantage of LEDs over conventional lighting is that light emitted from an LED is directional. Incandescent, halogen, or fluorescent lights are omni directional, emitting light in all directions. Lighting must be redirected using secondary optics or reflectors. Each time a light beam is reflected it looses some of its intensity, resulting in fixture losses typically from 40 to 60%. The directed nature of LEDs can result in fixture efficiencies of 80 to 90%, requiring less total lumens to provide the same level of illuminance.

11.4.5. Office Equipment and Plug Load

Office equipment or plug load consists of the computers, monitors, printers, photocopiers, facsimile machines, televisions, refrigerators, vending machines -- virtually any equipment that gets "plugged in" to electrical receptacles in the space. Energy efficient office equipment provides equivalent or better performance than standard equipment to users but using significantly less energy. Energy use in the office has increased significantly in recent years due to rapid growth of microcomputer use. This has led to a corresponding increase in energy required to operate this equipment and associated loads on heating, ventilation, and air conditioning systems. Federal guidelines have been established to promote energy efficiency in the acquisition, management, and use of microcomputers and associated equipment.

Plug load power density in watts per square foot may exceed the lighting UPD in some areas of the facility. It is essential to make sure that plug load energy is not ignored. The Energy Manager should inventory major equipment, noting wattage where available. If wattage is estimated from nameplate voltage and current, multiply by 0.3 for an estimate of actual average operating power. Primarily look for ways to reduce operating hours of existing equipment and to influence customer selection of properly sized energy-efficient equipment in the future.

The ENERGY STAR® program, established by EPA in 1992 for energy efficient computers, provides on its web page, a list of products meeting its strict criteria for energy efficiency and other environmental benefits. Also consider the following in attempting to manage office equipment and plug load:

- Are computers, monitors, printers, copiers, and other electronic equipment left on at night?
- Is EPA ENERGY STAR® equipment specified for new purchases?
- Does existing ENERGY STAR® equipment have its capability enabled at system startup?

Everyone can save energy and money by enabling power management on their computer monitors. With over 55 million office computers in the U.S., EPA estimates that over 11 billion kWh could be saved through monitor power management.

Free software provided by the EPA automatically puts monitors to rest when not in use - saving a significant amount of energy and money. What's more, monitor power management will not affect computer or network performance.

NOTE: See section 11.4.20 ENERGY STAR® products.

11.4.6. Domestic Hot Water (DHW) System

Domestic hot water systems are used to heat water for hand-washing, bathing, cooking, cleaning, and other potable hot water uses. Systems may be simple, self-contained water heaters or complex, site-built systems with extensive recirculation distribution systems.

The creation of domestic hot water (DHW) represents approximately 4% of the annual energy consumption in typical non-residential buildings. Where sleeping or food preparation occurs, this may increase to 30% of total energy consumption.

A typical faucet provides a flow of 4 to 6 gallons per minute (gpm). Substantial savings can be realized by reducing water flow. Purchasing reduced-flow faucets or adding a faucet aerator is a cost-effective way to save water. Self-closing and metered faucets shut off automatically after a specified time, or when the user moves away, resulting in significant water savings. Faucet aerators replace the faucet head screen, lowering the flow by adding air to the spray. High-efficiency aerators can reduce the flow from 2-4 gpm to less than 1 gpm at a fraction of the cost of replacing faucets.

It has been shown that reductions in DHW temperature can also save energy. Since most users accept water at the available temperature regardless of what it is, water temperature can be reduced from the prevailing standard of 140 degrees Fahrenheit (F) to a 105 degrees F utilization temperature, saving up to one half of the energy used to heat the water.

An often overlooked energy conservation opportunity associated with DHW is the use of solar energy for water heating. Unlike space-heating, DHW needs are relatively constant year round and peaks during hours of sunshine in non-residential buildings. Year round use amortizes the cost of initial equipment faster than other active-solar options. Also consider:

- Could a lower cost energy source be used for heating water?
- If use is high year round and conventional energy sources are relatively expensive, solar water heating may be practical.
- Is hot water delivered at the lowest possible temperature to meet the load and maintain health requirements?
- Are tanks and distribution lines properly insulated?
- Is water use minimized by use of low-flow showerheads and faucet aerators?
- Could self-closing faucets be used?
- For recirculation systems, is the circulation pump shut off or the system temperatures reduced during low-use periods?

11.4.7. Process Systems

The process system will vary greatly based on the type of facility. In food service facilities, the process system will consist of food preparation, storage, cooking, and associated cleanup equipment. In manufacturing facilities, the process system is that used to manufacture the product. In industrial facilities, the process system typically represents the largest component of energy use. While studies have shown that the potential for process re-engineering to reduce energy use is tremendous, process re-design is outside the scope of most energy audits.

Talk to facility maintenance personnel to get their input into how to reduce energy use in the process. Inventory major equipment and note operating schedules. Look for ways to *reduce the price* of energy by rescheduling equipment.

- Could big electrical loads such as fork lift battery chargers and arc welders be rescheduled for off-peak times?
- Major savings in process energy are frequently found in secondary utilities generation and in reducing leaks in distribution systems throughout the plant.
- Large thermal loads coincident with high electrical demand year round for two and three shift plants may indicate potential for cogeneration of thermal and electric energy. Look also for ways to reduce the load or need for energy and to increase the operating efficiency.

- Could heat be recovered from one process or component and used to reduce use of another?
- Could heat-generating systems be removed from the air-conditioned environment?
- Should insulation be added, repaired, or replaced?
- Could process temperatures or pressures be modified?
- Could the efficiency of electric motors or drive systems be increased?

11.4.8. Steam Systems

Energy savings can often be realized through the installation of more efficient steam equipment and processes. Upstream inefficiencies will affect process heating and cost of producing steam; while downstream inefficiencies (leaks, bad traps, poor load control) can also affect process heating and have severe effects on the boiler and cost of producing steam. Opportunities for energy reduction can be found in implementing some of the following actions:

- Generating steam through boiler controls, water treatment, and cogeneration.
- Checking steam leaks and bad insulation.
- Replacement of faulty steam traps.
- Optimizing excess air in the boiler for more efficient steam generation.
- Ensuring an effective water treatment system is in place.

Steam traps are an important element of steam and condensate systems and may represent a major energy conservation opportunity. Steam traps are automatic valves that allow condensate formed in the heating process to be drained from the equipment. They also remove non-condensable gases from a steam space. Inefficient removal of condensate and non-condensable gases almost always increases the amount of energy required by the process because these act as insulators and thereby reduce system efficiency.

Although monitoring equipment does not save energy directly, it does identify the status of failed steam traps. The rate of energy loss is related to the size of the orifice and system steam pressure. The maximum rate loss occurs when traps fail with valves stuck in the open position. The orifice could be any fraction of the fully open position.

Water losses will be proportional to energy losses when condensate is not returned to the boiler. Even when condensate is returned to the boiler, if steam bypasses the trap and is not condensed prior to arriving at the deaerator, it may be vented out of the system along with non-condensable gases. This translates to a reduction in heating capacity and a reduction in steam system efficiency.

11.4.9. Electric Motors

Electric motors are a subcomponent of many energy-using systems. The majority of electrical energy in the United States is used to run electric driven motor systems. Motor systems consume about 70% of all the electric energy used in the manufacturing sector. Although motor systems consist of several components, most programs have focused on the motor component to improve motor system energy efficiency. Studies have shown that opportunities for efficiency improvement and performance optimization are actually much greater in the other components of the system, such as the controller, the mechanical system coupling, and the driven equipment.

Although motors tend to be quite efficient in themselves, several factors can contribute to efficiency gain. An electric motor performs efficiently when it is maintained and used properly. The “Energy Management Handbook 4th Edition” by Wayne C. Turner provides reference to “The Motor Performance Management Process (MPMP),” a tool to evaluate, measure and most importantly manage electric motors. It is deemed to be a logical, systematic and structured approach to reduce energy waste.

The largest energy use and best potential for cost-effective savings will typically be for larger three-phase asynchronous motors that can be modified or replaced independent of the equipment they serve. Inventory all 1-HP and larger motors, noting motor size, nameplate data, operating hours, age, drive system type, etc. Consider the following:

- Turning off unneeded motors – there may be ceiling fans on in unoccupied spaces, exhaust fans operating after ventilation needs are met, or cooling tower fans operating when target temperatures are met.
- Look for ways to reduce motor system usage.
- Consider replacement of motors with more energy efficient ones versus rewinding, especially for those with high operating hours.
- Is the drive system properly adjusted?
- Could V-belts be replaced with grooved belts or cogged belts to reduce drive system losses?
- An optical tachometer can be used to determine revolutions per minute (RPM) under load and no-load conditions to assess the size of the motor relative to the load. Could the motor size be reduced to increase the operating efficiency and power factor?

To assist energy managers with motor selections and performing savings analysis, the U.S. Department of Energy provides a software tool, MotorMaster+. The software has many capabilities including that of calculating efficiency benefits for utility rate schedules with demand charges, based upon peak kVA or kilowatt readings. Additional information on the tool can be found from links on the DOE's Energy Efficiency and Renewable Energy (http://www.eere.energy.gov) web site.

11.4.10. Energy Management Control System (EMCS)

The DoD Components are encouraged to apply EMCS or other energy management technology on all new and existing system expansion applications subject to funding availability and cost effectiveness. The DoD Components shall ensure that installed systems are provided with the necessary O&M support to maintain efficiency and resultant savings. EMCS implementation using shared energy savings contracts, which provide continuous O&M through the contract term, is an option to assure adequate O&M support.

The objective of an Energy Management Control System (EMCS) is to obtain an optimal level of occupant comfort while minimizing energy consumption and demand. This is achieved by the control of energy consuming devices such as fans, pumps, heating/cooling equipment, dampers, and thermostats.

A direct digital control (DDC) EMCS functions by measuring a variable (such as temperature); comparing the variable to a given setpoint; and then signaling a terminal device (such as a damper) to respond. Manually toggling on and off devices based on need evolved to simple time-clock and thermostat based systems, which are still in use today. A DDC EMCS can be programmed for more customized monitoring, control, and sequencing of HVAC and lighting systems. Terminal devices are now able to respond quicker and with more accuracy to a given setpoint, optimizing the use of energy. Additionally such systems can lead to improved environmental comfort and air quality.

Installation of an EMCS does not guarantee that a building will save energy. Commissioning is critical to the optimal operation and realized potential savings. Some of the possible energy conservation strategies are provided below.

- Scheduling provides for optimal start stop schedules for each piece of equipment.
- Chiller/boiler optimization schedules the equipment to maximize efficiency by giving preference to the most efficient item.

- Demand limiting interfaces EMCS with equipment controls to reduce maximum capacities in several steps.
- Temperature resets control temperatures of supply/mixed air and hot/chilled water to optimize system efficiency.
- Alarm monitoring and reporting for conditions such as manual override of machinery, high or low temperatures and equipment failures.

11.4.11. Building Commissioning

Building commissioning has become very important in an energy management program. It can offer facility owners a high potential of savings with minimal or no capital investment. Commissioning is the systematic process of optimizing building systems so that they operate more efficiently. Ideally commissioning should begin from the pre-design phase through the construction and acceptance phases of a new building.

When applied to existing buildings, this process is called retrocommissioning. Retrocommissioning seeks to improve the functionality of equipment in existing buildings and optimize the way they operate together to increase occupant comfort and reduce energy waste. Although priorities by building owners may vary, retrocommissioning usually focuses on energy-using equipment such as lighting, HVAC systems, and related controls.

Many existing buildings have operation and maintenance (O&M) problems. Retrocommissioning offers the opportunity to find and correct those problems. In many cases, the resulting energy savings alone make retrocommissioning a viable business investment.

Retrocommissioning is completed in several phases. To begin the process, it's important to first identify potential buildings to be analyzed. Secondly an on-site assessment should be conducted to determine how systems are supposed to operate and how they are actually operating. Deficiencies found are documented. Then based on priority, the most cost effective opportunities are selected, operational deficiencies are corrected, and proper operation verified. The last phase involves turnover or handing off the improved systems to the facility owners and operators for continued operation.

It is important to have an accurate determination of actual energy consumption prior to implementation of any retrofits. This data is obtained from data loggers, long term interval metering data, or utility bills. If reliable data is unavailable, basic metering should be installed to collect this baseline data.

The Continuous Commissioning® process involves the many of the same elements as commissioning and retrocommissioning. Its goal is to optimize the HVAC system operation and control to minimize building energy consumption and maximize comfort based on the current building conditions and requirements. In addition, metering is installed to gather pre and post energy use. Data is then continuously compared to post-commissioning benchmarks. The goal of continuous commissioning is to ensure systems continue to operate optimally.

Problems that can be identified by the commissioning process include but are not limited to:

- Variable or adjustable speed drives that no longer adjust properly
- Components operating more or less than necessary
- Controls that are out of calibration
- Energy management systems that are not being used to their full potential or capabilities.

Some of the benefits include:

- Energy and cost savings
- Reduction in comfort complaints
- Increased equipment life
- Reduction in time spent on emergencies and equipment failure rates
- Elimination of targeted indoor environmental quality problems.

An excellent resource and one of the most comprehensive sources on building commissioning, is the Federal Energy Management Program's *Continuous Commissioning*[SM] *Guidebook for Federal Energy Managers*. Full reference information on the Guidebook is provided in Appendix E. This guide provides detailed discussion on basic commissioning measures in addition to those for air handling units, water/steam distribution, central heating and chiller plants, and thermal storage systems. The guidebook is available for downloading through the FEMP web site.

A list of commissioning providers is available through the Building Commissioning Association (BCA) at http://www.bcxa.org. Additional resources on commissioning are available through the CCB and at http://www.peci.org.

Note: Continuous Commissioning® is a registered trademark of the Texas Engineering Experiment Station, Texas A&M University.

11.4.12. Cool Roofs

Researchers for the Heat Island Project at Lawrence Berkeley National Laboratory (LBNL) define cool roofs as those that “reflect solar radiation and emit thermal radiation well.” Cool roof systems are beneficial because they can save money and energy during peak cooling periods. This benefits electric utilities and, ultimately, all utility customers, who will see reductions in their cooling costs and the “heat-island effect.”

In an article published in “Professional Roofing” magazine in October of 1998, scientists with the Heat Island Project at Lawrence Berkeley National Laboratory (LBNL), Berkeley, Calif., have been studying the effects of roof system color and type on the energy used to cool a building. The results of this research indicate that roofing professionals should consider the reflectance and emittance (i.e., how well a material releases heat it absorbs) of the roof systems they install. In a study funded by the U.S. EPA, the Heat Island Group carried out a detailed analysis of energy-saving potentials of light-colored roofs in 11 U.S. metropolitan areas. About ten residential and commercial building prototypes in each area were simulated. They considered both the savings in cooling and penalties in heating. They estimated saving potentials of about $175 million per year for the 11 cities.

There are three properties to look for when selecting a roof material to reduce building cooling load: 1) high solar reflectance, 2) endurance of high reflectance over time, and 3) high emittance. Roof products that have earned the ENERGY STAR® can reduce building energy use by up to 50%. They work by reflecting more of the sun's energy back into the atmosphere, keeping your building cooler and reducing your air conditioning bills. With rare exceptions, cool roofs are only cost effective when an old roof is in need of replacement or during new construction. A cool roof should be approximately the same cost as replacing an old roof and in some cases may be actually less than the cost of replacing the old roof since the old roof does not have to be removed. This results in less environmental damage also since the old roof does not have to be hauled to a landfill.

The Navy’s Technology Validation Program (https://energy.navy.mil, then select “Techval”) is currently partnering with LBNL to demonstrate and validate the long term application of cool roof coatings to save the Navy money both on energy bills and maintenance. Further information on the Program is provided at the end of this chapter.

Cool roof coatings are coatings that are applied to the roof of a building to reflect the heat of the sun rather than absorb it. The greater the level of heat absorbed by a building's roof, the more cooling required removing the heat. A dark roof can be as much as 90 degrees hotter than the air temperature on a sunny day, whereas cool roof coatings have a temperature rise of as little as 15 degrees. This translates to a reduction in energy consumption and costs. Energy savings of 13 to 40% have been shown on buildings with cool roof coatings. Lawrence Berkeley National Laboratory and the Oak Ridge National Laboratory with funding from DOE and EPA have both done research proving that this technology works.

The "roofing calculator" at the ENERGY STAR® web site is intended to roughly estimate the savings a reflective roof can offer to a typical building and aid in the decision whether to choose a reflective roof. Refer to that site for additional information.

11.4.13. Daylighting

Daylighting is one of the most cost effective and environmentally responsible lighting techniques available today. It is the process of using natural light to illuminate buildings. As opposed to utilizing fluorescent lighting, daylighting brings indirect sunlight into the building. Daylighting can save money on energy bills by slashing both lighting and cooling costs.

The Daylighting Collaborative, created in 1995 by the Wisconsin Public Service Commission, defines the technique of "cool" daylighting as an integrated approach that uses natural light to reduce the need for electric lighting, while also reducing solar heat gain and glare. Cool daylighting controls the amount of light entering a building with several key techniques:

- Exterior shading
- Carefully placed windows
- Low-transmittance glass
- Window blinds
- Paint and fabric colors.

New control technologies and improved daylighting methods allow conservation of energy and for optimization of employee productivity. The above referenced information, as well as additional resource information, can be found at the www.daylighting.org web site. Additional information on daylighting techniques can be found through the Building Technologies Department at LBNL, which develops window, lighting and glazing technologies that save energy and maximize visual and thermal comfort of building occupants. Their web site is found at http://eetd.lbl.gov/BT.html.

The Navy's Technology Validation Program (https://energy.navy.mil, then select "Techval") will be demonstrating daylighting in FY05.

11.4.14. Thermal Energy Storage

Thermal energy storage (TES) is the concept of generating and storing energy and shifting energy usage to a later period to take advantage of cheaper time-based utility rates and/or to reduce overall energy demand. TES technologies significantly reduce energy costs by allowing energy-intensive cooling equipment (i.e., chillers, rooftop units) to be predominantly operated during off-peak hours when power rates are lower. It should be noted however that due to the inefficiencies inherent in storing thermal energy that this technology results in greater energy use. It can show cost savings if the utility rate structure has an off-peak savings for energy use or demand charges.

Thermal energy storage has the potential to balance the daily loads on a cooling system. By running the chillers during off-peak hours and storing the capacity for use during on-peak hours, a reduction in energy costs can be realized. If a TES system is implemented during new construction or retrofit projects, smaller chillers can be purchased and installed since it would no longer need to be sized for peak loads.

In the United States, the primary use of thermal energy storage is for cool storage since summer air conditioning is the dominant electric load. Cooling storage mediums of choice are water, ice, and eutectic salts.

There are generally two types of storage systems – full storage and partial storage. Full storage systems shut the chiller down during on-peak times and run completely off the storage system. Partial storage systems supplement chiller during on-peak times. Full storage systems have a higher initial cost, but do realize greater savings than the partial system since the chiller is completely off during on-peak times.

Yuma Proving Ground, AZ has successfully operated an external-melt ice-on-coil storage cooling system with nominal tank storage capacity of 1050 ton-hr for the past 12 years. The objective of the system was to eliminate the electrical demand of the 220-ton chiller during the peak window of 1200-1600 hours. Supplementing the existing chilled water system resulted in yearly net savings of $22,450 in electrical utility costs.

A 2.25 million gal (8,517 m3) chilled water storage cooling system for the Central Energy Plant (CEP) #2 at an Army installation has been in operation since May 1996. The system was able to shift more than 3 MW of electrical demand from the on-peak to off-peak period during its first year of operation resulting in electrical cost savings of $430,000. Details can be found on this and other TES applications at the Publications link at the U.S. Army Corps of Engineers Construction Engineering Research Laboratory web site at http://www.cecer.army.mil.

The Air Conditioning Contractors of America (ACCA) Educational Institute at web site http://www.acca.org/tes/ contains additional articles on TES, as well as links to other sites. The ACCA Educational Institute is working with DOE's National Renewable Energy Laboratory (NREL) at http://www.nrel.gov/ to promote usage of TES applications and its benefits.

11.4.15. Solid State Power Conditioners

Another application being investigated by the Navy Tech-val Program is one to demonstrate and validate the performance of power conditioners for demand and energy reduction. Power conditioners are electrical add-on devices that can provide a solution to power quality problems. Power conditioners usually address power quality problems such as power factor, harmonics, and voltage balancing, as well as electrical protection concerns over surges, spikes, and sags. Manufacturers have identified common commercial applications that yield about 10% or more in energy and demand savings. Due to the use of industrial systems such as chillers, ventilation fans, and pumps throughout naval facilities, the application of this power conditioning technology has the potential for significant savings in energy and costs.

11.4.16. Natural Gas Chillers

A recent Navy and Marine Corps demonstration program has installed eighteen natural gas chillers and sixty-seven natural gas engine driven heat pumps at Navy and Marine Corps facilities nation-wide. Old, inefficient cooling equipment, including steam absorption chillers, electric chillers, and package air conditioning units have been replaced with approximately 6,132 tons of natural gas cooling technologies and 2,100 tons of new electric chillers. The total projected cost avoidance is estimated to be over $850,000 per year.

Although gas fired chillers cost more than their electrical driven counterparts, this cost can often be recouped through reductions in electricity demand and infrastructure costs. But gas chillers aren't as efficient or generally as cost effective as electric driven ones, the energy manager should perform a thorough life cycle cost analysis. Gas chillers may be cost effective in areas where gas prices are low and electric rates are high. Indirect fired steam absorption chillers may be very cost effective where a source of waste heat is available that is not currently being used. Screening tools are available through a variety of web sites, one being that for Xcel Energy at http://www.xcelenergy.com.

11.4.17. Magnetic Bearing Compressors

The magnetic bearing compressor is an oil-free compressor specifically designed for Heating, Ventilation, Air Conditioning and Refrigeration (HVACR). Various HVACR original equipment manufacturers are using these compressors in both new and retrofit applications. The magnetic bearing compressor is another of the active projects being investigated by the Navy's Techval Program. For additional information, reference the Navy's Techval web site (https://energy.navy.mil, then select "Techval").

11.4.18. Airius Thermal Equalizer

Avedon Development, LLC manufactures a line of products called thermal equalizers, under the trade name "Airius Thermal Equalizer." This system of products is designed to provide thermal equalization of the air in a building either by transporting the hot air that naturally rises to the ceiling, to the colder air that sits near the floor creating a more uniform temperature in the space. Information gathered from EERE's Weatherization & Intergovernmental Program Rebuild America, offers that independent studies have confirmed that these products significantly reduce any pre-existing floor to ceiling air temperature differential. Benefits from the installation of these thermal equalizers include 1) annual energy savings of 15-50% by utilizing the hot air at the ceiling to heat the floor area; 2) payback period as short as 1-3 years; 3) employee and customer comfort; and 4) reduced indoor condensation in special building applications such as pool areas, gyms, and indoor tennis courts. Contact information on Avedon is available through the Rebuild America web site http://www.rebuild.org or at 303-365-1353. The Navy's Technology Validation Program is currently demonstrating air destratification.

11.4.19. Adjustable Speed Drives

Research has shown that the use of adjustable speed drives (ASD) provides significant energy savings when properly selected and applied, over that of constant speed motor-driven systems. In June of 2002, Pacific Northwest National Laboratory (PNNL) issued a publication PNNL-13879 entitled "Technology Demonstration of Magnetically-Coupled Adjustable Speed Drive Systems." This document presents the findings of a technology demonstration for magnetically-coupled adjustable speed drives, which are couplings that mount between the motor and the load shaft slowing control of the output speed to better respond to system load. Per their report, while most large electric motors run at nearly constant speed, the devices they drive particularly pumps, fans, and blowers are often used to meet loads that vary over time. The results of the study conclude that magnetically coupled ASD technology shows good potential for application in Federal facilities.

Magnetic variable speed drives do have a fairly limited application though. They are only more efficient than a VFD between 90% and 100% of a motor's rated speed, so unless the motor spends most of its time between 90% and 100%, a VFD would be more cost effective. The other application where magnetic variable speed drives make sense is where power quality is an issue. VFDs are both sensitive to and generate harmonics. So if the building had equipment that was sensitive to harmonics or equipment that generated harmonics, you might consider a magnetic drive.

11.4.20. ENERGY STAR® and Other Energy-Efficient Products

When life-cycle cost effective, ENERGY STAR® and other energy-efficient products shall be selected in acquiring energy-consuming products. The DoD Components shall invest in energy-efficient technologies, such as high efficiency lighting and ballasts, energy-efficient motors, and use of packaged heating and cooling equipment with energy efficiency ratios that meet or exceed Federal criteria for retrofitting existing buildings. Information technology hardware, computers and copying equipment shall be acquired under the ENERGY STAR® Program using GSA Schedules, Government-wide contracts, or Service Contracts. The DLA distribution centers shall serve as the focal point of the Department of Defense's program to procure energy and water efficient products. DLA and GSA product catalogs shall be widely used, as well as the Construction Criteria Base (available on CD-ROM and the Internet). Procuring agents, including users of government credit cards, shall procure ENERGY STAR® products and other products in the top 25 percent of energy efficiency.

DOE's Federal Energy Management Program offers up-to-date information on a wide range of energy efficient products, including that for commercial and residential HVAC systems, lighting and water technologies, office, and construction. They also offer recommendations for federal procurement of these products. Contact the FEMP Help Desk and World Wide Web site at 800-363-3732 or http://www.eere.energy.gov/femp.

11.5. Energy System Maintenance

11.5.1. Overview

Energy system maintenance is one of the most cost-effective methods for ensuring energy conservation. Inadequate maintenance of energy-using systems is a major cause of energy waste in both DoD and in the private sector. Energy losses from leaks, uninsulated lines, improperly adjusted or inoperable controls, and other losses resulting from poor maintenance are often considerable.

Good maintenance practices can generate substantial energy savings. Moreover, improvements to physical plant maintenance programs can often be accomplished immediately and at a relatively low cost.

Sophisticated modern heating and cooling systems require ongoing, comprehensive maintenance for peak operating efficiency. Not only is maintenance necessary for existing systems, it is essential to sustain the savings gained from new energy conservation projects. A comprehensive energy management program should include preventive maintenance that is custom designed for each building or system at the installation.

11.5.2. Maintenance Strategies

Maintenance costs, as defined by normal plant accounting procedures, are normally a major portion of the total operating costs. Traditional maintenance costs in the U.S. have escalated at a tremendous rate over the past 10 years. Evaluations indicate that between one third and one half of these maintenance dollars are wasted through ineffective maintenance management methods.

An effective maintenance program is important to building owners and operators. Different maintenance approaches have been developed over the years to ensure that equipment reaches the end of its design life. The following describes the various approaches:

Reactive Maintenance. In this strategy, systems are basically run until failure. There are no proactive efforts utilized to prevent inopportune failures. Disadvantages include:

- Failure of secondary devices caused by failure of the primary device.
- Increased labor cost due to possibly more extensive damage than would have been realized had the approach been routine or preventive. Labor costs could also be more extensive if the

equipment fails during off-normal hours, resulting in technician/operator overtime.
- Material cost might also be more significant than that for routine maintenance.
- Loss of productivity of the people or processes served by the failed energy system due to the unplanned downtime.
- Inefficient use of maintenance staff.

Routine Maintenance. Here non-emergency work is carried out in response to incoming requests (work orders) such as replacing burned-out light bulbs.

Preventive Maintenance. With preventive maintenance, actions are performed on a pre-determined schedule to preclude or mitigate degradation of equipment or systems, thus sustaining or extending its useful life. It includes but is not limited to minor lubrication, adjustments, filter changes, and recording of equipment settings. There are some disadvantages with this type of program which includes performing un-needed equipment maintenance, increased potential to damage other components while performing the un-needed maintenance, and its labor intensity. Although not an optimum strategy, preventive maintenance does have advantages over a purely reactive maintenance program. Those include:

- Increase of equipment life by dramatically reducing the need for eventual corrective repair.
- Reduces energy use by catching and correcting excessive energy waste before long term losses occur. Energy savings as a result of more efficient component or system operation.
- Reduction in equipment or process failures.
- Identification of impending major repairs or replacements which makes it possible to plan or schedule these tasks.

Reliability Centered Maintenance (RCM). This methodology involves the evaluation of the maintenance requirements of a "physical asset in its operating context." This strategy recognizes that not all equipment assumes the same importance in the process or in facility safety. RCM is the systematic process of assessing a facility's equipment and resources to obtain high reliability and cost effectiveness. Although relying heavily on predictive maintenance, RCM recognizes that some equipment maintenance may be better left to reactive maintenance. And because RCM is so heavily reliant on a predictive maintenance strategy, its advantages and disadvantages closely mirror those of a predictive maintenance program.

Predictive Maintenance – In a predictive maintenance program, tasks are performed based on a quantified condition of components or equipment rather than on a preset schedule as with a preventive program. Advanced technologies are used to sense machinery operating characteristics such as vibration spectra, temperature, noise, and pressure. These measured values are then compared to historical or other pre-established criteria to assess the equipment's condition. Degradation mechanisms are then controlled or eliminated to prevent further component deterioration. Predictive maintenance goes a long way towards preventing catastrophic failures of components. Some of the advantages of having a predictive maintenance program include:

- Reduction or elimination of catastrophic failures due to preemptive corrective actions.
- Reduction or elimination of unscheduled downtime.
- Increased manpower utilization.
- Lower costs for parts and labor.
- Increased process optimization and component/equipment life cycles.
- Savings realized over a reactive or preventive maintenance programs.
- Energy savings due to optimum equipment and system operation.

There are disadvantages however to implementing a predictive maintenance program due to initial start up costs. These include diagnostic equipment costs, some of which cost in excess of $50,000. There are also substantial costs associated with training facility personnel in predictive technologies and to effectively operate the equipment. The program will require firm commitments from management as well as maintenance organizations.

Preventive and routine maintenance are often accorded a low priority at military installations in favor of solving the most immediate problems. As a result, the backlog of maintenance and repair grows. Preventive maintenance reduces energy use by catching and correcting excessive energy waste before long-term losses occur. In addition to saving energy, preventive maintenance also dramatically reduces the need for eventual corrective repair and extends equipment life.

The emphasis on solving immediate maintenance problems is understandable because of limited available funds and staffing. However, a good preventive maintenance program, using predictive technologies, once in place, frees maintenance personnel to complete other productive jobs, including more and better maintenance. By investing funds and staff effort on preventive maintenance, installations can save time and money in the long run.

11.5.2.1. Predictive Maintenance Technologies

There have been great advances in predictive maintenance technologies in recent years. Implementation of this type program requires serious commitment. As with any new technology, proper implementation, application, and training are vitally important. Some of the latest methods in predictive maintenance technology are described below.

Infrared Thermography. Infrared (IR) thermography is a diagnostic technique that involves the detection of component problems by taking an infrared scan or picture. When equipment "goes bad" it generally heats up. IR radiation increases with temperature. An IR camera takes images of objects based on their surface temperature and proportional emittance of IR radiation. Taking an infrared survey of a component helps to detect a problem and have it repaired before it manifests into a costly failure. Benefits of the technology include the prevention of unscheduled shutdowns by allowing repairs to be made at a convenient time, improvements in production efficiency, plant safety, thermogram documentation, and a reduction in energy bills. Other advantages of IR thermography are that the equipment doesn't need to be shutdown to take the infrared scan and direct contact with the equipment is not necessary. Just some of the many possible applications of using IR thermography include detection of problems in electrical systems such as motors, transmission lines, distribution systems, various mechanical rotating equipment, steam systems, and heaters. The following vendors are suppliers of infrared thermographic measurement equipment. This list is by no means all-inclusive.

