DRAFT Guidance for the Implementation and Follow-up of Identified Energy and Water Efficiency Measures in Covered Facilities

(per 42 U.S.C. 8253 Subsection (f), *Use of Energy and Water Efficiency Measures in Federal Buildings*)

December 9, 2010

I. PURPOSE

This document provides specific guidance to agencies pertaining to the implementation and follow-up of energy and water efficiency measures identified and undertaken per Section 432 of the Energy Independence and Security Act of 2007 (EISA) (42 U.S.C. 8253(f)(4) and (5)) This guidance also provides context for how these activities fit into the comprehensive approach to facility resource (energy and water) management outlined by the statute and incorporates by reference previous DOE guidance released for Section 432 of EISA and other related documents.

II. BACKGROUND

A. Authority

Section 432 of EISA amends section 543 of the National Energy Conservation Policy Act by adding a new subsection, *Use of Energy and Water Efficiency Measures in Federal Buildings* (42 U.S.C. 8253(f)) (See Appendix B for a reprint of Section 432 of EISA.) The new subsection, referred to as "the statute" in this guidance, outlines a framework for facility energy and water project management and benchmarking, including the following requirements for Federal agencies:

- Designate "covered facilities" and assign "facility energy managers" for ensuring compliance of "covered facilities" subject to the requirements;
- Conduct "comprehensive energy and water evaluations";
- Implement identified efficiency measures;
- Follow-up on implemented efficiency measures;
- Deploy and use web-based tracking system for covered facilities' energy use, evaluations, projects, follow-up, and analysis;
- Benchmark metered buildings that are, or are part of, covered facilities; and
- Disclose agency progress in evaluating covered facilities, project implementation, follow-up status, and benchmarked building performance monitoring status.

B. Related DOE Guidance and Activity

EISA Section 432(f)(6) required the Secretary of Energy to issue guidelines that each Federal agency shall follow for designating covered facilities, assigning energy managers, and performing comprehensive evaluations per 42 U.S.C. 8253(f)(2) and (3). This published guidance, **"Facility Energy Management Guidelines and Criteria for Energy and Water Evaluations in Covered Facilities"** is located at http://www1.eere.energy.gov/femp/pdfs/eisa_s432_guidelines.pdf.

This guidance document at hand updates and supersedes relevant elements from the interim guidance documents for Federal agency covered facility reporting released in May 2009 and April 2010. EISA Section 432(f)(7) includes a requirement for Federal agencies to report and certify compliance with EISA Section 432 through a web-based tracking system. While the web-based system was being developed by DOE, agencies reported comprehensive evaluations findings for their covered facilities to DOE using spreadsheet reporting templates provided by DOE's Federal Energy Management Program (FEMP). The **interim reporting guidance** from May 2009 and April 2010 was provided for use in conjunction with the spreadsheet reporting templates. Data

from these evaluations was collected and uploaded into the web-based tracking system currently under development by DOE FEMP, referred to as the EISA 432 Compliance Tracking System (CTS).

DOE was also required to select or develop a building energy use benchmarking system for building performance monitoring and to issue guidance for use of the system per 42 U.S.C. 8253(f)(8). This guidance, **"Building Energy Use Benchmarking Guidance,"** April 15, 2010, is located at http://www1.eere.energy.gov/femp/pdfs/eisa432_guidance.pdf.

Other published guidance directly related to achieving requirements set by EISA Section 432 includes the following:

- DOE FEMP's **"Guidance for Electric Metering in Federal Buildings"** located at http://www1.eere.energy.gov/ femp/pdfs/adv_metering.pdf.

- DOE FEMP's **"Energy Savings Assessment Training Manual"** which provides information leading to self-sufficiency in and the ability to conduct on-site energy audits. This manual is currently in review to be released soon.

- DOE FEMP's **"Operations & Maintenance Best Practices: A Guide to Achieving Operational Efficiency, Release 3.0"** which provides updates to areas of O&M technologies, equipment performance, costs, water use and the impacts of recommended O&M practices on water efficiency. This guide is located at http://www1.eere.energy.gov/femp/pdfs/omguide_complete.pdf.

- The **"Life-Cycle Costing Manual for the Federal Energy Management Program" (NIST Handbook 135)**, located at http://www.bfrl.nist.gov/oae/publications/handbooks/135.pdf explains, in detail, the principles of life-cycle cost analysis and integrates them with FEMP criteria and how agencies shall use life-cycle cost analysis in making decisions about investments in products, services, construction, and other projects to lower the Federal Government's costs and to reduce energy and water consumption. Annual updates to the handbook are posted for Federal agencies to review located at http://www1.eere.energy.gov/femp/pdfs/ashb10.pdf. The National Institute of Standards and Technology (NIST) developed the Building Life-Cycle Cost (BLCC) software to provide computational support for the analysis of capital investments in buildings located at http://www1.eere.energy.gov/femp/information/cfm/register_blcc.cfm.

- **"Federal Water Efficiency Best Management Practices"** located at http://www1.eere.energy.gov/femp/program/waterefficiency_bmp.html. FEMP originally developed Federal Water Efficiency Best Management Practices (BMPs) in response to Executive Order (E.O.) 13123 requirements. E.O. 13423 superseded E.O. 13123. To account for the superseded requirement changes, water use patterns, and advancing technologies, the Environmental Protection Agency's WaterSense Office updated the original BMPs. The updated BMPs help Federal agencies achieve the water efficiency goals of E.O. 13423 and E.O. 13514.

III. EISA FACILITY MANAGEMENT APPROACH

EISA Section 432(f)(3)-(8) describes a comprehensive approach for deploying energy and water efficiency and conservation measures (ECMs) in Federal buildings and monitoring project and building performance. (For the purpose of this document, the acronym "ECM" will always represent both water and energy efficiency measures. Efficiency *projects* may consist of one ECM or implementation of several ECMs combined within one project.) Two general frameworks, one for managing energy and water efficiency projects and one for monitoring performance, are indicated within the statute:

- Energy and Water Efficiency Project Management: The EISA facility project management approach is a cyclical process of continuous improvement that is intended to "ensure persistence of savings of implemented projects" and provides a structure for ongoing evaluation of facilities, implementation of energy and water saving projects, and reporting of project and performance impacts. This four-year cycle of activity includes evaluating facilities, identifying and implementing projects, and following up on and maintaining efficiency measures as part of the re-evaluation process to ensure an ongoing cycle of continuous improvement. As agencies identify and implement their projects, initial estimates of energy and water savings from implemented projects are confirmed and tracked through project follow-up and re-commissioning. Projects and associated ECMs are monitored to determine net energy and water savings. Throughout this process, the findings are entered into the web-based CTS.

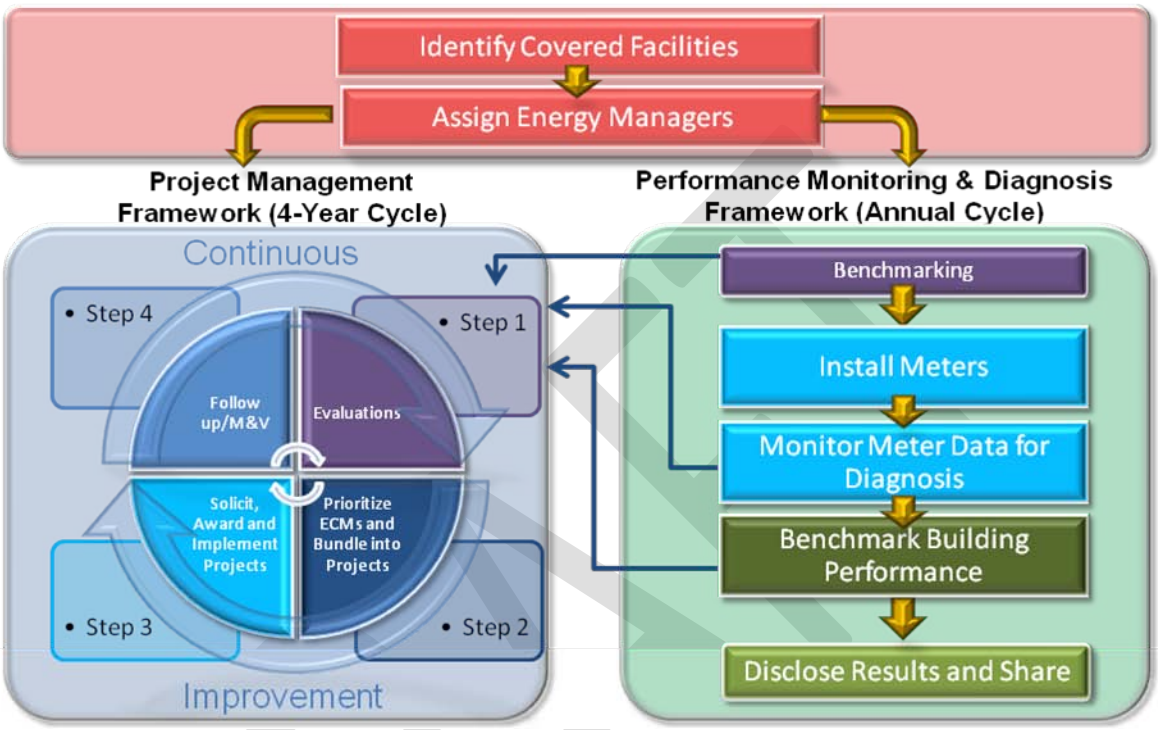
- Performance Monitoring Framework: Complementing the continuous improvement project management process is the requirement for annual building performance monitoring. This framework provides for ongoing performance monitoring and disclosure of results, supported by metering and ongoing benchmarking of buildings covered under the statute. This provides opportunities to use the EISA 432 CTS for disclosure within the agency to facilitate recognition programs, instill "friendly competition" between energy managers at other facilities, with successes and lessons-learned in one facility being shared among other similar facilities.

The integration of these two frameworks in the graphic below demonstrates a cycle of continuous improvement and persistence of savings as projects are implemented, measured and verified, and re-commissioned. Under the performance monitoring framework, buildings are monitored; deficiencies corrected; lessons are learned; and these findings inform the next round of facility evaluations. Also, benchmarking individual buildings against similar types over time will indicate potential for additional ECM opportunities and corrective action for ECMs that are not persistent in saving energy and water.

The narrative that follows provides context for all of EISA-prescribed facility resource management activities in general terms. More details on designating covered facilities, assigning energy managers, and performing comprehensive evaluations are in the published guidance, "**Facility Energy Management Guidelines and Criteria for Energy and Water Evaluations in Covered Facilities,"** http://www1.eere.energy.gov/femp/pdfs/eisa_s432_guidelines.pdf. "**Building Energy Use Benchmarking Guidance,**" April 15, 2010, is located at

http://www1.eere.energy.gov/femp/pdfs/eisa432_guidance.pdf. More details on implementing the potential ECMS identified during comprehensive evaluations and following up on those projects to ensure persistence of savings are in Section III of this guidance.

EISA Facility Management Approach



A. Facility Energy and Water Efficiency Project Management

The energy and water efficiency management process begins with the identification of covered facilities and the assignment of facility energy managers. A four-year cycle of evaluating facilities, identifying and implementing projects, and following up on and maintaining efficiency measures assures persistence of savings and ongoing efficiency improvement.

1. Identify Covered Facilities

According to the "**Facility Energy Management Guidelines and Criteria for Energy and Water Evaluations in Covered Facilities,"** Federal agencies are to identify covered facilities where it makes the most sense to concentrate their efforts. The recommended approach for this is to rank facilities according to highest energy use. Under the statute, each top-tier agency must designate "covered facilities" that comprise at least 75 percent of its facility energy use. Agencies shall include in their inventory all of the facilities where this energy management approach makes sense with 75 percent as a required minimum threshold. The agency may not want to include smaller facilities that are widely dispersed, especially if it can capture the largest percentage of energy use in the smallest number of larger, energy-intensive facilities.

Facility

The term "facility" means any building, installation, structure, or other property (including any applicable fixtures) owned or operated by, or constructed or manufactured and leased to, the Federal Government. This includes:

- A group of facilities at a single location or multiple locations managed as an integrated operation; and Contractor-operated facilities owned by the Federal Government 42 U.S.C. 8253(f)(1)(C)(i) and (ii)
- The statute excludes from this definition any land or site for which the cost of utilities is not directly paid by the Federal Government 8253(f)(1)(C)(iii)

2. Assign Energy Managers

Each agency must have appropriately-trained energy managers assigned for each of its covered facilities. The term "energy manager," with respect to a facility, means the individual who is responsible for ensuring the facility's compliance with the statute and efficient use of energy and water at the facility.

Given the statute's additional reporting requirements and clear assignment of responsibility to facility energy managers, it is recommended that agencies delegate these EISA Section 432 responsibilities to facility energy managers, empower them and facilitate their activities. Agencies are encouraged to use the CTS to share successes, lessons learned, and results from implemented projects with other energy managers within their agency. This will help to foster a collaborative community across the agency.

Energy Manager

The term "energy manager" may include:

- A contractor of a facility;
- A part-time employee of a facility;
- An individual who is responsible for multiple facilities. 42 U.S.C. 8253(f)(1)(B);

At a minimum, facility energy managers must meet the definition of "trained energy managers" from Section 151, Subtitle F of the Energy Policy Act of 1992, which states that: "'trained energy manager' means a person who has demonstrated proficiency, or who has completed a course of study in the areas of fundamentals of building energy systems, building energy codes and applicable professional standards, energy accounting and analysis, life-cycle cost methodology, fuel supply and pricing, and instrumentation for energy surveys and audits." 42 U.S.C. 8262(3)

3. Facility Comprehensive Evaluations

Within a four-year period, agencies must conduct comprehensive energy and water evaluations for all covered facilities, which include energy and water audits and a commissioning assessment for the purpose of identifying ECM opportunities. "Evaluation" means that ". . . energy managers shall complete, for each calendar year, a comprehensive energy and water evaluation for approximately 25 percent of the [covered] facilities of each agency . . . in a manner that ensures that an evaluation of each such facility is completed at least once every 4 years." (42 U.S.C. 8253(f)(3)(A))

Energy managers with metered facilities may choose to start the evaluation process by benchmarking buildings' performance data to assess the scope of potential savings. The evaluation may also identify the need for additional metering or sub-metering for diagnostic purposes. Energy managers with non-metered facilities *ideally* should first install meters and appropriate sub-metering *at the building level* before commencing with the evaluation process.

During the comprehensive evaluation process, facility energy managers identify potential energy and water conservation measures that can be implemented separately or bundled into projects. The evaluation also assesses facility energy and water use and operational issues as part of a commissioning assessment. These findings might lead to retro- or re-commissioning measures. The evaluation also identifies implementation costs to accomplish potential ECMs and the estimated energy and water savings that would result.

