

Improving Energy Efficiency in Federal Commercial Buildings

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ABSTRACT

Mandatory requirements and energy goals call for Federal agencies to improve the energy efficiency of their owned and leased buildings. This paper provides a current review of the various activities going on within the Federal sector to help the Federal agencies meet energy and environmental related mandates and goals. This paper also addresses several important policy drivers that dictate what the Federal agencies are able to do to improve energy efficiency and maintain healthy environments for their employees to work in.

While these energy efficiency activities have arisen from different sectors of the Federal government and often through different drivers, they are largely complementary. Where not directly complementary, ongoing efforts to streamline regulations and guidelines both between agencies and with private sector activities, such as the improvement of the *Energy Standard for Buildings Except Low-Rise Residential Buildings* (ASHRAE Standard 90.1) and the improvement of U.S. Green Building Council's (USGBC) *Leadership in Energy and Environmental Design* (LEED) ratings, will result in more usable regulations and a more coherent overall Federal building energy efficiency program.

Introduction

This paper is an overview of various activities underway in the Federal sector to help improve the energy efficiency in new and existing Federal commercial buildings. The two main drivers for the energy efficiency upgrades within the Federal sector are Executive Orders (E.O.) from the Executive branch and the legislative requirements passed by the legislative branch and then signed into law by the Executive branch of the U.S. Federal Government. The recent Executive Orders pertaining to this discussion are the E.O. 12902 (1994) and the E.O. 13123 (1999). The legislative requirements are contained in the Energy Policy Act (EPACT) of 1992, which amended the Energy Conservation and Production Act (ECPA), and the pending Energy Policy Act of 2003.

For example, E.O.13123, Section 403(d), instructs Federal agencies to develop sustainable design principles and use them in planning and building new facilities. This Order also instructs agencies to optimize life-cycle costs and other environmental and energy costs associated with the construction, life-cycle operation, and decommissioning of a facility. The Order's primary goals are to reduce greenhouse emissions associated with Federal facility energy use, by 30% by 2010, in comparison to 1990 levels; to reduce energy consumption by 35% between 1985 and 2010; and to increase water conservation and the cost-effective use of renewable energy.

A pending legislation in the Senate (S.2095 – Energy Policy Act of 2003) requires that, if life-cycle cost-effective, new Federal buildings shall be designed to achieve energy consumption

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levels at least 30% below those of the most recent ASHRAE Standard 90.1. It also requires that sustainable design principles be applied to the siting, design, and construction of all new and replacement buildings. An overview of this legislation is available at: http://www.energy.senate.gov/legislation/energybill2004/s2095_overview.pdf.

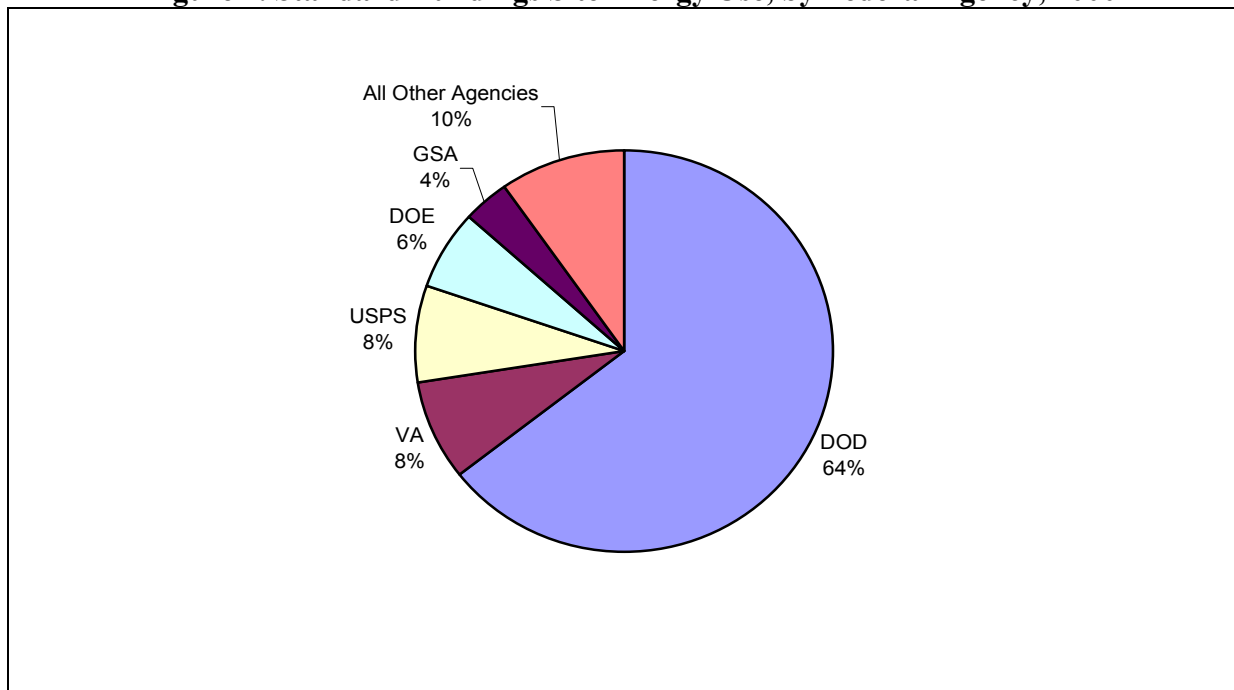
In addition to executive and legislative drivers, the policy drivers for energy efficiency upgrades include the following:

- Reduction of America's dependence on foreign oil to strengthen our national security
- Reduction of America's energy and operational costs
- Extension of the life of America's existing buildings and equipment
- Improvement of the health and performance of America's employees through better building performance.