Product Providers:
Raytek Headquarters
1201 Shaffer Road
PO Box 1820
Santa Cruz, CA
95061-1820 USA
800-866-5478
http://www.raytek-northamerica.com

ISG Thermal Systems United States
190 Stanley Court
Lawrenceville, GA 30045 USA
877-733-3473
http://www.isginfrared.com/

Ultrasonic Analysis. Ultrasonic analysis is also an important part of predictive maintenance and subsequently an energy conservation program. Most rotating equipment and many fluid systems emit sound patterns that fall in the ultrasonic frequency spectrum, which can be detected by non-contact ultrasonic detectors. Changes in ultrasonic wave emissions are reflective of equipment condition (i.e. wear, fluid leaks, vacuum leaks, component failures, etc.). Ultrasonic wave detection is useful in detecting abnormal conditions. As with any energy management program, optimal equipment performance translates into energy savings. Ultrasonic analysis is less complex and less costly than some of the other predictive technologies, as equipment costs are moderate and training is minimal. Some of its applications include diagnosis of pressure/vacuum leaks in steam traps, pipes, valves, and compressors, as well as with other problems with pumps, bearings, motors, gearboxes, etc.

Service/Product Providers:
East Coast Industries Inc.
P.O. Box 344
Edison, NJ 08818
732-548-4311
http://www.eci-ndt.com/

Digi-Key Corporation
701 Brooks Avenue South
Thief River Falls, MN 56701
800-344-4539
http://www.digikey.com

Vibration Analysis. Vibration analysis is a predictive methodology used to measure and diagnose abnormal vibration levels in devices. Studies have shown that a large percentage of rotating equipment failures is attributable to misalignment. When degeneration of the device is beyond certain established limits, an action has to be taken. Although impossible to establish absolute vibration limits, in a predictive maintenance program it is necessary to establish some severity criteria.

When machine parts rotate, each generates vibrations at different levels and in distinctive patterns. Vibration instrumentation and signature analysis software provides a means to detect the difference in these levels and quantify the magnitude of the vibration. By using detection equipment and software, signals can be displayed in a manner that defines vibration severity. An individual trained and experienced in vibration signature analysis can interpret this information to define the machine problem to the component level.

A variety of equipment exists for performing vibration analysis, depending on the application. Regardless of the application, a sensing device is required to measure the vibration and translate it into an electronic signature. Various transducers are available that will measure the vibrational displacement (total distance traveled by the vibrating part from one extreme limit of travel to the other), velocity (speed during the oscillating motion), or acceleration (rate of change of velocity) and translate that vibration into an electrical output. Size of the transducers is relatively small and they can be permanently or periodically mounted to the monitoring location for data collection.

Vibration analysis can be used to detect and diagnose a variety of problems with rotating equipment including misalignments, resonance problems, mechanical looseness, defective bearings, worn/broken gears and electrical problems. Other benefits include the identification of improper balancing or alignment procedures, poorly designed equipment, and excessive operating conditions.

Service Providers:
Flowserve World Headquarters
5215 N. O'Connor Blvd., Suite 2300
Irving, TX 75039
972-443-6500
http://www.flowserve.com/contact.htm

Polytec, Inc.
North American Headquarters
1342 Bell Avenue, Suite 3-A
Tustin, CA 92780
714-850-1835
http://www.polytec.com

The Operations and Maintenance Best Practices Guide available from the Federal Energy Management Program (FEMP) web site provides additional resource information on these and other technologies. The manual provides more detailed information on the technology itself, types of equipment available along with associated costs, and possible applications. Companies providing specialized services in these technologies are available through a search of the world-wide web.

11.5.3. Obtain Top Management Support

Energy managers should seek full support from their installation command structure to carry out an effective maintenance program. A good way to start is by recommending a written maintenance schedule to appropriate members of the EMT and have them seek command approval for it. Such a command-supported schedule is very important because it allows required or preventive maintenance to be scheduled with the same priority as other command needs. Approaching energy efficiency by equating it with increased productivity is one way to gain management attention and support.

In addition, energy managers should monitor energy consumption regularly and issue periodic reports to management that illustrates efficiency trends in energy systems. Installation and activity commanders throughout DoD are paying more attention to productivity measures with the advent of management strategies that emphasize productivity, such as the Defense Business Operations Fund (DBOF).

When designing management reports, energy use by each system should be compared with a base period. For example, compare monthly energy use against the same month for the prior year or against the same month in a particular base year (such as 1985). If efficiency standards for a particular system are available, compare your system's performance against that standard as well. The point of such comparisons in management reports is not to assign blame for poor maintenance and inefficient systems but rather to motivate efficiency improvements through improved maintenance.

11.5.4. Maintenance Planning

The fundamental purpose of an installation maintenance program is to maintain equipment in optimum operating condition. The result of this effort maximizes energy efficiency.

To establish an installation maintenance program, the energy manager should do the following:

- Establish a schedule for preventive maintenance, where appropriate
- Implement predictive and reliability centered maintenance programs to improve equipment reliability and reduce maintenance cost expenditures
- Define specific maintenance procedures for the operations staff
- Train the operations staff in the principles and technologies applicable to their buildings or systems
- Provide continuous technical assistance to the operations staff by completing periodic reviews of the installation's performance
- Keep staff informed of new energy maintenance technologies
- Monitor energy consumption regularly (usually monthly) and compare it with a base period, the prior period, or with other energy-efficiency standards. It is important to include the effects of weather data, occupancy patterns and production levels when making these comparisons.

The energy manager should recommend appropriate maintenance activities to achieve energy and water efficiency and suggest that clear lines of responsibility be established for all maintenance tasks. Most installations use some work order request system for scheduling the various types of maintenance. The work order system should be designed to provide a database of historical records of repairs and alterations made to energy systems. Ideally, the system will assign priorities to work orders and estimate the time and staff required for each job.

Also included in this historical record database should be maintenance activities based on predictive and reliability centered maintenance strategies. In addition to scheduled maintenance and work-order generated maintenance, energy managers and their staff members must develop maintenance requirements by inspecting systems for potential and developing problems. Catching such problems in advance of breakdowns saves energy, saves money, and reduces unexpected downtime and makes more effective use of maintenance resources.

A well-maintained physical plant is a more efficient plant. Maintenance is easy to defer, but it is essential to energy efficiency and high productivity. Experienced managers, supervisors, and maintenance staff are key to good maintenance.

11.5.5. Maintenance Duties

Having an up-to-date building documentation package is an essential first step in facilities maintenance. Ideally, a set of the documentation package should be located in the facility in the mechanical room or in the facility manager's office. The package should include as a minimum the following:

- Original design documentation
- As-built drawings
- Equipment list with nameplate data and dates of installation
- Equipment operation and maintenance manuals
- Testing, adjusting, and balancing (TAB) reports
- Control schedule documentation, including control diagrams, sequences of operation, special control strategies, etc.
- Current preventive maintenance logs or schedules.

Selection of the specific maintenance procedures to use depends upon the installation's particular energy systems and circumstances. Nevertheless, general guidelines for the types of things to look for during an inspection and the actions to be performed in any maintenance program are described below. Appendix D also provides an "ECM Idea List" and O&M checklist for the various systems.

11.5.5.1. Steam System Maintenance

Many DoD installations use steam systems to distribute thermal energy. These systems are often prime candidates for improved maintenance. Less efficient than "direct delivery" of energy to end sources, steam system efficiency rapidly degrades without proper maintenance. A preventive maintenance program should require regular inspections and the prompt repair of leaks, malfunctioning traps, and stuck bypass valves. To keep steam plants operating at top efficiency, the maintenance staff should:

- Continuously survey the steam system to identify and repair all steam leaks
- Use acoustic or temperature probes to find non-visible steam leaks
- Diligently monitor and maintain boiler water chemistry and perform frequent boiler tune-ups
- Inspect and repair steam traps periodically; replace steam traps at least every 4 years; ensure that all traps are properly sized
- Inspect insulation on pipes and pressure vessels annually, and repair or replace deteriorated or missing insulation
- Annually inspect the waterside and fireside of the boilers.

Steam traps permit condensate, air, and noncondensible gas to pass out of the system while trapping steam within the system. Air and noncondensible gases act as insulators that reduce system efficiency. Improperly sized traps can be replaced either immediately or when the trap reaches the end of its useful life. Old traps should not be maintained beyond their useful life; steam traps generally last less than 4 years and should be replaced before then. Keeping track of component lives is one essential function of a good maintenance plan. Damaged or missing insulation on steam lines is a major energy waster.

Generally, continual inspection and upkeep of condensate lines ensures adequate return of condensed boiler water with a minimum loss of energy. To maintain condensate systems, the maintenance staff should:

- Look for steam coming from the collecting tank or deaerator vent, evidence of malfunctioning traps
- Check condensate line temperatures, since temperatures above 190 deg F indicate a malfunctioning steam trap
- Insulate all condensate lines since condensate usually returns at about 190 deg F
- Continually repair and replace all worn or damaged insulation, including tanks, valves, strainers, and piping.

11.5.5.2. Lighting System Maintenance

Light output from electric lamps tends to decrease as fixtures get older because the dirt accumulating on lamps and lenses reduces the amount of light supplied. Lumen output from recessed fluorescent fixtures can drop 15% in just one year, even in a fairly clean environment. Designers compensate for light reductions by over-lighting the space so that minimum adequate illumination is still provided as the lenses get older (and dirtier). Dirty lenses can reduce illumination by as much as 50%. Lens cleaning can sometimes reduce the amount of light degradation, even allowing some of the lamps to be removed without reducing illumination below the required level.

To help remove unnecessary lamps or luminaires from service while maintaining proper illumination, the energy manager should:

- Maintain interior illumination levels in accordance with the following guidelines from 41 CFR 101-20.107, Energy Conservation:
  - 50 foot-candles at work-station surfaces during working hours
  - 30 foot-candles in work areas during working hours
  - 10 foot-candles in non-work areas
- Establish washing cycles for lamp lenses and luminaries
- Replace discolored plastic diffusers in fluorescent fixtures. Prismatic lenses are generally the most efficient type for the degree of glare control provided; fresnel-type lenses are the most efficient for recessed incandescent and high-intensity discharge (HID) fixtures.
- Use light-colored paints, carpets, tile, and upholstery when redecorating
- Replace all lamps on a given circuit at about 70% of their average lamp life, adjusted for typical hours per start. After 70% of rated life, lamp failures occur at an increasing rate and, therefore, it is an economically optimum time to replace lamps and clean fixtures.
- In areas with similar hours of operation, replace all lamps in a group to reduce relamping labor costs.

11.5.5.3. Cooling System Maintenance

Many maintenance actions essential for proper and efficient cooling system operation may be covered by a contract with the manufacturer's service representative. Those contracts usually address the following items:

- Checking for leaks and proper purge system operation
- Brushing condenser tubes of water-cooled open tower systems
- Checking condition and levels of refrigerant and oil
- Checking chiller safety devices.

Although most chiller maintenance is performed by skilled technicians, it is desirable to have someone on the maintenance staff that is trained in the field of refrigeration systems. This ensures proper system operation between service intervals and reduces the potential for breakdowns. Detailed maintenance procedures for particular machines are often found in the operating instructions.

11.5.5.4. HVAC System Maintenance

To ensure that HVAC systems operate at peak efficiency, the maintenance staff should complete the following routine maintenance procedures:

- Check for cooling/heating equipment short-cycling
- Check, adjust, calibrate, and repair all controls such as thermostats, controllers, and valve and damper operators
- Adjust zone temperature and air handler unit temperature set-points to the minimum levels necessary to satisfy occupant or process requirements.
- Check to ensure that the economizer (if so equipped) works properly
- Check the system time clock (if so equipped) to ensure that the system shuts down during unoccupied periods
- Replace dirty filters and keep economizer dampers clean
- Keep all heating and cooling coils clean
- Eliminate all duct work leaks at joints and flexible connections
- Keep hot and cold ducts adequately insulated
- Repair or replace all defective dampers
- Check, adjust, or replace fan belts
- Check fan/motor alignment
- Lubricate all bearings and other friction points, such as damper joints
- Inspect fan wheels and blades for dirt accumulation and clean them as required
- Adjust or repair packing glands and seals on valve stems and pumps to eliminate leaks of cooling and heating water
- Ensure that no oil or water enters the main air supply for pneumatic control systems
- Inspect integrity of chilled water pipe insulation
- Eliminate all piping leaks and replace insulation if needed

Most air-handling units (AHUs) have both heating and cooling coils. Leaking steam, hot water, and chilled water valves on those coils and leaky dampers require heating, cooling, and then reheating of the same air. Proper maintenance eliminates that inefficient use of energy. Leaks or deteriorated insulation on chilled water piping will allow condensation to form, with the potential to cause moisture/mold problems throughout a facility. Leaks must be repaired and insulation replaced as quickly as possible. Controls are the remarkably sensitive nerve-ends of the HVAC system. Improperly calibrated controls degrade comfort conditions and waste energy dollars. It is extremely important to have a staff member trained to inspect and service those controls.

Excess HVAC capacities often hide the need for improved maintenance procedures. In many cases, institution of a preventive maintenance program allows for the elimination of excess capacity saving even more in energy costs.

11.5.5.5. Gas Line and Compressed Air Maintenance

Leaks in combustible gas lines -- natural gas, methane, butane, propane, or hydrogen -- are not only a waste of expensive fuel but are also highly dangerous. Left untreated, such leaks can result in fires and explosions. Leaks in compressed air lines are less dangerous but also expensive. Like steam lines, compressed air lines distribute energy throughout a facility. Left untreated, such leaks waste air compressor HP and result in either higher fuel consumption, less capability available from the compressed air, or both.

11.5.6. Maintenance Personnel

Computerized energy management systems can be an important component of an energy system maintenance program. However, they are no substitute for manual inspections and repair by qualified personnel. Inspections completed by experienced maintenance personnel can detect slight leaks, faulty connections, loose or missing parts, frayed belts, and other danger signs that computerized systems might overlook or detect only after failure.

An effective energy maintenance program requires someone in overall control, usually the PWO, utilities chief, or plant engineer. That person bears the overall responsibility for planning, implementing, and supervising the program. The energy manager must coordinate with that person to link the installation command structure with maintenance operations. Through proper management, an effective maintenance program minimizes disruptions to mission accomplishment and the quality of life at the installation. It is also the maintenance manager's responsibility to balance routine, scheduled, preventive, and emergency maintenance.

The energy system maintenance program also needs experienced maintenance superintendents or coordinators to carry out specific portions of the maintenance plan. The superintendent makes sure that work is carried out according to schedule, records repair and inspection results, and occasionally inspects physical systems to assess system condition and maintenance program effectiveness.

A highly motivated maintenance repair department is essential. This team completes maintenance and repair tasks and observes additional problems on inspection rounds. They must stock the necessary parts and tools, process work orders, and record completed work. The key to effective energy-system maintenance is the availability of "hands-on" maintenance and operations personnel, the more experienced and well-trained, the better.

In addition to fulfilling work-order requests and performing scheduled preventive maintenance, maintenance workers need to spend some time periodically inspecting energy system components. For instance, there are many examples of sophisticated, automated energy management control systems which appear to be "controlling" air handlers when, in fact, the fan belts driving the fans are actually broken or missing. Unless the maintenance staff periodically inspects each energy-consuming piece of equipment on schedule, the energy management program will be ineffective.

11.5.7. Coordination, Communication, and Motivation

One of the keys to a successful maintenance program is organizational coordination. The maintenance manager must not only effectively coordinate the maintenance staff but must also coordinate maintenance efforts, including shutdowns, while minimizing disruptions to mission requirements and personnel comfort.

Good communication is essential. The energy manager must communicate with the installation commander, the PWO, the maintenance staff, and other installation personnel (or customers).

A meeting should be scheduled between the maintenance manager, maintenance superintendents, and the maintenance staff at least once each month. All major decisions, particularly concerning equipment shutdowns, should be announced publicly well in advance. If the effect of a planned shutdown will be localized, all affected personnel must be notified. If the impact will be base-wide, the maintenance department should advertise the shutdown widely through the installation newsletter and through notices at major installation facilities.

An enthusiastic, efficient, public works, utility, or maintenance organization results from the efforts of people working together for the common good, furthering the installation's mission and saving energy. Existing Service and DoD award programs should be publicized. For example, some installations organize a maintenance "employee of the month" plaque, which is posted in a conspicuous location. Training programs motivate employees in addition to adding to their knowledge and furthering their careers. They give employees a feeling of recognition and add to the organization's capabilities.

11.5.8. Training Requirements

One of the hallmarks of a good energy management program is an effective training program. The maintenance operations staff needs to be well-trained in the principles and technologies that are used in the buildings and systems that they service. Training for maintenance staff should, however, concentrate on the practical, hands-on aspects of maintenance. Some good training practices are:

- Primarily, concentrate on training that is specific to the systems for which the maintenance staff is currently responsible. As old systems are replaced with newer technologies, plan to provide training on the new systems
- Secondarily, provide general energy systems management training. It is helpful for maintenance personnel to have at least a working understanding of the theory behind the design of the systems they maintain.
- Provide maintenance personnel with cross-training to the maximum extent practical based on employee capabilities and existing work rules. Workers with a broader range of skills tend to be more effective and more highly motivated.
- Keep records on the effectiveness of different training courses; know which ones work and which ones are either ineffective or not applicable to your installation's particular needs; maintain records to avoid duplication or inconsistent training
- Provide building operations staff who are not involved in maintenance with some basic cross-training from the maintenance staff so that building occupants become additional eyes for recognizing potential system problems. They can also be trained to assist the maintenance staff by monitoring energy use within each building.

11.6. Electrical Load Reduction

As a result of the Presidential Memorandum dated May 3, 2001 (reference (l)), DoD installations' emergency load reduction plans were updated. The DoD Components shall continue to identify load shedding techniques to cut electricity consumption in buildings and facilities during power emergencies. Examples of these techniques include: EMCS, sub-metering, cogeneration, thermal storage systems, duty cycling of air conditioning in military family housing by EMCS, alternative energy sources for air-conditioning, and turning off unneeded lights with motion sensors and separate lighting circuits.

11.7. References

A full references list is included at the end of the DoD Energy Manager's Handbook in Appendix F. However the following represent major references used for this chapter and from which a substantial amount of the data was adapted.

1. Turner, Wayne C., Energy Management Handbook 4th Edition, Fairmont Press, Lilburn, GA, 2001.
2. Haasl, Tudi and Sharp, Terry, A *Practical Guide for Commissioning Existing Buildings* (ORNL/TM-1999/34), Office of Building Technology, State and Community Programs, U.S. Department of Energy, April 1999.
3. Pacific Northwest National Laboratory, *Operations & Maintenance (O&M) Best Practices Guide*, Release 2.0, Federal Energy Management Program, Department of Energy, July 2004.
4. National Aeronautics and Space Administration, *Facilities Maintenance and Energy Management Handbook* (NHB 8831.2A), Washington, DC, October 1994.
5. Akbari, Hashem, and Bretz, Sarah, "Cool systems for hot cities," *Professional Roofing*, October 1998.
6. Pacific Northwest National Laboratory PNNL-13879, *Technology Demonstration of Magnetically-Coupled Adjustable Speed Drive Systems*, New Technology Demonstration Program, Federal Energy Management Program, Department of Energy, June 2002.
7. Portland Energy Conservation, Inc. *Operation and Maintenance Assessments: A Best Practice for Energy-Efficient Building Operations*, www.peci.org, September 1999.
8. *Facilities Maintenance and Repair Cost Data*, R.S. Means Company, Inc. Kingston, MA, updated annually.

In addition to references listed above, information on some of the technologies specified was incorporated from the Navy's Technology Validation Program's web site (at https://energy.navy.mil, then select "Techval"). The purpose of the Technology Validation Program, Techval, is to assess the effectiveness and the viability of Navy-wide implementation of selected technologies that have potential for reducing Department of the Navy (DON) energy consumption toward goals set forth in Executive Order 13123. The Techval program is available to team together the energy-engineering experts from Naval Facilities Engineering Service Center (NFESC) with technical experts from throughout the Navy and Marine Corps, DOD, Department of Energy, and Universities. Techval provides installations the opportunity to acquire new technologies at no cost to the installation, participate in the testing and evaluation of the technologies, and to provide lessons learned from the user's perspective.

12. Alternative, Renewable, and Clean Energy

12.1. Key Points

- Alternative, renewable, and clean energy is energy produced from nontraditional sources or recovered from conversion, including such forms as solar thermal, photovoltaic (PV), geothermal, wind and biomass.

- DoD's goal is to increase to the amount of alternative, renewable, and clean energy consumed by implementing projects that are LCC effective or acquiring renewable energy from commercial sources.

12.2. Background

12.2.1. Definition

Generally, alternative, renewable, and clean forms of energy are produced by nontraditional sources and/or conversion processes. They have low emissions and minimal negative impact on the environment. Examples are solar thermal, photovoltaic, geothermal, wind, landfill methane, fuel cells, refuse derived fuel (RDF), hydrogen combustion, and hydroelectric energy generation. This chapter provides a brief overview of how to apply the technologies that are most appropriate for DoD installations, i.e., solar thermal, photovoltaic, geothermal, wind and biomass.

12.2.2. Energy Conversion Policies

In line with EO 13123, DoD is committed to creating opportunities to install renewable energy technologies and purchase electricity generated from renewable sources when life-cycle cost effective to enhance energy flexibility. The Military Services shall purchase renewable energy generated from solar, wind, geothermal, and biomass sources when cost-effective and any premium is considered to be fair and reasonable. The DoD Components are encouraged to aggregate regionally when considering renewable energy purchases to leverage the Departments buying power and produce economy of scale savings.

Opportunities to acquire renewable energy using technologies such as wind, biomass, geothermal, ground source heat pumps and photovoltaics shall be pursued when life cycle cost effective. Self-generated power may be coupled with photovoltaic arrays and wind generators, to produce electricity at isolated locations, such as range targets, airfield landing strip lighting and remote water pumping stations. Electrical requirements can be reduced using ground-source heat pumps or solar water heating systems.

The Energy Policy Act of 1992 calls for implementation of projects having a payback of 10 years or less. The energy conversion requires replacing some current fuel sources with any form of alternative, renewable, and clean energy sources or with solid fuels, e.g., coal, waste-to-energy, coal/water, or coal/oil mixtures. The Military Services must actively seek out LCC applications for alternative, renewable, and clean energy sources.

Title 10 USC, Section 2857, requires that renewable energy alternatives be selected for construction of military facilities if the additional cost of the renewable energy system can be recovered over the expected life of the facility. The Office of the Secretary of Defense issued an ECIP policy letter stating that additional consideration will be given to ECIP projects that substitute renewable energy for nonrenewable energy during the ECIP approval and funding processes.

The Clean Air Act (CAA) Amendment of 1990 renewed emphasis on the wider application of alternative, renewable, and clean energy technologies. The Amendment limits emissions of sulfur dioxide (SO_2) and establishes an SO_2 trading system for annual emission allowances. Any offender who does not have enough allowances to cover their emissions will be severely penalized and fined. It will become more difficult to meet these emission limits in future years because annual allowances are to reduce by an established amount each preceding year. DoD installations can reduce and obtain additional SO_2 emissions allowances, if necessary, by investing in renewable technologies, which in turn will help to achieve compliance with the CAA and avoid the imposition of heavy fines.

In 2002, funding was set aside by Congress to assess the renewable energy potential of U.S. military installations. The Department of Defense (DoD) created a Renewable Energy Assessment Team to explore solar, wind and geothermal energy resources at military installations. The joint-services program will explore new and established technologies for collecting, storing, and transmitting renewable power.

Led by the U.S. Air Force, the Team conducted on-site assessments at military bases in the Continental United States to summarize wind, solar, and geothermal resources available at installations. They prioritized those installations with the best potential for generating significant amounts of renewable-based electricity. Additional information on the efforts of the team can be found at OSD's Installations and Requirement Management (IRM) web site link to the

DoD Renewable Energy web site. Those links respectively are:

- http://www.acq.osd.mil/ie/irm/Energy/renew_energy/renewable.htm
- http://dod-renewablesassessment.pnl.gov/

The Tri-Service Renewable Energy Committee is also an organization chartered by OSD. The TREC charter states in part "...The TREC is established to serve as a coordinating council of the Defense Energy Action Group for DoD activities which promote the development, technology transfer, and implementation of renewable, alternative, and/or non-conventional technologies. Working with tri-service sub-committees which address specific technology areas, the TREC will assist the Office of the Assistant Secretary of Defense (Economic Security) in defining its policies and goals regarding renewable energy technologies, and coordinate the efforts to implement those objectives within the Department of Defense." For a TREC project listing by Service, reference Renewable Energy link on the OSD IRM web site.

12.3. Solar Energy

Solar energy is abundant and perpetually renewable, making it an ideal energy source in many ways. The amount of solar energy a site can receive is dependent upon location, time, and environmental conditions. Solar radiation is the "resource" of solar energy. Given the inefficiencies of collection and conversion equipment, the usable energy is a fraction of the total available. Furthermore, at most sites, the available solar energy (insolation) varies greatly from summer to winter due to weather conditions.

Solar energy can be converted to either thermal energy (solar thermal) or electric energy. Solar energy systems may be further classified as either active or passive systems. Active solar systems incorporate pumps to circulate liquids and/or motors to provide movement of fans or collectors. Passive systems either do not utilize active components such as pumps and motors, or use them only to a minimal extent. Passive designs utilize standard construction principles and design features to maximize the benefit of the sun, such as building or window orientation, shading, roofing materials, and other architectural features. Using natural ventilation for cooling is also considered passive solar design.

Solar energy has been proven to be LCC effective in many applications. However, as with most renewable energy systems, the "free" energy is offset by the high initial capital investment costs. Applications that are most likely to be cost-effective are those where there is a relatively uniform load throughout the year, good solar availability, and relatively high cost of conventional fuel. Some States offer rebates or tax incentive that may make solar projects financially viable.

In new installations, systems may be cost-effective in remote applications where cost of connecting to conventional energy sources is high. Many DoD facilities have solar heating systems installed in the 1970s or 1980s that are no longer functioning properly. The cost of repairing and recommissioning these systems has the potential to be very cost-effective. ESPC is a financing method that can help reduce the initial cost burden on an installation.

Because of energy security, location, weather, and cost-effectiveness issues, relying on solar energy as the primary energy source for meeting all facility energy requirements is generally not practical. However, selective use of solar energy as a supplementary energy source offers a wide range of attractive applications. Many factors must be weighed before considering a solar energy system. Critical is the availability of engineers and technicians qualified to design, install, operate and maintain a solar energy system so that it works well with a building's primary energy system. Many solar energy systems have been shut down in the past because of a lack of O&M knowledge. Contract O&M may be a cost effective way to keep systems operating.

Location is a critical factor in determining feasibility of solar energy applications. In certain locations in the United States, such as the northwest, solar projects are usually not viable options. However, in the southern states, solar applications can be very practical. Even where solar insolation is plentiful and conventional fuel costs high, a year-round load or need for the solar energy coincident with the availability is necessary for economic feasibility.

Before making a decision to use a solar energy application, energy managers should seek assistance in determining whether potential solar projects are technically and economically feasible. DoD's Solar Energy Assessment Team has reviewed the potential for solar development at all major military installations on a macro level. Experts from each service can be made available to assist with developing specific installation projects. As solar power cannot generally compete with the price of power from conventional or even other renewable sources, the DOD solar assessment focused on both solar power and solar thermal technologies that displace energy purchased from conventional sources, including electricity, natural gas, propane, fuel oil, and diesel. The result of their investigation is a short list of solar technologies and applications with associated performance and cost (capital, installation, and O&M) metrics.

In addition to assistance offered by the Services, DOE's national laboratories can provide support. Both Sandia National Laboratory (SNL) in Albuquerque, New Mexico, and the National Renewable Energy Laboratory (NREL) in Golden, Colorado, offer technical and operations assistance with solar energy systems. Both can provide assistance in determining project feasibility. Each laboratory also has a wealth of experience and data on solar insolation at DoD installations. NREL has a special program designed to help diagnose and correct problems with non-functioning existing solar systems in Federal facilities.

The Department of Energy's Solar Energy Technology Program sponsors research and development that improves the performance and reduces cost of solar technologies. This Program conducts research and development in three major technology areas: concentrating solar power; solar electricity, also known as photovoltaics or PV; and solar heating and lighting. For additional information on the Program and associated technology applications, reference DOE's Energy Efficiency and Renewable Energy's web site.

12.3.1. Solar Thermal Applications

Solar thermal energy is the most widely used form of solar energy. All solar thermal systems absorb the sun's radiant heat energy and convert it to a usable thermal energy. There are many types of solar thermal system designs, ranging from a simplistic direct gain system to a solar absorption cooling system.

Passive solar thermal systems are virtually maintenance-free and can be easily integrated into building designs. All new building designs shall incorporate the use of passive solar thermal technology when cost-effective over the life of the project. Passive solar designs, such as building orientation and window placement and sizing are currently being implemented within DoD facilities. Active solar heating applications have included maintenance facility solar walls, swimming pool heating, and hot water heating. At the time of new construction, passive solar features may add little, if any, additional cost but can greatly reduce the energy costs if properly implemented.

Similarly, renovations to existing facilities should not be made without consideration of passive solar thermal technologies. Other appropriate solar thermal applications are process hot water/hot air applications and low-/high-pressure steam applications. In many cases, the use of solar energy for preheating process hot water or providing DHW has been shown to be economically competitive with conventional practices.

12.3.2. Photovoltaic Application

Although photovoltaic (PV) energy systems are not as numerous as solar thermal systems, their application is rising because of the advances in solar cell design. PV technology has improved steadily. New PV systems are more reliable at a lower cost than previous systems. The output configurations for PV systems are virtually unlimited. Modules of solar cells can be connected in either parallel and/or series to provide different current and voltage outputs. This modularity also factors heavily in system expansion and repair.

Because the application of PV technology is relatively new, its full potential is still being developed. Based on past performance, PV technology is well suited for use at remote locations where access to the power grid is not feasible. Some examples of effective use of PV technology are remote power supply for lighting, range instrumentation, navigational aids, and communication repeater stations.

When identifying potential PV projects, consider remote or stand-alone applications that are currently being powered by gasoline or diesel units or by batteries. PV-generator hybrid systems can save money and reduce energy vulnerability. When calculating LCC, include savings from reducing maintenance and fuel delivery. In some cases, economic payback for remote site applications is less than 1 year.

12.4. Geothermal Energy

Geothermal energy is derived from the thermal energy of Earth. It is generally associated with volcanoes, hot springs, geysers, and steaming mud pots, such as those found at Mount St. Helens and Yellowstone National Park. However, practical applications of geothermal energy are found in a variety of places, most of which have none of these commonly associated surface manifestations. The use of geothermal energy fall into three basic categories (listed in order of greatest application): geothermal (ground-coupled) heat pumps, direct-use applications, and power generation.