In scheduling completion of evaluations, agencies are provided some flexibility under the statute in completing evaluations of "approximately" 25 percent of covered facilities each calendar year, as long as each covered facility is evaluated at least once every four years. Based on the specified "180 days after the date of enactment" language in the statute, findings from evaluations completed during the past year are to be entered into CTS by June of the following year. This also aligns with the mid-year Sustainability/Energy Scorecard assessments of agencies by the Office of Management and Budget (OMB).

During the initial four year period, evaluation progress will be tracked by the CTS. After that, compliance will be determined by verifying that each covered facility continues to be evaluated every four years. OMB will assess agency progress on their Sustainability/Energy Scorecard during the initial four year reporting periods based on the following milestones:

- Complete evaluations on 25% of covered facilities by June 30, 2009,
- Complete evaluations on 50% of covered facilities by June 30, 2010,
- Complete evaluations on 75% of covered facilities by June 30, 2011,
- Complete evaluations on 100% of covered facilities by June 30, 2012.

Agency progress in completing evaluations in covered facilities will be reported in the CTS under the following three performance metrics by percentage in terms of:

- Number of covered facilities evaluated,
- Energy use of covered facilities, or
- Square footage of covered facilities.

In addition, comprehensive evaluations have a critical role in follow-up of implemented measures which should be conducted when the facility is reevaluated.

Comprehensive evaluations are comprised of two basic components: Energy and water audits, and a commissioning assessment. These components may be accomplished separately, either with in-house expertise and/or through contracting with private sector auditors and commissioning authorities. While both audits and the commissioning can lead to improvements in facility operations and resource and cost savings, there are fundamental differences between the two components:

1. Energy and water use audits identify performance deficiencies when compared against similar structures. These deficiencies might lead the facility energy manager to recommend improvements to the building. Recommended improvements might include both no-cost and low-cost improvements and the more capital-intensive replacement of inefficient equipment and systems.

2. Commissioning is an ongoing process that ensures that building systems are operating to original design specifications. It requires a detailed evaluation of current (including newly installed) building systems and can lead to operating cost savings without having to install expensive new equipment. Aspects of ongoing commissioning processes are often referred to as re-commissioning (the subsequent commissioning of a previously commissioned system) and retro-commissioning (the commissioning of an existing system that was not commissioned within a year of initial installation).

It is often more cost-effective to do the commissioning component of the evaluation first followed by the energy and water retrofit audit. This is because the payback period on the retrofits is inherently a function of the performance of the current equipment and also because the post-commissioning baseline is often fairly different than the pre-commissioning baseline. Of course, in certain cases it might make more sense to install some retrofits first, an automation or energy management control system, for example. Facility managers may chose to use separate providers for commissioning and retrofit auditing. For cost-effectiveness, the same provider should generally perform both stages of the commissioning process (assessment and commissioning measures). Similarly, an ESCO that performed the energy or water audit may also be called upon to implement the identified ECMs.

Agencies may consider newly-constructed and commissioned buildings as already evaluated. Therefore, agencies can wait four years before having newly-commissioned buildings re-evaluated. If the building has been audited and re-commissioned in the prior four years, the requirement for a comprehensive evaluation is considered to be fulfilled.

In order to complete comprehensive evaluations, agencies can draw upon the following resources:

- Government employees with training in managing energy and water use (in-house facility engineering staff);
- DOE National Laboratory staff through a work-for-others interagency agreement;

- Private sector contractors either on a fee-for-service basis or through a financed arrangement under a utility energy service contract (UESC) or energy savings performance contract (ESPC);
- Private audit contractors retained on a fee-for-service basis through the General Services Administration (GSA) Schedule 03FAC, Facilities Maintenance and Management, Energy Management Support and Services Solutions (www.gsa.gov/energyservices), under Category 871 201, Energy Audit Services; or
- Resource Efficiency Managers, whether fully dedicated to a facility or shared.

More detail on the requirements of comprehensive evaluations are in **"Facility Energy Management Guidelines and Criteria for Energy and Water Evaluations in Covered Facilities"** http://www1.eere.energy.gov/femp/pdfs/eisa_s432_guidelines.pdf.

a) Facility Energy and Water Audits

To standardize the energy audit process, the energy manager may choose to utilize the protocols created by the American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE). ASHRAE defines several energy audit "stages", the most frequently used of which are the Level I and Level II analyses (see "Audit Levels" call-out box on next page). The Level I "walk-through" analysis assesses a building's energy efficiency by analyzing utility bills and conducting a brief on-site survey of the building. A Level I analysis identifies and provides a savings and cost analysis of low-cost or no cost ECMs, and a listing of additional capital improvements and their potential costs and savings for further consideration. For *many* facilities, a Level I audit will be adequate to meet the statute. A Level II analysis includes a more detailed survey and cost-benefit analysis of potential ECMs. The Level II analysis will be adequate for *most* covered facilities. In some cases in which capital intensive modifications are desired, an ASHRAE Level III analysis may be performed. A Level III analysis performs energy modeling to verify potential savings and includes additional systems measurements, schematics and equipment lists. For more information, see the case studies on conducting an ASHRAE Level I audit (Appendix D) and an ASHRAE Level II audit in (Appendix E).

While the ASHRAE energy audit levels provide detail and standardize approaches for agencies to follow, it is the DOE Guidance referenced above that outlines what is required to meet the statute. While the DOE audit requirements are sufficiently rigorous, it is flexible enough to ensure that viable energy-saving projects are identified, and also not so onerous as to require extensive resources to be spent auditing structures where engineers can quickly and easily conclude that no viable projects currently exist. The report format for this audit process is based on the Energy Saving Performance Contract (ESPC) Preliminary Assessment (PA) level audits. A PA-level audit contains the documented findings of a walk-through survey and "may include, but is not limited to, an evaluation of energy cost savings and energy unit savings potential, building conditions, energy consuming equipment, and hours of use or occupancy, for the purpose of developing preliminary technical and price proposals…."

For conducting water audits, FEMP has provided guidance via its "Water Efficiency" website for resources on measuring and tracking water performance (http://www1.eere.energy.gov/femp/program/waterefficiency.html). In addition, FEMP and the U.S. Environmental Protection

Agency (EPA) list 14 best management practices for water efficiency that will be useful to facility energy managers (www.femp.energy.gov/program/waterefficiency_bmp.html). The FEMP guidance on "Increasing Federal Office Building Water Efficiency" (http://www1.eere.energy.gov/femp/pdfs/ waterefficiency_fedoffices.pdf) describes four steps for conducting a facility water audit. Web based training for conducting a water audit can be accessed at: (http://femptraining.labworks.org/ mod/resource/view.php?id=46).

Audit Levels

The audit component of comprehensive evaluations must identify potential energy or water conservation measures (ECMs) including annual water and energy savings information, life-cycle investment and implementation costs and cost savings. EISA audits typically equate with Levels 1 or 2 audit activities as described by the American Society of Heating, Refrigerating, and Air-Conditioning Engineers (ASHRAE). Depending on the physical and energy-use characteristics of a building, and the needs and resources of the owner, these steps can require different levels of effort. A commercial building energy analysis can generally be classified into the following levels of effort:

1. **Type I audit, or preliminary or walk-through audit,** is the simplest and quickest type of audit. In general, a Type I audit is comprised of basic utility invoice analysis; interviews with site-operating personnel; a review of facility operations data, such as; operating hours, personnel and occupancy loading, and mission requirements; a room-by-room walk-through of the facility to identify obvious areas of energy waste or inefficiency; data analysis; development of energy conservation measures (ECMs). This level of audit, while not sufficient for reaching a final decision on implementing proposed measures, is adequate to prioritize energy-efficiency projects and to determine the need for a more detailed audit and project prioritization. Advantages include: least expensive audit to perform; can be conducted by personnel with minimum to moderate audit experience; and provides preliminary data prior to investing in more detailed audits. Disadvantages include: has limited accuracy and is insufficient by itself to support large capital improvement projects.

2. **A Type II audit, or general audit** expands on the preliminary audit by collecting more detailed information about facility operations and by performing a more detailed evaluation of energy conservation measures. The Type II audit goes beyond simple observation and makes energy use analysis an important element of the process. Utility bills are collected for a 12 to 36 month period to allow the audit team to evaluate, trend, and compare the facility's energy rate structure, demand, and usage profiles. In addition, strategically placed energy monitoring devices extend the capability of the energy audit team by providing a steady stream of energy use information for specific building systems. Advantages include: balances time, effort, and cost with more complete, accurate, recommendations; has a greater degree of accuracy than a Type I energy audit; and incorporates methodical data collection that maximizes savings, makes analysis easier, and documents recommendations in a way that simplifies implementation. Disadvantages include: more costly and resource-demanding and requires more time to perform than a Type I energy audit.

3. **A Type III audit or comprehensive audit,** expands on the Type II audit by providing a dynamic model of energy-use characteristics of both the existing facility as-is, and the predicted energy-use characteristics of the facility after implementing selected energy conservation measures identified. The building model is calibrated against actual utility and weather data to provide a realistic baseline against which savings generated by implementing the proposed measures are calculated. Extensive attention is given to daily, weekly, monthly, and annual existing utility data supplemented with sub-metering of major energy consuming systems and data monitoring of system operating characteristics. Advantages include: provides detailed and accurate information through data collection and computer simulations; provides comprehensive data on project cost and savings based on published sources; and can identify energy conservation measures that are not quite so obvious. Disadvantages include: is typically the most expensive type of audit to perform; susceptible to "garbage in – garbage out" if the input data, assumptions used, and output results are not checked; and requires highly technical understanding.

b) Facility Re-/Retro-Commissioning

Commissioning is a systematic process of assuring through verification and documentation, from the design phase to a minimum of one year after final acceptance, that all facility systems perform interactively in accordance with the design documentation and intent, and in accordance with the owner's operational needs, including preparation of operational personnel. The commissioning process ensures that all of the equipment and systems within a facility are currently operating and functioning properly, and identifies items that need to be fixed or adjusted, typically in a low or no cost fashion.

Commissioning can also be conducted on a retroactive basis. The statute defines "retro-commissioning" as the retroactive commissioning of equipment or a system that was not commissioned at the time of installation or during the warranty phase. Typically, retro-commissioning is performed long after the facility is constructed and placed into service.

"Re-commissioning" is the process of commissioning a previously commissioned facility or system after expiration of the project development and warranty phases. The primary goal of re-commissioning is to optimize facility performance, in accordance with design or operating needs, over the useful life of the facility.

Re-commissioning

Re-commissioning provides additional opportunities to improve facility efficiency and addresses issues that may have arisen since the original commissioning. It can help reduce energy consumption, maximize the efficiency and output of the air and water distribution systems, enhance performance, and enhance the occupants' working environment and comfort. Re-commissioning may involve functional performance testing of most or all major building systems, particularly if they have been problematic or highly energy inefficient. However, re-commissioning is most often applied to the existing building's HVAC, refrigeration, and electrical systems and their controls, which often are the sources of the biggest operational problems.

All forms of commissioning seek to ensure that all energy-using and energy-conserving systems in a building work together to meet the needs of the current occupants and the actual performance requirements of the owner.

As part of a covered facility's comprehensive evaluation, the statute requires identifying and assessing re-commissioning measures (or, if the facility has never been commissioned, retro-commissioning measures). To fulfill the requirement of the commissioning component of the energy and water evaluation, DOE recommends a four-step approach:

1. Planning: Determine the commissioning objectives and the scope of the equipment to be re-commissioned or retro-commissioned.
2. Discovery/Design Review: Review the original design intent and the basis of design for the equipment or system being re-commissioned or retro-commissioned. Update the basis of design if warranted by changes in building or facility use or occupancy. Measure and monitor operating performance and list and prioritize equipment and/or system deficiencies.
3. Implementation and Verification/Correction: Determine performance baselines and measure the performance of existing equipment and/or systems against baseline. Adjust the equipment and retest if deficiencies are found. Perform corrections from highest

priority to lowest priority items. Perform functional tests to ensure that performance deficiencies have been corrected.

4. Reporting and Periodic Review. Complete the commissioning report. Update operations and maintenance manuals for equipment and systems to reflect commissioning findings. Train operations and maintenance staff on operations and maintenance of equipment and systems (see http://www1.eere.energy.gov/femp/pdfs/commissioning_fed_facilities.pdf)

4. Project Implementation and Follow-up

This part of the facility project management process is the core content of this guidance and is presented in Section III. This section details the process for developing projects to implement the potential ECMs and commissioning measures identified during comprehensive evaluations, and also describes the follow-up activities required for implemented projects. Section III addresses the requirements of subsections 4 and 5 of the statute. (42 U.S.C. 8253(f)(4) & (5))

B. Building-Level Performance Monitoring

The annual, on-going performance monitoring framework outlined by the statute complements and provides input to the project management process. The framework also provides the facility managers with key tools for measuring and capturing the energy and water savings that can be achieved from instilling behavioral change.

1. Benchmarking for Prioritizing Covered Facilities for Evaluation

Facility- or installation-level benchmarking can be used at an agency's headquarters coordinating level to prioritize the agency's covered facilities for completion of comprehensive evaluations within the required four-year schedule. For example, comparisons of the total annual energy intensity of covered facilities, whether strictly in terms of Btu-per-square-foot, or adjusted for local weather impacts, or even considering the carbon-intensity of the facilities energy use, can be used to focus early attention on those covered facilities that present the greatest opportunity for improvement under the various benchmarking metrics.

2. Installation of Building-Level Metering

More rigorous benchmarking activity and analysis occurs at the individual building level which necessitates an appropriate level of metering or sub-metering if the buildings are part of a larger campus or installation. Each agency should ensure that their buildings meet appropriate level of metering required under National Energy Conservation Policy Act (NECPA) (42 U.S.C. 8253(e)(1)), as amended by the Energy Policy Act of 2005 and EISA 2007. All appropriate buildings are required to be metered for electricity usage by October 1, 2012, and with natural gas and steam usage appropriately metered by October 1, 2016. The CTS will include the capability of tracking metering compliance of appropriate buildings (and their associated square footage) that are, or are part of, covered facilities.

Separate metering of individual buildings on large installations greatly facilitates benchmarking and monitoring of individual building performance. Many covered facilities, particularly multi-

building installations, do not have the adequate level of metering in place to diagnose problems or benchmark performance of the major buildings on those covered facilities. Installing appropriate levels of metering and sub-metering at the facility is the first step for rigorous performance monitoring and can be also used for the following purposes:

- Energy billing and procurement activity, including measuring tenant use, verifying bills, identifying best utility rate tariffs, and participating in demand response programs.
- Management of utility use, including monitoring existing utility usage and utility budgeting support.
- Performance measurement, verification and optimization, including diagnosing equipment and systems operations; benchmarking utility use; identifying potential retrofit/replacement projects; and monitoring, diagnosing, and communicating power quality problems.
- Baseline development, measurement and verification (M&V) of savings in energy savings performance contracts (ESPC) and utility energy services contracts (UESC)
- Promoting energy use awareness for building managers and occupants.