12.4.1. Geothermal Applications

12.4.1.1. Geothermal (Ground-Coupled) Heat Pumps

The most widespread, yet least spectacular, application of geothermal energy is through ground-coupled heat pumps. This technology is a mature, proven money- and energy-saver in which the relatively constant temperature of Earth and the temperature difference between Earth and the atmosphere is used to power simple modular heat exchangers. Installation is simple, involving installation of a ground loop through which heat exchange fluid is pumped by a surface unit. These can be used in single building installations or in parallel for larger installations.
Taken from FEMP's Technology Focus Publication DOE/EE-0291, "Geothermal Heat Pumps Deliver Big Savings for Federal Facilities," geothermal heat pumps (GHPs) can help meet energy conservation as well as emission reduction goals. Replacing conventional heating and air conditioning systems with GHPs typically saves 15-25% of total

building energy use in nonresidential buildings and as much as 40% in residential. GHPs also contribute to meeting emissions goals because they use less electricity than conventional equipment to provide the same amount of heating and cooling.

Geothermal heat pumps have been installed and successfully operated in all climates ranging from the harsh winters of the upper mid-west to the desert southwest to the hot, humid climate of the southeastern US. Federal facilities have invested more than $200 million in geothermal heat pumps since 1993.

Because GHPs have no equipment outside in the elements, degradation of heat exchangers and compressors from the environment and temperature extremes is nonexistent. Compressors and coils inside the facility operate in a relatively stable environment and compressors operate at fairly stable condensing temperatures improving equipment reliability. The net result is maintenance costs are from 25% to 40% less than conventional systems.

Many GHP systems use small GHPs distributed through out buildings to form zones. In such systems, HVAC controls are very simple making system reliability very high and the need for control adjustment and maintenance almost non-existent. Additionally, these systems lend themselves to central fresh air distribution systems that can take advantage of exhaust system heat recovery and can be used to control humidity in areas where mold and mildew are problems. A central system lends it self to the future addition of specialized filtration equipment for anti-terrorism/force protection.

An added benefit of GHPs is the heat of compression can be used to generate hot water through out the summer and, depending on design conditions, parts of the winter.

12.4.1.2. Direct-Use Geothermal

Direct-use geothermal techniques use hot water or steam taken from the ground to heat facilities or, when used in conjunction with heat exchangers, to make hot water for domestic use. As with GHPs, this technology is mature and has been used in numerous applications in the residential and commercial sector. NAS Keflavik, Iceland, obtains all of its domestic hot water and heating energy from a local supplier. Direct-use possibilities exist throughout the western US, in some Midwestern states, Alaska, and Hawaii.

12.4.1.3. Electricity Production

The least common but most spectacular use of geothermal energy is for electricity production. In this application, hot fluids are brought to the surface of Earth through specially drilled wells. The steam is extracted from the fluids by various processes and used to turn turbines, which drive generators to make electricity. Facilities of this type are fully industrial in their nature and have been successfully constructed and operated at the Naval Air Weapons Station in China Lake, California. At that site, four power plants have been constructed using an innovative third-party agreement called Public/Private Venture Capital contract. Under this arrangement, the Government continues ownership of the resource, but the contractor builds, owns, and operates the facilities to utilize the geothermal fluids for generation of electricity. Revenue/benefits are substantial to the Navy. They come in the form of reduction of the excess power (over and above what is used locally) into the local power grid. These funds are used to underwrite additional geothermal investigations at other locations as well as in short-term energy-cost avoidance projects. The technology for this application is also well-proven and widely used throughout the world. Most of the sites that have any electric power potential are found in the western US, Alaska, and Hawaii. There is a possible resource located beneath the Gulf Coast states in the form of geopressured geothermal resources. This particular resource, however, is not cost-effective currently because of the low cost of natural gas and other hydrocarbon fuels.

12.4.2. Geothermal Energy Resources

Many DOD facilities are located in areas with geothermal resources. Development of these resources may provide power that is competitively priced in local power markets. DOD is not interested in developing geothermal power plants itself, however but is rather interested in forming public-private partnerships to see these resources developed for commercial markets.

The DoD Geothermal Assessment Team has membership from all branches of the U.S. military, as well as private industry and government agencies. The potential of various military installations for geothermal development has been assessed. The Team recommended exploration where there is a high probability of resource development. Because exploration costs are very high, any development of the resource should return to the installation and DOD sufficient funds to compensate for the resources DOD expends up-front as well as value for the loss of use of land and associated mission compromises. For additional information on the Team's mission and expectations, reference the DoD Renewables Assessment web site from the OSD IRM site.

The DOE's EERE's Geothermal Technologies Program also works in partnership with U.S. industry to establish geothermal energy as an economically competitive contributor to the U.S. energy supply.

For information on the Geothermal Technologies Program's key activities and for geothermal application information, reference the EERE's web site. The site also provides information on the Navy's Geothermal Program.

12.5. Wind Energy

Development of wind resources on DoD facilities may provide the facility with a secure power source during a power grid failure. Although not interested in owning wind farms for itself, DoD is interested in forming public-private partnerships to see these resources developed for commercial markets. If the price of wind power is competitive with other sources, the facility may choose to purchase power from the on-site resource.

DoD's Wind Assessment Team has been drawn from all branches of the U.S. military, as well as private industry and government agencies. This team compiled a database of all military sites in the United States and identified the potential of each installation for wind power development In general, there are few locations where utility sized on-base wind farms are feasible. There are many locations where smaller (less than 1 MW) wind potential exists. Where the wind database shows promise, a site visit can be scheduled to verify wind potential, land characteristics such as the topography and size, and to consult with staff at the local installation about potential locations, land access, and mission conflicts. Results from wind monitoring and analyses of energy markets will be compiled into a business case/economic analysis for each site. These business cases will provide a foundation for negotiations with industry to develop these resources.

12.5.1. Wind Applications

Wind technologies include those for small turbines [100 kilowatts (kW) or less] used for remote applications such as battery charging, water pumping, telecommunication sites, village power, hybrid systems, and distributed power; and for large turbines [100 kW to 5 megawatts (MW)] used as central-station wind farms, distributed power, and offshore wind generating stations. In 1999, the federal government installed two small 7.5-kW turbines on 30-m (100-ft) towers along with a 5-kW solar array, a 48-volt dc battery bank, switchgear, and two sine wave inverters to provide power for a Federal Aviation Administration aircraft navigation beacon at Chandalar Lake in the Brooks Range in Alaska. These renewable resources replaced the diesel generators that supplied power to this site, which required fuel to be flown in regularly. And in 1996, the Air Force Space Command installed four NEG Micon 225-kW turbines on Ascension IslandThat project has nearly paid for itself already. Drawing on this success, the AF tripled the capacity of the site in 2003.

Small wind applications look very promising especially in locations where utility costs are high or where diesel fuel or gasoline must be hauled to a site. The installed cost of wind generators is significantly less than solar photovoltaic systems so wind is very effective in hybrid applications.

For more information on wind power, applications, and resources, visit the Office of Energy Efficiency and Renewable Energy web site.

12.6 Biomass

Biomass is frequently overlooked as a renewable energy source but there are a remarkable number of biomass opportunities. For the past four years, biomass has been the leading source of renewable energy in the United States and it is the fourth largest energy resource after coal, oil, and natural gas. Biomass is used for heating (such as for wood stoves and for process heat and steam in industries such as for pulp and paper), cooking, transportation (such as ethanol and biodiesel), and for electric power generation. Research shows that current biomass consumption is dominated by industrial use. However there has been a major increase in the use of liquid transportation fuels such as ethanol and biodiesel.

The benefit of biomass projects is the fuel cost, which tends to be very low resulting in reduced power costs. An obvious fuel source is landfill gas that can be economically piped to a power plant on or near an installation. Other approaches involve gasification of animal wastes, use of energy intensive crops, tires (consumed without emissions), wood chips and much more. Because of utility regulations and the cost of transmission, these projects usually are most cost effective if the plant is on or adjacent to the installation.

The U.S. DOE’s Office of the Biomass Program (OBP) partners with industry to foster research and development on advanced technologies in order to transform the nation’s abundant biomass resources into clean, affordable, and domestically-produced biofuels, biopower, and high-value bioproducts. Its activities directly support the overall mission and priorities of the Department of Energy, Office of Energy Efficiency and Renewable Energy, and the National Energy Policy by contributing to the creation of a new bioindustry and reducing U.S. dependence on foreign oil by supplementing the use of petroleum for fuels and chemicals.

DOE established the National Bioenergy Center (NBC) in 2000 to unify all the relevant biomass laboratory resources, provide technical assistance, and manage the core research activities of the OBP. RTthe NBC is managed by the National Renewable Energy Laboratory (NREL) and includes R&D by NREL, Oak Ridge National Laboratory (ORNL), Pacific Northwest National Laboratory, Idaho National Engineering and Environmental Laboratory (NEEL), and Argonne National Laboratory (ANL).

A Biomass Research and Development Technical Advisory Committee was established by the Biomass R&D Act of 2000 (Biomass Act). The committee's mandates under the Biomass Act include advising the Secretary of Energy and the Secretary of Agriculture, facilitating consultations and partnerships, and evaluating and performing strategic planning.

Biomass projects add to installation energy security and frequently provide a major environmental benefit to the region by using a polluting substance, such as chicken waste, as the fuel source. DoE has technology specific Energy Savings Performance Contracts to help implement biomass projects. Additionally, the Renewable Energy Study has developed purchasing strategies to assist in acquiring biomass power from energy providers.

12.7 Distributed Energy Generation

Distributed Energy Resources shall be used for on-site generation using micro-turbines, fuel cells, combined heat and power, and renewable technologies when determined to be life-cycle cost effective or to provide flexibility and security to mitigate unacceptable risk. In most cases, larger scale, off-grid, electrical generation systems should be privately owned and operated. Off-grid generation, owned and operated by the DoD Components may make sense for mission criticality and remote sites when it is life-cycle cost-effective. In these cases, innovative energy generation technologies such as solar lighting, large photovoltaic arrays, wind turbine generators, micro-turbines and fuel cell demonstration projects shall be utilized.

Biomass is showing promise as a type of distributed generation. Small privately owned plants, placed on or near the perimeter of installations, can provide all the power needs of the installation. The benefit is reduced energy costs and energy security. Fuel options for such plants are almost limitless.

The Army is actively engaged in the demonstration of distributed generation technologies through programs undertaken by the U.S. Army Engineering Research Development Center (ERDC) / Construction Engineering Research Lab (CERL) and closely follows the distributed energy program of the DOE. For information on their efforts, reference web site http://www.dodfuelcell.com/intro.html.

The DOE's Distributed Energy (DE) Program was established in 2001. Its strategies include (reword) developing a portfolio of research, development, and demonstration investments in advanced, on-site, small-scale, and modular energy conversion and delivery systems for industrial, commercial, residential, and utility applications. The Program strives to build R&D partnerships with industry and others to make these systems more energy-efficient, reliable, and affordable to consumers. The ultimate goal is to improve the energy and environmental performance of the distributed technologies and increase the level of technology integration among on-site energy generation alternatives so the nation can achieve a more flexible, smarter energy system. For additional information on the DE Program activities and contacts, visit: http://www.eere.energy.gov/de/about_der/about_der.shtml.

12.8. DOE's FEMP Renewable Energy Program

Through its renewable energy program, DOE's FEMP works with the National Renewable Energy Laboratory (NREL) and industry to help Federal agencies take advantage of the benefits offered by renewable energy technologies and implement the renewable energy provisions of EPAct and EO 13123. The program helps Federal agencies identify renewable opportunities and implement successful renewable projects. FEMP chairs and coordinates the Renewable Working Group, which includes more than 100 representatives from Federal agencies, DOE programs, and the renewable industry. This group has developed the Renewable Implementation Plan to introduce cost-effective, main-stream renewable technologies and designs into the Federal Government. The plan encourages agencies to implement at least one renewable energy showcase project to serve as a model within the agency.

FEMP has several resources available to support consideration of alternative energy applications. DOE's Energy Efficiency and Renewable Energy Clearinghouse operates FEMP's Help Line and can provide information, printed resources, and information about available training opportunities. EERE can be reached at (877) DOE-EERE. The Federal Renewable Energy Screening Assistant (FRESA) software tool identifies and prioritizes renewable energy projects according to cost-effectiveness. For more information, see Chapter 15. FEMP has also developed costing guidelines for renewable energy projects that will help energy managers better assess the cost effectiveness of solar or other renewable projects. For more information about the FEMP renewable energy program and their other services provided, reference Chapter 21.

13. Water Conservation

13.1. Key Points

- Water conservation is the responsibility of the DoD energy manager.
- The same common-sense approaches that apply to energy conservation and information management are equally applicable to water conservation.
- Water conservation measures that have a payback of 10 years or less should be implemented at DoD installations.

13.2. DoD Water Situation

13.2.1. Introduction

Water and water disposal costs are increasing at a rate greater than inflation for many DoD installations. Water shortages can create situations that impact the mission and morale of installations. Cost-effective opportunities to reduce water use should be pursued by DoD energy managers. Installations shall incorporate water management plans in their existing O&M plans and shall focus on dissemination of information to all levels to educate personnel on water conservation practices. Audits shall be conducted to identify the best opportunities and where economical, installations shall initiate water conservation projects using O&M, ECIP, UESC or ESPC.

13.2.2. Applicable Legislation

The Energy Policy Act of 1992 added water conservation to the Federal Government's energy management efforts. It requires Federal agencies to implement all water conservation measures that pay back in 10 years or less.

Executive Order 13123 requires water efficiency improvement goals for Federal Agencies, suggesting specific strategies that include development of a water management plan and adoption of at least four of the Federal Energy Management Program Water Efficiency Improvement Best Management Practices (BMP). The BMPs range from system-related (boiler and/or steam, cooling tower, faucets and showerheads, etc.) to public information and education programs. (For information on the BMPs, reference the Water Efficiency Best Management Practices from the FEMP web site Resources section.)

13.2.3. DoD Water Use

Water conservation should be an integral part of any energy management program. In Fiscal Year (FY) 2003, DoD consumed over 162,000 million gallons of potable water and spent more than $292 million on water related services. Reducing the use of water will decrease water pollution, increase energy savings, and create more efficient use of water resources. Water requires a significant energy input for treatment, pumping, heating and process uses. By implementing water conservation measures, the Federal government can save more than 120 million gallons of water per day, or 40% of the estimated 300 million gallons or more it now consumes daily, as conservatively estimated by the Federal Energy Management Program (FEMP).

In 1997, FEMP conducted a study of water use in Federal facilities. It concluded that the government consumes more than 50% of its water in 3 types of Federal facilities mainly housing, hospitals, and office buildings. The study estimated this cost to be at least $229 million per year, based on an average water/wastewater rate of $2.08 per 1000 gallons. Many opportunities exist for water use reduction at these facilities in kitchens, restrooms, and laundry areas. Water efficiency measures can be as simple as installing low flow faucets to a more complex measure such as installing a computer controlled irrigation system.

Most of the funding for water and wastewater comes from the revenues generated by prices. Therefore, pricing water to accurately reflect the true costs of providing high quality water and wastewater services to consumers is needed to both maintain infrastructure and encourage conservation. Compared with other developed countries, the United States has the lowest burden for water/wastewater bills when measured as a percentage of household income.

One of the difficulties in instituting water conservation programs on DoD installations is the lack of information on where and how the water is being used. Water meters are rare, so little information is available on the best opportunities to save water.

13.2.4. DoD Wastewater Use

As would be expected, the pattern of wastewater use is similar to that of water use. However, there has been a greater reduction in the quantity of wastewater treated in recent years. Water conservation measures that also reduce wastewater quantities provide an additional opportunity for savings. Many measures in housing as well as food preparation, command laundry facilities, HVAC cooling tower and boiler blow down, and wash rack discharge will fall into this category.

Water conservation measures not only reduce water use and cost, but it also reduces the cost for water treatment. Many DoD installations in semi-arid areas use lagoons for domestic wastewater treatment. The lagoons often discharge effluent to desert areas, whereupon the effluent water evaporates or percolates through desert sand into the groundwater. The U.S. Corps of Engineers Construction Engineering Research Laboratory (CERL) has designed and constructed wetland systems at Utah Test and Training Range (UTTR), Hill Air Base, UT, and Sierra Army Depot, CA.

13.3. Water Management

13.3.1. Rate Structures

While many water suppliers use flat rate or decreasing block rate structures, some use rate structures designed to promote water conservation. These are generally one of two types: increasing either block rates or summer demand peak surcharges. Increasing block rates are used to promote year-round conservation. Summer demand peak surcharges are used to reduce the peak in water demand occurring in the summer because of increased irrigation, pool use, etc.

13.3.2. Water Use Characterization

To make effective use of resources for water conservation, it is important to have an idea of where and how water is used on an installation. The 1997 FEMP study referred to earlier, found that more than 50% of the Federal government's water usage was consumed in mainly in housing, hospitals, and office buildings.

Obviously, the best way to determine where water is used on a particular installation is to install water meters. However, this is impractical on most installations. As an alternative, meters can be installed on selected representative buildings to provide an estimate of water use at similar facilities.

Various tools are available to assist the energy manager with improving energy efficiency through the Energy Efficiency and Renewable Energy's web site. WATERGY is a spreadsheet model that uses water/energy relationship assumptions to analyze the potential of water savings and associated energy savings.

Water Resource Management (WRM) Training Workshop is a two-day workshop to introduce options for managing water resources in the Federal sector, There is also WRM session as part of FEMP's Energy Management Telecourse.

Another tool for characterizing water use on DoD installations is the Installation Water Resource Planning and Analysis System (IWRAPS). IWRAPS includes a software package that helps users assess historical and future water requirements. IWRAPS is able to produce seasonally based, sectorally disaggregated water requirements forecasts and has the capability to address mobilization and conservation scenarios. Versions of the software exist for the Army, and Air Force. Before the Energy Policy Act of 1992, water management issues were directed to the Master Planning section at most installations. Therefore, this system and the relevant water use data may already be available at the Master Planning office on some installations.

When no other information is available, estimates of water use may be obtained from literature. The American Water Works Association (AWWA) publishes a variety of manuals and books that characterize water usage. Other sources include the Environmental Engineers' Handbook, which provides water use data for a number of different facility types. For housing water use, a wealth of data is also available from the California Department of Water Resources.

13.4. Water Conservation Methods

13.4.1. Interior Water Use

As noted previously, one of the primary water users on DoD installations is housing. Many opportunities exist for conserving water in housing areas. In fact, much of the work by municipalities has focused on this area. Additionally, many of the household measures discussed here can also be used in administrative or other types of buildings.

13.4.1.1. Toilets and Urinals

The first water-using device usually considered when developing a water conservation program is the toilet. Toilets generally account for 35 to 40% of typical household water use. The Energy Policy Act of 1992 reduced the maximum amount of water used to flush a toilet to 1.6 gallons per flush.

There exists great potential for retrofitting or replacing older technologies with water-saving products. A variety of federal offices are using low-flush and ultra-low-flush toilets. When low flush toilets were first introduced, they were thought to be ineffective because they required additional flushes. However these have been redesigned to provide more effective flow. Some ultra low flow models consume only a pint of water per flush.

Waterless urinals are also available and accepted by the plumbing code. Previously, most "water-conserving" toilets used 3.5 gallons per flush (gpf). Non-conserving models can use 5 or more gpf. In order to comply with Energy Policy Act of 1992, new urinals must consume no more than 1 gpf. A waterless or water-free urinal requires water only for cleaning. Instead they use a biodegradable, immiscible fluid through which heavier liquid waste passes. Manufacturers of these waterless urinals are listed in the publication Domestic Water Conservation Technologies, DOE/EE-0264 available from the publications link on the FEMP web site.

Hundreds of the waterless urinals have been installed in government facilities. Most of the feedback on their water efficiency has been favorable. Upon consideration for existing installations, note that waterless urinals do not require additional water supply plumbing. They also only add negligible load to the waste system.

Where water and sewage costs do not justify replacement of toilets, inexpensive retrofit devices can be used to substantially reduce toilet water use. Retrofit devices range in complexity from simple displacement devices, e.g. plastic jugs filled with water and a few rocks, for weight, to dual-flush devices, which allow the user to use different amounts of water to flush liquid and solid wastes. The low-cost of these devices can lead to paybacks of 2 years or less, even at installations with average water and sewage costs (approximately $2 per kilo gallon, combined water and sewage costs). Some of these devices are available through the General Services Administration (GSA).

13.4.1.2. Showerhead and Faucets

Showers can also provide an opportunity for considerable water savings. One of the problems encountered in estimating savings from showers is that water use estimates are often based on the maximum rated flow rate of the showerhead, while the actual flow rate is usually lower, because of throttling back by the user. In the early 1980s, the Department of Housing and Urban Development (HUD) conducted a study that included actual shower flow rates and duration of showers. The results showed that the average flow rate for no conserving showerhead [rated flow 5-8 gallons per minute (gpm)] was 3.4 gpm. For low flow (rated flow 2.75 gpm), the average actual flow rate was 1.9 gpm. In both cases, shower duration was approximately 5 minutes per person per day.

Using these figures and an average combined water and sewage cost of $2 per kilo gallon, the expected payback period for water and sewage costs alone was found to be less than 2 years. It is expected that inclusion of the energy costs for heating the water would further reduce the payback period.

Low-flow faucets are required in new Federal construction and along with aerators offer water efficiency for Federal buildings. Faucet aerators are very inexpensive and offer great savings in water and costs, making them cost effective in almost any application. They are especially cost effective in large facilities with frequently used faucets such as hospitals, public restrooms, and large office buildings. Because kitchen areas usually require a higher pressure flow for sanitizing, aerators are not as suitable for those areas.

Metered and sensor-operated faucets tend to be more cost effective than manual ones in large kitchens and high traffic lavatories where a lot of water is wasted. These faucets are operated by batteries or low voltage AC.

Pressure reduction valves, where applicable, can reduce water usage approximately 25% in some small commercial type buildings. Reducing or stabilizing the pressure helps to reduce leaks and flow rates from faucets, showerheads, and other equipment.

Several low flow showerhead, as well as flow restrictors and aerators to reduce the flow of non-conserving fixtures, are available through GSA and ENERGY STAR.

13.4.1.3. Laundry and Food Service

Cold water savings alone will generally not justify replacement of older appliances, such as clothes washers and dishwashers; however, these costs should be considered along with energy costs whenever water-using appliances are considered for replacement. Laundry and food service areas are also prime candidates for heat recovery by use of heat pump water heaters, providing efficient water heating as well as providing the additional benefit of “free cooling.”

Today’s new washing machines use much less water than older models did. They have either a horizontal-axis or vertical-axis tub or drum. A study conducted in 1995 by EPRI and a group of utilities found that horizontal-axis machines used an average of 25% less water than the vertical-axis machine did. However today’s new vertical-axis machines offer better water and energy savings. The horizontal-axis machines do cost more but paybacks from water and energy savings often justify these additional costs, especially in areas with high energy costs.

Many of the newer model dishwashers use less water and less energy to heat water than their older counterparts. Several have boosters to heat water to higher temperatures. Older residential models used 9 to 15 gallons of water per cycle, whereas newer ones use between 4.5 and 9 gallons of water. In addition, operating the dishwashers at full load maximizes water and energy savings.

13.4.1.4. Water Audits

Although not in itself a means of saving water, a water audit can identify where water is being wasted. The first step is to look for leaks. Leaks in faucets and showerhead are easily detected visually. Leaks in toilets can be found by putting dye tablets (available from companies selling water conservation products) or a few drops of food coloring in the toilet tank and looking in the bowl after about 15 minutes. Any color in the bowl indicates a leak. (Often, these leaks can be fixed by simply replacing the flapper or clearing any debris that has collected under it. Since the tank must be emptied to do this, it also provides an opportunity to install retrofit devices into older toilets.)

Next, flow rates from faucets and showerhead should be measured. With this information, it can then be determined if replacement of the fixtures would be cost-effective.

Audits can be accomplished in a number of different ways. They can be done whenever a unit is entered for a service order call or during cleaning between occupants. Alternately, water audit/conservation kits can be provided to residents through self-help stores. Kits should include dye tablets (or food coloring), plastic bag(s) for measuring faucet/shower flow, a brochure describing how residents can save water, and possibly aerators, flow restrictors, and/or toilet retrofit devices. Such kits can be put together at the installation or purchased from suppliers of water conservation products.

13.4.2. Exterior Water Use

13.4.2.1. Landscaping

Irrigation can account for over 50% of the water used at an installation. Proper landscaping can significantly reduce the amount of water needed for irrigation. Using the following seven principles of Xeriscape™ landscaping can not only reduce water use by 30 to 80% but can also result in a healthier, easier-to maintain landscape:

a. Planning and design - Intended use for the area, climatic conditions, topographical conditions, and the amount of effort available for maintenance should all be considered in developing a landscape design.

b. Soil analysis - Factors such as the soil's ability to hold water should be examined.
c. Plant selection - In addition to aesthetics and land use, consideration should be given to grouping plants according to their need for supplemental watering. The purpose of this is to limit the areas that will require supplemental watering.
d. Placement of turf areas - Limiting turf areas, where turf is not required for the intended use of the landscape, can also reduce the amount of supplemental watering required.
e. Proper irrigation - Where supplemental watering is needed, it should be designed to promote deep root growth and avoid over-watering.
f. Use of mulches - Mulches can reduce both the amount of water lost to evaporation and the growth of weeds.
g. Proper maintenance - Limiting use of water and fertilizers to the amounts needed to maintain healthy plants and mowing only when grass reaches 2-3 inches in height can make landscapes better able to resist drought conditions.

Proper design of landscaping to minimize water use requires a thorough knowledge of local conditions. Thus, the best source of assistance in developing a landscape is likely to be local nurseries or the local water utility.

13.4.2.2. Irrigation Practices

Whether or not Xeriscape™ principles have been used in the development of a particular landscape, proper irrigation can reduce the amount of water used and result in healthier, more drought-resistant plants.

Simple measures -- such as positioning sprinklers so that they do not overspray onto paved areas -- are effective in reducing water waste. Plants should be watered deeply and infrequently, as this promotes deeper root growth and helps the plants resist drought. Again, local nurseries are the best source of information on plants' water needs.

The timing of irrigation can also influence the amount of water used. Watering should be accomplished during pre-dawn hours, to limit evaporation and ensure that moisture is in the root zone during early daylight hours, when it is most beneficial to the plant. Moisture sensors can also be installed, to ensure that water is only provided to plants when needed.

Finally, when a new irrigation system is to be installed, it is better to select a drip irrigation system, which will deliver water directly to the root zone, rather than a sprinkler system, which will lose a much greater portion of the water to evaporation. Possibly, a subsurface irrigation system could also prove beneficial.

Consideration should also be given to reusing water from other applications such as laundries, vehicle and aircraft wash facilities, cooling towers, or industrial processes. Utilizing reclaimed water from the local sewage treatment plant should also be investigated. Many localities have recently modernized their plumbing codes to allow such reuse, and some water districts require it. Refer to EPA Manual “Guidelines for Water Reuse” for detailed information.

13.4.3. Industrial Water Use

13.4.3.1. Cooling/Boiler Water

One often-overlooked area with substantial potential for water conservation is boiler and cooling tower use. Water is lost from recirculating cooling towers in two ways: (1) evaporation, which provides the cooling; and (2) blowdown, which removes scale-causing constituents from the recirculating water. Blowdown provides the opportunity to conserve water.

As water evaporates, scale-causing impurities are left behind (and concentrated) in the recirculating water. When the impurities are concentrated beyond their saturation point, they settle out of the water as scale. Blowdown is used to remove the impurities before they settle out.

By chemically treating the recirculating water, these impurities can be concentrated beyond their normal saturation point without settling out. Thus, cycles of concentration can be increased and blowdown reduced. (Cycles of concentration refers to the number of times a given constituent is concentrated in the tower.) In some applications, injection of ozone for biocidal treatment will make further blowdown reductions possible.

A similar situation exists for boilers. The calculations, however, can be somewhat simpler, since there is no evaporation to consider. Cycles of concentration can be easily calculated from the conductivities of the blowdown and the feedwater.

13.4.3.2. General Tips for Industrial Water Efficiency

The following tips are taken from the U.S. EPA’s web site. Additional resource information can be found at the web site as well as referenced at the end of this chapter.

For equipment:

- Install high-pressure, low-volume nozzles on spray washers.
- Install in-line strainers on all spray headers; inspect nozzles regularly for clogging.
- Replace high-volume hoses with high-pressure, low-volume cleaning systems.
- As equipment wears out, replace with water-saving models.
- Equip hoses with spring loaded shutoff nozzles.
- Install ultra-low flow toilets, or adjust flush valves or install dams on existing toilets.

Other measures:

- Detect and repair all leaks.
- Identify discharges that may be re-used and implement re-use practices. Some discharges with potential for re-use are:
  - final rinses from tank cleaning, keg washers, fermenters
  - bottle and can soak and rinse water
  - cooler flush water, filter backwash
  - pasteurizer and sterilizer water
  - final rinses in wash cycles
  - boiler makeup
  - refrigeration equipment defrost
  - equipment cleaning
  - floor and gutter wash
- Use fogging nozzles to cool products.
- Handle waste materials in a dry mode where possible.
- Adjust overflows from recirculation systems by controlling the rate at which make-up water is added: install float-controlled valve on the make-up line, close filling line during operation, provide surge tanks for each system to avoid overflow.
- Turn off all flows during shutdowns. Use solenoid valves to stop the flow of water when production stops.
- Adjust flow in sprays and other lines to meet minimum requirements.
- Wash vehicles less often, or use a commercial car wash that recycles water.
- Discontinue using water to clean sidewalks, driveways, loading docks, and parking lots.

13.4.4. Leak Detection and Repair

The DoD Components shall continue to concentrate on early leak detection and repair. The American Water Works Association estimates that 10 to 20% of the water treated at a typical plant is lost to distribution system leaks or other unaccounted uses. Some of this water may be used for beneficial purposes, such as flushing mains, but much of it is lost to the ground.

Accurate determination of the position of leaking water pipes within a supply system and subsequent repair serves to conserve water as well as energy. Water that is lost after treatment and pressurization, but before delivery to customers, is money and energy wasted.

Municipalities can usually determine their unaccounted water use by subtracting customer meter readings from the production meter readings. On many military installations, this is not possible because end-use of water usually is not metered. AWWA publication M36, "Water Audits and Leak Detection," can be used as a guide to determine if you need leak protection. An alternate means to determine if leaks are likely to be a problem is presented in Public Works Technical Bulletin (PWTB) 420-46-2, "Procedure to Detect Water Distribution System Leaks."

The procedure consists of measuring flow into and out of the distribution system over a 24-hour period and during the time of "minimum-night flow," usually between 0000 - 0300 hours. If the ratio of minimum night flow to average daily flow is more than about 0.4 -0.5, it is likely that leaks are a problem in the distribution system. In this case, it is probably worthwhile to contract for a leak detection survey with a local firm. As noted in the PWTB, the Construction Engineering Research Laboratory has a spreadsheet to help installations estimate the cost effectiveness of a leak detection survey.

The Spring 2002 issue of Water Conservation News (accessed through the California Department of Water Resources web site at http://www.owue.water.ca.gov) discusses the methodology for conducting leak detection surveys. It also cites a new technology currently in production which includes a single unit comprised of audible leak detection hardware coupled with a data logger, radio transmitter and extended life battery (10+ years). Multiple units are permanently installed at multiple pipe locations within the water supply system and continually monitor for sounds characteristic to pipe leakage. When a unit detects an audible reverberation indicative of leakage, the onboard radio transmitter sends a signal to an above ground receiver. The survey team now has only to drive about the survey area with the receiver to identify locations in which to return with a noise correlator for pinpointing or discounting potential leakage spots. The primary drawback to such a system is that large quantities of data loggers are necessary to accommodate a large water system.