As noted in FEMP's **"Guidance for Electric Metering in Federal Buildings,"** http://www1.eere.energy.gov/femp/pdfs/ adv_metering.pdf, metering is an ongoing process that affects long-term energy use: "Metering is not a one-time event where equipment is purchased and installed; the application of meters to measure energy use will not result in any energy or utility cost savings. Instead, meters are a technology that enables improved energy management while metering is an on-going process." See a case study for installing and maintaining meters in Appendix J.

3. Monitor Meter Data for Diagnostics

The key benefit of metering is the higher resolution of information provided on how energy and water is being used within a covered facility. At larger installations, individual building metering can quickly highlight abnormal variances in consumption that might not be noticeable in readings at the installation-level.

Metering equipment is also frequently used to monitor equipment performance, diagnose problems, prescribe corrective action and monitor results. Once the meters are installed, the agency energy management team monitors equipment or system performance and takes corrective action if needed. If a system or equipment problem is discovered, adjustment or repair can be undertaken. For example, as noted in FEMP's "Operations & Maintenance Best Practices: A Guide to Achieving Operational Efficiency," meters can be used to discover and diagnose abnormal vibrations in rotating equipment.

4. Benchmark Building Performance

Metering plays the central role in supplying performance data for building benchmarking. In multi-building sites, the energy manager installs meters for each appropriate individual building. Buildings can be benchmarked against similar buildings or against their own historical performance.

EISA requires energy managers to enter energy use data for each metered building that is (or is a part of) a covered facility into a building energy use benchmarking system, such as the Energy Star Portfolio Manager tool (Portfolio Manager). (42 U.S.C. 8253(f)(8)(A) In addition, energy managers shall post and update the benchmarking data each year in the web-based tracking system (CTS) developed by the Secretary of Energy to track compliance with Section 432 of EISA. (See 42 U.S.C. 8253(f)(8)(C))

FEMP's **"Building Energy Use Benchmarking Guidance,"** April 15, 2010 http://www1.eere.energy.gov/femp/pdfs/eisa432_guidance.pdf defines "benchmarking" of metered buildings as: "The process of accounting for and comparing a metered building's current energy performance with its energy baseline, or comparing a metered building's energy performance with the energy performance of similar types of buildings (based on use, such as comparing the energy performance of a hospital to that of other hospitals)." The statute applies to metered buildings, all buildings that are stand-alone or are separately-billed, and multiple sites with individual facilities. Benchmarking can be used to compare performance over time, within and between peer groups, or to document top performers. Benchmarking data, which the statute requires to be compiled and updated annually, demonstrates potential building-level changes in water and energy use and can be used as criteria for choosing new ECMs, diagnosing problems and mitigating issues with current projects, and sharing best practices within the agency.

Agencies should establish a timeline for completing benchmarking of all metered buildings that are, or are part of, covered facilities and incorporate these milestones into the annual sustainability planning process. Agency progress in benchmarking required buildings will be assessed annually in terms of percentage of benchmarked floor space compared to overall covered facility square footage.

5. Disclose Results/Share Success and Lessons Learned

The statute states that DOE must make the web-based tracking system available to Congress, other Federal agencies, and the public through the Internet. (42 USC 8253(f)(7)(C)(i)) At the request of a Federal agency, DOE may exempt specific data for specific facilities from disclosure for national security purposes. (42 USC 8253(f)(7)(C)(ii))

The performance information generated by a benchmarking system from energy managers' inputs shall be posted into the web-based CTS. This process will be automated for agencies using Energy Star Portfolio Manager (the benchmarking system selected per the released Benchmarking Guidance). This information shall be updated each year, and the CTS will include the previous years' information to allow changes in building performance to be tracked over time. This provides opportunities to use the EISA 432 CTS for tracking building performance within the agency to facilitate recognition programs and instill "friendly competition" between other facility energy managers, with successes and lessons-learned in one facility being shared among many other similar facilities. This tracking also facilitates energy managers in sharing their findings, experience, and insights for best practices. This information sharing increases the potential energy savings and persistence of savings throughout the agency.

DOE will make the building-level benchmarking information in the web-based tracking system available to the public through the Internet. Overall agency progress in benchmarking buildings will be tracked in the CTS system and also made available to the public. Below are the building-level benchmarking metrics which will be tracked annually in the CTS:

- Building Name
- Building Identifier---Real Property Profile Unique Identifier
- Location---city, state, zip code
- Type of building---per current Energy Star PM types and mixed use/other (those that can be rated and those without ratings)
- Building total floor space (Sq. Ft.)
- Annual energy use in terms of site-delivered million Btu
- Annual energy use in terms of source million Btu
- Annual site-delivered energy intensity (calculated Btu/Sq. Ft.)
- Annual source energy intensity (calculated Btu/Sq. Ft.)
- Annual weather-normalized site-delivered energy intensity (Btu/Sq. Ft.)
- Annual weather-normalized source energy intensity (Btu/Sq. Ft.)
- Energy Star Rating for applicable building type (1-100) (if applicable)
- Annual water use (thousand Gallons)
- Annual water use intensity (Gallons/Sq. Ft.)
- Greenhouse Gas Emissions (MT CO_2e)
- Sustainability Guiding Principles Completion (optional)

By default, building-level benchmarking data for most recent and prior years will be displayed by agency with building/covered facility identity and location made available to the general public. Agencies may request that specific information on individual buildings and/or entire facilities not be made public if public disclosure would raise national security concerns. Agencies should submit requests for exemption from disclosure of specific data for specific covered facilities to the Secretary of Energy within 90 days of the release of this Guidance. Requests should identify each covered facility and the specific data for which the exemption is sought and the reason public disclosure would affect national security. See Section V of this Guidance, page 28 for more information on public disclosure and transparency.

IV. PROJECT IMPLEMENTATION AND FOLLOW-UP

This section provides specific guidance to agencies pertaining to the implementation and follow-up of energy and water efficiency measures identified and undertaken per EISA Section 432 (42 U.S.C. 8253 (f) (4) and (5)) and fulfills the requirement that the Secretary of Energy issue such guidelines (42 U.S.C. 8253 (f) (6)(A)(ii)). These guidelines focus on the project management activities that commence after the completion of the required comprehensive evaluations and identification of potential projects.

A. Prioritize ECMs, Bundle, and Package into Projects

In developing potential ECMs into projects, facility energy managers (with the assistance of their agency energy coordinators) analyze the findings from the comprehensive evaluations paying particular attention to life-cycle cost analysis data, prioritize the potential ECMs for implementation, and package these into projects that best align with available funding approaches. Agencies are encouraged to bundle individual ECMs that are less cost-effective with those that are more cost-effective into projects that generate a more positive return on investment. This allows implementation of ECMs that may have longer payback periods, but achieve other mandated sustainability goals such as water efficiency, renewable energy generation, and greenhouse gas reduction.

1. Life-Cycle Cost (LCC) Analysis

LCC analysis is an economic evaluation of a project in which all costs arising from acquiring, constructing, owning, operating, maintaining, and disposing of a project are key decision criteria. LCC analysis costs represent the sum of present values of investment costs, capital costs, installation costs, energy costs, operating costs, maintenance costs, and disposal costs over the life-time of the project, product, or ECM. LCC present values are obtained by "discounting" all project costs to the present, with the discount rate representing the time value of money over the project life cycle. Discount rates for Federal projects are frequently determined on the basis of the interest rate on U.S. Treasury securities of similar maturity to the project life cycle.

LCC analysis is used to calculate several economic performance measures for evaluation of potential projects, such as Life-Cycle Cost (LCC), Net Savings (NS), the Savings to Investment Ratio (SIR), and an adjusted internal rate of return (AIRR). 42 U.S.C. 8254 and 10 C.F.R. 436 require that agencies use LCC analysis, and the associated economic performance measures, to evaluate and prioritize potential projects. Agencies will indicate NS of implemented projects in the web-based CTS. LCC analysis is well suited to the economic evaluation of design alternatives that satisfy a required performance level but may have differing investment, operating, maintenance, or repair costs, and possibly different life spans. LCC analysis is particularly relevant to the evaluation of investments where high initial costs are traded for reduced future cost obligations.

To evaluate individual ECMs solely on the basis of cost criteria, DOE recommends using the criteria of lowest LCC or highest NS when comparing mutually-exclusive projects in terms of

level of efficiency, system selection, or for combinations of interdependent ECMs. For independent projects being considered for allocation of limited budget funding, the projects should be ranked in descending order of SIR or AIRR until the budget is exhausted. Optionally, the SIR and AIRR metrics can be used as an adjunct to LCC and Net Savings rankings, but there are drawbacks to their use and users should be cautioned about their limitations:

- SIR and AIRR may favor less-efficient ECMs.
- The results of SIR and AIRR analyses may be inconsistent with the more accurate LCC and NS results.
- SIR and AIRR should not be used to make accept/reject decisions among mutually-exclusive ECMs. Their use should be confined to ranking efficient ECMs for eventual implementation during periods of limited funding.

For more information, please see the following FEMP LCC resources:

- The "Life-Cycle Costing Manual for the Federal Energy Management Program" (NIST Handbook 135): http://www.bfrl.nist.gov/oae/publications/handbooks/135.pdf
- "Energy Price Indices and Discount Factors for Life-Cycle Cost Analysis" Annual Update: http://www1.eere.energy.gov/femp/pdfs/ashb10.pdf.
- "Guidance on Life-Cycle Cost Analysis" http://www1.eere.energy.gov/femp/pdfs/lcc_guide_05.pdf
- Building Life-Cycle Costing Program Information: http://www1.eere.energy.gov/femp/information/download_blcc.html

See case study for conducting a LCC analysis in Appendix F.

2. Bundling ECMs

Where appropriate, agencies shall consider the LCC of combinations of projects, particularly to encourage bundling of energy efficiency projects with water efficiency and renewable energy projects. That said, there are often situations in which it makes sense for a project to be comprised of a single ECM. Facility energy managers should also consider retiring inefficient equipment on an accelerated basis where replacement results in lower life-cycle costs.

FEMP recommends that ECMs be bundled in order to optimize energy-saving and/or environmental benefits from a project. Renewable energy measures and other measures that save large amounts of energy, improve energy-related infrastructure, reduce water use, or reduce greenhouse gas emissions may be bundled with other ECMs as long as the overall project is life-cycle cost effective. ECMs in a bundle should be complementary, i.e., an integral part of the project, and no single ECM should be significantly cost-ineffective. Furthermore, energy managers should take an integrated systems approach when defining the scope of a building retrofit or other energy-related project. In many cases, a decision about one ECM will directly affect the scope or type of other ECMs.

Why is it important to bundle ECMs? Less cost-effective projects can be bundled with more cost effective projects to accomplish other goals such as water reduction, introducing more renewable

generation, and lowering greenhouse gas emissions. With the issuance of Executive Order 13514, it is increasingly important to ensure renewable energy options and other GHG mitigation strategies are included in projects. The Executive Order also directs agencies to "take into consideration environmental measures as well as economic and social benefits and costs in evaluating projects and activities based on lifecycle return on investment."

3. Tailor ECM Package for Funding Source

Part of the process of packaging ECMs into projects is to consider the funding approach that is being pursued. If the agency has a central fund for capital or infrastructure improvements, the potential projects from within the agency can be ranked against each other for allocation of limited funds, as other projects are separately identified as more appropriate for alternative funding.

At times a facility may not be able to implement projects for reasons including: insufficient central funding or operating funds or projects are not attractive to ESCOs or utilities for alternative funding. In these cases, documenting the potential cost-effective projects identified by energy managers can demonstrate to an agency's chief financial officer and OMB that additional resources are necessary.

Federal agencies are encouraged to make maximum use of authorized sources of alternative or private sector funding to cost effectively meet these requirements. It is up to each facility and agency to decide the role alternative funding approaches will play in executing new projects under their specific budget environments. Direct funding and alternative funding approaches are outlined below:

a) Direct Funding

In general, direct funding includes appropriations or other funding from centralized agency funding accounts for larger capital-intensive projects or from decentralized operating budgets for smaller projects. Examples of centralized agency funding include agency infrastructure improvement funds under the American Recovery and Reinvestment Act, the Department of Defense's Energy Conservation Investment Program (ECIP), and the General Services Administration's Federal Buildings Fund. Decentralized operation and maintenance budgets administered by agency regions and sites are also important source of efficiency investment.

Agency sites should apply for centralized capital improvement funding for those projects which most closely match the selection criteria for that funding. Also, agencies should explore revolving fund arrangements supported by project savings funding streams (see Section III(C)(2) of this guidance).

b) Alternative Funding Approaches

In addition to directly funding the projects, agencies may negotiate and use alternative funding approaches to implement projects paid for from cost savings realized over time. These alternative approaches include Utility Energy Service Contracts (UESC), Energy Savings Performance Contracts (ESPC), Power Purchase Agreements (PPA), and Enhanced Use Leases (EUL). Also, if a facility has an existing relationship with a provider (such as a local utility or

energy service company (ESCO)) that might be leveraged, new projects might be considered for that type of alternative funding. Agencies are encouraged to talk to their appropriate offices about the potential for employing the alternative sources of funding for energy efficiency and water improvements at Federal facilities detailed below:

Energy Savings Performance Contracts (ESPCs)
An ESPC is a contract (such as a task order under DOE's multiple award, indefinite-delivery, indefinite-quantity (IDIQ) umbrella contract and awarded to an energy service company) that provides for the performance of services for the design, acquisition, financing, installation, testing, operation, and maintenance and repair, of an identified energy, water conservation, or renewable energy measure or series of measures, at one or more locations. Such contracts shall provide that the contractor must incur costs of implementing energy savings measures, including at least the cost (if any) incurred in making energy audits, acquiring and installing equipment, and training personnel in exchange for a predetermined share of the value of the energy savings directly resulting from implementation of such measures during the term of the contract. Payment to the contractor is contingent upon realizing a guaranteed stream of future energy and cost savings, with any savings in excess of that guaranteed by the contractor accruing to the Federal Government. Agency sites should work with DOE FEMP project facilitators and financing experts at other agencies to package potential ECMs together to make the effort attractive to energy service companies and private sector investment. More details can be found at http://www1.eere.energy.gov/femp/financing/espcs.html.

Utility Energy Service Contracts (UESCs)
A UESC is a contract between a Federal agency and a local utility providing energy, water, or sewage services, as well as provision of technical services and/or upfront project financing for energy efficiency, water conservation, and renewable energy investments, allowing Federal agencies to pay for the services from the savings generated from improvement projects over time, either on their utility bill, or through a separate agreement. Agency sites should leverage existing relationships with servicing utility to request proposals for those projects that reduce demand of the commodity it provides, especially if demand side incentives are available from the utility. Agencies can also use a GSA Utility Areawide master contract to procure utility services and to finance energy efficiency projects with guaranteed savings. More information can be found at: http://www.eere.energy.gov/femp/financing/uescs.html and http://www.gsa.gov/graphics/pbs/procuring_energy_R2H915_0Z5RDZ-i34K-pR.pdf.

Enhanced Use Leasing (EUL)
An Enhanced Use Lease is an authority by which some Federal agencies can lease underutilized real property to the public or private sector as a means of obtaining services, facilities, revenue, space, etc., that enhance their mission. Under a EUL agreement, underutilized agency land or facilities can be leased to a developer, or energy service company in exchange for a wide variety of energy improvements, including large or long-term renewable energy and cogeneration projects.

Power Purchase Agreements (PPA)
Agencies should strongly consider the use of Power Purchase Agreements, where permitted, to finance the development of renewable (or other) energy projects at their facilities. As defined by

FEMP, under a PPA, a developer installs a renewable or other energy system on agency property, pursuant to a contract that the agency will purchase the power generated by the system. The agency pays for the system through these power payments over the life of the contract. After installation, the developer owns, operates, and maintains the system for the life of the contract. By purchasing renewable power, the facility can obtain a percentage of its energy from renewable sources and meet the Federal renewable energy goal.

Incentive Programs
Most states and utilities have energy incentive programs that help offset energy costs while promoting energy efficiency and renewable energy technologies. Examples of these programs include:

Energy Efficiency and Renewable Energy Programs:

- Public purpose programs administered by utilities, state agencies, or other third parties and paid for by utility ratepayers, typically through a non-by-passable system benefits charge instituted as part of restructuring legislation or rules
- Utility programs administered by the local utility and paid for by utility ratepayers through their bundled rates
- Programs sponsored by state agencies that are designed to promote energy efficiency and renewable energy and which are usually funded out of general tax revenues.

Demand Response/Load Management Programs:
These are programs that provide incentives to curtail demand during peak energy usage periods in response to system reliability or market conditions. Agencies can participate in state and utility incentive programs in order to reduce their energy usage and control their energy costs. More details can be found at http://www1.eere.energy.gov/femp/financing/energyincentiveprograms.html

B. Solicit, Award, and Implement Projects

As projects are implemented, agencies are encouraged to follow project planning and implementation processes that maximize use of best industry standards to ensure greater chance of higher energy and water savings. Through tracking in the CTS, agencies will be able to assess the effectiveness of their projects, isolate the impact of projects on energy or water savings, and identify and overcome barriers to achieving their energy efficiency goals. Below is a brief outline of a standard project planning process that will contribute to greater persistence of energy and water savings.

1. Solicit and Award Contracts

Once the funding approach is identified for the potential ECMs, agency contracting officers issue solicitations or requests for proposals (RFPs) from interested contractors, award and manage projects, commence and complete construction. Agencies should be aware that many ESPCs and UESCs undertaken by ESCOs also require the contractor to repair and maintain the equipment during the contract term. The contract should also address appropriate levels of measurement and verification (M&V), if the contractor is responsible for these activities.

Contractors may be evaluated on a variety of performance metrics, including:

- Ability to provide and install ECM equipment or systems.
- Ability to maintain ECM equipment or systems.
- Ability to offer ongoing M&V of ECM equipment or system performance.

It is recommended that agencies solicit proposals that seek LCC effective energy and water efficiency ECMs. Incorporating LCC analysis requirements in contract requirements links procurement practices with the evaluation methodology prescribed in this Guidance (See Section IV(A)).

The contracting process can be implemented with any number of key steps as long as they comply with regulations guiding the solicitation process and the specific procurement policy of the agency. These general steps include, but are not limited to:

1. Define Requirements
2. Perform Market Research
3. Develop Acquisition Plan
4. Develop Source Selection Plan
5. Solicit Proposals
6. Receive Proposals
7. Evaluate Proposals
8. Notification of Award

2. Commissioning/Acceptance

At the end of the implementation step, the project is commissioned upon acceptance to ensure the equipment, material, and controls meet manufacturer's specifications and operate in accordance with the design specifications.

Energy managers will report in the EISA 432 CTS key status milestones for implemented projects including date of contract award, substantial completion, and project acceptance which indicates that all installed equipment or systems have been commissioned and incorporated into O&M planning.

3. O&M Plan/Life of Contract Management

As stated in 42 U.S.C. 8253(f)(5)(B), for each implemented measure, each energy manager shall ensure that "a plan for appropriate operations, maintenance, and repair of the equipment is in place at acceptance and is followed." All facilities are required to have in place an O&M plan encompassing life of contract management for implemented projects. Operations and maintenance are the decisions and actions regarding the ongoing control and upkeep of property and equipment. These are inclusive, but not limited to, the following:

1. Actions focused on scheduling, procedures, and work/systems control and optimization; and

2. Performance of routine, preventive, predictive, scheduled and unscheduled actions aimed at preventing equipment failure or decline with the goal of increasing efficiency, reliability, and safety.

The O&M plan should include: timelines, budget and cost estimate basis, work plan, staffing plan, quality assurance plan, safety and security plan, resource allocation plan, and management control plan for the system, hardware, and equipment upon the completion of the commissioning process. See an example of implementing an effective maintenance plan in Appendix H.

Continuous commissioning is an on-going, whole building approach to prevent persistent operational problems and optimize energy use in existing commercial and institutional buildings and physical plants. Throughout the life cycle of the project, continuous commissioning accomplishes the following:

- Identifies maintenance issues,
- Corrects identified operating problems,
- Improves building thermal comfort and indoor air quality,
- Minimizes building energy consumption and cost, and
- Provides knowledge-based and hands-on operations and maintenance training to in-house facility management staff.

Other aspects of project management that help to maximize the value of energy efficiency projects should also be undertaken: managing the behavior of facility occupants and choosing the right energy management system. Behavior change as it affects energy efficiency is a change in energy-consuming activity originated and controlled by a person or a group of people within an organization. An example of behavioral change is adjusting a thermostat setting, or changing appliance use habits. Behavior change by facility occupants can contribute significantly to either the success or failure of an energy efficiency project. A case study of behavior change can be found in Appendix I.

The quantity of data needed for meeting compliance requirements and maximizing the value created through energy and water efficiency means there is increasing demand on facilities management software. The number of systems and meters, personnel, facilities, maintenance, and changes in use and schedules increase the complexity of managing facilities and data effectively. Energy Management Control Systems (EMCS) integrate traditional facilities management functions, while Integrated Workplace Management Systems (IWMS) offer cross-functional platforms to manage data for all corporate assets, including facilities, production and distribution equipment and transportation systems. Advances in EMCS and IWMS can assist the energy facilities manager in effectively collecting and reporting critical facility information and maximizing the value of the energy efficiency.

C. Project Follow-Up/Measurement and Verification

It is recommended that project follow-up activities be accomplished during the next scheduled comprehensive evaluation of the facility, as these activities relate closely to the re-commissioning component of the every-four-year evaluation. The key reasons for the follow-up step include ensuring that the project performs in accordance with equipment and system specifications and

agency and occupant needs, measuring project savings, justifying future project investment, and replicating savings efforts throughout the agency. EISA-required project follow-up activities can be performed by in-house staff or can be included in project or maintenance contracts.

1. Measurement and Verification (M&V)

Project follow-up comprises an appropriate level of measurement and verification (M&V) to determine the energy savings derived from completed ECMs. Standardized M&V procedures exist that address factors that can affect baseline conditions so that valid before-and-after energy use comparisons can still be made. Three factors could affect a project's energy savings once it is up and running:

(1) Changes in baseline conditions,
(2) Changes in equipment performance, and
(3) Changes in conditions outside the control of the energy manager (such as the weather or mission tempo).

Appropriate levels of M&V procedures are described below that can be used to determine energy savings for ECMs implemented and for reporting *actual* project savings into the CTS system as part of the follow-up activities required under the statute. Actual project savings can then be compared to the *estimated* projects savings previously reported. More details on appropriate M&V procedures for particular project types can be found in **"M&V Guidelines: Measurement and Verification for Federal Energy Projects Version 3.0"** located at http://www1.eere.energy.gov/femp/pdfs/mv_guidelines.pdf.

Three broad M&V options—conventionally referred to as Options A, B, and C—can be used individually, or in combination, to determine the savings realized from any ECM, regardless of the complexity of its energy saving mechanisms. (A fourth option, Option D, Calibrated Computer Simulation is used to model energy performance of a whole-facility is not frequently used due to cost, but details of this option are included in the guidelines mentioned above.) All three main options are based, in part, on the ECM's "potential to perform," and verification begins by determining whether the ECM is performing as expected. For example, if high-efficiency lighting is installed in a building, the installer guarantees the fixtures will perform to the levels specified by the manufacturer. A monitoring program would then be used to verify that the lights are indeed performing as guaranteed.

M&V options are divided into two general types: retrofit isolation and whole-facility analyses. Retrofit isolation methods look only at the affected equipment or system independent of the rest of the facility; whole-facility methods consider the total energy use and de-emphasize specific equipment performance. Options A and B are retrofit isolation methods; Option C is a whole-facility method. Each option has advantages and disadvantages based on site-specific factors and the needs and expectations of the agency. They are briefly described below:

a) Option A, Retrofit Isolation with Key Parameter Measurement

Option A is based on a combination of measured and estimated factors when variations in factors are not expected. Measurements are spot or short-term and are taken at the component or system

level, both in the baseline and post-installation cases. Measurements should include the key performance parameter(s) which define the energy use of the ECM. Estimated factors are supported by historical or manufacturer's data. Savings are determined by means of engineering calculations of baseline and post-installation energy use based on measured and estimated values. Option A does not involve long-term measurements, but regularly scheduled inspections and short-term metering or spot measurements will likely be conducted to ensure the performance goals are being met. In general, Option A techniques are useful when an energy-efficiency project has resulted in a finite change in system performance. For example, performance of end-use-based ECMs such as lighting efficiency and fully loaded motors can be verified using Option A techniques. Savings are determined by means of engineering calculations of baseline and post-installation energy use based on measured and estimated values.

b) Option B, Retrofit Isolation with All Parameter Measurement

Option B verifies the same items as Option A, but also verifies actual achieved energy savings during the term of the contract using long-term or permanently installed metering/monitoring systems. Option B would be applied, for example, to verify the performance of ECMs for isolated components or systems whose energy use is affected by external variables such as weather patterns or inconsistent operating schedules or changes in occupant behavior. Depending on the operating environment, ECMs such as variable-speed drives and chillers would be potential candidates for Option B verification techniques. Essentially, Option B entails long-term periodic measurements for capturing substantial operating variations in isolated components or systems that cannot be accurately assessed using the engineering and spot-metering techniques stipulated in Option A. Savings are determined from analysis of baseline and reporting period energy use or proxies of energy use.

c) Option C, Utility Data Analysis

Option C determines energy savings at the whole building level and is applied to projects in which the effect of the ECMs cannot be accurately assessed by measuring the before-and-after energy use of an isolated component or system. Option C is used, for example, when the ECMs installed interact extensively with each other, making the performance of a single ECM extremely difficult to quantify. Option C verification techniques involve whole building metering using hourly performance data or utility billing data. Savings are determined from analysis of baseline and reporting period energy data. Typically, regression analysis is conducted to correlate with and adjust energy use to independent variables such as weather, but simple comparisons may also be used.

2. Retention of Savings

Measurement and verification of project savings have an additional benefit, in that certain agencies may retain verified savings from implemented projects to fund additional unfunded ECMs identified during facility evaluation, resuming the cycle of facility efficiency improvement. Section 546(e) of the National Energy Conservation Policy Act (NECPA) as amended by the Energy Policy Act of 2005 Section 102(f), states:

> RETENTION OF ENERGY AND WATER SAVINGS.--An agency may retain any funds appropriated to that agency for energy expenditures, water expenditures, or wastewater treatment expenditures, at buildings subject to the requirements of section 543(a) and (b), that are not made because of energy savings or water savings. Except as otherwise provided by law, such funds may be used only for energy efficiency, water conservation, or unconventional and renewable energy resources projects. Such projects shall be subject to the requirements of section 3307 of title 40, United States Code.
> (42 U.S.C. § 8256(e))

As noted in the reprint of the statute above, an agency may retain unexpended appropriated funds intended for payment of energy and water costs at buildings subject to the energy performance requirements for Federal buildings of NECPA section 543 (42 U.S.C. § 8253). This is the requirement for agencies to reduce energy use per gross square foot by 30 percent in fiscal year 2015 compared to the fiscal year 2003 base year.

Agencies must document the energy and water savings realized from energy efficiency and water conservation projects in accordance with FEMP's **"M&V Guidelines: Measurement and Verification for Federal Energy Projects Version 3.0"** located at http://www1.eere.energy.gov/femp/pdfs/mv_guidelines.pdf . The M&V Guidelines provide Federal energy managers, procurement officials, and energy service providers with standard procedures and guidelines for quantifying savings. Types of Federal projects included cover areas such as energy efficiency and water conservation measures, construction, improved operation and maintenance, cogeneration, and renewable energy.

Agencies are encouraged to consult with their appropriate legal and financial offices to determine the extent to which they may rely on the retention of savings provision.