13.4.5. Industrial Water Audit

Industrial processes are so specialized that it is not possible to provide general recommendations for effective water conservation at industrial facilities. The best approach is to conduct an individual water audit of the facility in question. One prime area of consideration in industrial facilities is water reuse. In some cases, water discharge for one process can be reused, without treatment, in another.

13.4.6. Public Information Programs

Public information programs can be used in conjunction with all other water conservation measures. Recent environmental concerns have provided some emphasis on water conservation. Many people are motivated to save water, not only because of the potential money savings but also because it is environmentally responsible.

Information programs can take the form of handouts to housing residents, posters in administrative buildings, school programs, etc. Some installations have provided water conservation kits, including informational packets and retrofit devices, to new housing residents. Information packets can be developed to provide installation-specific information, or brochures from EPA or other sources can be used.

13.5. References

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10. US Army Construction Engineering Research Laboratory. Distribution of

Water Use at Representative Fixed Army Installations, August, 1983.
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Table 13-1 - Example Water Audit Elements

Heating, Ventilating, and Air Conditioning Systems
- Employ non-chemical treatment systems to increase cooling tower cycles of concentration to maximum levels without scaling, reduce bleed-off.
- Cooling tower modifications (e.g., drift eliminators) to improve efficiency.
- Install air-cooled as opposed to water-cooled systems wherever cost-effective.
- Return condensate to boilers.
- Control unnecessary evaporation loss.

Potable Water Distribution System
- Leak detection and repair - quantify leak losses. Recommend cost-effective projects in the upgrade of selected systems by installing suitable controls and meters, etc., where feasible.
- Pressure reduction - install pressure reducing valves where applicable.

Landscape
- Use low-flow sprinkler heads instead of turf sprinklers in areas with plants and trees
- Install timers and/or moisture sensors on irrigation systems and check sprinklers for even watering pattern and delivery rate to prevent over-watering.
- Use natural landscaping/Xeriscaping to reduce irrigation.
- Inspect and repair irrigation equipment for leaks.
- Use reclaimed water or ponded rainwater for irrigation watering.
- Use drip or subsurface emitting systems.

Vehicle/Aircraft Wash Facilities
- Install water reuse/recycle system.
- Recommend cost-effective engineering solutions.

On-Site Wastewater Recycling
- Graywater systems.
- Combined wastewater treatment and recycling systems.

Plumbing Products
- Low-flow/no-flow toilets and urinals.
- Low-flow showerhead and low-flow faucets

Mess Hall Appliances/Dishwashers
- Limit water temperature and flowrate settings to manufacturers' recommendations. (To avoid compromising sanitation, do not set the temperature below 140 deg F.)·
- Install electric eye or sensor systems in conveyor-type machines so the presence of dishes moving along the conveyor activates the water flow.
- Install low-temperature dishwashers that sanitize primarily through use of chemical agents rather than high water temperatures.

Laundry Equipment
- Consider rinse water recycling or ozone laundering (using ozone and cold water instead

of detergent and hot water to clean the laundry -- reduces operating costs and improves recyclability of the rinse water since no detergents are added).

14. Funding Energy and Water Conservation Projects

14.1. Key Points

- Meeting energy- and water- reduction goals will require implementation of capital-intensive projects that are life cycle cost effective.
- Government funding sources will be insufficient to implement all cost-effective energy measures, requiring energy managers to seek outside sources of funding. Alternate financing mechanisms such as DSM, ESPC and UESC programs should be considered.
- For projects with higher SIR, UESC and/or ESPC should be pursued prior to ECIP funding.

14.2. Sources of Funding

There are many different funding sources available to support energy conservation projects. The budgeting procedures to be followed to obtain funds are different for each funding source. Detailed explanations of how to build the budget and how to do project programming for all funding sources are beyond the scope of this Handbook. The most common funding sources for energy conservation projects are described in the paragraphs below. These funding sources give energy managers some idea about when and how to use a funding source given the nature of the project, e.g., scope, type of building, work classification, and payback potential. Funding sources may be categorized into four basic groups: Government funding sources, utility funding sources, Energy Savings Performance Contracts (ESPCs), and Utility Energy Services Contracts (UESCs).

Partnerships with the private sector through Utility Energy Services Contracts and Energy Savings Performance Contracts are a crucial tool for financing energy efficiency measures. Projects with higher SIRs should first pursue using UESCs and ESPCs before consideration for ECIP, since typically these projects shall be more attractive to the commercial sector.

14.3. Government Funding Sources

14.3.1. Operations and Maintenance Funds

The majority of energy conservation projects are funded by O&M funds. This is the same account that pays for core military operational needs such as fuels and bullets. Installations are allocated a portion of O&M dollars in the beginning of each fiscal quarter to carry out assigned missions. Installation commanders have authority and flexibility in deciding how these O&M funds are to be spent. The DoD Components shall ensure that the energy efficiency measures are incorporated into repair and minor construction projects using available O&M funding. The Components shall also ensure that sufficient funding is available to support other projects using alternative financing vehicles such as UESC and ESPC contracts.

Even when O&M funds are earmarked for energy conservation efforts, commanders can reallocate the funds to other priorities as they see fit. This is the primary reason for gaining the commander's strong support for energy conservation programs. In a declining budget environment, it is easy for the installation commander to defer O&M funding for energy retrofit projects in favor of mission essential requirements.

14.3.2. Military Construction

Congress closely controls the MILCON program by line-item approval of each individual project. Any new construction valued at $750,000 or more is classified as a MILCON project; special Congressional approvals and appropriations are required before construction can begin. The MILCON programming process is complex and confusing. Major command counterparts can provide more information on the MILCON program.

14.3.2.1. Energy Conservation Investment Program Funds

The ECIP is a special MILCON-funded program for energy conservation retrofit or replacement construction projects valued at $300,000 or more. In general, the ECIP can fund energy conservation projects for new or existing energy systems or buildings at any DoD-owned facilities where DoD pays the energy bills. Competition for program funds is very fierce, but a well thought out, high savings-to-investment project has an excellent chance of being funded. For Navy, the main metric used to rank ECIP projects is the total MBTUs of energy and KGAL of water saved per $1000 of investment. Project documentation must clearly show project costs and expected savings.

Congress and the OSD have set aside a special fund to finance ECIP projects. Therefore, ECIP projects do not compete with other mission-related MILCON projects for funding. Funds shall be allocated on a fair share basis based on the DoD Component’s previous year reported facility energy use and factoring in the obligation rate for the last 5 years. This approach allows the DoD Components to manage the program with a degree of funding certainty and encourages timely execution.

The DoD Components shall strive to obligate 100 percent of the ECIP funds provided by the end of third quarter in which the funds were issued. At the end of the third quarter, any unobligated funding at that point may, at the discretion of the Office of the DUSD (I&E) (IRM), be withdrawn and redistributed to another DoD Component poised to obligate against a valid design-complete project, with priority given to renewable energy projects. MILCON funding should only be applied to projects that directly produce energy savings and/or cost reduction, however the Office of the DUSD (I&E)(IRM) shall have the discretion to directly apply funding for other uses such as studies and assessments if deemed appropriate. Realized saving should not only be auditable, but initial submission on DD Form 1391 of proposed projects shall identify the method to be used for savings verification.

Project lists shall include project title, installation, Savings to Investment Ratio (SIR), and payback, as well as the estimated project cost and annual energy savings in British Thermal Units and dollars. At the discretion of the DoD Component, up to 10 percent of its annual ECIP target budget may be programmed against renewable energy applications that do not necessarily meet the SIR and payback criteria in order to expand use of renewable energy applications and to meet the goals of Executive Order 13123. Detailed ECIP program guidance can be found in Office of the Assistant Secretary of Defense for Logistics Memorandum of March 17, 1993.

It is the energy manager's responsibility to prioritize ECIP projects. The manager needs to rank projects to qualify for funding on the basis of their Savings-to-Investment Ratios (MBTUs + KGAL saved)/$1K for Navy). Exceptions are made for investments involving the substitution of renewable energy for nonrenewable energy sources that have a beneficial environmental effect. Energy managers should contact their next level of command for further information on investing in renewable energy projects.

Although projects funded under ECIP must meet certain criteria, many worthwhile projects should be able to meet them easily. They must have a SIR greater than 1.25 and a discounted payback of less than 10 years. See Chapter 14 for a detailed discussion of Life-Cycle Costing and economic decision statistics.

14.4. Utility Funding Sources

14.4.1. Demand Side Management Programs

DSM is the planning, implementation, and monitoring of utility activities designed to influence customer use of energy in ways that will produce desired changes in load shape. Improvement in the overall utility load shape reduces their costs. Therefore, it may be profitable for the utility to invest in energy and water improvements at DoD facilities that provide beneficial load shape improvements.

DSM programs are public utility-sponsored programs that encourage energy-efficiency improvements by offering financial incentives (rebates), subsidies, or other support to their customers for installation of energy-efficient technologies. DoD installations can, and should, take advantage of DSM programs if their local utility offers them. Many DSM programs are run by electric utility companies that see improved energy efficiency or load shifting as a means of avoiding expensive new plant construction. However, many natural gas utilities are also offering DSM programs at the prompting of their public regulatory commissions.

EPAct directed Federal agencies to take full advantage of DSM programs offered by public utilities. DEPPM 94-1 establishes guidelines for participation in or negotiation of DSM programs with utilities. The Army is designated as the lead agency for implementation of DSM programs.

Energy utility companies have traditionally concentrated on the supply side of the meter. They have focused on providing a reliable supply of electricity or natural gas to customers. Electric utilities, in particular, have viewed themselves as being in the business of building and operating power plants.

DSM is a relatively new business approach used by energy utilities; in DSM, they take actions on the demand side of the meter, rather than solely on the supply side. Increased energy production costs and the difficulty of positioning new plants have led utilities and, more importantly, utility regulatory bodies to place a new emphasis on energy conservation as a way of obtaining kilowatts. A kilowatt hour saved through efficiency is a kWh that does not need to be generated by a new plant. Because the electric power generation business is no longer a declining cost industry, energy-efficiency improvements are a cost-effective way to reduce the need for new generating capacity. Increased efficiency also satisfies customer needs by reducing their costs.

Many Public Utility Commissions (PUCs) are requiring their regulated utilities to implement DSM programs as part of their least-cost planning or Integrated Resource Plans (IRPs). Such plans aim to minimize the cost of energy by comparing the cost of various efficiency measures with the cost of traditional sources of energy supply.

Depending on the utility's avoided cost -- the cost that it avoids by eliminating or postponing the need for new generating capacity – and its load profile, the utility may promote overall efficiency measures or be primarily interested in technologies that shift demand away from peak demand periods. For example, thermal storage is a technology that uses energy during lower cost off-peak demand hours to create ice or chilled water at night, which then cools the building during the day with minimal daytime energy use. By reducing peak demand time energy use, the utility reduces the need for capacity to meet those peak energy requirements.

For the electric industry as a whole, the Electric Power Research Institute projects DSM programs to reduce growth in summer peak demand by 20% and growth in annual energy consumption by 11% from 1990 to 2010. Even with aggressive DSM programs, overall electricity demand will increase. This provides an economic incentive to avoid load growth as an economic alternative to new long-term capital investment in generation capacity. As utilities prepare for dramatic changes in the electric industry resulting from deregulation, they will require long-term commitments for service from customers receiving DSM financial incentives.

14.4.2. DSM Programs and Energy Services

For many DoD installations, local electric or gas utilities may have programs in place that provide energy efficiency services, including free or subsidized energy audits and subsidies or rebates for energy-efficient technologies. DSM programs are usually targeted toward specific energy-user groups. For example, residential programs include home energy audits and rebates on installation of compact fluorescent bulbs, hot water tank insulation, and similar measures. Commercial and industrial programs also provide audits and rebates for specific technologies. In addition, these programs provide financial incentives for measures proposed by the customer because energy use among commercial and industrial customers varies more than for residential customers; customer needs are more specialized. DoD installations have users reflecting the entire spectrum of utility customers, ranging from military family housing to advanced industrial facilities. Thus, installations can take advantage of all or most utility DSM programs.

Taking advantage of utility DSM programs is one of DoD's major strategies. By taking part in such innovative utility programs, installations can obtain partial or total funding for lighting and certain other energy efficiency measures that are taken. In addition to learning about and taking part in existing utility programs, most bases are large enough to be able to negotiate customized programs with their local utilities. Such customized programs have the potential to achieve relatively large efficiency gains.

To take advantage of innovative utility programs, the installation energy manager should find out what programs are available from the local electric and gas utilities. Energy managers should never proceed with a project before checking whether the utility will partially or totally subsidize the project. However, energy managers should not stop at that point; it may be possible to develop a complete customized DSM program, particularly for large energy users operating industrial processes.

As deregulation is implemented, changes in the electric utility industry are forcing utility companies to reconsider how they invest in DSM programs. The issue of stranded investment costs is a critical one. Utilities cannot afford to invest capital funds in a customer who may leave their service in a few years. For this reason, utilities may require long-term contracts for DSM financial incentive recipients.

Many utility companies are phasing out DSM programs and creating energy services groups. They serve a similar function, but the implementation may be substantially different. Utility investment in a customer may be tied to long-term negotiated contracts or linked to ESPC. Energy managers should research available programs through databases maintained and distributed by DOE and EPA and commercial publications such as Energy User News. However, where only one or a small number of utility companies is involved, the best way to get accurate and up-to-date information is to contact the utility company directly.

14.4.3. Negotiated DSM Programs

Each Service is negotiating to obtain customized DSM programs at several locations. Some negotiations are being conducted in cooperation with other Federal Government installations in a utility's service area. Such cooperative Government approaches give the Services even more clout. The aim is to obtain full funding for energy-efficiency improvements as much as possible. Utilities provide subsidies in two ways: they may provide the up-front capital needed for a specific project in advance, or they may provide a rebate once the technology has been installed. When the utility provides the full capital costs for efficiency improvements, a portion of that capital cost must often be repaid later as separate direct payments or as additions to the installation's energy bill. While rebate programs require the base to provide the initial capital, savings usually begin sooner.

DoD installations are permitted to receive rebate checks from their utilities and to apply those rebated funds to their O&M accounts. However, if an installation is uncomfortable receiving a check directly from a utility, it can negotiate the rebate as a temporary reduction in its utility bill.

14.4.4. Utility Energy Services Contracts

A UESC is a vehicle that a Federal agency and its utility can use to implement energy efficiency, water conservation, and renewable energy projects. In a UESC, a utility agrees to provide Federal agencies with services or products (or both) that are designed to make Federal facilities more energy efficient. Federal facilities can also obtain project financing from a utility through a UESC. During the contract period, the facility pays a lower utility bill as well as a payment to the utility for the UESC. The total of these two payments may be less than or equal to an average amount of utility bills before the UESC. After the project is complete, the utility bill will be reduced as a result of increased energy and water efficiency.

To help Federal agencies produce successful energy-saving projects with utilities, the Federal Energy Management Program (FEMP) offers training, assistance with technical and financial reviews, and information and project facilitation from utility partnerships. In addition, FEMP publications provide information about utility projects.

14.5. Energy Savings Performance Contracting

14.5.1. Definition

ESPC is a contracting procedure in which a private contractor (typically called an energy services company or ESCO) evaluates, designs, finances, acquires, installs, and maintains energy-saving equipment/systems for a client and receives compensation based on the energy consumption/cost savings performance of those equipment/systems. Potential equipment/system retrofit projects involve lighting, HVAC systems, automatic controls, building envelope improvements, water conservation measures, and alternative fuel systems. These contracts can be signed for periods up to 25 years.

Especially when little or no internal funding is available, ESPC can be an effective vehicle through which to implement energy conservation measures. The Deputy Secretary of Defense, in a 1 March 1991 memorandum titled "Defense Facilities Energy Management," directed that each military department initiate a minimum of three ESPC projects each fiscal year. In light of EO 13123 requirements for all Federal agencies to reduce their energy consumption by 35% by the year 2010 and considering current and future projected internal funding being somewhat limited, it is likely that ESPC will facilitate a large amount of energy conservation measures for DoD installations well into the next century.

14.5.2. Benefits & Concerns

The conditions of the ESPC agreement, determines the level of compensation to the ESCO, with the remainder of the energy consumption/cost savings retained by the client. Current statute allows DoD components to enter into such contracts for facilities owned by the component. This type of contracting provides an effective alternative method of implementing energy saving projects when installation resources such as manpower, technical expertise and/or internal funding are in low supply or simply not available. Simply put, ESPC provides a way for the private sector to finance Federal Government energy savings projects. However, compared to internally funded energy savings projects, ESPC requires a relatively complicated contracting process, a long-term commitment by both parties, and continual administration.

14.5.3. Basic Types

Generically, ESPC projects can be segregated by their scope, ESCO payment method, and/or contracting process. For example, the scope can involve a single technology (such as lighting retrofits), a single facility (such as a military hospital), a specified area (such as family housing), or an entire installation (such as an Air Force base). Federal compensation payments to the ESCO can be made as a financed monthly payment, which is determined as a function of projected monthly cost savings, or the payment can be made as a percentage "share" of verified monthly savings. ESPC projects can be solicited and negotiated with one (or more) ESCO pre-qualified by DoD or can be negotiated directly with a utility company regulated by the corresponding State Public Service Commission.

14.5.4. Applicable Legislation/Policy

ESPC is authorized by 42-USC-8287, 42-USC-8251 through 8261, 10-USC-2865 (c) and the Energy Policy Acts of 1992 and 2005 and encouraged by Presidential Executive Order 13123. The following is a brief chronological account thereof:

- 7 April 1986: Congress enacted legislation that permits Federal agencies to enter into energy conservation contracts. “Shared Energy Savings (SES)” projects are authorized by title VIII-Shared Energy Savings, Section 7201, Public Law 99-272 (42-USC-8287).
- 1 March 1991: The Deputy Secretary of Defense, in a memorandum titled “Defense Facilities Energy Management,” directed that each military department initiate a minimum of three energy savings performance contracts each fiscal year.
- 24 October 1992: The concepts and terminology of ESPC replaced Shared Energy Savings (SES) with President Bush’s signing of Public Law 102-486, the Energy Policy Act of 1992.
- 11 January 1994: The Department of Defense published DEPPM 94-2, Energy Savings Performance Contracts. This memorandum promulgated a simplified ESPC procurement procedure through establishment and selection of pre-qualified firms.
- 8 March 1994: Presidential EO 12902, Energy Efficiency and Water Conservation at Federal Facilities, further expanded Federal energy conservation requirements. Section 301 states, “Each agency shall develop and implement a program with the intent of reducing energy consumption by 30% by the year 2005, based on energy consumption per gross square foot of its buildings in use, to the extent that these measures are cost effective. The 30% reduction shall be measured relative to the agency’s 1985 energy use.”
- 10 April 1995: The Department of Energy published final rule 10 CFR Part 436, Federal Energy Management and Planning Programs, Energy Savings Performance Contract Procedures and Methods. This rule established a 5-year pilot program of ESPC procedures designed to accelerate private sector investment in cost-effective energy conservation measures in existing Federal buildings, thereby saving taxpayer dollars. This rule covers topics as required by section 801 of the National Energy Conservation Policy Act (42-USC-8287) such as qualified contractor lists, procedures and methods to select, monitor and terminate contracts, and substitute regulations for certain provisions in the Federal Acquisition Regulation (FAR) that are inconsistent with section 801 and can be varied consistent with their authorizing legislation.
- 3 June 1999: Presidential EO 13123, Greening the Government through Energy Efficiency Management, further expanded Federal energy conservation requirements. Section 202 states, “Through life-cycle cost-effective measures, each agency shall reduce energy consumption per gross square foot of its facilities, excluding facilities covered in section 203 of this order, by 30 percent by 2005 and 35 percent by 2010 relative to 1985.” EO13123 also set goals for industrial installations, renewable energy goals, and water conservation goals.

- 29 October, 2004: The President extended ESPC authority through 30 September 2006.
- 8 August 2005: The President signed the Energy Policy Act of 2005 as Public Law 109-190.

14.5.5. Contracting Process

14.5.5.1. Overview

On 11 January 1994, the Department of Defense published DEPPM 94-2, Energy Savings Performance Contracts. This memorandum promulgated a simplified ESPC procurement procedure through establishment and selection of pre-qualified firms. Federal/DoD agencies may solicit ESPC proposals only from this list of pre-qualified firms. If an unsolicited ESPC proposal is received from a pre-qualified firm, an announcement of such must be made to other pre-qualified firms to provide a similar opportunity before any unsolicited proposal may be accepted. Once a competitive selection is made, a Federal/DoD agency may negotiate an ESPC project and/or an indefinite delivery indefinite quantity contract directly with the selected/pre-qualified firm.

14.5.5.2. Value/Approach Determination

First, an installation energy manager must decide whether his/her facilities are good candidates for ESPC. If energy consumption/cost is relatively high, internal funding resources are relatively low, the existing energy infrastructure (aggregate) is approaching the end of its useful life, ongoing maintenance resources are severely limited, and reasonably accurate utility consumption/cost historical data are available (especially if any individual buildings are submetered), ESPC probably is a prudent alternative toward implementation of energy savings retrofit projects. If so, the process is typically started by submitting a Purchase Request (PR) package to the appropriate contracting office. This PR submission normally consists of a request for purchase, an SOW, and a cover letter. This PR does not have to be funded before initiating action.

Nevertheless, funding for the first year must be secured before an ESPC contract can be awarded. Since the installation normally pays the ESCO from funds budgeted for utility services, sufficient funds need to be reserved within the utility budget to pay for as much as the maximum estimated annual savings from the ESPC project. At this point, it may be prudent to check with corresponding local utility companies. If the installation is interested, a regulated utility providing energy services to that installation and regulated by the corresponding State Public Service Commission may be interested in pursuing a “Customized DSM” contract with the installation. Unless a specific technology, specific group of buildings, and/or specific building is already targeted for ESPC, then it may be advisable to consider a basewide ESPC approach. Normally, ESCO payment terms are negotiated on a contract-by-contract basis. However, many ESPC agreements are structured around monthly compensation payments calculated as a function of projected monthly energy cost savings. Of course, this approach must be supported by a valid written guarantee that will automatically reimburse the installation for any significant energy savings shortfall. Base-wide ESPC agreements are typically structured as an “indefinite delivery requirements contract,” which established monetary “margins” quoted by the ESCO, allowing the ESCO to research and negotiate individual delivery orders throughout the term of the contract.

14.5.6. Additional Resources

The following offices serve as the primary ESPC point of contact and technical/policy resource for each respective DoD agency:

Army: Office of the Assistant Chief of Staff for Installation Management
Directorate of Facilities & Housing
600 Army Pentagon
Washington, DC 20310-6000

Navy: Commanding Officer
Naval Facilities Engineering Service Center
1100 23rd Avenue
Port Hueneme, California 93043

Air Force: Headquarters, Air Force Civil Engineer Support Agency
Attn: HQ AFCESA/CESE
139 Barnes Drive, Suite 1
Tyndall AFB, Florida 32403-5319

Marines: Headquarters, Marine Corps
Facilities & Services
#2 Navy Annex (Code LFF-1)
Washington, DC 20380-1775

The Department of Energy provides support information/services to all DoD agencies interested in ESPC projects. A variety of references and training instruments are available. Contact:

US Department of Energy, EE-90

Federal Energy Management Program
1000 Independence Avenue, SW
Washington, DC 20585-0121
FEMP Help Line: (877) DOE-EERE
Internet: http://www.eere.energy.gov/femp

Part IV Analyzing Energy Projects

15. Life-Cycle Costing

15.1. Key Points

- The purpose of Life-Cycle Costing (LCC) is to help select the best energy and water projects.
- Properly implemented, LCC will help an energy manager meet or exceed energy goals with the lowest possible investment.
- A variety of excellent printed and software resources is available to support the DoD energy manager doing LCC analysis of projects.

15.2. Background

The primary purpose of energy and economic analysis of potential energy conservation measures is to make decisions. The type of decision will determine the appropriate type of analysis and the decision statistics to be used. Except for special situations where a measure is obviously cost-effective or not cost-effective or where the cost of the analysis would not be justified, DoD facilities should continue to utilize life cycle cost analysis in making decisions about their investment in products, services, construction, and other projects to lower the Federal Government's costs and to reduce energy and water consumption. All projects with 10 year or less simple payback that fit within financial constraints shall be implemented. The DoD Components shall consider LCC of combining projects and encourage aggregating of energy efficiency projects with renewable energy projects where active solar technologies are appropriate.

Various resources are available to assist energy managers with LCC analysis. Methodologies and procedures for LCC for Federal agencies are clearly outlined in 10 CFR Part 436. NIST publishes other publications and software supporting LCC analysis of energy projects; these are listed in Section 15.6.

DoD energy managers must make several types of decisions frequently. The most common is "Should I accept or reject this project idea?" Another decision is "Which of these proposed projects should I select?" This type of decision may be required for situations where multiple systems are being considered to do the same job, when deciding how far to go in conserving energy (for example, how much insulation), or when several combinations of interdependent systems are being considered. In these cases, the objective is to select the best (economically optimum) project from a series of alternatives, each of which may individually meet the pass/fail or accept/reject criteria. Another type of decision involves how to spend a limited amount of energy funds when presented with a long list of projects that are all cost-effective.

The same decision will be reached by multiple analysts if proper methods are used in accordance with 10 CFR Part 436 using the current fiscal year discount factors. This makes decisions regarding choice of energy systems, retrofit measures, and funding priority in DoD facilities fair and objective, rather than subjective. EPAct and EO 13123 require DoD agencies to make decisions regarding selection of energy systems on an LCC basis. Further, all retrofit measures with a payback of 10 years or less that fit within financial constraints shall be implemented. Specific funding programs, such as ECIP and FEMP, specify economic criteria for funding of measures under those programs. To qualify, measures must typically have a payback of 10 years or less and have a Savings-to-Investment Ratio of 1.25 or greater. Meeting these criteria does not ensure funding; however, since these programs have historically had many more requests than funds available. For this reason, projects with higher SIRs are more likely to receive funding. Projects that meet the specified criteria but that cannot be funded directly should be considered for implementation through ESPC or UESC.

The purpose of this chapter is to provide a basic understanding of LCC and of how to screen projects for cost effectiveness based on LCC statistics. Also, an understanding of how to accurately complete a Life Cycle Summary page for a DD 1391, funding request is important. Detailed information on LCC, discussion of how to use analysis software, and academic discussion of finer points of economic analysis are available in listed supplementary publications.

15.3. LCC Terminology and Concepts

LCC can seem confusing because of the special terminology and mathematics used to support the methodology. However, the basic concepts and procedures are simple and easy to implement. To reduce confusion, basic terms and concepts are described below. They are presented in logical, rather than alphabetic, order to facilitate understanding concepts through definition of the terminology.

15.3.1. Types of Costs

Investment costs are the initial costs of design, engineering, purchase, construction, and installation exclusive of sunk costs. *Sunk costs* are costs incurred before the time at which the LCC analysis occurs. Only cash flows that occur at present or in the future are pertinent to the LCC economic analysis. *Recurring costs* are future costs that are incurred uniformly and annually over the study period. These recurring costs may be energy costs or operation and maintenance costs. *Nonrecurring costs* are costs that do not uniformly occur over the study period. Non-recurring costs are typically maintenance, repair, or replacement costs.

Replacement costs are future costs to replace a building energy system, energy conservation measure, or any component thereof, during the study period. *Salvage value* is the value of any building energy system removed or replaced during the study period or recovered through resale or remaining at the end of the study period.

15.3.2. Time Period of the Economic Analysis

Study period is the time period covered by an LCC analysis. For Federal projects, the study period is typically either the estimated life of the system, the least common multiple of different alternatives' lives, or a time period specified by the funding program -- plus a planning and construction period of up to five years, if appropriate. Federal guidelines for LCC outlined in the CFR limit the assumed system lifetime to a maximum of 25 years. With a planning and construction period (maximum of five years), the maximum study period is 30 years. Table 15-1 lists recommended study periods for different categories of energy and water conservation projects.

The *base date* is the beginning of the first year of the study period, generally the date on which the LCC analysis is conducted. This is the date to which future cash flows are discounted to determine equivalent present value. The *service date* is the point in time during the study period when a building or building system is put into use, and operation-related costs (including energy and water costs) begin to be incurred. For convenience, the base date and the service date are frequently assumed to be the same. While this assumption does not reflect reality, it does greatly simplify the mathematics and is consistent with typical methods for calculating simple payback. In reality, there is normally a significant time period between the analysis and the service date of the project, typically 1-3 years. The time between the base date and the service date is the *planning and construction period*. The Federal LCC methodology and Building Life-Cycle Cost (BLCC) analysis software allow for up to a 5-year planning and construction period and a maximum 25-year economic life, for a 30-year maximum study period.

Table 15-1. Recommended LCC Analysis Life of Energy and Water Projects

Category	*Title*	*Description*
1	EMCS or HVAC Controls (10 years)	Projects to control energy systems centrally to adjust temperature automatically, shed electrical loads, control motor speeds, or adjust lighting intensities
2	Steam and Condensate Systems (15 years)	Projects to install condensate lines, cross connect lines, distribution system loops; to repair or install insulation, and to repair or install steam flow meters and controls
3	Boiler Plant Modifications (20 years)	Projects to upgrade or replace central boilers or ancillary equipment to improve overall plant efficiency, including fuel switching or dual fuel conversions
4	HVAC (20 years)	Projects to install more energy efficient heating, cooling, ventilation, or hot water heating equipment, including the HVAC distribution system (ducts, pipes, etc.)
5	Weatherization (20 years)	Projects to improve the thermal envelope of a building, including daylighting, fixtures, lamps, ballasts, photocells, motion/IR sensors, light wells, highly reflective painting
6	Lighting Systems (15 years)	Projects to install replacement lighting system/controls, including daylighting, fixtures, lamps, ballasts, photocells, motion/IR sensors, light wells, highly reflective painting
7	Energy Recovery Systems (20 years)	Projects to install heat exchangers, regenerators, heat reclaim units or to recapture energy lost to the environment
8	Electrical Energy Systems (20 years)	Projects to increase energy efficiency of an electrical device or system or to reduce cost by reducing peak demand
9	Renewable Energy Systems (20 years)	Any project utilizing renewable energy. This includes active solar heating, cooling, hot water, industrial process heat, photovoltaic, wind, biomass, geothermal, and passive solar applications
10	Facility Energy Improvements (20 years)	Multiple category projects or those that do not fall into any other category, to include water conservation projects.

15.3.3. Life-Cycle Cost Methods

Life-Cycle Cost is the total cost of owning, operating, and maintaining a system over its useful life, where costs are adjusted to their present value based on time of occurrence and time value of money, or discount rate. Figure 15-1 shows the basic concept of LCC of a project. LCC refers to the process of calculating LCC or other supplemental decision statistics based on the LCC method. Given several alternatives for accomplishing the same objective (*mutually exclusive* alternatives) and assuming that all non-quantifiable costs and benefits are equivalent, the alternative with the lowest LCC over a study period is the best choice. Figure 15-2 illustrates the tradeoff of higher investment cost to achieve lower total LCC, which is characteristic of most energy conservation projects.