V. ROLE OF THE EISA 432 COMPLIANCE TRACKING SYSTEM (CTS)

42 U.S.C. 8253(f)(7)(A) specifies that facility energy managers shall certify compliance for each covered facility with the 42 U.S.C. 8253(f)(2)-(5) requirements via a web-based tracking system. The EISA 432 CTS is being developed for the collection and reporting of data needed for the demonstration of compliance and progress toward meeting all energy and water efficiency requirements outlined in the statute. A suite of reports, available from within CTS, convey compliance and progress metrics for the following key areas:

Requirement of EISA 432	Compliance Metrics
Covered Facility Compliance	**Identify Covered Facilities:** Each agency shall identify Covered Facilities that constitute at least 75% of the total facility energy use of each agency. The term "facility" means any building, installation, structure, or other property (including any applicable fixtures) owned or operated by, or constructed or manufactured and leased to, the Federal Government. May include a group of facilities at a single location or multiple locations managed as an integrated operation; and contractor-operated facilities owned by the Federal Government.
Designation of Covered Facility Energy Manager	**Assign Energy Manager:** Each Federal agency shall designate an energy manager responsible for implementing 42 U.S.C. 8253(f) and reducing energy use at each covered facility.
Energy and Water Evaluation Progress	**Evaluate Covered Facilities:** A comprehensive energy and water evaluation must be completed for each facility at least once every 4 years. Approximately 25% of the Covered Facilities of each agency shall be evaluated each year. Progress will be measured at the agency-level by: number of facilities evaluated; square footage evaluated; or by energy use of evaluated facilities. During the initial 4 year period, progress reports will indicate: • Annual progress - should normally be around 25%; • Cumulative progress – will approach 100% by the end of the first 4 years. **Note:** Cumulative progress may not reach 100% if facilities were added to the inventory during the 4 year period. After the initial 4 years, other metrics will indicate progress: • Again, annual progress should be near 25% each year; • Additional metrics will indicate the % of facilities remaining in compliance (i.e. facilities evaluated within 4 years)

Requirement of EISA 432	Compliance Metrics
Implementation of Efficiency Projects	**Implement Projects:** Each energy manager may implement any energy- or water-saving measure that the Federal agency identified in the evaluation conducted that is life cycle cost-effective; and bundle individual measures of varying paybacks together into combined projects. Project progress metrics include the number of projects awarded per agency, the level of project investment level, the number of projects followed-up on, and the estimated vs. documented energy and water savings.
Follow-up (M&V) of Implemented Projects	**Follow-up of Projects:** For each measure implemented, each energy manager shall ensure that equipment, including building and equipment controls, is fully commissioned at acceptance to be operating at design specifications; develop a plan for appropriate operations, maintenance, and repair of the equipment is in place at acceptance and is followed; measure equipment and system performance during its entire life to ensure proper operations, maintenance, and repair; and measure and verify energy and water savings.
Benchmarking Progress Metrics	**Benchmark Buildings.** The energy manager shall enter energy use data for each metered building that is (or is a part of) a facility into a building energy use benchmarking system, such as the Energy Star Portfolio Manager. The percentage of agency covered facility square footage metered and benchmarked will be tracked by the system.

The EISA 432 CTS was initially deployed for agency use on July 19, 2010 with initial core functionality focusing on:

- registration of users;
- covered facility characteristics;
- energy manager assignments;
- evaluation findings;
- estimated energy, water and cost savings generated by the potential efficiency measures identified.

Functionality currently in development includes:

- expanded dashboard reports of compliance and progress performance metrics;
- a module for reporting on implemented efficiency projects;
- capability for recording data from follow-up measurement and verification reports of project savings; and
- linkage to Energy Star Portfolio Manager for retrieval of benchmarking data for metered buildings.

Pursuant to additional funding available to FEMP, proposed enhancements may include:

- automated data upload: import data captured in existing agency data systems into CTS via xml web services or xml import;
- calculation of GHG emission avoidance from implemented project energy savings.

System Design. The CTS is designed to manage the process of registration of users in the system, entering and managing data, and generating summary and progress reports. A complete User Guide for CTS will be available which includes detailed data entry instruction as well as descriptions of the reports which can be generated from the system.

A brief outline of the core functions of the system follows:

1. System Access and User Management. Full user administration is included within the CTS framework. Users are assigned to agencies, sub-agencies and facilities and specific access rights are controlled by the user's role and organizational affiliation. The primary roles are: the Agency Energy Coordinator (AEC) and delegates; and the Facility Energy Manager (FEM) and delegate. Users with the appropriate rights per role may manage user rights, assign, and approve new users within their organizational boundaries.

2. Agency Dashboard . An agency specific home page provides general CTS system information, user notifications, as well as graphical representations of the agency's compliance progress. Access to all system functionality as well as to pertinent guidance documentation is provided from this screen.

3. User Profile. System Users may manage their own personal information and login credentials within the User Profile module.

4. Data Download. All data which has been entered into the system may be downloaded (by authorized users) to excel spreadsheets and filtered by parameters such as sub-agency and reporting year.

5. Reports. Extensive reporting capability is available from within CTS. The reports fall into two general categories:

    1) Data summary reports: Various views of detailed agency data may be extracted from the application. Data can be viewed at the facility level or aggregated at the agency/ sub-agency level.
    2) Compliance progress reports: Demonstration of compliance and progress toward meeting the statutory requirements is expressed through various metrics. Depending on the specific metric, the report may be available at the facility, or agency level. For example, reports indicate the designation of the Facility Energy Manager at the facility level, as well as the overall percentage of facilities with designated managers for the agency overall.

    Access to reports and to various reporting capabilities and filters is constrained by the user's role and agency affiliation. See Appendix A for a detailed listing of reports.

6. Covered Facilities. Covered facility characteristic data (name, location) as well as annual energy data may be entered and edited within the Covered Facility module. Facilities are listed by sub-agency and can be filtered by Facility Energy Manager. Facility Energy Manager assignments can be made within this module by users with the appropriate access rights. Individual buildings within a larger covered facility may be listed individually for the purpose of capturing benchmark data of metered buildings.

7. Evaluations. Key findings from comprehensive evaluations may be entered and edited in CTS. Evaluation data is saved by reporting year and accessed from within the Covered Facility module.

8. Implementation of Projects. Data related to Implemented Projects is also accessed from within the Covered Facility module. The project status, investment, funding sources, bundled ECMs and estimated savings are all tracked within this module.

9. Follow-up of Projects. Measurement and Verification reports are also part of the individual facility's implemented project data record. Measured savings data may be entered and compared year by year.

10. Benchmarking. Building performance benchmarking data fields align with those stored at sites such as Energy Star's Portfolio Manager will be captured for metered buildings. Annual summary data will be collected and stored with the facility record at the building level.

11. Administration. Based on user role and organizational boundaries, users may have access to various administration functions including:
    1) Agency level data management
    2) Bulk Facility Energy Manager assignment
    3) User administration and approval

Public Disclosure and Transparency

Per 42 U.S.C. 8253(f)(7)(A), each agency should delegate responsibility to the facility energy managers for entering or uploading facility-level data into CTS, unless it is more efficient to accomplish this at another appropriate level within the organization. The CTS produces reports that can be viewed by designated users of the system within the agency as determined by that agency's energy coordinator. Detailed data and reports may be shared with other sub-agencies to encourage competition and provide opportunities to discover lessons learned and best practices.

The statute states that DOE must make the web-based tracking system available to Congress, other Federal agencies, and the public through the Internet. (42 USC 8253(f)(7)(C)(i)) CTS will provide data at the Federal agency level, facility-level, and sub-agency level (for some agencies). Each agency's data aggregated at the top-tier of its organization will be publically available to demonstrate Government and agency progress in meeting the requirements for facility evaluation, project implementation and follow-up, benchmarking and compliance with covered facility inventory requirements and energy manager assignments. Sub-agency aggregated data may also be made available to the general public, at the discretion of the top-tier agency or Department.

In general, complete facility-level detailed data will be publicly available within agency-defined organizational boundaries by default for the most recent and prior years. Facility energy managers and agency energy coordinators associated with a specific agency will have access to, and editing rights to, facility-level reports and facility-level detailed data. Facility-level data will be made available to the general public for review via facility-level reports unless the Secretary of Energy grants an exemption from public disclosure for national security purposes.

Agencies may request that specific data from individual buildings and/or entire facilities not be made public if public disclosure would raise national security concerns. (42 USC 8253(f)(7)(C)(ii)) Agencies should submit requests to exempt data for specific covered facilities from public disclosure to the Secretary of Energy within 90 days of the release of this Guidance. Requests should identify each covered facility for which the exemption is sought, the specific data sought to be withheld, and the reason public disclosure would affect national security. Although facility-level data that is exempt from public disclosure will not be disclosed, this data may still be included in top-tier agency totals. If, in the future, there is a need to apply the exemption to a facility because building stock/functions change, requests to withhold data from public disclosure must be submitted to the Secretary of Energy 90 days in advance of the CTS posting deadline. Changes to the exemption status of specific data for specific buildings must be submitted to the Secretary of Energy 90 days in advance of the CTS posting deadline.

Data on potential ECMs identified in comprehensive evaluations will be disclosed in the aggregate for each facility, and the agency, but not at the individual ECM level. In public reports, the findings from evaluations will be clearly characterized as the upper bound of potential investment and savings as not all identified ECMs may be cost effective or in the interest of the agency to implement.

Estimated cost and savings of implemented projects will be disclosed in the aggregate for each facility, and the agency, but not at the individual project or ECM level. Measured cost and savings of implemented projects will also only be disclosed in the aggregate for each facility, and the agency. If the associated data is exempt from disclosure for national security purposes, then relevant facility-level project data will not be disclosed, although the data will be included in agency totals.

Benchmarking data for individually-metered buildings follow same exemption process as covered facilities.

The CTS reports assist in providing increased transparency for determining which agencies and projects are getting the best results. Greater transparency, through the provision of various data sets and reports for viewing by internal energy and facilities managers, other agency energy and facility managers, DOE, OMB, and the general public is meant to accelerate continuous improvement of efficiency measures, adoption of best practices, demonstration and achievement of savings, and optimization of energy and water efficiency measures.

Details for required CTS data fields and reports are in Appendix A: EISA Section 432 CTS Data Elements and Reports.

Appendix A: EISA Section 432 CTS Data Elements and Reports

This appendix is divided into two main sections: CTS Data Elements and CTS Reports.

CTS Data Elements

Field Name	Description	Data Type/ Validation	Required/ Optional
Covered Facility - Data Fields			
Facility Name	The Covered Facility name	Text: (75 char max)	Required
Facility Key	The CTS assigned unique facility identifier	System Generated	Required
Agency Facility #	Agency assigned internal facility identifier	Text: (50 char max)	Optional
City	City where Covered Facility is located.	Text: (50 char max)	Required
State	State where Covered Facility is located.	Text: (50 char max)	Required
Zip Code	The Zip Code where the Covered Facility is located.	Text: (50 char max) Formats: XXXXX (5 digit) XXXXX-xxxx (5 digit zip code, a hyphen, and the 4 digit extension) XXXXXXXXX (5 digit zip code, no hyphen, and the 4 digit extension)	Required
Agency Name	The Agency (sub-agency) to which the facility belongs	List Selection	Required
Gross Square Footage	Gross area of Covered Facility (fiscal year)	Numeric: (thousand sq ft)	Required
Total Annual Energy Use	Total Annual Energy Use of Covered Facility (fiscal year)	Numeric: (million btu)	Required
Total Annual Water Use	Total Annual Water Use for Covered Facility (fiscal year)	Numeric: (thousand gallons)	Required
Energy Intensity Reduction goal Exemption	Is this facility data exempt from the Energy Intensity Reduction Goal	Checkbox: (Y/N)	Optional
Water Intensity Goal Exemption	Is this facility data exempt from the Water Intensity Reduction Goal	Checkbox: (Y/N)	Optional
Public Disclosure Exemption	Is this facility data exempt from public disclosure?	Checkbox: (Y/N)	Optional
Reason for Public Disclosure Exemption	Describe reason for the public disclosure exemption indicated above	Text: (250 char max)	Optional
Comments	Include comment relating to any annual facility data field	Text: (1000 char max)	Optional
Facility Energy Manager Information			
Facility Energy Manager ID	Unique identifier of the energy manager assigned to the covered facility during the current reporting period (Used to determine FEM assignment compliance to statute)	Text: (50 char max)	Optional for CTS system

Field Name	Description	Data Type/ Validation	Required/ Optional
FEM Last Name	Text: (50 char max)	Text: (50 char max)	Optional if managed by agency
FEM First Name	First Name of Facility Energy Manager	Text: (50 char max)	Optional if managed by agency
FEM Email Address	Email Address of Facility Energy manager	Text: (75 char max)	Optional if managed by agency

Field Name	Description	Data Type/ Validation	Required/ Optional
Covered Facility Evaluation - Data Fields			
Evaluation Name	Descriptive name of this evaluation (included facility name and reporting year)	Text: (100 char max)	Required
Evaluation Date	Report Date of this evaluation	Date	Required
Evaluation Data Year	Reporting year that this evaluation was completed	Year (4 digit)	Required
Year Entire Facility Completed Evaluation	The most recent reporting year that an entire facility completed evaluation	Year (4 digit)	Optional
Gross Square Footage Evaluated	The square footage of the facility area evaluated (may include areas deemed not appropriate for detailed energy audit – ie. "desk audits")	Numeric (thousand sq ft)	Required
Estimated Implementation Cost	The estimated cost for implementing all of the efficiency measures identified in this reporting year's evaluation	Numeric : (monetary)	Required
Estimated Annual Energy Savings	The estimated site-delivered Btu *annual* energy savings expected from all identified energy efficiency measures for this reporting year's evaluation	Numeric (million btu)	Required
Estimated Annual Energy Cost Savings	The estimated *annual* energy cost savings expected from all identified energy efficiency measures	Numeric: (monetary)	Required
Estimated Annual Water Savings	The estimated *annual* water savings expected from all identified water use and disposal (sewer) efficiency measures	Numeric (thousand gallons)	Required
Estimated Annual Water Cost Savings	The estimated *annual* water cost savings expected from all identified water use and disposal (sewer) efficiency measures	Numeric: (monetary)	Required
Other Annual Ancillary Cost Savings	The estimated *annual* other ancillary cost savings expected from all identified efficiency measures. These may include savings due to reduced maintenance, operational costs, repairs, etc.	Numeric: (monetary)	Optional
Estimated Life-Cycle Energy Savings	The estimated site-delivered Btu energy savings expected from all identified energy efficiency measures over the collective life spans of the measures.	Numeric (million btu)	Optional
Estimated Life-Cycle Energy Cost Savings	The estimated energy cost savings expected from all identified energy efficiency measures over the collective life	Numeric: (monetary)	Optional

Field Name	Description	Data Type/ Validation	Required/ Optional
	spans of the measures.		
Estimated Life-Cycle Water Savings	The estimated water savings expected from all identified water use and disposal (sewer) efficiency measures over the collective life spans of the measures.	Numeric (thousand gallons)	Optional
Estimated Life-Cycle Water Cost Savings	The estimated water cost savings expected from all identified water use and disposal (sewer) efficiency measures over the collective life spans of the measures.	Numeric: (monetary)	Optional
Estimated Life-Cycle Other Ancillary Cost Saving	The estimated other ancillary cost savings expected from all identified efficiency measures over the collective life spans of the measures. These may include savings due to reduced maintenance, operational costs, repairs, etc.	Numeric: (monetary)	Optional
Retro/Re-Commissioning Assessment	Indicate if an assessment of retro- or re-commissioning measures was completed as part of the comprehensive evaluation	Selection: Values: Y,N,NA	Required
Potential ECMs Identified	Number of potential Energy Conservation measures identified by the current evaluation (by ECM type)	Numeric: (integer per each ECM type) (20 categories)	Required if savings were indicated
Comments	Add any comments related to any evaluation data field	Text: (2000 char max)	Optional