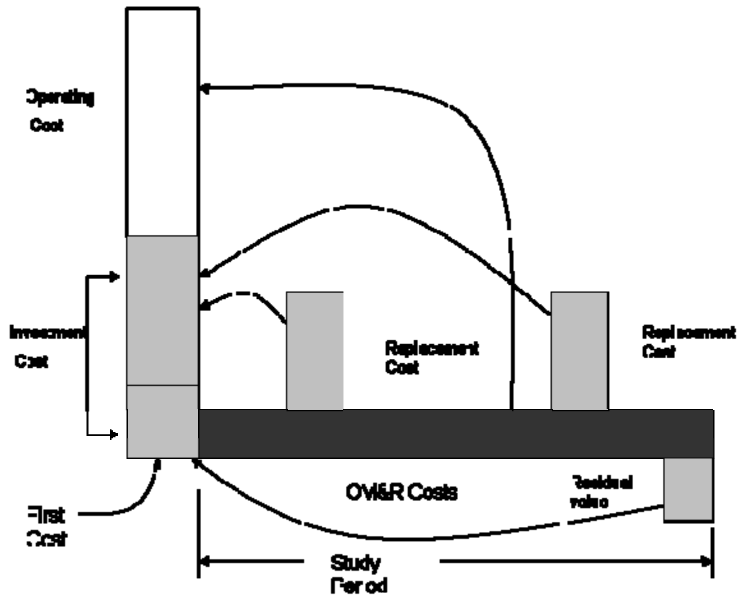

Figure 15-1 Life-Cycle Cost of a Project (the sum of all relevant project costs over a given study period, adjusted for time value of money)

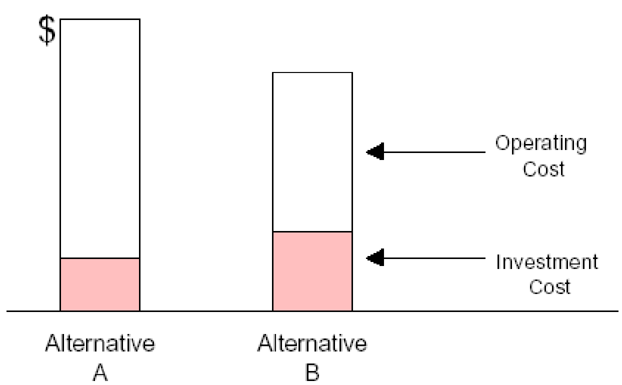

Figure 15-2. Tradeoff Associated with Lowest Life-Cycle Cost

Present Value (PV) is the time-equivalent value of past, present, or future cash flows as of the beginning of the base year, or the base date. *Discounting* is the process of calculating present values based on future cash flows. For purposes of mathematical convenience, cash flows are normally assumed to occur at the end of each year, although DoD has historically used middle-of-year cash flow convention. Either method is consistent with Federal requirements and will result in the same decisions, as long as a single method is consistently applied to all considered alternatives.

Discount rate is the rate of interest that reflects the Government's time value of money or opportunity cost. For Federal energy projects, the rate is determined annually by DOE based on short-term treasury rates but is limited to a low of 3% and a high of 10% regardless of interest rates. Energy project analyses should use the discount rate for the current fiscal year as reported in NISTIR 85-3273 and 4942. *Present Value* factors are discount factors that are calculated based on a given time period and discount rate, which, when multiplied by a future dollar amount, give the equivalent present value as of the base date. *Single Present Value (SPV)* factors are used to convert single future amounts to PVs. *Uniform Present Value (UPV)* factors are used to convert annually recurring amounts to PV. *Modified Uniform Present Value (UPV*)* factors are used to convert annually recurring amounts where amounts change based on escalation rates or where costs change differently from inflation, as in many types of energy costs. UPV* factors based on expected fuel price inflation for different energy types and regions of the country are published annually in NISTIR 85-3273 and 4942. Figure 15-3 summarizes the three basic PV factors used in Federal energy project analysis.

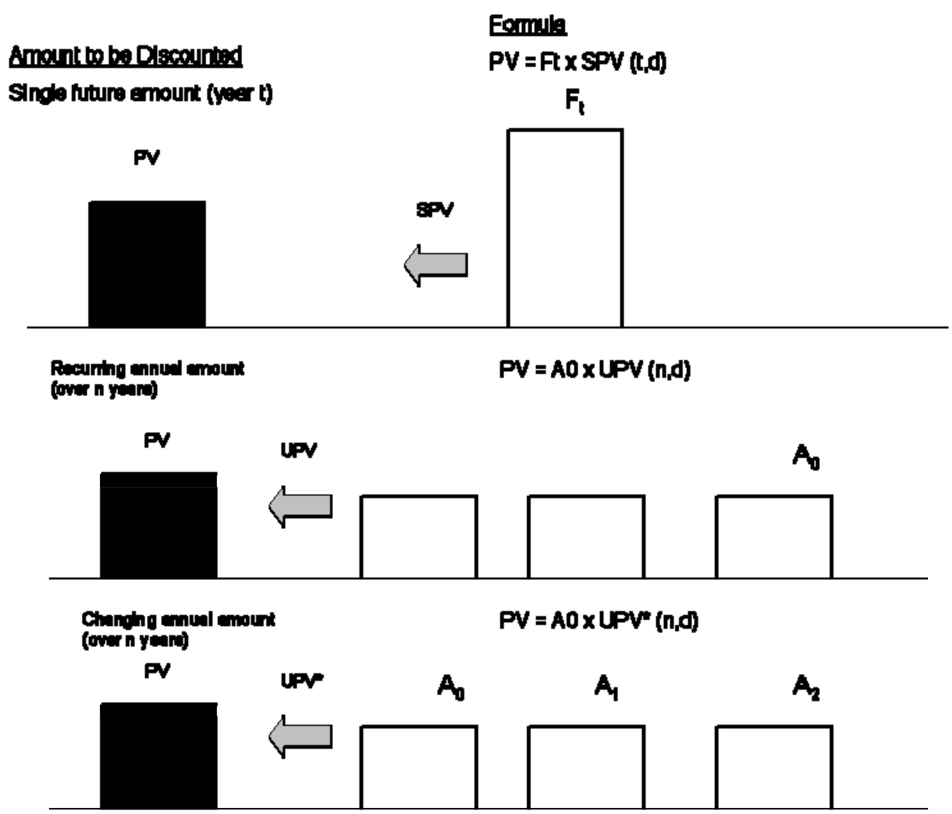

Figure 15-3. Present Value Factors Used in Federal Energy and Water Project LCC

15.4. Making Decisions With LCC Analysis

15.4.1. Lowest Total LCC

Discounting of all cash flows occurring over the study period for a project alternative is the basic computation needed for computing LCC. Decisions regarding selection of one of a group of mutually exclusive alternatives should be made using LCC. The alternative with the lowest LCC over the study period is the appropriate choice. These decisions are typical in planning for new construction. For example, "Which lighting system should I choose for a new building?" "Should I specify R19, R25, or R30 insulation." "Which of these HVAC system alternatives should be specified?" "Which combination of building envelope measures, lighting system alternatives, and HVAC system selection should I choose?" In each case, the answer is the alternative (or combination of interdependent systems) that has the lowest LCC over the study period.

In retrofit analyses, the first decision to be made is typically "Should this possible retrofit project be accepted or rejected?" In this case, two alternatives are being compared. The base case, or the "do nothing alternative"-- maintaining the status quo, is compared to the recommended measure. If the proposed retrofit has a lower LCC over the study period than the base case, then it should be recommended.

15.4.2. Payback Period

Usually the economic difference between two alternatives is expressed in terms of *payback*, or how long it takes to recover the additional investment cost. In this example, the investment cost is the first cost of the proposed retrofit, and assuming uniform annual cash flows, the annual savings is the difference between the O&M costs before and after the retrofit.

Simple Payback (SPB) relates how long it takes to recover an initial investment in a cost-saving measure, assuming the annual savings remain constant and that the time value of money is unimportant. To calculate SPB, simply divide the initial investment by the annual savings. For example, a $1,000 investment that will save $200 per year has a SPB of $1,000/$200 or 5.0 years.

From an academic standpoint, SPB suffers from two key flaws. First, it assumes that $200 received 1 year from today is equivalent to $200 received 5 years from today. Most organizations assign a higher value to dollars received sooner that those received later, based on their opportunity costs or their discount rate. The second flaw is that payback does not consider the effects of different lives of alternatives being considered. For example, investments A and B each cost $1,000 and save $200 per year; therefore both have an SPB of 5.0 years, making them seem equally acceptable. However, if investment A has a useful life of 5 years and investment B has a useful life of 10 years, investment B is obviously a better choice.

Discounted Payback (DPB) is similar to SPB in that it expresses results in time to recover investment costs. However, savings are discounted to their present value based on the discount rate, making DPB consistent with LCC methods. At lower discount rates, SPB and DPB values are closer together. As the discount rate increases, the DPB becomes longer because of the reduced value of future cash flows, while the SPB does not change since it is not based on the LCC method.

Despite the academic problems with SPB, it is still commonly used to make accept/reject decisions. However, Federal guidance for energy and water projects that refer to *payback* mean DPB. Therefore DPB should be used rather than SPB to comply with the intent of Federal guidelines. This will undoubtedly seem confusing at times, since some DoD forms (such as ECIP 1391 report) call for SPB.

A payback of substantially less than the expected life of a project ensures that the project will be cost-effective and should be accepted. DoD's policy is that agencies make decisions regarding selection of energy systems on an LCC basis. All retrofit measures with a payback of 10 years or less that fit within financial constraints shall be implemented.

15.4.3. Savings-to-Investment Ratio

Savings-to-Investment Ratio is a measure of economic performance for a project alternative that expresses the relationship between the present value of the savings over the study period to the present value of the investment costs. It is a type of benefit-to-cost ratio where the benefits are primarily savings, typical of energy projects. SIR is relative measure of performance, meaning it can only be computed with respect to a designated base case. For most energy projects, the base case is the existing situation and the potential project is the alternative.

SIR is most useful as a means of ranking independent projects as a guide for allocating limited investment funding. When faced with a large number of energy/cost saving projects, each of which meet DoD criteria for energy projects but where funding limits the number of projects that can be implemented, SIR should be used to rank the projects for funding. Higher SIRs should be funded first, except in special circumstances that are discussed fully in NIST Handbook 135. The reason for this ranking is that SIR tells how many dollars of savings are generated per dollar of investment. If projects with higher SIRs are funded, this means that DoD receives more total dollars of savings for the same investment than if the shortest payback or other criteria were used.

SIR should not be used for choosing among mutually exclusive alternatives to a designated base case. Lowest LCC should be used for these decisions. SIR can be used as an accept/reject statistic, but payback is normally preferred because of its simpler and more intuitive understanding. As long as SIR is 1.0 or higher, the project is costeffective. Under DoD funding programs, SIR is typically required to be 1.25 or higher.

15.5. Life-Cycle Cost Summary for Funding Requests

A Life-Cycle Cost Summary is required to support DD Form 1391 funding requests for DoD energy projects. The purpose of the form is to document the basic LCC inputs and decisions statistics needed to support the project and assist in making funding decision based on SIR rankings. The form can be accessed from the DoD Forms Program at http://www.dtic.mil web site.

Section 1 of the summary summarizes the investment-related costs of the project. These data are used in computation of payback and in the denominator of the SIR statistic. Section 2 summarizes the PV savings and/or additional costs of energy and water over the study period. These are annually recurring costs and are treated separately from non-energy data shown in Section 3 to apply appropriate escalation-adjusted discount factors for the specific energy type. These discount factors are found in the annual supplement publications listed in section 14.6. Section 3 lists recurring and non-recurring non-energy savings separately from energy savings since these costs are assumed to inflate at the rate of general inflation, rather than at project energy inflation rates. Line 5 shows the result of SPB calculations, and line 7 shows the SIR statistic. These are the two primary decision statistics that will be used from the form.

This form can easily be completed by hand using the discount factor tables from supplementary publications. Some energy managers prefer to use electronic spreadsheets, rather than completing by hand. However, two computer programs are available to assist in the analysis and production of the summary form. BLCC, produced by NIST, and Life-Cycle Cost in Design (LCCID), produced by CERL, both produce the LCC summary page. These tools are both available on the CCB and are described further in Chapter 15.

15.6. Resources to Support Energy LCC Analyses

15.6.1. DOE/FEMP/NIST Materials

Following are a series of resources produced by NIST and the DOE that are available to support the DoD energy manager in doing LCC analysis of energy projects. To obtain any of the following resources, contact the FEMP Help Desk at 877-DOE-EERE or 337-3463.

Life-Cycle Costing Manual for the Federal Energy Management Program, Handbook 135 (1995) is a guide to understanding LCC and related methods of economic analysis as they are applied to Federal decisions, especially those subject to DOE 10 CFR 436 rules related to the economic analysis of energy and water conservation projects and renewable resource projects. It describes the required procedures and assumptions, defines and explains how to apply and interpret economic performance measures, gives examples of Federal decision problems and their solutions, explains how to use the energy price indices and discount factors that are updated annually in the supplement, and provides worksheets and other computational aids and instructions for calculating the required measures. The 1995 edition of Handbook 135 is a complete revision of the 1987 edition, with updated information on the FEMP LCC requirements of 10 CFR 436.

Present Worth Factors for Life-Cycle Cost Studies in the Department of Defense, NISTIR 4942, (updated annually in October) provides tables of present worth factors to be used in computing the present worth of future costs or cost reductions in economic analyses for projects in the DoD Military Construction Program. These factors are especially useful for the LCC analysis of investments in buildings or building systems that are intended to reduce future operating, maintenance, repair, replacement, and energy costs over the life of the facility. This publication complies with the Tri-Services Memorandum of Agreement (MOA) on Criteria/Standards for Economic Analyses/Life Cycle Costing for MILCON Design, March 1994. The present worth factors listed differ from those listed in the following publication in that they are based on mid-year discounting, rather than end-of-year. Also, initial investment costs are assumed to occur at the mid-point of a planning and construction period. UPV* values are based on projected industrial sector energy rate escalation, based on the assumption that DoD facilities buy energy on industrial rate schedules.

Energy Price Indices and Discount Factors for Life-Cycle Cost Analysis - Annual Supplement to NIST Handbook 135, NISTIR 85-3273, (updated annually on April 1) provides energy price indices and discount factor multipliers needed to estimate the present value of energy and other future costs. The data are based on energy price projections developed by the Energy Information Administration of the US Department of Energy.

The NIST "Building Life-Cycle Cost" (BLCC) Computer Program, NISTIR 5185, (updated annually in conjunction with NISTIR 85-3273 and 4942) runs on IBM-compatible personal computers and provides an economic analysis tool kit for evaluating the relative cost effectiveness of alternative buildings and building-related systems or components. BLCC complies with Handbook 135 as well as the DoD Tri-Services MOA on "Criteria/Standards for Economic Analyses/Life Cycle Costing for MILCON Design," dated March 1994. It also complies with ASTM standard practices for building economics. It will produce the required LCC summary page to support DD Form 1391 funding requests. In addition to availability through DOE, BLCC software is on the CCB.

In addition to the publications listed above, NIST has produced a three-video training film series called "Least-Cost Energy Decisions: "An Introduction to Life-Cycle Cost Analysis," "Uncertainty and Risk," and "Choosing Economic Evaluation Methods." The videos and companion workbooks can be ordered from:

Video Transfer, Inc.
5709-B Arundel Avenue
Rockville, MD 20852
(301) 881-0270

15.6.2. US Army ERDC-CERL Materials

ERDC-CERL has developed the Life-Cycle Cost in Design program under the guidance of US Army Corps of Engineers (USACE); Headquarters, US Air Force; and Headquarters, Naval Facility Engineering Command. LCCID permits the designer to perform an economic study, energy-related or otherwise, that conforms to the economic criteria of all three services. LCCID contains the correct economic methodologies, discount rates, fuel escalation values, and algorithms. It performs calculations conforming to Army, Air Force, and Navy criteria; standard Federal criteria; and ECIP criteria. The program produces reports that conform to USACE requirements outlined in Technical Manual 5-802-1, Economic Analysis for Military Construction Applications, dated 1986, for design projects as well as ECIP summaries. With appropriate supporting information, these reports can be used for design submittal.

Economic analysis is available from:

ERDC-CERL:
P.O. Box 9005
Champaign, IL 61826-9005
800-USA-CERL

LCCID, complete with user instructions, is available from:

BLAST Support Office
Commercial: (217) 244-8182
Internet: support@blast.bso.uiuc.edu
University of Illinois
Department of Mechanical & Industrial Engineering
140 Mechanical Engineering Building, MC-244
1206 West Green Street
Urbana, IL 61801

15.6.3. Air Force Economic Analysis Guide

Air Force Instruction 32-1089, AF Military Construction and Family Housing Economic Analysis Guide, provides specific guidance and samples on the preparation of economic analysis as a part of energy and water project justification. Examples provided are for documentation for MILCON, Military Family Housing (MFH), and energy and water (ECIP/FEMP) projects. The procedures and methodologies presented in this manual are based on Air Force Instruction (AFI) 65-501, Economic Analysis. The document is available on the CCB and will assist in:

- Defining the project, formulating assumptions, and identifying alternatives
- Collecting project data
- Conducting the benefits analysis
- Conducting the Economic Analysis (EA) and analyzing the results
- Documenting the EA results.

16. Using Software Tools

16.1. Key Points

- Federal software is available to the DoD energy manager at no cost. Programs are available to do multiple-facility energy audit screening, detailed energy analysis of buildings or sub-systems, and economic analysis. A comprehensive list of software is available at the FEMP web site at http://www.eere.energy.gov/femp/

- Commercial software is also available to the user but requires purchase or licensing to use. In many cases, the cost may be justified based on the benefits.

16.2. Federal Software

16.2.1. Overview

Federally funded software for energy analysis is normally available to the DoD energy manager at no cost or perhaps for a handling fee only. This software is developed to support specific programs or objectives but does not always stay as current with industry changes in operating system versions and user interface enhancements as commercial software. However, the energy programs available at no cost are excellent tools that should be used, where possible, to support analysis and justification of energy projects. Following are descriptions and contact information on selected energy software available at low or no cost.

16.2.2. Construction Criteria Base (CCB)

The CCB Information System was developed by the National Institute of Building Sciences at the request of Federal agencies having construction responsibilities. The Air Force participated in the development and DoD has endorsed CCB as the construction criteria information system for all the military services. The Army and Navy have also implemented CCB. Many of the references and software tools mentioned in this Handbook are found in the CCB or at DOE's http://www.energycodes.gov.

CCB is a compact disk system containing the complete text of thousands of documents needed for design and construction that includes built-in software for automatically accessing and processing the information. The software automates many searching and processing functions that would otherwise be time-consuming, error-prone or impossible with less sophisticated technology. The documents on CCB are produced by Federal agencies and more than125 industry trade associations, professional societies, standards writing organizations, and code bodies. The information currently incorporated into CCB is contained on six discs which collectively contain more than one million printed pages. A subscription to CCB includes quarterly updates.

The CCB is also available on the web at http://www.ccb.org/. Your subscription number is used as the password to access the system. Items on the CCB are downloadable from the web site.

16.2.3. COMcheck™

COMcheck is a compliance tool that incorporates software and prescriptive methods that can be used for complying with ASHRAE/IES Standard 90.1. It was developed by DOE's Pacific Northwest National Laboratory (PNNL) to simplify the commercial code compliance process. For more information about COMcheck software or training, contact the PNNL Building Energy Codes Program at (800) 270-CODE or download from the DOE web site http://www.energycodes.gov.

16.2.4. REScheck™

REScheck (formerly MECcheck) software was developed by PNL to provide a simple compliance procedure for the Model Energy Code for residential construction. The user enters R-values (or U-values for glazing and doors) and area values. The software is well suited for playing "what ifs" to quickly determine compliance for a particular building. For more information about REScheck software, materials or training, contact the PNNL Building Energy Codes Program at (800) 270-CODE or download from the DOE web site http://www.energycodes.gov.

16.2.5. Facility Energy Decision Screening

The FEDS System is under continuing development at PNL for the US DOE FEMP and the USACERL. The FEDS System includes a family of software tools designed to provide a comprehensive approach to fuel-neutral, technology-independent integrated (energy) resource planning and acquisition. The focus for the tools are FEDS models, a top-down, first-pass energy systems analysis and energy resource acquisition decision software for buildings and facilities; and extended analysis, which allows specific engineering inputs and provides detailed output.

FEDS is a user-friendly, menu-driven, PC-based software program that can be used by utility, institution, agency, energy, or installation managers to prioritize investments in energy efficiency among several site and/or to assess the potential for cost-effective energy efficiency projects at a single site or facility with limited metered energy-use data. It is used to target and prioritize the most promising building and endues retrofit opportunities and to estimate capital investment requirements and potential energy and cost savings.

The FEDS Level-1 analysis will typically be followed by a FEDS Level-2 analysis, which allows detailed energy-system information input, returning detailed project-by-project technology selection and economic information.

The FEDS software and User's Guide are available free of charge to Federal agencies. In addition, FEMP regularly holds workshops for Federal energy managers to train them in the FEDS System tool kit and the use and application of the FEDS software. For further information, contact:

Pacific Northwest National Laboratory
PO Box 999
Richland, Washington 99352

16.2.6. A Simplified Energy Analysis Method (ASEAM)

ASEAM is a modified bin method program for calculating the energy consumption of residential and simple commercial buildings. It provides reasonable accuracy for estimating energy savings from a variety of building retrofit measures. However, because it does not do hourly analysis, it may not accurately estimate demand reduction to support DSM studies or other analyses in which demand charges are more critical than energy charges. ASEAM runs on an IBM PC and compatibles only. ASEAM features include the following:

- Entering data into ASEAM is easy and straightforward. Input questions are accessed through cursor control keys on the keyboard. ASEAM has many user-friendly features, including error checking, help messages, and default values. Data entry and editing features are included. Given a limited amount of input data, such as building shape and dimensions, percent glass, space types, and system types, ASEAM can calculate areas and use default values based on the information provided and can write complete input files for the calculations.

- Wherever possible, ASEAM uses recognized algorithms from such sources as the ASHRAE, IES, the DOE2 program, and NIST. You can display and print the calculations simply by pressing function keys while the calculations are being performed.

Many of the calculations are displayed graphically. ASEAM can perform calculations for a typical five-zone building in 7 minutes. Up to 15 thermal load zones can be specified in ASEAM. Thirteen different system types, five heating plants, and seven cooling plants can be simulated. ASEAM calculates both zone and building peak loads and can automatically size equipment based on these loads. You can also specify equipment sizes.

- Calculations can be performed in several modes:
  - Single or Batch Mode: As many as 20 combinations of input files can be selected for analysis. A wide range of outputs can be selected for each analysis.
  - Parametric Processor Mode: The parametric processor is a powerful tool for analyzing many alternate building and system configurations. When using the parametric processor, you begin by defining the base-case input files to be modified and then selecting both the input variables to be changed and the output variables for the report. ASEAM then performs the calculations, automatically changing input values in a looping pattern. Variables can be studied individually or in combination with other variables.

ASEAM Version 5 is a DOS application that utilizes a Graphical UserInterface (GUI) to make the program even easier to use. The next release of ASEAM will support creation of a PowerDOE file where an hourly analysis is indicated.

Energy Conservation Opportunities (ECOs) are studied with ASEAM by comparing original (base case) energy consumption and cost with alternative (ECO) energy consumption and cost. ECOs can be studied individually or in combination with other ECOs. The LCC program BLCC, developed by NIST, is integrated into the program. For further information, contact:

ASEAM Coordinator
ACEC Research & Management Foundation
1015 15th Street, NW, Suite 802
Washington, DC 20005

16.2.7. Energy Plus

EnergyPlus is a building energy simulation program for detailed modeling of building heating, cooling, lighting, ventilating and other energy flows. It builds on the most popular features and capabilities of the legacy programs Building Loads Analysis and System Thermodynamics (BLAST) and DOE-2, but also includes many innovative simulation capabilities such as time steps of less than an hour, modular systems and plant integrated with heat balance-based zone simulation, multizone air flow, thermal comfort, and photovoltaic systems.

http://www.eere.energy.gov/buildings/energyplus/

16.2.8. Federal Lighting Energy eXpert (FLEX)

FLEX was sponsored by the DOE FEMP and developed cooperatively by the National Renewable Energy Laboratory as part of the Federal Relighting Initiative. This program is the product of a collaborative development effort involving many individuals. Other software available from this initiative includes an agency SCREEN tool (called LSST), which speeds the screening of many buildings for relighting potential and a Lighting Technology Screening Matrix (LTSM) for evaluation of fixture-by-fixture retrofits in a building.

For more information, contact the FEMP Help Desk at:

US Department of Energy, EE-2L
Federal Energy Management Program
1000 Independence Avenue, SW
Washington, DC 20585-0121
Commercial: 877-DOE-EERE (or 877-337-3463)

To download FLEX or other FEMP software from the Internet, access the FEMP home page at http://www.eere.energy.gov/femp.

16.2.9. Federal Renewable Energy Screening Assistant

The FRESA software tool identifies and prioritizes renewable energy projects according to cost effectiveness. It provides users with weather information for over 200 sites, renewable energy costs, and economic assumptions for conducting LCC analysis consistent with 10 CFR Part 436. Sixteen technologies are evaluated, including photovoltaics, solar thermal water heating, biomass, and wind energy.

FRESA screening is a two-step process:

1. The user inputs the facility zip code, energy use, and costs. Then FRESA determines the likelihood that a certain renewable energy application would be cost-effective at that facility.

2. The user then inputs data on energy use patterns and facility parameters for those projects that look most promising. FRESA calculates a SIR and DPB period.

FRESA is not designed to provide complete detailed project economics but can provide the energy manager with valuable insight into which renewable energy projects are potentially cost-effective.

16.2.10. Life-Cycle Costing

The NIST BLCC program, available through DOE, and LCCID program, available through ERDC-CERL, allow for detailed economic analysis of energy projects in compliance with Federal LCC methodologies. These programs are discussed in more detail in Chapter 14. They will each produce the LCC summary in a format required for DD 1391 funding requests.

In addition to the main program, several supplementary programs are available with BLCC. A "Quick Input" module (QI) included with BLCC can be used to set up multiple project alternatives for LCC analysis in a single input file. While the range of input data is somewhat limited, QI is sufficient for many simple LCC problems and provides a link to the DOE ASEAM energy calculation program as well as the DOE Motor Challenge tool, MotorMaster. QI can be used to generate input data files for BLCC when more comprehensive analysis is required.

BLCC and QI are designed to run on an IBM-PC or compatible microcomputer with approximately 640K of random access memory and a hard disk or disk drive capable of handling high-density diskettes. BLCC and QI are updated annually (on October 1) to include the current DOE energy price projections and Federal discount rates.

The DISCOUNT program computes discount factors and related present values, future values, and periodic payment values of cash flows occurring at specific points. DISCOUNT is especially useful for solving LCC analysis problems that do not require the comprehensive summation and reporting capabilities provided by the BLCC program. DISCOUNT performs all of the functions of standard discounting tables, computing present values of future amounts, future values of present amounts, present and future values of periodic payments, periodic payments corresponding to present and future amounts, and corresponding discount factors. In addition, DISCOUNT computes the present value of periodic payments, which increase at known rates over time, and the present value of energy costs, which increase at rates projected by DOE for use in Federal LCC analysis. DISCOUNT provides the added flexibility of accepting non-integer discount rates, time periods, and escalation rates in its computations. DISCOUNT runs on most IBM-PC and compatible microcomputers. The DISCOUNT program is included on the BLCC.

ERATES is a computer program for calculating monthly and annual electricity costs under a variety of electric utility rate schedules. Both kWh usage and kW demand can be included in these costs. Most typically these calculations will be used to support engineering-economic studies that assess the cost effectiveness of energy conservation measures or measures to shift electricity use from on-peak to off-peak time periods. With ERATES a user can set up time-of-use rate schedules, block rate schedules, and demand rate schedules and save these schedules to a disk file. ERATES can then use these schedules to compute monthly and annual electricity costs, given hourly or monthly kWh usage and kW demand data for a building or building system. ERATES is a menu-driven, interactive program, designed to be run on an IBM-PC or compatible microcomputer. ERATES can be used to create block rate and demand rate schedules, which can be used with BLCC 4.0. ERATES is not intended for use by utilities in setting up or administering such schedules.

16.2.11. Installation Water Resources Analysis and Planning System (IWRAPS)

IWRAPS is a water forecasting tool for military facilities. It is part of the Water Resources Planning Series for Fixed Army Installations developed by the Corps of Engineers' Institute for Water Resources.

IWRAPS contains water-use coefficients developed from real-life data obtained from a nationwide survey of military installations. It can be used to predict water requirements for such things as plumbing fixtures, irrigation, and vehicle washing units. The user must input any known efficiency data on the installed retrofits. In return, the program will calculate water usage for the installed devices. For more information, contact the Army Center for Public Works, the Air Force Center for Environmental Excellence, or:

Planning and Management Consultants, Ltd.
2845 S. Illinois Avenue
Carbondale, IL 62903
(618) 549-2832

16.2.12. WATERGY

WATERGY V 3.0 is a spreadsheet model that uses water/energy relationship assumptions to analyze the potential of water savings and associated energy savings. The spreadsheet allows input of utility data (energy and water cost and consumption data for the most recent twelve months) and facility data (number and kind of water consuming/moving devices and their water consumption and/or flow rates. It then estimates direct water, direct energy, and indirect energy annual savings, as well as total cost and payback times for a number of conservation methods.

Most of the assumptions that WATERGY uses for energy/water calculations can be grouped into the following categories: the heating values of fuels (e.g., the heating value of natural gas in Btu/cf); the efficiencies of energy and water consuming devices or processes (e.g., number of kilowatt hours consumed per gallon for electric water heaters, or number of kilowatt hours consumed per 1000 gallons of treated waste water); time-of-use for fixtures (e.g., number of minutes per use of infra-red sensor faucets); and percentage of hot water use in machines or fixtures (e.g., percentage of water usage that is hot water for a typical faucet.

WATERGY also makes simple assumptions about capital and labor costs of equipment and fixture replacements. All assumptions WATERGY uses can be modified by the user.

At this time, WATERGY estimates potential conservation opportunities for installation of water saving toilets and urinals, automatic faucets, faucet aerators, water-saving showerheads, boiler blow-down optimization, efficient dishwashers, efficient washing machines, landscape irrigation optimization

The WATERGY software is available from the Department of Energy FEMP web site at http://www.eere.energy.gov/femp/.

16.2.13. Cogeneration Ready Reckoner

This program was initially developed Australian Department of Industry, Science, and Resources. The primary use of this program is the screening of industrial cogeneration applications. It provides a baseline comparison (grid electricity and separate steam boiler) to an equipment data library. The library contains gas turbines, reciprocating engines and generator sets. Combined heat and power (CHP) applications covered are process steam, hot water, and chilled water. The analysis duration/time step is 20 years, up to monthly. The system performs economic analyses, cash flow, payback, NPV and IRR. It is available free (download from http://www.eere.energy.gov/der/chp/chp-eval2.html.)

16.2.14. Renewables and Energy Efficiency Planning (REEP)

The REEP software was developed at the Army's Engineer Research Development Center – Construction Engineering Research Lab. It is a flexible analysis model for screening and prioritizing energy and water conservation retrofit projects in DoD on an installation, regional or national level. REEP has broad-spectrum technology coverage including energy and water efficiency technologies, renewable technologies, electric load shifting and combined heat and power generation. Energy, water, cost and environmental impacts are assessed. REEP analysis is available on a cost-reimbursable basis from ERDC-CERL. Additional information is available at http://www.cecer.army.mil/reep.

16.2.15. Water Distribution System Simulators Aquis and EPANet

Aquis and EPANet are water distribution simulation software packages that analyze and monitor hydraulic and water quality problems in water distribution systems. Dynamic computer-based water distribution system simulations can provide the understanding necessary to solve a variety of water system problems and planning issues. They provide detailed understanding of how flow rates, pressures and key chemical concentrations such as the chlorine residual are expected to very over time at all locations in the system.

These systems can operate "on-line" where the simulation software interfaces with sensors (such as flow meters, pressure sensors, and water chemistry sensors/analyzers) throughout the water distribution system, or "off-line" where the simulation does not interface with sensors but instead uses information entered manually based on field measurement and/or estimates. Both on-line and off-line simulations can be used to evaluate distribution system capacity, determine optimal locations for sensors and meters, identify critical vulnerable system components, test various candidate courses of action for emergency situations, and optimize overall system performance. On-line simulations can provide near real-time water distribution system monitoring and can quickly alert personnel to leaks, water losses, water contamination, malfunctioning equipment or other problems so that corrective action can be taken immediately.

EPANet is a public domain software package that operates off-line. Aquis is a commercially available software package that can operate either on-line or off-line. ERDC-CERL has experience with these systems and can be contacted at http://www.cecer.army.mil.

16.3. Commercial Software

A variety of commercial software is available to support energy management efforts. These include energy accounting, energy auditing, energy simulation, economic analysis, project design, and drafting applications. While Government-produced software is normally available without licensing fees, user support may not be as readily available as for commercial software. Also, updates of commercial software respond more quickly to user needs and demands since they are market driven, rather than subject to the special circumstances surrounding many Government-funded projects. In some cases, private contractors produce enhanced versions of Government software, e.g., for Windows vs. DOS, to respond to perceived user needs. Industry trade journals are an excellent source of referrals regarding commercial software.

16.3.1. HEATMAP©

HEATMAP© is a WINDOWS-based software package that aids energy planners in designing and evaluating district energy (heating and cooling) systems, including integrated Combined Heat and Power (CHP) and geothermal applications. HEATMAP© provides comprehensive computerized simulations that allow users to analyze the performance of existing networks as well as model proposed systems, expansions, or upgrades. It can help optimize the capacity and operating strategy of a production plant or system (e.g., multiple plants, fuel alternatives, steam vs. hot water) and determining the proper distribution pipe sizes to carry the load during scenario evaluations. HEATMAP© provides analysis of air-pollutant emissions, including carbon dioxide, and allows comparison between the various alternatives being considered. Also included is life-cycle cost analysis. HEATMAP© is available to DoD installations at a special reduced price from the Washington State University Cooperative Extension. To order HEATMAP©, contact the Washington State University Cooperative Extension Energy Program at HEATMAP@energy.wsu.edu.

Part V Service Energy Programs

17. Army Energy Programs

17.1. Army Energy Program

17.1.1. Objectives

The Army Energy and Water Management Program objectives are to:

- Ensure the availability and supply of energy to the Army in accordance with mission, readiness, and "quality of life" priorities.
- Participate in the national effort to conserve energy and water resources without degrading readiness, the environment, or quality of life.
- Attain established energy and water conservation goals per EO 13123 and other goals established by DoD.
- Participate in research and development efforts regarding new and improved energy technologies contributing to defense and energy conservation.

17.2. Department of the Army Energy Management Organization

Responsibilities of the following organizations and positions are per Army Regulation 11-27, Army Energy Program. (AR 11-27 is available at the Army's Publishing Directorate's webpage, http://www.apd.army.mil/, or through the Army's energy webpage at http://hqda-energypolicy.pnl.gov/.

17.2.1. Assistant Chief of Staff for Installation Management (ACSIM)

The ACSIM has overall Army General Staff responsibility for planning, directing, and budgeting for the Army Energy and Water Management Program; developing the Army's long range Energy Strategy; maintaining the Army Energy Campaign Plan; providing guidance and oversight for energy research and development programs; and coordinating policy for the allocation, supply, conservation, and management of energy resources within the Army.

17.2.2. Army Energy Steering Committee

The committee is appointed by the Assistant Secretary of the Army for Installations and Environment (ASA(I&E)). It is a working group comprised of action officers from the offices of the ASA(I&E) and ACSIM, various Army Staff elements, Headquarters, Installation Management Agency (IMA), and the Army National Guard Bureau. Subject matter experts will provide technical expertise on energy policy subjects such as the Army's energy data reporting system, publicity, and awards.

17.2.3. Army Energy Team

The Army Energy Team is a working group chaired by senior energy program managers from the Office of the ACSIM and formed from representatives of Headquarters, Installation Management Agency, U.S. Army Corps of Engineers, IMA Regions and selected garrisons. Its mission is to facilitate the review, prioritization and technology transfer of energy and water R&D performed by the U.S. Army Corps of Engineers laboratories.

17.2.4. Installation Management Agency

The Installation Management Agency, through its Regions and installations, executes the Army Energy and Water Management Program. Regional program management and execution provides for operational efficiency and consistent standards across installations.

17.2.5. Garrison Commanders

Garrison commanders establish and maintain active energy and water management offices with adequate staff to manage all command energy and water conservation matters; actively promote command emphasis on energy and water conservation and awareness activities; and designate an energy coordinator, trained to standards established in the Energy Policy Acts of 1992 and 2005 and Army Energy and Water Management Program standards.

17.2.6 Installation Energy Coordinator (ENCON)

The energy coordinator serves as the focal point for energy-related activities and inquiries. The ENCON also serves as the commander's principal advisor and special staff assistant on all energy and water conservation related matters; develops and maintains an active energy and water conservation program and coordinates awareness activities; actively participates on the command energy council; conducts annual energy surveys; and prepares installation annual energy conservation progress reports for submittal.

17.2.7. Technology Standards Group

The Technology Standards Group is composed of representatives from OACSIM, IMA, USACE and others to provide a systematic evaluation and implementation of technological innovation in support of the Army's installation management mission.

17.3. Army Energy Goals

Army energy goals are consistent with those established by the current Energy Policy Act, Executive Orders, Department of Energy (as the proponent for the Federal Energy Management Program) guidance and Department of Defense directive. Each Region is to achieve these goals in support of the Army as a whole meeting the goals.

17.3.1. Army Energy and Water Reporting System (AEWRS)

The Army tracks performance toward meeting energy goals through AEWRS. The system and instructions for its use are at https://hqradds.hqda.pentagon.mil/. AEWRS facilitates energy management by providing timely, reliable, and accurate information on energy products utilized by the Army. The system provides essential energy management information to installations, Regions, major subordinate commands (MSCs), MACOMs, and HQDA. This information is used to evaluate energy trends and to determine progress toward goals/targets.

17.3.2. Annual Energy Report and Implementation Plans

Installations prepare an energy report and implementation plan annually per Department of Energy, DoD and HQDA guidance. The Report highlights energy and water management program accomplishments of the previous year and the Implementation Plan describes initiatives planned to improve performance.

17.4. Army Energy Management Support

17.4.1. Training and Awareness

Awareness and training programs are a critical part of DoD's efforts to achieve and sustain energy-efficient operations at the installation level. AR 11-27 provides that training and education programs will include the exchange of energy and water awareness information and the dissemination of instruction on correct practices, design, and other newly developed techniques for saving water and energy. A strong internal energy information program at every level of command will be maintained.

The Army provides access to energy awareness seminars, certification programs for energy managers, and training courses available from commercial sources, such as the Association of Energy Engineers. The Army provides assistance to installation staffs by providing energy awareness seminars at 15 to 20 installations annually. These seminars identify low cost/no cost opportunities, help to heighten the awareness of installation personnel, and assist the installation in identifying new and improved technologies and energy-saving projects.

17.4.2. Army Energy Awards Program

Energy conservation awards are presented to individuals, organizations, and installations in recognition of their energy-savings efforts. In addition to recognition, these awards also provide motivation for continued energy-reduction achievements. The Army participates in two energy awards programs -- the Secretary of the Army Energy Conservation Awards and the Federal Energy and Water Management Awards.

17.4.2.1. Secretary of the Army Energy and Water Management Awards

This program recognizes annual energy conservation achievements of Army installations and provides incentives to further reduce energy consumption. Award categories are: Active Army, Army National Guard, and Army Reserve. Regions, Readiness Commands and the National Guard should nominate installations in accordance with provisions described in AR 11-27.

17.4.2.2. DOE Federal Energy and Water Management Awards

This program recognizes organizations, small groups, and individuals for outstanding achievements in several energy-related categories within the Federal sector. Categories include energy management, renewable energy, and water conservation. Each Service can also recognize one outstanding individual for overall contribution to the program. Nomination procedures are similar to those of the Secretary of the Army Energy and Water Management Awards.

17.5. Energy Retrofit Support

Legislation requires Federal agencies to implement all energy conservation projects with a payback of 10 years by year 2005. To implement these requirements, Federal agencies are to perform energy surveys of their buildings to the extent possible; use these surveys to apply energy conservation measures in the most cost-effective manner possible; and ensure that effective operation and maintenance procedures are applied.

17.5.1. Energy Conservation Investment Program (ECIP)

ECIP is a DoD program to reduce energy and water consumption through self-amortizing projects to retrofit existing facilities. ECIP is funded with military construction (MILCON) funds.

The Assistant Chief of Staff for Installation Management (ACSIM) plans, executes, and monitors Army participation, less the Army National Guard (ARNG), in ECIP. The Chief, National Guard Bureau (CNGB) performs these functions for ARNG. Commanders will identify and recommend to the ACSIM proposed projects for inclusion in ECIP, in accordance with policies and procedures set forth in programming and budget directives.

ECIP projects are evaluated and prioritized on the basis of savings to investment ratio (SIR). SIR calculation is performed using methods described in Chapter 14. An LCC analysis for each overall project and for each discrete retrofit action included within the project is performed and included with the DD Form 1391 project documents submitted for consideration.

17.5.2. Army Suggestion Program

The Army Suggestion Program is used to encourage, recognize, and reward worthwhile ideas on energy and water conservation by individuals. A full range of cash and honorary awards are authorized per AR 672-20, Incentive Awards.

17.6. Army Energy Research & Development Plan

Army energy R&D will focus on the research, development, evaluation, and exploitation of energy technologies that improve energy efficiency and provide secure energy sources to operate on a worldwide basis. This will include R&D that leads to:

a. Sustainable building design and efficient operation of building and utility systems.
b. A secure and sustainable energy supply through deployment of distributed energy and renewable energy systems.
c. Efficient vehicles and equipment or leads to modifications to the current inventory to reduce fuel consumption.

d. Use of renewable energy sources and the development of reduce dependence on cost-effective alternatives that petroleum fuels.
e. In-process reviews on proposed Army weapons systems, vehicles, and equipment, including an analysis of energy requirements. Energy used in development, production, and operation of the item will be evaluated, and the energy impact of alternative proposals will be considered.
f. Effective energy management and analysis techniques.

17.7. Energy Security Program

Energy Security Programs should exist at all Army installations. The Army will continue to revise, update, and provide guidance on its security program as new OASD guidance, lessons learned from the installations, Regions and MACOMs.

Installations should develop local risk assessments and plans. These local plans will identify vulnerability, consequences of disruptions, and corrective action options. Additional information on the Army's Energy Security Program is being incorporated into the Army Energy Campaign Plan, currently under development.

18. Department of Navy Energy Programs

18.1. Navy Energy Management Offices

18.1.1. The Department of Navy Shore Energy Policy Board

This policy board is responsible for DON shore energy policy. Its membership consists of the Deputy Assistant Secretary of the Navy (Installations and Facilities), Commandant of Marine Corps (LFF-1), Commander Navy Installations (Energy/Utilities Program), Chief of Naval Operations (N42), and Naval Facilities Engineering Command (Director, Public Works).

18.1.2. Energy Offices

In accordance with OPNAV Instruction 4100.5 and Marine Corps Order P-11000.9, energy offices for facilities are to be established by all DON regions and Marine Corps installations respectively, and staffed as necessary. Each energy office shall, as a minimum, consist of a collateral duty POC responsible for coordinating issues with, and reporting status to, the commander, and Navy installations (Energy/Utilities Program).

18.1.3. Commander, Navy Installations and Commandant of Marine Corps (LFF-1)

CNI and CMC, with NAVFAC support, provide policy and resources necessary to identify and implement energy conservation actions to assist the commands in meeting the DON energy goals and objectives. They monitor subordinate command energy management performance, and take actions necessary for those commands to achieve their energy goals. By March 1 of each year, the installations provide CNI and CMC with a detailed report describing the actions that were taken in the preceding fiscal year to attain the stated goals. They also ensure that energy efficiency improvements are incorporated into repair projects.

18.1.4. The Naval Facilities Engineering Command

NAVFACis the Navy’s energy program manager and provides policy, guidance and resources to support the DON energy program. NAVFAC chairs the DON Shore Energy Policy board for the DASN (I&F), and is the Director of the Shore Energy Office.

Responsibilities include development and maintenance of a Shore Energy Business Plan, Annual Energy Plan and Report, coordination with Office of Secretary of Defense and management of the Energy and Utilities support provided by NAVFAC component commands..

In addition, NAVFAC acts as the Major Claimant for MILCON ECIP projects within the Navy PPBS. NAVFAC is also responsible for management of revenue obtained from the sale of energy from all geothermal, alternative energy, or cogeneration power plants that are owned or controlled by the Navy.

NAVFAC, with assistance from the Naval Facilities Engineering Service Center, and Facility Engineering Commands staffs the Department of Navy Shore Facilities Energy Office, which is responsible for:

a. Developing an annual energy program execution plan for shore facilities and vehicles, including the allocation of all energy program funds, by each October, and managing and coordinating the plan's execution.
b. Chairing the Navy Shore Energy Policy Board . The Policy Board meets once a year, as a minimum, to update the energy program execution and business plan, review energy conservation progress, develop policy and prioritize the energy program budget.
c. Administering the Navy DUERS which provides reports on installations energy consumption, cost, square footage and goal progress.
d. Developing and managing all energy projects and documenting them in the Energy Project Status System.
e. Managing energy awareness funds and developing and managing a Navy-wide energy awareness program.
f. Developing energy-efficient maintenance policies and guidelines.
g. Developing and coordinating renewables applications.
h. Issuing a standard reporting format and consolidating all Major Claimant reports on energy management activities.
i. Developing and managing an integrated energy system training program.
j. Managing research, development, testing, and evaluation (RDT&E) and Technology Validation programs to introduce new energy technology to the shore installations. Operate energy and utilities systems on installations and provide energy management products and services to host and tenant commands.

18.1.5. Navy Shore Installations

Installations manage energy consumption and are directly responsible for meeting energy reduction goals in accordance with the business plan and annual plan established by the Shore Energy Policy Board. At the activity level, DUERS reports are submitted based on the procedures issued by NAVFAC and OPNAV Instruction 4100.8A, Defense Energy Information System. These Navy activities also comply with the energy management standards for shore facilities contained in OPNAV Instruction 4100.5, review and update their quarterly Energy Audit Report (EAR) to assess their energy management performance, and take the actions necessary to achieve Navy energy goals and objectives.

Activities review and update the Energy Project Status System (EPSS) to provide information on all energy and water projects. They also provide Major Claimants with technical and financial information on energy projects to ensure timely and accurate allocation of funds.

Navy shore activities must also develop and maintain a comprehensive plan to achieve energy reduction goals and, by February 1 of each year, provide their Major Claimants with detailed reports describing the actions taken during the preceding fiscal year to achieve those goals. Activities are to utilize energy-efficient maintenance and replacement components in daily operations and to train all energy system operators, such as central heating/chiller plant operators, by 1998.

19. Air Force Energy Programs

19.1. Air Force Energy Management Offices

At the Headquarters level of the US Air Force (HQ USAF), the Directorate of Logistics Readiness, (AF/ILG), is the overall manager of the Air Force Energy Program. AF/ILG is the agency responsible for developing, reviewing, and coordinating Air Force energy planning from a policy standpoint. Specifically, the Director of Logistics Readiness is the chairperson of the Air Force Energy Management Steering Group (EMSG) and a member of the Defense Energy Policy Council (DEPC).

The following sections explain the roles and responsibilities of various Air Staff functional offices that have responsibilities related to energy programs..

19.1.1. The Air Force Energy Management Steering Group

The Air Force Energy Management Steering Group (the "Steering Group" or EMSG), chaired by HQ USAF/ILG Director of Logistics Readiness, provides top level management and oversight of progress made in implementing the strategies for achieving target energy goals. Each level of command – HQ USAF, MAJCOM, and base is responsible for establishing and EMSG composed of representatives from all major energy managing activities, including civil engineering, public affairs, transportation operations, budget, aircraft maintenance, logistics, and fuels management. The EMSG convenes semiannually to review energy consumption reports to OSD and to review progress toward meeting the facility and mobility energy use goals.

19.1.2. Materiel Management Division, Directorate of Logistics Readiness, Deputy Chief of Staff (DCS) for Logistics (AF/ILGM)

The Material Management Division functions as the office responsible for Air Force Fuels Energy Policy. AF/ILGM is the coordinating office for all fuels matters in the Air Force and provides fuel planning and management support to the Secretary of the Air Force and the Air Force chief of staff. AF/ILGM is a primary participant in the Air Force working group on Alternatively Fueled Vehicles.

19.1.3. The Distribution & Traffic Management Division, Deputy Chief of Staff (DCS) for Logistics (AF/ILGD)

The Distribution & Traffic Management Division is the policy focal point for all issues concerning vehicle operations, maintenance, and the environment. This office chairs the Alternatively Fueled Vehicle Policy Working Group (AFVPWG), made of functional representatives throughout the Air Staff. The AFVPWG is responsible for developing specific guidance promulgating an Air Force alternative fueled vehicle program.

19.1.4. The Combat Support Operations Division Deputy Chief of Staff (DCS) for Logistics (AF/ILGC)

This organization is responsible for oversight of Air Force vehicle procurement. The Air Force is aggressively acquiring Alternatively Fueled Vehicles (AFVs) to reduce our Nation's dependence on imported oil and protect our environment as required by the Energy Policy Acts of 1992 and 2005 and the Clean Air Act of 1990. AFVs will be assigned on a priority basis to units located in non-attainment areas as defined by the Clean Air Act. When insufficient AFV s are available from the auto manufacturers to meet the mandates of EPACT, late model vehicles currently in the inventory may be converted to operate on alternative fuels. The Alternative Fueled Vehicle System Program Office (AFVSPO) was established to coordinate MAJCOM efforts to comply with legislative requirements regarding AFVs. AF/ILGD/ILGM/ILGC/ILEV participate in the Interagency Committee on Alternative Fuels and Low Emission Vehicles.

19.1.5. The Office of the Civil Engineer (AF/ILE)

AF/ILE manages the facility energy management program. The focal point within AF/ILE for all Air Staff actions relating to installation energy is the Readiness and Installation Support Division (AF/ILEX). This division provides facility energy planning and management support to the Secretary of the Air Force and the Air Force chief of staff. AF/ILEX will monitor legislation and policy guidance, issue broad policy directives, and advocate for resources, as appropriate. HQ AFCESA/CES will oversee all aspects of execution; develop plans for implementing new guidance in coordination with AF/ILEX and the MAJCOM/CE's. HQ ACFESA will monitor progress against mandated goals; determine periodic reporting requirements; and manage calls for all energy projects including ECIP and the Annual Energy Report to Congress. HQ AFCESA will be the focal point for the day-to-day energy and water conservation concerns and has the authority to communicate directly with the staffs of OSD and SAF on matters pertaining to facility energy and water conservation, as well as, solicit information to answer congressional and other inquiries. All congressional responses will be routed through AF/ILEX. The Energy Policy Act of 1992 requires energy managers at all installations to be trained. HQ AFCESA and the Air Force Institute of Technology Civil Engineering School conduct frequent training seminars to meet this requirement. Additionally, AFCESA will centrally track and provide the guidance to the bases and commands, develop guidelines, provide the legislative requirements and include the data from the awarded ESPCs in the annual energy report.

The Air Force Utility Rates Management Team (URMT), located at AFCESA, helps Air Force Installations procure reliable utility service at a fair and reasonable price. The team includes engineers and Air Force Legal Services Agency Utility Litigation Team (ULT) attorneys. Working together, these professionals assist individual bases with issues surrounding the rates paid for electricity, gas, water and wastewater. They not only help with negotiating the best deals possible for these important services, but also litigating disputes with regulated utilities. When the Air Force is the largest federal customer of the utility, the ULT represents the consumer interests of the federal executive agencies before state Public Utility Commissions in rate case proceedings.

19.1.6. MAJCOMs/FOAs/DRUs

MAJCOMs, FOAs, and DRUs develop plans to support or supplement Air Force goals and strategies, execute programs (includes programming funding to support various energy program mandates), evaluate energy usage of subordinate units, provide inputs required by HQ USAF for annual reports and nominate their most successful units for energy awards.

19.1.7. Installations

Installations should develop plans to support or supplement Air Force goals and MAJCOMs goals/strategies, execute those plans, measure and evaluate their base energy usage, provide inputs required by their MAJCOM for annual reports, and nominate their most successful people and units for energy awards.

19.2. Air Force Energy Policies/Goals

The Energy Policy Acts of 1992 and 2005 and Executive Orders, including EO 13123 “Greening the Government through Efficient Energy Management” established energy goals for the Federal government. The Air Force energy management program supports implementation of the long-term

National Energy Strategy to pursue new and smarter ideas for implementing management strategies to meet assigned goals.

The Air Force's policy for energy management is to assure energy availability and its efficient use in support of national security goals.
Under revision the Air Force Energy Program Procedural Memorandum (AFEPPM) 96-1, *Air Force Energy Management Plan*, is the implementation plan for Air Force philosophy, organizational relationships, responsibilities, and procedures for implementing and managing the Air Force Energy Program estimated revision date is 1 Dec 2004.

Detailed policies and guidelines are outlined in the Air Force Energy Program Procedural Memoranda (AFEPPMs), Air Force Regulations (AFRs), AFIs, and other directives.

19.3. Air Force Facilities Energy Program

19.3.1. Objectives

The focus of the Air Force Facility Energy Program is to minimize energy consumption and costs while meeting all operational mission requirements and providing quality working and living conditions for Air Force personnel and family housing occupants. The Program's primary objective is to meet or exceed mandated reduction goals without degrading military readiness, safety, and mission effectiveness or quality of life. This will be accomplished by implementing management actions, investing in energy conservation technology and equipment, creating energy conservation and management awareness throughout the Air Force. The Air Force will strive to:

- Increase energy efficiency in all energy-use areas. This will be achieved by research and development programs for more efficient fuels and more efficient engines for aircraft and vehicles through purchase of energy efficient equipment and parts, proper O&M and most importantly by implementing user-oriented energy conservation awareness programs.
- Reduce energy used by the mobility forces. Programs to reduce consumption may be implemented after a complete evaluation by associated commands. Mobility fuel energy consumption should be targeted for reduction only when it can be achieved without degrading capability.
- Use alternative energy. Consider the most life cycle, cost-effective energy conservation alternatives for facilities and operations. Reduce use of petroleum fuels and convert to other sources when economical.

19.3.2. Implementation Strategies

Air Force facility energy and water conservation goals will be met through systematic implementation of 10 complementary strategies outlined below.

19.3.2.1. Implementation and Measurement

This strategy is oriented to establishing or renewing command energy conservation plans. It requires actions to establish plans and develop procedures to maximize benefits.

a. *Facility Energy Plans*. Each MAJCOM and base will develop a plan to reduce its overall facility energy consumption. The MAJCOM plan should strive to provide a reduction of 30% in MBTU per square foot consumption (FY2005 vs. FY1985 baseline).
b. *Funds Retention.* The ability to retain the dollar savings associated with conservation initiatives is part of the emphasis on the energy program and is inherent in public law. This initiative has not been actively pursued because procedures developed do not provide any incentives to base or MAJCOM commanders beyond those they now have. Savings identified as a result of energy conservation initiatives may be retained and reused during the current fiscal year with no further action. More elaborate procedures are available, allowing the retention of the funds into the next fiscal year; however, these procedures are time consuming and awkward and provide little benefit. Individual commands may pursue this at their discretion; however, all commands are responsible for identifying the savings associated with their energy initiatives and the reuse of the funds saved.
c. *Defense Utility Energy Reporting System.* This management information system reports energy and water consumption as well as other statistical information and is the energy program report card. Command plans must emphasize the importance of accurate data reporting. This information is forwarded through the MAJCOM to AFCESA for consolidation and release through AF/CEO to OSD. This report is critical since it is the only indicator of progress towards the goals. The program is under modification to provide interface with the real property module of the Automated Civil Engineer System (ACES). Another effort is planned to increase the utility of the report by adding user-friendly management tools to the system.
d. *Annual Energy Report.* The DOE is responsible for consolidating inputs from all Federal agencies and providing the report to Congress and the President. They provide the format and due date in the fall of each year. AF/HQ AFCESA requests the MAJCOMs to report their efforts in the Facility Energy Program, in the

format specified, to AFCESA/CESM for consolidation and forwarding to DoD.

19.3.2.2. Improved Operations And Maintenance

This strategy is intended to improve operations and maintenance of facilities, energy and water systems, including improved operator and facility manager training.

a. *Energy Manager Training.* The Energy Policy Act of 1992 requires that energy managers receive training. This requirement will be filled by Air Force Institute of Technology (AFIT) ENG 464, Energy Management Technology Course.
b. *Construction Criteria Base.* A web-based subscription to the CCB, by the National Institute of Building Sciences, has been provided to each MAJCOM and base. The CCB contains the majority of the documents and computer tools MAJCOMs or base-level energy managers need to develop and manage an effective facility energy program. It also contains most construction standards a base-level design engineer would need. The web address is: http://www.ccb.org/
c. *O&M Type Surveys.* Each command is to perform O&M-type surveys that establish priorities for improving operator training and maintenance of energy systems. This area should identify efforts underway or planned for improvements in day-to-day operations.
d. *Facility Energy Decision System.* FEDS, a computer program, was developed by DOE and is more complex than REEP in that it selects the least LCC retrofit for a single building or an entire installation. This tool provides the user the ability to track peak demand and to choose a retrofit technology and provides very detailed efficiency recommendations.
e. *Showcase Facilities.* Each command is responsible for identifying a showcase facility in both the existing facility and planned facility category. There are no specific guidelines for defining a showcase facility; however, existing buildings chosen should be those that highlight the application of state-of-the-art energy/water conservation technologies and practices. Programmed facilities should be selected based on design characteristics (sustainability) that emphasize energy and water conservation applications or innovations included in the AE development of the facility.

19.3.2.3. Life-Cycle Cost-Effective Capital Investment

This strategy is intended to serve as "seed" money for energy conservation efforts.

a. *Energy Conservation Investment Program.* The MILCON-funded ECIP is a DoD-managed program and is anticipated to be funded at about $16.0M per year. This funding avenue is intended for high-cost investment projects that have a positive payback of less than 10 years and a SIR greater than 1.25. MFH can be done under ECIP but must compete with the rest of the projects for best SIRs. Renewable projects receive higher emphasis and are moved ahead even with low SIR or extended payback.
b. ECIP Program Guidance. A web based distance learning package is being developed and it addresses the procedures for submitting a project under ECIP. These procedures cover the responsibilities for base/MAJCOM/Air Staff, including identifying the different category types to use at the bases. Program guidance varies each year to some extent. Annual correspondence inviting projects and advising of current selections are provided. The wed-based training will be available from theAFECSA web site by 1 Jan 05.
c. *Energy Efficiency in Military Family Housing.* For MFH, the design criteria for new construction is to use the EPA's ENERGY STAR program IAW UFC 3-400-01 Design: Energy Conservation.

19.3.2.4. Participation in Innovative Public Utility Programs

This strategy is intended to emphasize the use of services provided by the local utility company.

a. *Utility Energy Service Contracts*. The National Defense Authorization Act for Fiscal Year 1991 allows Air Force installations to secure comprehensive energy conservation services from the local utility company. Using a customized Utility Energy Service Contract (UESC), the utility can provide energy audits and the design, execution, and financing of energy and water conservation projects. Authority is provided under 10 USC 2865 for the sole-source negotiation of a UESC agreements and for repayment of the financing with interest from utility funds. The repayment schedule is arranged so the project savings are adequate to make the monthly payment.
b. *AFCESA Utility Rates Management Team (URMT).* The URMT provides direct support to bases to negotiate UESC agreements. The installation and local utility contract for UESC services uses an "umbrella" agreement to document the basic UESC concepts. Projects are executed with individual "site-specific" agreements that identify the specific facility area and type of work to be completed.
c. *Utility Company Offered Incentives and Rebates.* Under certain conditions utility companies will offer financial rebates for the installation of energy-efficient equipment. Bases should work with their utility companies to identify and secure incentives and

rebates that will support the execution of energy conservation projects. 10 USC 2865 allows the bases to participate in utility-sponsored incentive programs and retain the rebate.

d. *Energy Audits/Surveys*. Bases should talk to their utility companies to see if they offer no-cost/no-obligation facility energy conservation audits and surveys or any other service that would assist the base energy program.

19.3.2.5. Energy Savings Performance Contracts

This strategy is intended to emphasize the use of services provided by the private sector.

a. *Energy Savings Performance Contracts*. ESPC, formerly known as Shared Energy Savings Contracting, is an alternative to the traditional method of financing energy efficiency improvements in federal buildings. Under this alternative financing arrangement, federal agencies contract with energy service companies (ESCOs), who pay all the up-front costs. These costs include identifying building energy requirements and acquiring, installing, operating, and maintaining the energy-efficient capital improvements. In exchange, the ESCO receives a share of the cost savings resulting from these improvements until the contract period expires, which can be up to 25 years. Upon contract completion, the Federal Government retains all the savings and equipment. Contract payments are made from the savings realized in utility and maintenance costs.

b. *Strategy for ESPC Execution*. The DoD strategy recommends that each Service develop a centralized program for executing ESPC. Air Force installations have three vehicles for access to ESPCs: Air Force Regional Energy Savings Performance Contracts (RESPC) where there are six Indefinite Delivery/Indefinite Quantity (ID/IQ) contracts for ESPC services that are available to all bases in their respective regions; Army Corps of Engineers (COE) Huntsville District Under the AFCESA MOA, the base may use Option A or Option B. Under Option A (USAESCH), Huntsville delegates ordering authority to Air Force COs at the requesting base after AFCESA has assured training in ESPC and a copy of the CO's warrant has been received. Under Option B (Full Service), the base must pay the Army to be trained and pay a service fee (about 1 percent of the base utility budget) for the Army to administer the ESPC for that base. The base will coordinate with the MAJCOM before proceeding with either option; and Individual base-wide contracts, where Bases may pursue their own ESPC, and AFCESA will assist as resources permit. There are also Department of Energy Regional Super ESPCs and Technology Specfic ESPCs. The AFCESA has entered into Interagency Agreement with the Department of Energy (DOE). This agreement authorizes the Air Force to obtain DOE support services and access to the DOE Regional Super Energy Savings Performance Contracts (ESPC) and Technology Specific Contracts, providing specific Air Force requirements and guidance are met.