Field Name	Description	Data Type/ Validation	Required/ Optional
Implemented Project – Data Fields			
Project Name	The Project Name	Text: (50 char max)	Required
Agency Designated Project ID	Internal Agency identifier	Text: (50 char max)	Optional
Project Status	Current Project Status expressed as date fields of specific project milestones: • Project Initiation (contract award) • Project Implementation (substantial completion) • Project Acceptance (fully commissioned) • O & M Plan (in place)	Date field(s)	Some dates optional based on project progress
Funding Source	Funding Source Type: • Direct (ARRA) • Direct (Centralized Capital Funding) • Decentralized Operating Budgets • Utility Energy Service Contract (UESC) • Energy Savings Performance contract (ESPC) • Power Purchase Agreement (PPA) • Enhanced Use Lease (EUL) • Incentive Program	Select List: Allow multiple sets of Funding Source/ Funding Level	Required

Field Name	Description	Data Type/ Validation	Required/ Optional
	• Other		
Funding Level	$ value associated with funding source	Numeric: (monetary)	Required for each funding source type selected
Total Project Implementation Cost	*Calculated field:* Total Project Implementation Cost by Funding Source. Does not include financing and interest payments	system calculated total of funding levels above (monetary)	Required
Financing Costs	Total financing from all funding sources	Numeric: (monetary)	Required (if applicable)
Total Awarded Contract Value	*Calculated field:* Total Project Implementation Costs + Total Financing Costs for all sources	system calculated total (monetary)	Required
Estimated LCC Net Savings	Measure of cost effectiveness used to validate this project. Value in $ entered directly	Numeric: (monetary)	Required
Life of Project	Estimated life of project in years	Integer	Optional
Estimated Annual Energy Savings	Estimated Gross Site Savings (entered directly in million btu) **OR** Converted from fuel savings to million BTU. • Electricity Savings (kwh) • Natural Gas Savings (thou cu ft) • Coal - Anthracite (short tons) • Coal - Bituminous (short tons) • Coal - Coke(short tons) • Distillate Fuel Oil #1 (gallons) • Distillate Fuel Oil #2 (gallons) • Distillate Fuel Oil #4 (gallons) • Residual Fuel Oil #5 (gallons) • Residual Fuel Oil #6 (gallons) • Propane (gallons) • Liquid Propane (gallons) • Purchased Steam (Thou. Lbs) • Chilled Water - Electric Driven (ton hours) • Chilled Water - Absorption (ton hours) • Chilled Water – Engine Driven (ton hours) • Kerosene (gallons) • Diesel (gallons) • Other	Numeric: (million btu)	Required
Estimated Annual Water Savings	Estimated Annual Water Savings	Numeric: (gallons)	Required (if applicable)
Estimated Renewable Savings (Electricity)	Estimated Annual Renewable Electricity Output	Numeric: (kwh)	Required (if applicable)
Estimated Renewable Savings (Thermal)	Estimated Annual Renewable Thermal Output	Numeric: (million btu)	Required (if applicable)

Field Name	Description	Data Type/ Validation	Required/ Optional
Energy Conservation Measures Implemented	List of Energy Conservation Measures implemented within this project grouped by Technology Category; # of ECMs bundled is indicated.	Select list: Allow selection of multiple Technology Categories and ECMs. (choose at least 1 of 20 categories)	Required
Project Note	Text field for capturing any notes related to this implemented project	Text: (2000 char max)	Optional

Field Name	Description	Data Type/ Validation	Required/ Optional
Project Follow-up Measurement and Verification – Data Fields			
M&V Report Date	Indicate date of this M & V report	Date	Required
M & V Methodology	Identify the M & V Methodology used: • Option A: Key Parameter monitoring (short term metering/ spot measurements of key parameter) • Option B: All Parameter monitoring (long term monitoring of all parameters normalizing for weather occupancy etc.) • Option C: Whole Building monitoring • Option D: Calibrated Computer Simulation	Select list: select one	Required
Measured Annual Energy Savings	Measured Gross Site Savings (entered directly in million btu) **OR** Converted from fuel savings to million BTU. • Electricity Savings (kwh) • Natural Gas Savings (thou cu ft) • Coal - Anthracite (short tons) • Coal - Bituminous (short tons) • Coal - Coke(short tons) • Distillate Fuel Oil #1 (gallons) • Distillate Fuel Oil #2 (gallons) • Distillate Fuel Oil #4 (gallons) • Residual Fuel Oil #5 (gallons) • Residual Fuel Oil #6 (gallons) • Propane (gallons) • Liquid Propane (gallons) • Purchased Steam (Thou. Lbs) • Chilled Water - Electric Driven (ton hours) • Chilled Water - Absorption (ton hours) • Chilled Water – Engine Driven (ton hours) • Kerosene (gallons) • Diesel (gallons) • Other	Numeric: (million btu)	Required
Measured Annual	Measured Annual Water Savings	Numeric: (gallons)	Required (if

Field Name	Description	Data Type/ Validation	Required/ Optional
Water Savings			applicable)
Measured Renewable Savings (Electricity)	Measured Annual Renewable Electricity Output (Solar PV, Wind, etc.)	Numeric: (kwh)	Required (if applicable)
Measured Renewable Savings (Thermal)	Measured Annual Renewable Thermal Output (Geothermal, Active/Passive Solar Biomass, etc)	Numeric: (million btu)	Required (if applicable)

Field Name	Description	Data Type/ Validation	Required/ Optional
Benchmarking of Metered Buildings - (Proposed) Data Fields			
Building Name	Building identifier/ name	Text (100 char max)	Required
Real Property Profile Identifier	Real Property Unique Identifier	Text (50 char max)	Required
Building Type	Current Energy Star Portfolio Manager building types: • Bank/Financial Institution • Courthouse • Data Center • Hospital (acute care and children's) • Hotel • House of Worship • K-12 School • Medical Office • Municipal Wastewater Treatment Plant • Office • Residence Hall/Dormitory • Retail Store • Supermarket • Warehouse (refrigerated and non-refrigerated) • Other	Selection List:	Required
Building Location	City State Zip Code (other regional identifier)	Text (50 char max) each	Required
Building Total Floor Space	Building Area benchmarked	Numeric: (thousand sq ft)	Required
Benchmark Date	Date of annual benchmark summary	Date	Required
Benchmarking Comments	Notes for annual benchmarking report	Text (2000 char max)	Optional
Annual Energy Use (site)	Annual Energy Use in terms of site-delivered BTU	Numeric: (million btu)	Required
Annual Energy Use (source)	Annual Energy Use in terms of source BTU	Numeric: (million btu)	Required
Annual Energy Intensity (site)	*Calculated field:* Annual site-delivered energy intensity	Numeric: (btu/sq ft) System calculated	Required
Annual Energy Intensity (source)	*Calculated field:* Annual source energy intensity	Numeric: (btu/sq ft) System calculated	Required

Field Name	Description	Data Type/ Validation	Required/ Optional
Benchmarking of Metered Buildings - (Proposed) Data Fields			
Annual Weather-normalized Energy Intensity (site)	Annual weather-normalized site-delivered energy intensity	Numeric: (btu/sq ft)	Required
Annual Weather-normalized Energy Intensity (source)	Annual weather-normalized source energy intensity	Numeric: (btu/sq ft)	Required
Energy Star Rating	Energy Star rating (if applicable building type)	Integer: (1-100)	If applicable
Annual Water Consumption	Annual Potable Water Use	Numeric: (thousand gallons)	Optional
Annual Water Intensity	*Calculated field:* Annual Water Intensity	Numeric: (gallons/sq ft)	Optional
GHG Emissions	Equivalent CO2 emissions of source energy usage	Numeric: (metric tonnes of CO2 e)	Optional
Guiding Principles	Completion of Sustainability Guiding Principles	Selection: (Y/N)	Optional

CTS Reports

Report	Metrics
Government Level	
Government Wide EISA s432 Compliance Report (annual)	Total Number of Agencies
	Total Facility Energy Use for All Agencies (Billion BTU)
	Total Covered Facility Energy Use for All Agencies (Billion BTU)
	% of Covered Facility Energy Use
	Total Number of Covered Facilities
	Total Number and Percentage of Covered Facilities with Designated Energy Manager
	Agencies Meeting the Covered Facility Threshold (number and percentage)
	Agencies with Energy Managers at each Covered Facility (number and percentage)
	Total Number and Percentage of Covered Facilities with Designated Energy Manager
	Total Potential Energy Savings (Billion BTU)
	Total Potential Water Savings (Billion BTU)
	Total Potential Cost Savings (Million Dollars)
	Total Estimated Cost of Implementation
	Covered Facility Evaluation Progress (number and percentage)

Report	Metrics
Agency Level	
Agency Compliance Report	Total # of Covered Facilities
	Total Number and Percentage of Covered Facilities with Designated Energy Manager
	Total Facility Energy Use (Billion BTU)
	Total Covered Facility Energy Use (Billion BTU)
	% of Covered Facility Energy Use
Compliance Progress Report	% of Total Facility Energy Use Comprised By Covered Facility
	% of Covered Facilities With Designated FEM
	% of Covered Facility that have completed Evaluations (by # Facilities; by Square Footage; by Covered Facility Energy Use)
Covered Facility Evaluation Progress Report (Annual and Cumulative)	Number of Covered Facilities Completely Evaluated
	Covered Facility Gross Area Evaluated (Thousand SQ FT)
	Covered Facility Energy Use of Completely Evaluated Facilities (Million BTU)
Covered Facility Evaluation Progress (Annual and Cumulative Reports)	Covered Facilities Evaluation Progress Percent of Total Facilities
	Covered Facilities Evaluation Progress Percent of Square Footage
	Covered Facilities Evaluation Progress Percent Energy Use
Agency/ Sub-Agency Evaluation Detail Report	Covered Facilities Completed Evaluations (Percentage)
	Covered Facility Gross Area (Thousand SQ FT)
	Covered Facility Energy Use (Million BTU)
	Gross Area Evaluated (Thousand SQ FT)
	Annual Energy Use of Completely Evaluated Facilities (Million BTU)
	Estimated Implementation Cost (Dollars)
	Estimated Annual Energy Savings (Million BTU)
	Estimated Annual Water Savings (Million Gallons)
	All Detail Evaluation Data Aggregated at Agency/ Sub-Agency Level

Report	Metrics
Facility Level	
Facility Evaluation Progress Report	Total Gross Facility Area (Thousand SQ FT)
	Total Annual Covered Facility Energy Use (Billions BTU)
	Completely Evaluated (Y/N)
	Gross Area Evaluated (Thousand SQ FT)
	Progress of Evaluation by Sq Ft.(Percentage)
	Evaluated Energy Use (Million BTU)
Facility Evaluation Detail Report	All Detail Evaluation Data
Facility Energy Manager Report	Agency/Facility Name
	FEM Unique ID
	First Name, Last Name
	Email
	Covered Facilities with FEM Assigned (Y/N)
Facility Location Info Report	Agency / Facility Name
	Facility Key
	Facility Number
	Facility State
	Facility Zip
	Energy Conservation Measures Implemented

Report	Metrics
Facility Level (Proposed)	
Project Implementation: Funded Projects by Facility	Project Name
	Project Status (Milestones)
	Funding Source
	Funding Level (Dollar)
	Total Project Implementation Cost (Dollar)
	Financing Costs (Dollar)
	Total Awarded Contract Value (Dollar)
	Estimated LCC Net Savings
Agency Level (Proposed)	
Project Implementation: Funded Projects by Agency	Project Status (Milestones)
	Funding Source
	Funding Level (Dollar)
	Total Project Implementation Cost (Dollar)
	Financing Costs (Dollar)
	Total Awarded Contract Value (Dollar)
Completed Projects by Agency	Total Project Implementation Cost
	Financing Costs
	Total Awarded Contract Value
	Estimated LCC Net Savings
	Savings To Investment Ratio (calculated)
	Life of Project
	Estimated Annual Energy Savings
	Estimated Annual Water Savings
	Estimated Renewable Savings (Electricity)
	Estimated Renewable Savings (Thermal)
	Energy Conservation Measures Implemented

Report	Metrics
Facility Level (Proposed)	
Follow-up: M&V Report by Facility	M&V Report Date
	M & V Methodology
	Annual Energy Savings (Million BTU
	Annual Water Savings (Million Gallon)
	Renewable Savings (Electricity)
	Renewable Savings (Thermal)
	Estimated vs. Measured Savings
Agency Level (Proposed)	
Follow-up: M&V Report by Agency	Annual Energy Savings (Million BTU
	Annual Water Savings (Million Gallon)
	Renewable Savings (Electricity)
	Renewable Savings (Thermal)

	Estimated vs. Measured Savings

Report	Metrics
Facility Level (Proposed)	
Benchmarking Report by Facility	Building Identifier
	Building Type
	Building Location
	Building GSF
	Annual Energy Use (site)
	Annual Energy Use (source)
	Annual Energy Intensity (site)
	Annual Energy Intensity (source)
	Energy Star Rating
	Annual Site Energy Use Intensity (BTU/GSF/year)
	Annual Source Energy Consumption for preceding 12 months (BTU)
	Annual Source Energy Use Intensity (BTU/GSF/year)
Agency Level (Proposed)	
Benchmarking Report by Agency	Total Building Benchmarked GSF
	% Buildings Metered and Benchmarked
	Annual Energy Use (site)
	Annual Energy Use (source)
	Annual Energy Intensity (site)
	Annual Energy Intensity (source)

Appendix B: Section 432 of the Energy Independence and Security Act of 2007 (EISA)

SEC. 432. MANAGEMENT OF ENERGY AND WATER EFFICIENCY IN FEDERAL BUILDINGS.

Section 543 of the National Energy Conservation Policy Act (42 U.S.C. 8253) is amended by adding at the end the following:

``(f) *Use of Energy and Water Efficiency Measures in Federal Buildings*.--

``(1) **DEFINITIONS**.--In this subsection:

``(A) **COMMISSIONING**.--The term `commissioning', with respect to a facility, means a systematic process--

``(i) of ensuring, using appropriate verification and documentation, during the period beginning on the initial day of the design phase of the facility and ending not earlier than 1 year after the date of completion of construction of the facility, that all facility systems perform interactively in accordance with--

``(I) the design documentation and intent of the facility; and

``(II) the operational needs of the owner of the facility, including preparation of operation personnel; and

``(ii) the primary goal of which is to ensure fully functional systems that can be properly operated and maintained during the useful life of the facility.

``(B) **ENERGY MANAGER**.--

``(i) **IN GENERAL**.--The term `energy manager', with respect to a facility, means the individual who is responsible for--

``(I) ensuring compliance with this subsection by the facility; and

``(II) reducing energy use at the facility.

``(ii) **INCLUSIONS**.--The term `energy manager' may include--

``(I) a contractor of a facility;

``(II) a part-time employee of a facility; and

``(III) an individual who is responsible for multiple facilities.

``(C) **FACILITY**.--

``(i) **IN GENERAL**.--The term `facility' means any building, installation, structure, or other property (including any applicable fixtures) owned or operated by, or constructed or manufactured and leased to, the Federal Government.

``(ii) **INCLUSIONS**.--The term `facility' includes--

``(I) a group of facilities at a single location or multiple locations managed as an integrated operation; and

``(II) contractor-operated facilities owned by the Federal Government.

``(iii) **EXCLUSIONS**.--The term `facility' does not include any land or site for which the cost of utilities is not paid by the Federal Government.

``(D) **LIFE CYCLE COST-EFFECTIVE**.--The term `life cycle cost-effective', with respect to a measure, means a measure the estimated savings of which exceed the estimated costs over the lifespan of the measure, as determined in accordance with section 544.

``(E) **PAYBACK PERIOD**.--

``(i) **IN GENERAL**.--Subject to clause (ii), the term `payback period', with respect to a measure, means a value equal to the quotient obtained by dividing--

``(I) the estimated initial implementation cost of the measure (other than financing costs); by

``(II) the annual cost savings resulting from the measure, including--

``(aa) net savings in estimated energy and water costs; and

``(bb) operations, maintenance, repair, replacement, and other direct costs.

``(ii) **MODIFICATIONS AND EXCEPTIONS**.--The Secretary, in guidelines issued pursuant to paragraph (6), may make such modifications and provide such exceptions to the calculation of the payback period of a measure as the Secretary determines to be appropriate to achieve the purposes of this Act.

``(F) **RECOMMISSIONING**.--The term `recommissioning' means a process--

``(i) of commissioning a facility or system beyond the project development and warranty phases of the facility or system; and

``(ii) the primary goal of which is to ensure optimum performance of a facility, in accordance with design or current operating needs, over the useful life of the facility, while meeting building occupancy requirements.

``(G) **RETROCOMMISSIONING**.--The term `retrocommissioning' means a process of commissioning a facility or system that was not commissioned at time of construction of the facility or system.

``(2) **FACILITY ENERGY MANAGERS**.--

``(A) **IN GENERAL**.--Each Federal agency shall designate an energy manager responsible for implementing this subsection and reducing energy use at each facility that meets criteria under subparagraph (B).

``(B) **COVERED FACILITIES**.--The Secretary shall develop criteria, after consultation with affected agencies, energy efficiency advocates, and energy and utility service providers, that cover, at a minimum, Federal facilities, including central utility plants and distribution systems and other energy intensive operations, that constitute at least 75 percent of facility energy use at each agency.

``(3) **ENERGY AND WATER EVALUATIONS**.--

``(A) **EVALUATIONS**.--Effective beginning on the date that is 180 days after the date of enactment of this subsection and annually thereafter, energy managers shall complete, for each calendar year, a comprehensive energy and water evaluation for approximately 25 percent of the facilities of each agency that meet the criteria under paragraph (2)(B) in a manner that ensures that an evaluation of each such facility is completed at least once every 4 years.

``(B) **RECOMMISSIONING AND RETROCOMMISSIONING**.--As part of the evaluation under subparagraph (A), the energy manager shall identify and assess recommissioning measures (or, if the facility has never been commissioned, retrocommissioning measures) for each such facility.

``(4) **IMPLEMENTATION OF IDENTIFIED ENERGY AND WATER EFFICIENCY MEASURES**.--Not later than 2 years after the completion of each evaluation under paragraph (3), each energy manager may--

``(A) implement any energy- or water-saving measure that the Federal agency identified in the evaluation conducted under paragraph (3) that is life cycle cost-effective; and

``(B) bundle individual measures of varying paybacks together into combined projects.

``(5) **FOLLOW-UP ON IMPLEMENTED MEASURES**.--For each measure implemented under paragraph (4), each energy manager shall ensure that--

``(A) equipment, including building and equipment controls, is fully commissioned at acceptance to be operating at design specifications;

``(B) a plan for appropriate operations, maintenance, and repair of the equipment is in place at acceptance and is followed;

``(C) equipment and system performance is measured during its entire life to ensure proper operations, maintenance, and repair; and

``(D) energy and water savings are measured and verified.

``(6) **GUIDELINES**.--

``(A) **IN GENERAL**.--The Secretary shall issue guidelines and necessary criteria that each Federal agency shall follow for implementation of--

``(i) paragraphs (2) and (3) not later than 180 days after the date of enactment of this subsection; and

``(ii) paragraphs (4) and (5) not later than 1 year after the date of enactment of this subsection.

``(B) **RELATIONSHIP TO FUNDING SOURCE**.--The guidelines issued by the Secretary under subparagraph (A) shall be appropriate and uniform for measures funded with each type of funding made available under paragraph (10), but may distinguish between different types of measures project size, and other criteria the Secretary determines are relevant.

``(7) **WEB-BASED CERTIFICATION**.--

``(A) **IN GENERAL**.--For each facility that meets the criteria established by the Secretary under paragraph (2)(B), the energy manager shall use the web-based tracking system under subparagraph (B) to certify compliance with the requirements for--

``(i) energy and water evaluations under paragraph (3);

``(ii) implementation of identified energy and water measures under paragraph (4); and

``(iii) follow-up on implemented measures under paragraph (5).

``(B) **DEPLOYMENT**.--

``(i) **IN GENERAL**.--Not later than 1 year after the date of enactment of this subsection, the Secretary shall develop and deploy a web-based tracking system required under this paragraph in a manner that tracks, at a minimum--

``(I) the covered facilities;

``(II) the status of meeting the requirements specified in subparagraph (A);

``(III) the estimated cost and savings for measures required to be implemented in a facility;

``(IV) the measured savings and persistence of savings for implemented measures; and

``(V) the benchmarking information disclosed under paragraph (8)(C).

``(ii) **EASE OF COMPLIANCE**.--The Secretary shall ensure that energy manager compliance with the requirements in this paragraph, to the maximum extent practicable--

``(I) can be accomplished with the use of streamlined procedures and templates that minimize the time demands on Federal employees; and

``(II) is coordinated with other applicable energy reporting requirements.

``(C) **AVAILABILITY**.--

``(i) **IN GENERAL**.--Subject to clause (ii), the Secretary shall make the web-based tracking system required under this paragraph available to Congress, other Federal agencies, and the public through the Internet.

``(ii) **EXEMPTIONS**.--At the request of a Federal agency, the Secretary may exempt specific data for specific facilities from disclosure under clause (i) for national security purposes.

``(8) **BENCHMARKING OF FEDERAL FACILITIES**.--

``(A) **IN GENERAL**.--The energy manager shall enter energy use data for each metered building that is (or is a part of) a facility that meets the criteria established by the Secretary under paragraph (2)(B) into a building energy use benchmarking system, such as the Energy Star Portfolio Manager.

``(B) **SYSTEM AND GUIDANCE**.--Not later than 1 year after the date of enactment of this subsection, the Secretary shall--

``(i) select or develop the building energy use benchmarking system required under this paragraph for each type of building; and

``(ii) issue guidance for use of the system.

``(C) **PUBLIC DISCLOSURE**.--Each energy manager shall post the information entered into, or generated by, a benchmarking system under this subsections, on the web-based tracking system under paragraph (7)(B). The energy manager shall update such information each year, and shall include in such reporting previous years' information to allow changes in building performance to be tracked over time.

``(9) **FEDERAL AGENCY SCORECARDS**.--

``(A) **IN GENERAL**.--The Director of the Office of Management and Budget shall issue semiannual scorecards for energy management activities carried out by each Federal agency that includes--

``(i) summaries of the status of implementing the various requirements of the agency and its energy managers under this subsection; and

``(ii) any other means of measuring performance that the Director considers appropriate.

``(B) **AVAILABILITY**.--The Director shall make the scorecards required under this paragraph available to Congress, other Federal agencies, and the public through the Internet.

``(10) **FUNDING AND IMPLEMENTATION**.--

``(A) **AUTHORIZATION OF APPROPRIATIONS**.--There are authorized to be appropriated such sums as are necessary to carry out this subsection.

``(B) **FUNDING OPTIONS**.--

``(i) **IN GENERAL**.--To carry out this subsection, a Federal agency may use any combination of--

``(I) appropriated funds made available under subparagraph (A); and

``(II) private financing otherwise authorized under Federal law, including financing available through energy savings performance contracts or utility energy service contracts.

``(ii) **COMBINED FUNDING FOR SAME MEASURE**.--A Federal agency may use any combination of appropriated funds and private financing described in clause (i) to carry out the same measure under this subsection.

``(C) **IMPLEMENTATION**.--Each Federal agency may implement the requirements under this subsection itself or may contract out performance of some or all of the requirements.

``(11) **RULE OF CONSTRUCTION**.--This subsection shall not be construed to require or to obviate any contractor savings guarantees.".

Appendix C: Technology Categories and Associated Energy and Water Efficiency Measures

1. **Boiler Plant Improvements -** Efficiency measures such as, but not limited to:
   - Boiler control, including new controls and retrofits to existing controls
   - Replacement of existing boilers with high efficiency boilers
   - Boiler decentralization

2. **Chiller Plant Improvements -** Efficiency measures such as, but not limited to:
   - Chiller retrofits or replacements
   - Chiller plant pumping, piping, and controls retrofits and replacements

3. **Building Automation Systems/Energy Management Control Systems (EMCS) -** Efficiency measures such as, but not limited to:
   - Heating, Ventilating, and Air Conditioning (HVAC) upgrade from pneumatics to Direct Digital Control
   - Upgrade or replacement of existing EMCS systems

4. **Heating, Ventilating, and Air Conditioning** (HVAC, not including boilers, chillers, and Building Automation System (BAS)/Energy Monitoring/Management Control System (EMCS)) - Efficiency measures such as, but not limited to:
   - Packaged air conditioning unit replacements
   - HVAC damper and controller repair or replacement
   - Window air conditioning replacement with high efficiency units
   - Cooling tower retrofits or replacements
   - Economizer installation
   - Fans and pump replacement or impeller trimming
   - Thermal energy storage
   - Variable air volume retrofit

5. **Lighting Improvements -** Efficiency measures such as, but not limited to:
   - Interior and exterior lighting retrofits and replacements
   - Intelligent lighting controls
   - Occupancy sensors
   - Light Emitting Diode technologies
   - Daylighting
   - Spectrally enhanced lighting
   - Fiber optic lighting technologies

6. **Building Envelope Modifications -** Efficiency measures such as, but not limited to:
   - Insulation installation
   - Weatherization
   - Window replacement

- Reflective solar window tinting

7. **Chilled Water, Hot Water, and Steam Distribution Systems –** Efficiency measures such as, but not limited to:
   - Piping insulation installation
   - Hot water heater repair and replacement
   - Steam trap repair and replacement
   - Repair or replacement of existing condensate return systems and installation of new condensate return systems

8. **Electric Motors and Drives -** Efficiency measures such as, but not limited to:
   - Motor replacement with high efficiency motors
   - Variable speed motors or drives

9. **Refrigeration -** Efficiency measures such as, but not limited to:
   - Replacement of ice/refrigeration equipment with high efficiency units

10. **Distributed Generation -** Efficiency measures such as, but not limited to:
    - Cogeneration systems installation
    - Microturbines installation
    - Fuel cells installation

11. **Renewable Energy Systems -** Efficiency measures such as, but not limited to:
    - Photovoltaic system installation
    - Solar hot water system installation
    - Solar ventilation preheating system installation
    - Wind energy system installation
    - Passive solar heating installation
    - Landfill gas, waste water treatment plant digester gas, and coalbed methane power plant installation
    - Wood waste and other organic waste stream heating or power plant installation
    - Replacement of air conditioning and heating units with ground coupled heat pump systems

12. **Energy/Utility Distribution Systems -** Efficiency measures such as, but not limited to:
    - Transformers installation
    - Power quality upgrades
    - Power factor correction
    - Gas distribution systems installation

13. **Water and Sewer Conservation Systems -** Efficiency measures such as, but not limited to:
    - Low-flow faucets and showerheads
    - Low-flow plumbing equipment
    - Water efficient irrigation

- On-site sewer treatment systems

14. Electrical Peak Shaving/Load Shifting - Efficiency measures such as, but not limited to:
- Thermal energy storage
- Gas cooling

15. Energy Cost Reduction Through Rate Adjustments - Efficiency measures such as, but not limited to:
- Change to more favorable rate schedule
- Lower energy cost supplier(s) (where applicable)
- Energy service billing and meter auditing recommendations

16. Energy Related Process Improvements - Efficiency measures such as, but not limited to:
- Production and/or manufacturing improvements
- Recycling and other waste stream reductions
- Industrial process improvement

17. Advanced Metering Systems

18. Appliance/Plug-load reductions - Efficiency measures such as but not limited to:
- Replace air-cooled ice/refrigeration equipment
- Replace refrigerators
- De-lamp vending machines
- Plug timers
- Energy Star® products

19. Commissioning Measures

20. Other – Efficiency measures that cannot be included in any of the above categories

Appendix D: Case Study: Conducting an ASHRAE Level I Energy Audit

The Level I protocol of the American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE) provides for the review of building energy usage versus peer facilities, combined with a walk-through analysis to determine the efficiency of building energy systems and operating procedures. The ASHRAE Level I analysis is used to generate a list of no-cost or limited cost energy upgrades.

The three-year retrocommissioning of the DOE William R. Wiley Environmental Molecular Sciences Laboratory (EMSL), a 200,000 square foot federal scientific user facility located in Richland, Washington, illustrates how an ASHRAE Level I evaluation can lead to the development of a low-cost energy conservation program. EMSL used the following steps to carry out its retrocommissioning program:

- Planning: Team assembly and selection of program objectives and strategies.
- Investigation: Review of building energy performance records, followed by the on-site inspection and assessment of building systems and operations, and the development of a detailed master checklist of potential energy conservation measures (ECMs).
- Implementation: Finalizing program budget; selecting, scheduling and implementing ECMs; and testing completed work to ensure quality.
- Evaluation and Feedback: Following the completion of ECMs, EMSL monitored and evaluated ongoing energy efficiency and occupant satisfaction, and continued to fine-tune building operating procedures to optimize performance.