19.3.2.6. Use of Energy-Efficient Goods and Services

This strategy is intended to encourage the use of energy-efficient building components, lighting systems, office equipment, etc. Procuring agents, including users of government credit cards, shall procure ENERGY STAR products and other products in the top 25 percent of energy efficiency.

a. *Energy Management and Control Systems.* Emphasis should be added to the increased use of new EMCS and continued training on existing systems.
b. *Procurement of Energy-efficient Equipment.* Procedures should be developed to ensure procurement of energy-efficient products to include vendor provision of technical data to permit LCC comparisons.
c. *DLA Bulb Catalogue.* DLA has produced a new catalog to identify most efficient light bulbs. DLA has established a telephone number [(800) DLA-BULB] for additional information.
d. *MotorMaster.* This program allows an individual to analyze the requirements of an existing motor and compare it to a new, more energy-efficient motor. An executable copy of the latest version can be down loaded from DOE's Energy Efficiency and Renewable Energy (EERE) web site.
e. *Software Packages for Selecting Energy-efficient Equipment.* Numerous documents and software packages are located on the DOE web site.

19.3.2.7. Sustainable New Buildings for Energy-Efficient Designs

This strategy is intended to assure new construction and major retrofits are designed and built with energy efficiency in mind.

All new construction shall be designed and constructed to comply with the sustainable energy performance standards as set forth in ASHRAE 90,1. Additionally, the LEEDS certification program will be established to validate compliance..

19.3.2.8. Using Alternative, Renewable, and Clean Energy

This strategy is intended to encourage the use of alternative, renewable, and clean energy sources when they are cost effective and do not impact mission.

a. *Guidance on Use of Renewables*. Reference DoD's OSD/IRM web site and FEMP's web site for guidance on use of renewable energy systems. These documents are under revision.
b. This strategy is not intended to prove the technology. We are not to become a proving range for these systems. We should limit our applications to existing technology unless the potential is very significant.

19.3.2.9. Water Conservation

This strategy is intended to encourage water conservation from the consumption and energy saving standpoint.

a. *Water Conservation Program***.** As part of the Air Force Energy/Water Conservation program, all bases should conduct comprehensive audits and leak detection surveys on their facilities. All water conservation measures with a payback of less than 10years should be implemented. The most cost-effective types of projects will generally include plumbing retrofit, e.g., low-flow showerhead, leak detection and repair, xeriscaping, wastewater reuse, and industrial water process modifications. The economics of projects will vary depending upon the cost of water, sewer, electricity, and gas. Local climate and labor rates can also influence economic evaluations. Water conservation awareness training and publicity have shown excellent results in private industry and should be made a part of the Air Force plan.

19.3.2.10. Balancing Energy and Environmental Goals

The purpose of this strategy is to coordinate energy and environmental activities. Take credit for energy projects that reduce or prevent pollution, and document the impact on the energy program from meeting environmental requirements.

a. MAJCOM/base energy managers should coordinate with their counterparts in the pollution prevention area to assure their programs are supporting each other. Energy managers should also emphasize the environmental benefits of energy conservation such as the reduction of particulate emissions resulting from decreased electrical consumption.

20. Defense Energy Support Center (DESC)

20.1. Defense Energy Support Center Mission

The Defense Energy Support Center (DESC) acts as the Defense Logistic Agency's (DLA) agent in the integrated material management of energy commodities and related services, certain chemicals, and gases. DESC also acts as the central procurement agency for natural gas direct supply, coal, and propellants. DESC in its effort to keep up with ever increasing changes also initiates and develops new programs and business practices including Fuels Automated System (FAS), the Balanced Scorecard, information technology and transformation issues. DESC's mission is to provide the DoD and other government agencies comprehensive energy solutions in the most efficient and effective manner possible.

DoD Directives providing guidance to DESC include but are not limited to DoD 4140.25-M "DoD Management of Bulk Petroleum Products, Natural Gas, and Coal" and DoDD 5101.8 "DoD Executive Agent (DoD EA) for Bulk Petroleum." DoD 4140.25-M provides guidance, supply procedures, and assigns functional responsibilities for the DoD integrated materiel management of bulk petroleum products. It also provides policy guidance and management procedures for central procurement of natural gas and coal as direct supply by the Defense Energy Support Center.

DoDD 5101.8 designates the Director – DLA as the Executive Agent for bulk petroleum for the DoD with authority to re-delegate to the DESC. This Directive addresses the roles, responsibilities, and authorities of the DoD EA for Bulk Petroleum and the relationship of the DoD EA for Bulk Petroleum to other DoD Components worldwide in peacetime, wartime, and contingencies other than war.

20.2. History

The DESC's history dates back to World War II, when its mission was to administer critical petroleum product requirements. The Agency has undergone several name changes as well as changes in organizational structure. It became part of what's now known as the Defense Logistics Agency in 1962 and has now progressed from a central entity to purchase and manage the DoD's petroleum products and coal to the integrated materiel manager for the DoD's pretroleum, coal, and natural gas requirements.

The initiative to deregulate electricity in the Continental United States (CONUS) also added to the Agency's mission. As states deregulate, DESC pursues and awards contracts for electricity to CONUS DoD and Federal Civilian Agency installations in the same manner as procurements for natural gas.

20.3. DESC Organizations

20.3.1. Director (DESC-D)

The Director of DESC directs the DoD organization that is responsible for purchasing and managing all petroleum resources used by the United States military. In addition, the DESC-D guides the growing mission of total energy support by developing strategies to buy and sell deregulated electricity and natural gas to DoD and other federal agency customers.

20.3.2. Quality Operations Division (DESC-BQ)

This Division acts as the principal adviser and assistant to the Commander in the development, monitoring coordinating, publishing and implementing of policies, programs and system application of DESC commodity Quality Assurance (QA), reliability, and, maintainability issues affecting DESC operations policy, procedures, plans, and programs. The DESC-BQ is also responsible for analysis and establishment of QA and Quality Surveillance (QS) for (CONUS/ OCONUS) and technical operations policies, MIS, and ADP support needs, for all operational guidance and directions provided within the directorate and Commodity Business Units (CBUs). DESC-BQ additionally provides policy, programs, planning and management of DESC area laboratory systems and provides QA and QS support to DoD or Civilian Agencies as defined in Inter-Service Support Agreements and directives.

20.3.3. Product Technology and Standardization (DESC-BP)

DESC-BP acts as principle technical advisor to the Director of DESC for technical matters on petroleum, missile fuels, coal and related products and services. DESC-BP also maintains specification and measurement contract clauses and represents DESC at industry standardization groups such as American Society for Testing and Materials (ASTM) and the American Petroleum Institute (API) and Federal regulatory agencies (Environmental Protection Agency, Internal Revenue Service, US Customs, Department of Energy, etc.) to ensure that product specification changes do not adversely impact the end user applications.

20.3.4. Office for the Center Senior Procurement Official (DESC-C)

This Office directs the implementation of Federal, Department of Defense and DLA contracting regulations, directives and programs at DESC, including the development of local contracting policies and procedures. They also maintain oversight of the procurement system, manages the contracting officer warrant and review programs, and the Contract Oversight Plan.

20.3.5. Energy Enterprise Office (DESC-E)

The Energy Enterprise Office provides contracting, technical, pricing, and program management expertise to the Military Services and Office of Secretary of Defense through the implementation of Utility System Privatization and Energy Savings Performance Contracts. Utilities Privatization enables the Military Services to re-capitalize its utility infrastructure with commercial sector investment capital and expertise in a timely manner and greatly enhances the reliability of installation utility systems, which are critical to supporting military missions and providing essential services to military service personnel.

20.3.6. Facilities and Distribution Management (DESC-F)

DESC-F is advisor on matters concerning worldwide fuel terminal operations, storage and acquisition programs. The office directs plans and programs for operation and maintenance of Government Owned-Contractor Operated (GOCO) and Contractor Owned-Contractor Operated (COCO) facilities; administers the bulk fuels military construction and maintenance, repair and environmental programs; provides environmental support to DoD bulk petroleum facilities; negotiates with foreign governments; plans and administers DESC laboratory testing, alongside fueling, and large purchase base contracts.

20.3.7. Bulk Fuels (DESC-B)

DESC-B acts as principal advisor and assistant to the Director DESC/Deputy Director Operation in directing the accomplishment of mission responsibilities to provide worldwide support of authorized activities in the areas of contracting, distribution, transportation, and inventory control of: bulk fuels including jet fuels, distillate fuels, residual fuels, automotive gasoline (for overseas locations only), specified bulk lubricating oils, aircraft engine oils, fuel additives such as fuel system icing inhibitor, and crude oil in support of the Department of Energy Strategic Petroleum Reserve Program. Bulk Fuels also accomplishes the sale of excess petroleum products as authorized by 10 U.S.C. 2404.

20.3.8. Installation Energy (DESC-A)

Installation Energy procures natural gas, electricity and coal for the Department of Defense and federal civilian agencies in the continental United States, Germany, and Alaska. DESC-A also acts as the single Utility Energy Manager for the Department of Defense Direct Supply Natural Gas Program.

20.3.9. Direct Delivery Fuels (DESC-P)

DESC-P provides worldwide acquisition and integrated materiel management of fuels delivered directly to using activities by contracted vendors as required to support the Military Services, DoD Activities and designated Federal agencies. This includes fuels delivered by the vendor to the customer (Ground Fuels), fuels delivered into aircrafts at commercial airports (Into-Plane Fuels), and ship propulsion fuels for military and other Government ships (Bunker Fuels).

20.3.10. Missile Fuels (DESC-M)

Missile Fuels manages missile fuels, propellants, and various chemicals and gases largely in support of the United States Air Force and the NASA space launch and satellite program. DESC-M also buys specialized petroleum products used primarily by Department of Defense customers.

20.4. Worldwide Energy Conference

DESC hosts an annual world wide energy conference to exchange information on an array of energy topics of interest to their customers and suppliers in industry in an effort to help them all stay current in defense and federal-wide programs, and in the latest technologies used in the private sector. The conference is an opportunity for attendees to learn from top industry and government experts about the challenges and needs that lie ahead. The conference includes informative briefings and workshops. At the conference's Trade Show, vendors and government agencies have an opportunity to showcase new products, services and the latest in federal energy programs. Information on the time and place of this event, as well as other information on the conference is available on the DESC World Wide Web site referenced.

20.5. DoD's Centralized Natural Gas Program

Defense Energy Program Policy Memorandum (DEPPM) 91-1, issued

October 1990, assigned to DLA the mission of centralized acquisition of direct supply natural gas. DEPPM 93-1 issued January 1993 provides the most current operating procedures, guidelines, and management responsibilities for participants in DoD's direct supply natural gas program (DSNGP). DESC serves as the implementing agent of this mission.

DESC responsibilities include but are not limited to serving as the single manager for the acquisition of direct supply natural gas for DoD's installations; publishing and maintaining an acquisition schedule of DSNGP consolidating natural gas requirements reported by DoD installations; and preparing solicitations, awards, and administering contracts for the acquisition of direct supply natural gas deliveries to designated points, performing or arranging for the economic analysis of supply options; and for natural gas pipeline storage acquisition when determined to be economically advantageous. The additional responsibilities of DESC in regards to the DSNGP can be found in DoD 4140.25-M.

20.6. Contact Information

For additional information on any of these and other organizational responsibilities, reference the DESC web site at: http://www.desc.dla.mil. Referenced Directives as well as other DESC publications are available at the DESC web site at:http://www.desc.dla.mil/.

21. Federal Energy Management Program (FEMP)

21.1. Federal Energy Management Program Mission

The Department of Energy's Federal Energy Management Program (FEMP) works to reduce the cost and environmental impact of the Federal government by advancing energy efficiency and water conservation, promoting the use of distributed and renewable energy, and improving utility management decisions at Federal sites. FEMP's four basic service areas include Technical Assistance, Financing, Policy, and Outreach. The following offers a brief description of these as well as the other program areas where FEMP offers assistance. More detailed information on FEMP and its resources can be accessed through its main Web site at http://www.eere.energy.gov/femp.

21.2. Services

21.2.1. Technical Assistance

FEMP helps Federal energy managers in identifying, designing, and implementing new construction and facility improvements in projects including but not limited to energy efficiency, renewable energy, and water saving technology. They also provide unbiased technical assistance in:

- Energy and water audits for buildings/industrial facilities
- Peak load management
- Whole-building design and sustainability
- Renewable energy technologies
- Distributed energy resources
- Combined heat and power technologies and
- Laboratory design.

FEMP also provides access to software tools for project screening to assist agencies with choosing cost effective energy and water saving projects. High quality technical workshops cover areas such as life-cycle costing, financing, O&M, and sustainable design.

21.2.2. Financing

Because agencies need funds to make projects happen, FEMP provides assistance in choosing from various financing methods. These include energy savings performance contracts (ESPCs), utility energy services contracts (UESCs), state and utility sponsored rebates, and public benefits funds set aside to promote energy efficiency. ESPCs and UESCs are practical and flexible vehicles that allow upfront financing of long term energy projects by private sector companies. FEMP can assist throughout all stages of the contract, from project identification to measurement and verification of savings.

21.2.3. Policy

The Energy Policy Act of 1992, recent Executive Orders, and Presidential Directives all require Federal agencies to reduce their energy use by 35% from the 1985 levels by 2010. The Energy Policy Act of 2005 requires all Federal Agencies to reduce their energy use by 2% per year from a 2003 baseline effective in 2006. Agencies rely on effective coordination and sound guidance to help them meet this requirement. FEMP reports agencies' progress annually to the President and Congress, manages interagency working groups, and offers policy guidance and direction.

21.2.4 Outreach

FEMP participates in expositions, meetings, conferences to bring Federal workers together to share success stories, promote partnerships, and honor achievements. FEMP's communications and recognition programs help to increase awareness and reward outstanding efforts to achieve energy efficiency. Outreach efforts include the FEMP Focus newsletter, FEMP's Web site and Information Clearinghouse, You Have the Power campaign, and annual award ceremonies.

21.3. Program Areas

FEMP assists Federal agencies in many ways. This includes finding innovative solutions to address energy management responsibilities in new construction, building retrofits, equipment procurements, operations & maintenance, and utility management.

21.3.1. New Construction/Building Retrofits

In this area, FEMP resources help energy managers think through a myriad of questions related to new construction and building renovations. Assistance is provided in performing life cycle cost analysis (LCCA), implementing and incorporating energy efficient technologies into the project, and selecting energy-wise design firms.

Life cycle cost analysis should be performed to determine if projects are a wise investment. FEMP provides software, training, and publications to assist facility managers in making sound decisions by providing guidance on how to apply LCC in evaluating energy and water saving investments.

With the assistance of FEMP, the U.S. Bureau of Reclamation has become a showcase of energy and water efficiency. Using solar water heating, low-volume faucets and toilets, and energy efficient lighting and windows, the Bureau of Reclamation at its at Glen Canyon Dam visitor center, saves energy and water without sacrificing aesthetics or comfort.

Per FEMP, the Bureau followed seven steps to reduce energy and water use. Each of these is explained in greater detail on FEMP's Web site. The steps included:

1. Identify your opportunities
2. Develop an action plan
3. Conduct a detailed feasibility study
4. Design the project
5. Implement the project
6. Evaluate and verify project savings
7. Be recognized for your success

21.3.2. Equipment Procurements

The FEMP Web site provides access to product energy efficiency recommendations, interactive cost calculators, and other resources to assist with making smart purchases to meet energy goals and legal requirements. The FAR Part 23 and Executive Order 13123 and 13221 directs Federal buyers to purchase products that are ENERGY STAR labeled or designated to be in the upper 25% of energy efficiency in their class.

21.3.3. Operations & Maintenance

Effective maintenance can save substantial amounts of money in wasted steam and electricity. It is also one of the most cost effective solutions to ensuring reliability, safety, and energy efficiency. It has been estimated that 5% to 20% savings with minimal cash outlays, can be realized through maintenance programs targeting energy efficiency.

FEMP offers several publications, through its operations and maintenance Web site link, related to operations and maintenance of facilities related to energy savings. The *Operations and Maintenance Best Practices Guide* provides federal facility personnel with information on effective O&M practices for systems and equipment typically found at federal facilities. Recommendations in the guide supplement those of the manufacturer and highlights practices not requiring significant capital outlay.

The *Continuous Commissioning Guidebook for Federal Energy Managers*, also published by FEMP provides one of the most comprehensive resources in providing recommendations for resolving operating problems, improved comfort, energy use optimization, and identifying retrofits for existing commercial and institutional buildings. Commissioning has typically produced savings of 20% in paybacks fewer than 3 years.

Both of these guidebooks as well as other O&M resources can be accessed at their web site found at: http://www.eere.energy.gov/femp/operations_maintenance/. FEMP services and programs discussed in this chapter were also extracted from this web site.

21.3.4. Utility Management

FEMP will also assist the facility energy manager in utility management by finding up to date information about energy markets, utility restructuring, renewable power purchasing, demand response and state energy efficiency funding opportunities that can help manage costs, improve reliability, and reduce environmental impacts. Contact information in these various areas is also available at the Web site.

21.4. Additional Resources

FEMP and other organizations have developed a wealth of resources to help energy managers and others find smart solutions to today's energy and water management challenges. The Information Resources site link provides a wide range of materials - publications, software, videos, and more available for download or order to help design sustainable buildings, buy the most efficient products, and research new technologies.

The Technologies link offers information and resources about technologies as well as energy management practices. Sections explain basics as well as the latest information concerning renewable, distributed energy, and combined heat and power technologies. And managers committed to sustainable design as well as sustainable operation can learn more about how to build and operate facilities that can improve productivity and help protect the environment.

FEMP believes that federal agencies should lead by example in the government's management of energy use and costs and this is vital to America's future. Interested federal agencies should contact the nearest DOE Regional representative at: http://www.eere.energy.gov/femp/about/regionalfemp.cfm for more information, and to begin important contributions to national goals for energy use.

Appendix A: Glossary

ACEEE	-	American Council for an Energy-Efficient Economy
ACSIM		Assistant Chief of Staff for Installation Management
A-E	-	architectural-engineering
AEE	-	Association of Energy Engineers
AEO	-	Army Energy Office
AEP		Army Energy Program
A&F	-	accounting and finance
AFB	-	Air Force Base
AF/CE	-	Air Force Civil Engineer
AF/CEC	-	Directorate of Construction, Air Force Civil Engineer
AFCEE	-	Air Force Center for Environmental Excellence
AF/CEH	-	Directorate of Housing, Air Force Civil Engineer
AF/CEO	-	Directorate of Operations, Air Force Civil Engineer
AFCESA	-	Air Force Civil Engineer Support Agency
AFCESA/CES	-	Air Force Civil Engineer Support Agency, Technical Support Directorate
AFCESA/EN	-	Systems Engineering Directorate, AFCESA
AFEPPM	-	Air Force Energy Program Procedural Memorandum
AFI	-	Air Force Instruction
AFIT	-	Air Force Institute of Technology
AFMC	-	Air Force Materiel Command
AFPD	-	Air Force Policy Directive
AFR	-	Air Force Regulation
AFV	-	Alternative-Fuel Vehicle
AHU	-	Air-Handling Unit
ALC	-	Air Logistics Center
AMFA	-	Alternative Motor Fuels Act
AR	-	Army Regulation
ARI	-	Air Conditioning and Refrigeration Institute
ASEAM	-	A Simplified Energy Analysis Method
		ASHRAE American Society of Heating, Refrigeration and Air-Conditioning Engineers
ATTRS	-	Army Training Resource Requirements System
AWWA	-	American Water Works Association
BCE	-	Base Civil Engineer
BEM	-	Base Energy Monitor
BLCC	-	Building Life-Cycle Cost
BMP		FEMP Water Efficiency Improvements Best Management Practices
BSGP	-	Building Standards and Guidelines Program
BTU	-	British Thermal Unit
BTUh	-	British Thermal Units per hour
BX	-	Base Exchange
CAA	-	Clean Air Act
CCAP		Critical Asset Assurance Program

CBD	-	*Commerce Business Daily*
CCB	-	Construction Criteria Base
CDD	-	Cooling Degree Day
CE	-	Civil Engineering
CECSU	-	Civil Engineering Customer Service Unit
CENET	-	Corps of Engineers National Energy Team
CERL	-	Construction Engineering Research Laboratory
CESE	-	Civil Engineering Support Equipment
CFC	-	chlorofluorocarbon
CFR	-	Code of Federal Regulations
CINCLANTFLT	-	Commander in Chief, Atlantic Fleet
CINCPACFLT	-	Commander in Chief, Pacific Fleet
CNET	-	Chief of Naval Education and Training
CNO	-	Chief of Naval Operations
CNR	-	Chief of Naval Research
COBRA	-	Comprehensive Omnibus Budget Reconciliation Act of 1985
COE	-	US Army Corps of Engineers
CS	-	Chief of Staff
DA	-	Department of the Army
DAC	-	Design Assistance Center
DASA(LOG)	-	Deputy Assistant Secretary of the Army for Logistics
DBOF	-	Defense Business Operations Fund
DCNO	-	Deputy Chief of Naval Operations
DCS(LOG)	-	Deputy Chief of Staff for Logistics
DeCA	-	Defense Commissary Agency
DEDAP	-	Defense Energy Data and Analysis Panel
DEIS	-	Defense Energy Information System
DEH	-	Director/Directorate for Engineering and Housing
DEPC	-	Defense Energy Policy Council
DEPPM	-	Defense Energy Program Policy Memorandum
DFARS	-	Defense Federal Acquisition Regulation Supplement
DFSC	-	Defense Fuel Supply Center
DGSC	-	Defense General Supply Center
DHW	-	Domestic Hot Water
DLA	-	Defense Logistics Agency
DMRD	-	Defense Management Review Decision
DMSO	-	Director of Major Staff Office
DoD	-	Department of Defense
DoDAAC	-	DoD Activity Address Code
DoDD	-	DoD Directive
DoDI	-	DoD Instruction
DOE	-	Department of Energy
DOEOA	-	Department of Energy Organization Act of 1977
DOL	-	Director/Directorate of Logistics
DPB	-	Discounted Payback
DPW	-	Director/Directorate of Public Works
DSM	-	Demand Side Management
DUECC	-	Defense Utility Energy Coordinating Council

DUERS	-	Defense Utility Energy Reporting System
DUSD		Deputy Under Secretary of Defense
EA	-	Economic Analysis
EA	-	Environmental Assessment
EAR	-	Energy Audit Report
ECAP	-	Energy Cost Avoidance Program
ECB	-	Energy Conservation Board
ECI	-	Energy Cost Index
ECIP	-	Energy Conservation Investment Program
ECO	-	Energy Conservation Opportunity
ECR	-	Energy Conservation Report
EEP	-	Energy Engineering Program
EER	-	Energy Efficiency Ratio (in BTUh/W)
EERE		(Office of) Energy Efficiency and Renewable Energy
EFD	-	Engineering Field Division
EIS	-	Environmental Impact Statement
EMAAV	-	Energy Management Assessment and Assistance Visit
EMCS	-	Energy Management and Control System
EMPEP	-	Energy Management Professional Enhancement Program
EMT	-	Energy Management Team
ENCON		Energy Coordinator
EO	-	Executive Order
EPA	-	US Environmental Protection Agency
EPAct	-	Energy Policy Act of 2005
EPCA	-	Energy Policy and Conservation Act of 1975
EPRI	-	Electric Power Research Institute
EPSS	-	Energy Project Status System
ERDC	-	Engineer Research Development Center
ERL	-	Energy Resource Library
ERMP	-	Energy Resources Management Plan
ESCO	-	Energy Services Company
ESG	-	Energy Steering Group
ESP	-	Energy Services Program
ESPB	-	Energy Security Planning Board
ESPC	-	Energy Savings Performance Contracts
ETAP	-	Energy Technology Applications Program
ETL	-	Engineering Technical Letter
EUI	-	Energy Use Index
FAR	-	Federal Acquisition Regulation
FASCAP	-	Fast Payback Capital Investment
FASCO	-	Facilities Systems Office
FEAP	-	Facility Engineering Application Program
FEDS	-	Federal Energy Decision Screening
FEMIA	-	Federal Energy Management Improvement Act of 1988
FEMP	-	Federal Energy Management Program
FEP	-	Facility Energy Plan
FETS	-	Facilities Energy Technology Service

FLEX	-	Federal Lighting Energy eXpert
FOA	-	Field Operation Agency
FRESA	-	Federal Renewable Energy Clearinghouse
FY	-	fiscal year
GPF	-	gallons per flush
GPM	-	gallons per minute
GOCO	-	Government-Owned, Contractor-Operated
GSA	-	General Services Administration
GUI	-	Graphical User Interface
HDD	-	Heating Degree Day
HID	-	High-Intensity Discharge
HQ	-	Headquarters
HQDA		Headquarters, Department of Army
HQ USAF/LGSSF	-	Fuel Policy Office, Supply Fuels Policy Division, Directorate of Supply, DCS for Logistics
HQ USAF/LGTV	-	Vehicles, Equipment, and Facilities Division, Directorate of Transportation Policy, DCS for Logistics
HQ USAF/XOO	-	Director of Operations, DCS for Plans and Operations
HUD	-	Department of Housing and Urban Development
HVAC	-	Heating, Ventilation, and Air Conditioning
IAQ	-	Indoor Air Quality
IEMTF		Interagency Energy Management Task Force
IES	-	Illuminating Engineering Society
IFB	-	Invitation for Bid
IPB		Installations Policy Board
IRP	-	Integrated Resource Plan
ISWM	-	Integrated Solid Waste Management
IWRAPS	-	Installation Water Resources Planning and Analysis System
kW	-	kilowatt
kWh	-	kilowatt hour
LCC	-	Life-Cycle Cost
LCCID	-	Life-Cycle Cost in Design
MACOM	-	Major Army Command
MAJCOM	-	Major Command (Air Force)
Major Claimant	-	Major Command (Navy)
MBTUs	-	million British Thermal Units
MCA	-	Military Construction - Army
MCF	-	millions of cubic feet
MHF	-	Military Family Housing
MILCON	-	Military Construction
MILSPEC	-	Military Specification
MOA	-	Memorandum of Agreement
MOU	-	Memorandum of Understanding
MPG	-	miles per gallon
MSC	-	Major Subordinate Command
MUSE	-	Mobile Utilities Support Equipment
MWh	-	megawatt hour

MWR	-	Morale, Welfare, and Recreation
NAVAIR	-	Naval Air Systems Command
NAVFAC	-	Naval Facilities Contracting Office
NAVFAC	-	Naval Facilities Engineering Command
NAVSEA	-	Naval Sea Systems Command
NAVSUP	-	Naval Supply Systems Command
NCO	-	Noncommissioned Officer
NDAA	-	National Defense Authorization Act of 1988
NECPA	-	National Energy Conservation Policy Act of 1978
NFESC	-	Naval Facilities Engineering Service Center
NEPA	-	National Environmental Policy Act
NEW$	-	Navy Energy Works
NGPA	-	Natural Gas Policy Act of 1978
NIST	-	National Institute of Standards and Technology
NREL	-	National Renewable Energy Laboratory
OACSIM	-	Office of the Assistant Chief of Staff of Installation Management
OASD(P&L)	-	Office of the Assistant Secretary of Defense for Production and Logistics
OCNR	-	Office of the Chief of Naval Research
ODCSLOG	-	Office of the Deputy Chief of Staff for Logistics
ODUSD		Office of the Deputy Under Secretary of Defense
ODUSD (I&E) (IRM)		Office of the Deputy Under Secretary of Defense Installations & Environment, Installation Requirements and Management
O&M	-	Operations and Maintenance
OMB	-	Office of Management and Budget
OPNAV	-	Office of the Chief of Naval Operations
OSD	-	Office of the Secretary of Defense
OTA	-	Office of Technology Assessment, US Congress
PIF	-	Productivity Improvement Fund
PNL	-	Pacific Northwest Laboratory
PNNL		Pacific Northwest National Laboratory
POC	-	Point of Contact
POL	-	Petroleum-Oil-Lubricants
PPBS	-	Planning, Programming, and Budgeting System
PR	-	Purchase Request
PRESS	-	Progress Report on Energy Savings at Shore Activities
PROSPECT	-	Proponent Sponsored Engineer Corps Training
PSD	-	Private-Sector Development
PSRV	-	Pre-seminar Site Reconnaissance Visit
PUC	-	Public Utility Commission
PURPA	-	Public Utility Regulatory Policy Act
PV	-	Photovoltaic
PV	-	Present Value
PVRC	-	Photovoltaic Review Committee
PW	-	Public Works
PWTB	-	Public Works Technical Bulletin

PWO	-	Public Works Office/Officer
QI	-	Quick Input
RCRA	-	Resource Conservation and Recovery Act
R&D	-	Research and Development
RDT&E	-	Research, Development, Testing, and Evaluation
RDUECC	-	Regional Defense Utilities Energy Coordinating Council
REEM	-	Residential Energy Evaluation Manual
REEP	-	Renewables and Energy Efficiency Planning
RFP	-	Request for Proposal
RFQ	-	Request for Qualifications
ROICC	-	Resident Officer in Charge of Construction
SAF	-	Secretary of the Air Force
SBC	-	Single Building Controller
SECNAV	-	Secretary of the Navy
SEER	-	Seasonal Energy Efficiency Ratio
SES	-	Shared Energy Savings
SIR	-	Savings-to-Investment Ratio
SNL	-	Sandia National Laboratory
SOW	-	Statement of Work
SPB	-	Simple Payback
SPV	-	Single Present Value
SYSCOM	-	Navy System Command
TDY	-	Temporary Duty
THM	-	therms
TOU	-	Time of Use
TREC	-	Tri-Service Renewable Energy Commission
TQM	-	Total Quality management
UCAR	-	Utilities Cost Analysis Report
UESC		Utilities Energy Services Contract
UPD	-	Unit Power Density
UPV	-	Uniform Present Value
UPV*	-	Modified Uniform Present Value
URMT	-	Utility Rates Management Team
USAF	-	United States Air Force
USC	-	United States Code
USDA	-	US Department of Agriculture
USMC	-	US Marine Corps
W	-	Watts
WR	-	Work Request
XO	-	Executive Officer

Appendix B: Frequently-Asked Questions

Q1: What goals are established for DoD energy managers?

A1: DoD agencies are tasked to reduce energy use in standard buildings by at least 30% by FY2005 compared to FY85 and by 35% by 2010 (excluding facilities covered by section 203 of EO 13123). They are tasked to reduce energy consumption in industrial and laboratory facilities by 20% by FY2005 and 25% by FY2010 respectively relative to FY90. They are also to implement all energy and water conservation projects that are life cycle cost effective.

Q2: What is the legislative basis of DoD energy management programs?

A2: The most recent legislation was the Energy Policy Act of 2005, Public Law 109-190, and most recent Executive Order was EO 13123 in 1999. Energy managers should consult the DoD OSD/IRM web site and their major command for the latest guidance.

Q3: What happens if I can't reduce energy use by 30% cost-effectively at my installation?

A3: Legislation and executive orders cited clearly specify life cycle cost effectiveness as the overriding criteria behind federal investment in energy efficiency. A literal interpretation is that if 30% reduction is not cost-effective, then it would not be required. However, 30% reduction is a DoD-wide (and service-wide) goal. Based on current energy/water technology and cost, 30% appears to be an achievable goal for the DoD as a whole, and for each service as a whole. How application of that goal will be applied at the installation level where energy/water costs and use characteristics may be different from the norm is left to the service. All DoD energy managers should strive to meet established goals and should clearly document any situations which might detract from meeting those goals or which suggest that further investment in conservation would not be financially justified.

Q4: How do I finance all these energy and water conservation projects I have identified?

A4: Where possible, projects should be funded using "in-house" funds. However, ESPC, UESC and DSM programs will have to be used to fund many projects based on current limitations in budget allocations for energy and water projects. See Chapter 13 for a detailed discussion of project funding and consult your service's chapter and/or your MACOM/MAJCOM energy coordinator for more detailed and current information.

Q5: How do you decide if an energy/water project makes economic sense, i.e., is "cost-effective?"

A5: The FEMP web site provides a publication "*Guidance of Life-Cycle Cost Analysis Required by Executive Order 13123*" dated 8 January 2003. Consult Chapter 14 for a detailed discussion of life cycle costing, decision criteria, and other references. The link at the FEMP site is: http://www.eere.energy.gov/femp/pdfs/lcc_guide_rev2.pdf.

Q6: What reports do I have to submit on a regular basis?

A6: Defense Utility Energy Reporting System (DUERS) data is generally submitted monthly by the installation. For specific information on energy reporting requirements, consult Chapter 6, your service chapter, and guidance from your major command/claimant energy office.

Q7: Why is energy conservation frequently mentioned in conjunction with environmental initiatives?

A7: Energy conservation is a component of environmental initiatives because generation and use of energy usually involves production of environmental emissions that reportedly contribute to problems such as global warming and acid rain. For this reason, EPA and other environmental agencies target energy programs as a pollution prevention opportunity. For a detailed discussion of the energy/environmental connection, see Chapter 7.

Q8: I am overwhelmed by the size and complexity of my job as an energy manager. Where besides DoD can I get assistance to help meet my energy goals?

A8: Locally, the best sources of information and, perhaps, financial assistance, are utility suppliers (or potential suppliers). Since DoD installations are frequently the largest energy consumers in an area, they have considerable "clout" with suppliers who want to maintain the stability of sales to a large user, and are therefore interested in keeping the customer happy. Local chapters of energy-related professional societies are good sources of continuing education and networking opportunities. State energy offices sponsor programs unique to their state in coordination with many national programs. Many other organizations have energy or water conservation-related missions and may offer information resources. Consult Appendix C for a detailed listing of organizations and contact information.

Q9: Does the installation get to keep a portion of energy savings from projects they implement?

A9: Congress established a federal model of retention of energy savings in 10 USC 2865 which allows for Service and Defense agencies to retain two-thirds of their energy cost savings each year. Half of those energy savings were to be applied to additional energy-saving projects. The other half could be used for installation "quality of life" projects. While a sound model, the plan has not been totally successful in actual practice. Energy managers should consult their major command/claimant for specific guidance on retention of energy savings. ESPC provides a built-in method of savings-retention by providing for payment of capital amortization of the project out of energy funds. The capital amortization may include related operation and maintenance costs. This effectively provides a mechanism to retain savings although no funds are available for non-energy projects.

Q10: What happens if energy management goals or initiatives conflict with DoD's mission?

A10: DoD's primary mission always takes precedence over energy-reduction initiatives and goals. The job of the DoD energy manager is to look for ways to help achieve the primary mission in the most energy-efficient manner possible and to help insure a safe and secure energy supply. A program which compromises personnel safety, comfort, or productivity will not be successful in the long-term. Fortunately, energy goals can usually be met using technology which can improve comfort and productivity, upgrade the facility infrastructure, and still meet established criteria for cost-effectiveness.

Appendix C: Energy-Related Organizations

Air Conditioning and Refrigeration Institute (ARI)
4301 North Fairfax Drive, Suite 425
Arlington, VA 22203
tel: (703) 524-8800
fax: (703)528-3816
http://www.ari.org

Alliance to Save Energy
1725 K Street, NW, Suite 509
Washington, DC 20006-1401
tel: (202) 857-0666
fax: (202)331-9588

American Council for an Energy-Efficient Economy (ACEEE)
1001 Connecticut Ave, NW Suite 801
Washington, DC 20036
tel: (202) 429-8873
fax: (202) 429-2248
email: ace3-info%ace3-hq@ccmail.pnl.gov

American Gas Association (AGA)
1515 Wilson Blvd
Arlington, VA 22209
tel: (703) 841-8667

American Hospital Association (AHA)
840 North Lake Shore Drive
Chicago, IL 60611
tel: (312) 280-6000

American Institute of Plant Engineers (AIPE)
8180 Corporate Park Drive, Suite 305
Cincinatti, OH 45242
tel: (513) 489-2473

American Petroleum Institute
1220 L Street, NW, Suite 900
Washington, DC 20005
tel: (202) 682-8000

American Solar Energy Society (ASES)
2400 Central Ave, Suite G-1
Boulder, CO 80301
tel: (303) 443-3130
fax: (303)443-3212
email: ases~ases.org

http:flwww.engr.wisc.edu/ases.org/solar

American Society of Heating, Refrigeration and
Air Conditioning Engineers (ASHRAE)
1791 TuIlie Circle NE
Atlanta, GA 30329-2305
tel: (404) 636-8400
fax: (404) 321-5478

American Water Works Association
6666 Quincey Avenue
Denver, CO 80235-3098
tel: (303) 794-7711
email: watwise@awwa.org

American Wind Energy Association
122 C Street, NW, 4th Floor
Washington, DC 20001
tel: (202) 408-8988
fax: (202) 408-8536

Association of Energy Engineers
4025 Pleasantdale Road, Suite 420
Atlanta, GA 30340
tel: (404) 447-5083

Association of Home Appliance Manufacturers (AHAM)
20 N. Wacker Drive, Suite 1500
Chicago, IL 60606
tel:(312)984-5800
home appliances and air conditioners

Business Council for a Sustainable Energy Future
1725 K Street, NW, Suite 509
Washington, DC 20006-1401
tel: (202) 785-0507
fax: (202) 785-0514

Conservation and Renewable Energy Inquiry and Referral Service (CAREIRS)
Box 8900
Silver Spring, MD 20907
tel: (800) 523-2929 or (800) 233-3071

California Department of Water Resources Bulletins and Reports
P.O. Box 942836
Sacramento, CA 94236-0001
tel: (916) 327-1653

Center for Renewable Energy and Sustainable Technology (CREST)
777 N. Capitol Street, NE, Suite 805
Washington, DC 20009

tel: (202) 289-5370
fax: (202) 289-5354
email:www-admin@crest.org
http://solstice.crest.org/

Clean Energy Campaign
1725 K Street, NW, Suite 509
Washington, DC 20006-1401
tel:(202)466-5122
fax: (202)328-2101
E-Source
1033 Walnut Street
Boulder, CO 80302-5114
tel: (303) 440-8500
information clearinghouse

Electric Power Research Institute (EPRI)
P.O. Box 10412
Palo Alto, CA 94303
tel: (415) 934-4212

Energy Information Agency (EIA)
U. S. Department of Energy
Forrestal Building, Room lF-048
Washington, DC 20585
tel: (202) 586-8800
fax: (202) 586-0727
email: infoctr@eia.doe.gov
http://www.eia.doe.gov

Environmental and Energy Study Institute
122 C Street, NW, Suite 700
Washington, DC 20001-2109
tel: (202) 628-1 400
fax: (202) 628-1825

Federal Energy Management Program (FEMP)
U. S. Department of Energy
1000 Independence Ave, SW
EE-2L
Washington, DC 20585
tel: (202) 586-5772
Help Line: (800) DOE-EERE
http://www.eere.energy.gov/femp

Florida Energy Extension Service
University of Florida
3245 College Ave
Davie, FL 33314

Florida Solar Energy Center

1679 Clearlake Road
Cocoa, FL 32922
tel:(407)638-1000
fax: (407)638-1010
email: pio@fsec.ecf.edu
http://www.fsec.ucf.edu

Gas Appliance Manufacturers Association
(GAMA)
1901 N. Moore Street, Suite 1100
Arlington, VA 22209
tel: (703) 525-9565

Global Environment & Technology Foundation
7010 Little River Turnpike
Annandale, VA 22003-9998
tel: (703) 750-6401
fax: (703) 750-6506

Global Environmental Options
900 Park Avenue
New York, NY 10021
tel:(212)439-6042
fax: (212)794-4378
http://www.xmission.com/geo

Green Seal
1730 Rhode Island Ave, NW
Suite 1050
Washington, DC 20036-3101
tel:(202)331-7337, ext. 22

Greening of America
122 C Street, NW, 4th FL
Washington, DC 20001
tel:(202)383-2539
fax: (202) 383-2670

Hydronics Institute
PO Box 218
35 Russo Place
Berkeley, NJ 07922
tel: (908) 464-8200
fax: (908)464-7818

Illuminating Engineering Society of North
America (IESNA)
345 E 47th Street
New York, NY 10017
tel: (212) 705-7926

Industrial Energy Advisory Service (IdEA$)
The University of Alabama in Huntsville
Johnson Research Center
Huntsville, AL 35899
tel: (800) 874-3327 or (205) 890.6707
fax: (205) 890.6668

Institute of Electrical and Electronic Engineers (IEEE)
445 Hoes Lane
Piscataway, NJ 08855-1331
tel: (908) 981-0060

International Institute for Energy Conservation
750 First Street NE Suite 940
Washington, DC 20002
tel: (202) 842-3388
fax: (202) 842-1565

Interstate Renewable Energy Council
PO Box 1156
Latham, NY 12110-1156
tel: (518) 459-2601

Lawrence Berkeley Laboratories
Energy and Environment Division
1250 Maryland Ave, 5W, Suite 500
Washington, DC 20024
tel: (202) 484-0880

Motor Challenge Program
U.S. Department of Energy
tel: (877) EERE-INF

National Appropriate Technology Assistance
Center (NATAS)
P.O. Box 2525
Butte, MT 59702-2525
tel: (800) 428-2525

National Association of Energy Service Companies (NAESC)
1200 G Street, NW, Suite 760
Washington, DC 20005
tel: (202) 347-0419
fax: (202) 393-0336

National Association of State Energy Officials (NASEO)
1615 M Street, NW, #810
Washington, DC 20036
tel: (202) 546-2200
fax: (202) 546-1799

National BioEnergy Industries Association
122 C Street NW, 4th Floor
Washington, DC 20001
tel: (202) 383-2540
fax: (202) 383-2670

National Electrical Manufacturers Association (NEMA)
2101 L. Street, NW
Washington, DC 20037
tel: (202) 457-8400

National Hydropower Association
122 C Street, NW, 4th Floor
Washington, DC 20001
tel: (202) 383-2530
fax: (202) 383-2531

National Renewable Energy Laboratory (NREL)
1617 Cole Blvd
Golden, CO 80401
tel: (303) 275-3000
fax: (303) 275-4053

National Small Power Clearinghouse
West Virginia University
P.O. Box 6064
Morgantown, WV 26506-6064
tel: (800)624-8309

New Mexico State Engineering Office
P.O. Box 25102
Santa Fe, NM 87504
tel: (505) 827-3879

New York State Energy Research and Development Authority
2 Empire State Plaza, Suite 1901
Albany, NY 12223-1253
tel:(518)465-6251
fax: (518)449-4989

Northeast Sustainable Energy Association
50 Miles Street
Greenfield, MA 01301
tel: (413)774-6051
fax: (413) 774-6053

Passive Solar Industries Council
1511 K Street, NW, Suite 600
Washington, DC 20005
tel: (202) 628-7400
fax: (202)393-5043

Photovoltaics for Utilities
15 Haydn Street
Boston, MA 02131-4013
tel: (617) 323-7377
fax: (617) 325-6738

Photovoltaic Systems Assistance Center
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Safe Energy Communication Council
1717 Massachusetts Ave, NW, Suite 805
Washington, DC 20006-1401
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Solar Thermal Design Assistance Center Division 6216
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Solar Energy Industries Association (SEIA)
122 C Street, NW, 4th Floor
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Solar Ratings and Certification Corporation (SRCC)
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SUN DAY Campaign
3 15 Circle Avenue #2
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Union of Concerned Scientists
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United Biomass Commercialization Association
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http://www.paltech.com/ttc/ubeca

Utility Photovoltaic Group
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U.S. Army Corps of Engineers
Institute for Water Resources
Casey Building
U.S. ACE CEWRC lWR P
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tel:(703)355-2015
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email: iwr@net.hqusace.army.mil

U.S. Army Corps of Engineers
Engineer Research Development Center
Construction Engineering Research Laboratory
2902 Newmark Dr.
Champaign, IL 61822
Tel: (217) 352-6511 or 800-USA-CERL
http://www.cecer.army.mil

U.S. Department of Commerce
National Technical Information Service (NTIS)
5285 Port Royal Road
Springfield, VA 22161
tel: (703) 487-4600

U.S. Department of Energy
1000 Independence Avenue, NW
Washington, DC 20585

Energy Efficiency and Renewable Energy Information Center
Federal Energy Management Program
tel: (877) EERE-INF
http://www.eere.energy.gov

U.S. Environmental Protection Agency (EPA)
Office of Pollution Prevention and Toxics
401 M Street, SW
Washington, DC 20469
tel: (202) 260-3557

ENERGY STAR ® General Information Hotline
tel: (800) STAR-YES

Washington State Energy Ideas Clearinghouse
tel: (360) 956-2237
email: eicbbs.wseo.wa.gov
BallastMaster software
MotorMaster software

WaterWiser
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web: http://www.waterwiser.org

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Appendix D: Energy Audit Guidelines/Checklists

Energy Audit Guidelines

Introduction

The following is intended as a guide to a "fresh caught energy manager" who was just given the challenge to reduce energy consumption on a military installation and who may not have any idea how to start. Some of these steps may seem intuitively obvious, but are still sometimes overlooked by more experienced people looking for more sophisticated problems.

Preparation

1. Get a copy of the facility as-built drawings; study the drawings to get familiar with the floor plan and mechanical and electrical systems.
2. Get audit equipment (see Chapter 9 for additional information):
   a. Pocket or digital thermometer with a submersible probe.
   b. Flat head and Phillips screwdriver.
   c. Flashlight.
   d. Stepladder (4 or 6 foot).
   e. Note pad, pen/pencil.
   f. Retractable tape measure.

3. Contact facility manager, ask and note the function, days/hours of operation and number of people in the facility. Schedule time to accomplish facility audit; (always include facility manager in initial walk-through.)
4. Get operations and maintenance information to determine the actual level of maintenance performed and the number/type of trouble calls and/or requests for service. For Air Force go to Civil Engineering Production Control Section; for Army go to Directorate of Public Works or Directorate of Engineering and Housing Work Order Help Office; for Navy/Marines go to Public Works Facility Maintenance Contract Group or Planning and Estimating Group. Ask for last 6 to 12 months of data. This will be helpful in spotting problem areas, determining repairs required or the level of retrofit needed. Solicit assistance from operations and maintenance technicians responsible for and knowledgeable in the specific infrastructure systems.
5. Study utility supply and pricing information. Identify all utilities used and compile available data on past use. If no consumption data is available, consider doing short-term monitoring to characterize utility consumption and demand characteristics. Obtain copies of all pertinent rate schedules. Note location of utility metering points and characteristics of distribution system. Talk to utility representatives and get their assistance in studying options available to reduce price, improve reliability, and upgrade infrastructure.

Conduct On-Site Audit

Exterior Walk-Around

Do an outside walk-around of the facility to assess the condition of the building envelope and of exterior lighting:

Building Envelope

1. Walk around the outside of the facility checking for doors and windows broken or otherwise inoperative. Action: Initiate proper documents to repair or replace.
2. Check exterior doors for door closures, inoperative or missing. Action: initiate proper documents to repair, replace, or install.
3. Check for exterior doors and windows that are propped open. Action: Close, remove props, find out why (this condition is usually an indication that the HVAC and/or controls are broken), repair/replace as necessary.
4. Check for air gaps around doors and windows (1/16 inch or greater.) Action: initiate proper documents to repair/replace.

Exterior Lighting

1. Check for exterior lights that are on during daylight hours. Action: turn off, initiate proper documents to repair/replace, or install sensors/clocks/switches as required for automatic operation.
2. Find out what device controls security lighting: switch, circuit breaker or time clock. If clock, is it operational? Does it show the correct time of day and day of the week? If pin actuated, are they installed properly in order to perform the correct function? Action: repair/replace/calibrate as necessary.

Interior Walk-Through

Do an interior walk-through of the facility to assess how the building is used and zoned, HVAC system types and characteristics, domestic water heating, lighting and other electrical systems, and plug load or other specialized equipment:

Building Use and Zoning

1. Using available drawings, fire plans, or other sketches, draw in the existing walls, doors and windows, if different than shown on the drawings. (often walls/doors added or removed after original construction will result in poor conditioned air circulation and personnel discomfort; hot/cold temperatures, stagnant air, irritable and/or tired personnel, etc.) Action: get a copy of marked up drawings to CADD personnel for drawing update. Keep a copy; use it for facility upgrade, energy retrofit projects.

HVAC Equipment

1. Locate the HVAC equipment. Note the general appearance and check for obvious problems such as: loose belts, noisy bearings, excessive vibration, dirty filters, water leaking, air leaking, open ducts, oil spots on floor or equipment, pipe insulation missing or in need of repair, unusual noise or equipment short-cycling,

damper motor/linkage inoperative or disconnected, pneumatic air compressor/air dryer working correctly (ask your HVAC technicians to show you what to look for and how to do some simple tests; e.g., plugged in, frozen up, correct system pressure, clean/dry air, water/oil in the storage tank, short cycling.) Action: initiate proper documents to have necessary repairs accomplished by appropriate personnel.

2. Using the mechanical drawings, draw in the existing location and physical size of all supply, return and exhaust diffusers/registers if different than shown on the plans. Locate and draw in all exhaust fans/systems if not shown on the drawings. Check for proper operation. Action: get a copy of marked up drawings to CADD personnel for drawing update. Keep a copy; use it for facility upgrade, energy retrofit projects.
3. Talk to facility occupants about any hot/cold spots and note on drawings. Action: work with facility manager to relocate desks/work areas, if possible. Initiate proper documents to check heating/cooling/exhaust system, balance air system, make minor modifications to duct system.
4. Check and note control system thermostat/sensor location and look for obvious damage: (missing covers, broken, disfigured, leaking air, etc.) Action: initiate proper documents to have controls repaired/replaced.
5. Check if all energy/utility systems in the facility have EMCS installed. Action: insure EMCS is operational and work with EMCS system manager to prepare proper documents for upgrading EMCS as needed to include all energy/utilities systems and functions.
6. Note location, size and number of space heaters found during the walk through. Action: initiate proper documents to check facility central heating system, air balance system, make minor modifications to duct system. Objectives are; customer satisfaction and get rid of space heaters. Keep a copy; use it for facility upgrade, energy retrofit projects.
7. Note location, size and number of window type air conditioners found. Action: initiate proper documents to check facility central cooling system, air balance system, make minor modifications to duct system. Objectives are; customer satisfaction and get rid of individual window type units. Keep a copy; use it for facility upgrade, energy retrofit projects.

Lighting System

1. Count and note number/type of light fixtures in each room or area. Count and note type of exit signs. Action: initiate proper documents to retrofit facility with energy efficient lighting system. Retrofits can be done separately by facility or included in a multi-facility energy project. In older facilities with significant ballast replacements, retrofit an entire room rather than replace several magnetic ballasts.
2. Note areas that have modular type furniture and task lighting available. Action: initiate proper documents to de-lamp space lighting in favor of task lighting wherever possible.
3. Note any areas where you cannot turn the lights off via a wall switch in the immediate area. Action: initiate proper documents to have switch relocated or installed as needed. (This is a good time to retrofit system with automatic devices, if practical or more economically sound.)

4. Note areas that are equipped with motion sensors or other automatic devices to turn lights off/on. Check with occupants to see if these sensors work properly and if the occupant uses them or overrides. Action: initiate proper documents to calibrate, repair or replace as necessary.

Other Equipment

1. Note location of vending machines and see if they are internally lit. Action: consolidate/remove machines wherever possible, get vendors to de-lamp machines. (Your installation can save over $50.00/machine per year simply by de-lamping.)
2. Note concentrated areas of heat producing appliances or other equipment. Action: work with facility manager to disperse equipment, if possible. Initiate proper documents to check heating/cooling/exhaust system, balance air system, make minor modifications to duct system.
3. Note location, number and use status of computers, printers, copiers, etc. Talk with users to see if computers/monitors are on at night. Determine if ENERGY STAR® features are activated on computer systems. Action: initiate action to insure that ENERGY STAR® features are activated and that non-essential systems are turned off at night.
4. Note location, size and number of coffee dispensers found. Action: educate facility manager on the energy saving and safety benefits of having a centrally located coffee or other beverage dispensing equipment.

Water Systems

1. Check and note the domestic hot water temperature setting and the actual water temperature. (should be less than 110 degrees F for an office environment.) Action: reset controller; initiate proper documents to have controller recalibrated or replaced.
2. Locate and check all water systems in and around the facility for leaking pipes, continuous running, and dripping faucets/hose bibs/lawn sprinklers. Action: turn off immediately if possible. Initiate proper documents to have necessary repairs accomplished by appropriate personnel.

Conduct Follow-Up Analysis

Based on results of the walk-through audit and resulting awareness, operations and maintenance measures initiated, compile a preliminary list of possible energy/water conservation measures that would require capital investment:

1. Using ideas and strategies from the Handbook, particularly Chapters 4, 9, 10 and 12, as well as the lists below, compile a list of measures that show promise of being cost effective (i.e., payback of ten years or less, or that have a lower life cycle cost than the “do nothing” alternative).
2. Use rough estimates of project cost and savings to determine if a measure justifies further analysis. Hand calculations, project data from energy managers at other installations, or software tools such as FEDS or ASEAM may be sources of good data. If simple payback is 10 years or less, identify for further analysis.
3. For projects that show promise of feasibility and cost effectiveness, initiate a

detailed audit or analysis to provide necessary energy/water cost/savings data for project analysis and justification.

4. Use standard cost estimating guidelines to estimate the upgrade, retrofit, or replacement cost associated with the conservation measure.
5. Conduct life cycle cost analysis of projects to see if they meet criteria for cost-effectiveness. Rank projects that are cost-effective by SIR.
6. Prepare and submit funding requests for cost-effective projects. Where funding is not available, investigate utility programs or ESPC (see Chapter 14).

Implement Measures

Implement cost-effective measures and monitor results. As situations change, constantly look for new opportunities to conserve.

Energy Conservation Measure Idea List

Use the following lists to help generate ideas for possible energy conservation measures. Review the four fundamental ways to reduce energy/water cost (see Chapter 10) to help keep things simple. Lists are organized by system type or major energy end use area and categorized in two major categories:

1. Operations and Maintenance (O&M), no- or low-cost measures comprising awareness, operations, and maintenance measures (see discussion in Chapter 4).
2. Energy Conservation Measures (ECM's), measures requiring capital investment, comprising replacement, retrofit, or upgrade projects.

Building Envelope

O&M

- Seal cracks with caulking or other materials.
- Repair, replace or install weather-stripping on windows and doors.
- Replace broken glass.
- Repair doors and windows so they operate properly.
- Adjust, replace, or install automatic door closers.
- Seal vertical shafts and stairways.

ECM

- Install additional insulation.
- Install storm windows.
- Install new windows.
- Block up unneeded windows or other openings.
- Install plastic strip curtains or air curtains on service doors.
- Install vestibule or revolving door on high traffic entrances.
- Reduce solar gain.
- Install window film.
- Install interior shading such as blinds or curtains.

- Install exterior shading such as awnings or landscaping.
- Install reflective roof surfaces.
- Paint exterior surfaces light colors to reduce solar heat gain.

HVAC System

O&M

- Lower heating thermostat to 68-70 deg F.
- Raise cooling thermostat to 75-78 deg F.
- Turn off heating and cooling in unoccupied areas.
- Set heating and cooling timers to minimum run times.
- Insure time clock pins are installed and set properly.
- Eliminate use of portable electric heaters.
- Follow manufacturers’ recommended periodic maintenance procedures.
- Clean evaporator and condenser coils on packaged equipment.
- Clean chiller evaporator and condenser surfaces of fouling.
- Replace air filters.
- Clean fans.
- Clean ductwork.
- Repair duct leaks.
- Clean air diffusers and registers.
- Clean convection units/radiators.
- Turn off gas pilots except during heating season.
- Eliminate use of boilers for hot standby during mild weather.
- Balance HVAC system for proper operation and comfort, and to minimize reheat.
- Make sure that there are no instances of simultaneous cooling and heating of supply air unless specifically justified by the application.
- Set outdoor air ventilation rates to ASHRAE recommended values for IAQ and proper building pressurization.
- Use outside air for cooling when appropriate.
- Reset supply air temperatures.
- Reset hot/chilled water temperatures.
- Repair hot/chilled water or steam piping leaks.
- Replace/repair hot/chilled pipe insulation.
- Replace leaking or blowing steam traps.
- Insure refrigerant systems are properly charged.
- Test and adjust boiler.
- Clean boiler surfaces of fouling.
- Check flue for improper draft.
- Check for air leaks in boiler or furnace.

ECM

- Install programmable thermostat.
- Install time clocks.
- Install EMCS to control HVAC.

- Install outside-air economizer with enthalpy controller.
- Install evaporative cooling system.
- Install desiccant cooling system.
- Install cooling tower cooling system.
- Install roof-spray cooling system.
- Create air movement with fans.
- Exhaust hot air from attics.
- Replace HVAC packaged equipment with high-efficiency equipment.
- Convert constant volume systems to variable air volume.
- Install automatic boiler controls.
- Install flue gas analyzers for boilers.
- Preheat combustion air, feed water, or fuel oil with reclaimed waste heat.
- Install air-to-air heat exchangers.
- Install heat pump water heaters.
- Install ground-coupled heat pump.
- Isolate off-line chillers and cooling towers.
- Isolate off-line boilers.
- Install automatic boiler blow-down control.
- Install pulse or condensing boilers/furnaces.
- Install evaporative-cooled or water-cooled condensers.

Lighting Systems

O&M

- Clean and maintain fixtures.
- Remove unneeded lamps or fixtures.
- Turn off lights in unoccupied areas.
- De-lamp vending machines.
- Turn off lights near windows or skylights.
- Use partial lighting when building is not fully occupied.
- Re-schedule or reduce nighttime activities to reduce lighting operation.
- Reduce illumination levels to IES recommended values.
- Use only necessary safety and security lighting.
- Insure automatic controls are working properly.

ECM

- Install new lighting controls where needed.
- Install automatic controls or occupancy sensors.
- Replace incandescent lighting with compact fluorescent or other high-efficiency sources.
- Replace standard fluorescent lighting with electronic ballasts/T-8 fluorescent.
- Replace existing lighting with higher efficiency source.
- Install high pressure sodium lighting where color is not critical.
- Replace mercury vapor lighting with high pressure sodium.
- Use task lighting to reduce general illumination requirements.
- Install reduced output electronic ballasts where necessary to match

illumination levels with IES values.
- Replace incandescent and compact fluorescent exit signs with LED exit signs.
- Install dimming controls or light level occupancy sensors where windows and skylights provide daylighting.

Electric Power Systems

O&M
- Check and adjust connections in electric distribution systems.
- Disconnect or switch off unused transformers.
- Adjust drive belts of electric motor systems.

ECM
- Correct power factor.
- Install energy-efficient transformers.
- Install energy-efficient motors.
- Replace oversized motors with properly sized motors.
- Install variable speed drives.
- Install power factor controller on low load, constant-speed applications.
- Use load shedding to reduce peak demand.
- Use emergency standby generators to reduce peak demand.
- Install a cogeneration system
- Install a thermal storage system to reduce peak demand.

Water Systems

O&M
- Reduce hot water temperatures.
- Repair dripping or leaking fixtures.
- Locate and repair water distribution system leaks.
- Plan irrigation to minimize evaporation, typically early morning.
- Use low water plantings and drip irrigation.
- Adjust valves for minimal water use.
- Wash only full loads (laundry and dishwashing).

ECM
- Insulate hot water pipes and storage tanks.
- Install time or demand controls on hot water recirculation systems.
- Install point of use water heaters to eliminate recirculation.
- Install heat pump water heaters in kitchens and laundries.
- Install solar water heating system.
- Install efficient low-flow shower and faucet fixtures.
- Install efficient toilets and urinals.
- Install water-efficient laundry and dishwashing appliances.
- Redesign landscaping to use Xeriscape principles.

Appendix E: Suggested Professional Library and Resource Guide

1. Turner, Wayne C., Energy Management Handbook 4th Edition, Fairmont Press, Lilburn, GA, 2001.
2. Liu, Mingsheng, Claridge, David E. and Turner, W. Dan, *Continuous CommissioningR Guidebook: Maximizing Building Energy Efficiency and Comfort*, Federal Energy Management Program, U.S. Department of Energy, 2002.
3. Pacific Northwest National Laboratory, *Operations & Maintenance (O&M) Best Practices Guide, Release 2.0*, Federal Energy Management Program, Department of Energy, July 2004.
4. Haasl, Tudi and Sharp, Terry, *A Practical Guide for Commissioning Existing Buildings* (ORNL/TM-1999/34), Office of Building Technology, State and Community Programs, U.S. Department of Energy, April 1999.
5. Office of Energy Efficiency and Renewable Energy (EERE), Federal Energy Management Program (FEMP), *Operations & Maintenance Center of Excellence Guidebook*, "Contracting for a Resource Efficiency Manager," DOE/EE-0299, U.S. Department of Energy, July 2004.
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2. Liu, Mingsheng, Claridge, David E. and Turner, W. Dan, *Continuous CommissioningR Guidebook: Maximizing Building Energy Efficiency and Comfort*, Federal Energy Management Program, U.S. Department of Energy, 2002.
3. Pacific Northwest National Laboratory, *Operations & Maintenance (O&M) Best Practices Guide*, Release 2.0, Federal Energy Management Program, Department of Energy, July 2004.
4. Haasl, Tudi and Sharp, Terry, *A Practical Guide for Commissioning Existing Buildings* (ORNL/TM-1999/34), Office of Building Technology, State and Community Programs, U.S. Department of Energy, April 1999.
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6. U.S. Department of Defense Instruction Number 4170.11 "Installation Energy Management."
7. U.S. Department of Defense Fiscal Year 2003 Energy Management Report, 2003.
8. U. S. Department of Defense Fiscal Year 2004 Implementation Plan to Meet the Requirements of Executive Order 13123.
9. U.S. Air Force Energy Program Policy Memorandum (AFEPPM) 96-1, "Air Force Energy Management Plan," June 1996. (being revised 04-XX)
10. U.S. Navy OPNAV Instruction 4100.5D (N442G), "Energy Management," April 1994.
11. U.S. Navy NAVFAC Instruction 12271.1 (CHE), "NAVFAC Total Building Commissioning Policy," October 2003.
12. U.S. Army Regulation 11-27, "Army Energy Program," February 1997.
13. Office of Energy Efficiency and Renewable Energy (EERE), Federal Energy Management Program (FEMP), Federal Technology Alert (FTA) DOE/EE-0264, "Domestic Water Conservation Technologies," U.S. Department of Energy, October 2002.
14. U.S. Environmental Protection Agency, *ENERGY STAR® Building Manual*, October 2001.
15. National Renewable Energy Laboratory Subcontractor Report, NREL/SR-710, "Advanced Utility Metering," U.S. Department of Energy, September 2003.
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20. U.S. Army Energy Programs web site, http://hqda-energypolicy.pnl.gov/.
21. U.S. Army Corps of Engineers Construction Engineering Research Laboratory's web site, http://www.cecer.army.mil.
22. Air Force Civil Engineering Support Agency Facility Energy Management web site, http://www.afcesa.af.mil/ces/cesm/energy/cesm_energy.asp.