ESML identified over 2,300 low- or no cost building-specific ECMs. Roughly 200 projects were completed over three years, including the fine-tuning of HVAC and chiller systems; the adjustment of zoned thermostats and temperature setbacks; adding holiday schedules to building controls; shutting down unneeded computers at night; and performing light checks. The retrocommissioning cost $125,000 and generated estimated savings of $333,653, for a total return on investment of 167%. Estimated savings realized in the third year of the program included a 27% reduction in energy consumed and a 35% reduction in cost.

Benefits of Level I Energy Audits: Level I energy audits can generate significant energy savings at modest cost.

Risks of Level I Energy Audits and Their Mitigation. Risks associated with Level I energy audits include poor planning, execution and follow-up, which can yield suboptimal results. These risks can be mitigated by careful records review and team assembly, as well as by the development of careful investigative, implementation and evaluation protocols. An additional risk is that exclusive reliance on a Level I energy audit can limit a facility's opportunities to conserve energy. The use of ASHRAE Level II and/or Level III audits can suggest additional cost-effective strategies for energy conservation.

Source: http://www1.eere.energy.gov/femp/pdfs/om_retrocx.pdf

Appendix E: Case Study: Conducting an ASHRAE Level II Energy Audit

A recent comprehensive, ASHRAE Level II energy audit of an office building in Ithaca, NY, identified significant energy savings opportunities for the building's lighting system. To identify these opportunities, the energy auditors used the following protocol:

- Investigate all building energy usage: Evaluating all building energy usage (loads) and operating data, not just those of select systems, will proffer the biggest selection of energy saving opportunities.
- Treat every structure uniquely: Even similarly designed buildings do not have identical energy performance. Energy auditors should look for building anomalies that might explain performance inefficiencies.
- Consider right-sizing equipment, in addition to system efficiency: Energy auditors should consider right-sizing new equipment, in addition to system efficiencies. Equipment should be selected to meet occupants' energy needs; neither over-sizing nor under-sizing equipment is efficient.
- Room-specific data collection augments system performance data: Evaluating the occupant experience and occupancy schedules on a room-specific basis helps the auditors identify minor performance problems and energy savings opportunities.

The energy auditors identified sections of the Ithaca building where over-lighting was significant. By removing unnecessary light fixtures and lamps, and adding sensors that can dim lighting automatically, several of the building zones have reduced lighting energy use by nearly70%.

Benefits of Level II Energy Audits: A comprehensive, ASHRAE Level II energy audit can generate significant energy savings by identifying the largest selection of building energy use improvements.

Risks of Level II Energy Audits and Their Mitigation: A risk associated with ASHRAE Level II audits is that recommendations for building improvements cannot always be easily translated into work orders for facility staff and contractors. This risk can be mitigated by room- or section-specific evaluations of building performance, which lead to actionable work orders. Additional risks are that the energy auditor may overestimate the energy savings potential for the structure, or not be knowledgeable of recent building system technologies. These risks can be mitigated by hiring a competent energy audit firm with a long-term, proven track record for the selected property type.

Source:
http://www.energycostsolutionsgroup.com/resource/pdf/Energy%20Audit%20Article.pdf

Appendix F: Case Study: Conducting a Lifecycle Cost Analysis (LCCA) for a U.S. Coast Guard Water Heating System

Lifecycle Cost Analysis (LCCA) is a method for evaluating the total cost of a building system over its lifespan. LCCA can be used both for evaluating individual building systems, as well as for conducting whole building performance evaluations for both new and existing buildings. The U.S. Coast Guard used LCCA in 2002 to evaluate the feasibility of replacing an existing electric resistance water heating system with a solar water heating system for 278 residences at its base in Honolulu, Hawaii. Two alternatives were evaluated:

- Base Case. Maintain and repair the existing system, performing periodic capital replacement upgrades.
- Alternative: New solar hot water system financed through a contract with the local utility. Use a long-term utility energy services contract (UESC) to replace the current system with an energy-efficient solar hot water system that would be operational within a year.

The Coast Guard used the following LCCA protocol:

- Establish the objectives: The Coast Guard wished to determine which alternative would have the lower life cycle cost—including the costs of investment, contract administration, financing, operations, maintenance, repair and energy -- over a 21 year analysis period.
- Determine LCCA metrics: The two metrics used in the Coast Guard evaluation were (1) the lifecycle cost of each option, and (2) the Net Savings on the solar hot water system alternative relative to the base case.
- Identify the base case and develop the retrofit options: The project team modeled the lifecycle cost of maintaining, repairing and replacing the existing system (the base case), and the lifecycle cost for financing the installation of a new, solar water heating system under a UESC contract. The life cycle costs for both options were calculated over a 21 year period with a 5.6 percent discount rate. Other variables modeled in the analysis were initial and ongoing capital investments; financing and contract oversight charges; energy charges; operations, maintenance and repair costs; and the average rate of inflation over the analysis period.
- Perform lifecycle cost calculations: Using the cost information, determine the LCCA and Net Savings metrics for the base case and the alternative, and select the best solution.

LCCA Results. The LCCA analysis showed that financing a new solar hot water system had a lower life cycle cost than maintaining, repairing and replacing the existing heating system over time. The solar hot water system alternative produced Net Savings of $361,034 relative to the base case of maintaining, repairing and periodically replacing the existing system. As shown, the LCCA analysis demonstrated that it was preferable for the Coast Guard to install a new solar hot water system with UESC financing. Although the costs associated with the new solar hot water system were higher, the solar hot water system produced substantial operational savings over time, resulting in more favorable long-term financial results.

	Existing System Base Case	Financed Solar System Alternative	Savings Produced by Alternative
Life Cycle Cost (Present Value)	$2,320,104	$1,959,070	$361,034

Net Savings from Alternative Compared with Base Case:

Present Value of Operational Savings	$1,620,903 (Alternative produces $1,620,903 of operational savings v. base case)
Less	
Present Value of Differential Costs	$1,259,870 (Alternative is $1,259,870 more costly than base case)
Net Savings	$361,034 (Alternative produces net savings of $361,034 v. base case)

Benefits of LCCA: LCCA helps to determine the best retrofit option for facility managers who are considering energy efficiency measures, and want to select the most cost-effective alternative.

Risks of LCCA and Their Mitigation: Since it is difficult to predict future performance, LCCA outcomes should be assessed under expectations of result uncertainty. This risk can be mitigated by ensuring that the assumptions made in the LCCA calculations are as accurate as possible, and that findings are used to rank order competing approaches, rather than to pinpoint eventual operating results.

Source: http://www1.eere.energy.gov/femp/pdfs/lcc_guide_rev2.pdf

Appendix G: Case Study: Passive Heating and Cooling Strategies

The use of passive heating and cooling strategies minimizes the use of mechanical systems. Non-mechanical approaches have begun to be used in new construction and renovations around the globe and are among the greenest ways to render a building energy efficient.

The Zion National Park Visitor Center, created by the U.S. National Park Service in collaboration with the National Renewable Energy Laboratory, has reduced its energy consumption by 74.4%, in part by adopting passive heating and cooling strategies. While the Visitor Center, located in Springdale, Utah, is new construction, the passive strategies incorporated in its design can be used in building retrofits.

Passive heating and cooling strategies incorporated in the Zion National Park Visitor Center:

- Design and Placement of Windows and Landscaping. Windows and landscaping were designed and placed to maximize solar heat gain during winter and minimize it in summer, thereby helping to control interior temperatures.
- Natural Ventilation and the Stack Effect. Buildings can be heated and cooled by using natural ventilation in combination with the stack effect: the warming of air as it rises. If cool air is introduced to a building at lower levels, it mixes with hotter indoor air to keep indoor temperatures comfortable. The hottest air is then evacuated from the building through upper windows, chimneys or vents. The Zion National Park Visitor Center introduces cooler air through lower windows while releasing hotter air through clerestory windows near ceiling level. The natural mixing of hot and cool air helps to keep interior temperatures comfortable.
- Trombe Wall Heating and Thermal Massing. A Trombe wall provides most of the heating for the Visitors Center. Heat from the sun is trapped in a small space between a pane of glass and a black-coated wall which absorbs sunlight. Surface temperatures on the inside of the Trombe wall can often reach 100°F (38°C). An indoor masonry wall absorbs heat from the Trombe wall for release into the building later in the day, when temperatures decline—a process called thermal massing.[1]

Benefits of Passive Heating and Cooling Strategies: The use of passive heating and cooling systems can minimize reliance on mechanical systems, reducing energy use.

Risks of Passive Heating and Cooling Strategies: Risks of passive heating and cooling strategies include system inadequacies associated with the failure to coordinate and appropriately model diverse and interacting project features. These risks can be mitigated by the use of cross-disciplinary design teams and the meticulous modeling of system performance.

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[1] In other projects, thermal massing is frequently employed as both a heating and cooling strategy: interior walls and slabs can also used to absorb cold, nighttime air, in order to cool the building in preparation for the daytime sun.

Appendix H: Case Study: How to Maximize Energy Efficiency through Maintenance Planning

Maintenance planning can be a key element of building energy efficiency. The Federal Energy Management Program (FEMP) has found that well-executed maintenance programs can save federal agencies 5% to 20% on annual energy bills for limited capital investment. Successful building maintenance programs can also increase occupant safety, comfort and health.

FEMP recommends that federal maintenance personnel consider four potential maintenance approaches:

- Reactive strategies. Wait to repair equipment until it breaks.
- Preventive strategies. Schedule repairs on the basis of equipment run or calendar timetables.
- Predictive strategies. Use advanced monitoring technologies, including performance trending; thermography; ultrasound; and motor and oil analyses, to make repairs at the onset of equipment degradation.
- Reliability-centered strategies. Optimize reliability and cost-effectiveness by stressing predictive maintenance, while using reactive or preventive maintenance approaches for inexpensive and/or unimportant equipment.

Retro-commissioning and re-commissioning of building equipment—testing and recalibration to ensure that systems perform optimally—are key aspects of energy efficient building maintenance. Other maintenance activities that yield energy efficiency benefits include enhanced equipment monitoring and repair, and "load management"—the reprogramming or shutdown of equipment to eliminate unneeded energy use while maintaining occupant comfort and productivity.

Benefits of Maintenance Planning Strategies. Maintenance planning strategies can significantly reduce building energy costs for modest capital investment, while increasing equipment life and occupant comfort, health and safety.

Risks of Maintenance Planning Strategies and Their Mitigation: Maintenance planning strategies for energy efficiency can increase staff training and equipment testing costs, and potential benefits may be difficult to quantify. These risks can be mitigated by 1)using less thorough or less costly techniques for unimportant and/or inexpensive equipment; 2)quantifying paybacks for proposed programs; and 3)sharing best practices on how maintenance programs can achieve significant energy use and cost reductions for limited expenditure.

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Appendix I: Case Study: Saving Energy through Basic Changes in Personnel Behavior

Personnel behavior is critical to reducing Federal energy use, and buildings can be designed and renovated to reinforce energy-efficient behaviors. Multiple building design, renovation and operating practices can encourage federal workers to reduce energy consumption:

- Awareness Campaigns and Awards. Awareness campaigns and awards for behavioral changes can teach and reinforce employee energy efficiency, and honor, inspire and encourage personnel to take action. Twenty federal agencies have participated in such programs.
- Energy Efficient Commuting. New federal buildings can be sited near mass transit, while existing buildings can encourage fuel-efficient commuting by instituting mass transit shuttle and ride sharing services; remodeling to incorporate bicycle racks, showering and changing facilities; and providing preferred parking for hybrid cars, other fuel-efficient vehicles, and vehicles used in car-pooling and van-pooling.
- Telecommuting and Teleconferencing. Telecommuting and teleconferencing reduce fuel use by federal agencies and their employees. Legislation passed by Congress in 2010 is expected to place additional emphasis on federal telecommuting. Telecommuting can be encouraged by four-day work weeks and other flexible scheduling practices; job-sharing; and the use of hoteling (office space shared by two or more workers) and satellite telework centers. The operation and maintenance of audio and video conferencing services supports teleconferencing.
- Sensors and Timers. Motion or plug load occupancy sensors can be installed to shut off water fixtures, lights, computers and other office equipment when not in use. Lighting systems can be programmed to shut off or dim at certain daylighting levels, and irrigation systems can be programmed to stop operating on rainy days. These systems can help to compensate for human error and reinforce desired behavior.
- Dress Codes. Dress codes permitting informal seasonal attire can reduce reliance on mechanical heating and cooling.
- Internet-Based Monitoring. New Internet-based software that is linked to metering systems allows building occupants to monitor building energy use at their desktops in real time. The Empire State Building offers this option to its tenants.
- Benefits of Energy Efficiency Strategies to Influence Personnel Behavior: Employees are more likely to adopt energy-efficient behaviors when appropriate behavior is modeled, encouraged and reinforced. Many strategies that encourage energy efficiency among federal personnel, including bicycle use, job sharing, telecommuting and informal, seasonal dress codes are also popular benefits that can enhance employee recruitment and retention.

Risks of Energy Efficiency Strategies to Influence Personnel Behavior and Their Mitigation: Personnel strategies to encourage energy efficiency may decrease workplace productivity. To mitigate this risk, such programs should be developed with agency management and tested in pilot initiatives.

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Appendix J: Case Study: Metering of Covered Facilities

One Potomac Yard is a twelve-story office building in Arlington, Virginia, leased to the U.S. General Services Administration. The U.S. Environmental Protection Agency is the project's anchor tenant. Upon project completion in 2006, a key objective for GSA and EPA was to track energy and water usage over time in order to meet ongoing conservation goals.

A continuous metering program was developed and implemented for One Potomac Yard, using the following steps:

- Multiple systems were metered separately, including lighting systems and controls, motor loads, HVAC system loads and operations, building-related process energy systems and equipment, and water service systems.

- Data was monitored to ensure that the metering system was operating correctly.

- Data was benchmarked against the federal ENERGY STAR® building rating system.

- EPA disclosed and shared metering data to help the building's operations and maintenance staff optimize energy and water consumption over time. As of early 2010, One Potomac Yard had won the ENERGY STAR® designation in every year in which it was eligible.

Benefits of Metering. Metering benefits federal tenants, occupants and operations and maintenance personnel by: (1) generating actual data to guide energy conservation programs; (2) tracking the effectiveness of energy conservation measures and measuring results against expectations; and (3) allowing data-based results to be shared with the project team, throughout the agency and with the public.

Risks of Metering and Their Mitigation: Risks of metering include the use of inaccurate data; the failure to use data correctly; and the failure to choose appropriate benchmarks. These risks can be mitigated by (1) careful design, installation and maintenance of metering equipment, and by monitoring metering output for accuracy; (2) training facilities personnel to use metering data correctly when designing energy conservation measures; and (3) benchmarking on the basis of well-established databases, such as the federal ENERGY STAR® system, which track building performance against comparable properties.

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