Background

A snapshot of the building site energy use, by Federal agency in the year 2000, is shown in Figure 1 below. Buildings at Department of Defense (DOD) sites consume almost two-thirds of the total energy used in the Federal sector. The U.S. Postal Service (USPS) and Veterans' Affairs (VA) are the next two Federal agencies with 8% of the energy consumed.

Figure 1. Standard Buildings Site Energy Use, by Federal Agency, 2000



Source: FEMP Annual Report to Congress for FY 2000

The origin of the current Federal energy efficiency mandate of E.O. 13123 is the Federal Energy Management Improvement Act of 1988 (FEMIA). This law established a 10% facility energy reduction goal for Federal agencies by 1995, relative to 1985 facility energy use. All the Federal agencies were successful in achieving this goal; through fiscal year 1995 (FY95) the

Department of Energy (DOE) reported a 14.2% reduction in energy use relative to the 1985 baseline. Since the FEMIA goal, additional energy efficiency goals have been established for Federal agencies (Brown, Dirks and Hunt 2000):

- Executive Order 12759, April 17, 1991, “Federal Energy Management” – mandated an energy reduction of 20% by 2000, relative to 1985
- The Energy Policy Act of 1992 – legislated an energy reduction of 20% by 2000, relative to 1985
- Executive Order 12902, March 6, 1994, “Energy Efficiency and Water Conservation at Federal Facilities” – mandated an energy reduction of 30% by 2005, relative to 1985
- Executive Order 13123, June 8, 1999, “Greening the Government Through Efficient Energy Management” – mandated an energy reduction of 35% by 2010, relative to 1985.

Along the way there have been a number of estimates developed and made available regarding the potential level of cost-effective savings and/or investments to either meet or exceed the legislated and mandated goals. Examples of various activities within the Federal sector to improve energy efficiency in Federal commercial buildings are conducted within the U.S. Department of Energy’s Federal Energy Management Program (FEMP) and the Buildings Technologies Program (BT). FEMP’s activities in the Federal commercial buildings sector are to assist the facility managers, particularly the energy managers at the Federal sites, to identify energy savings opportunities and help develop training courses and workshops for energy system operators and other site personnel. The efforts by the BT office are in terms of promulgating a mandatory minimum energy efficiency standard that all Federal agencies must meet in the design and construction of new Federal commercial buildings. The building energy standard typically lays out a number of compliance paths, and some of the minimum requirements are prescriptive in nature. Certain Federal agencies have chosen to go beyond what is required as a “minimum” and have invested resources (cost, manpower training, etc.) to use other voluntary mechanisms and tools (e.g., design guides and guidelines) to save even more energy and associated costs throughout the life of their buildings. The General Services Administration (GSA) has, in cooperation with the American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc. (ASHRAE), recently developed a major design and construction guideline to help Federal agencies design and build their commercial buildings to meet certain energy efficiency goals. The individual military services within the Department of Defense (DOD) have historically developed their own department-specific commercial building guidelines that help them meet energy and cost targets. However, more recently, DOD has embarked on a new program, called the “Unified Facilities Criteria Program,” that strives to unify all technical criteria and standards pertaining to planning, design, construction, and operation and maintenance of real property facilities. See the following website for more details: http://www.wbdg.org/ccbref/pa_dod.php?category=pa.

Following is a description of what is going on within the Federal sector to assist the Federal agencies meet and exceed energy and energy cost goals and targets.

DOE’s Building Technologies Program Office Activities

There are several activities being conducted by BT. For example, DOE is supporting the improvement of the International Energy Conservation Code (IECC) and Standard 90.1.

BT is in the process of updating the Federal commercial building energy efficiency standard, 10 CFR 434, as required by Section 305 of the Energy Conservation and Production Act (ECPA), as amended by the Energy Policy Act of 1992. The requirement is for DOE to upgrade the standard, if significant energy savings would result, to include all new energy efficiency and renewable energy measures that are technologically feasible and economically justified. DOE is planning to replace the current Federal standard with a revised standard that is easy to use, enforceable, and designed to help Federal agencies meet the requirements of E.O. 13123. The draft proposed rule is based on the format and energy efficiency requirements of American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE) Standard 90.1-1999. To meet the economic justification criterion specified in Section 305 of ECPA, prescriptive requirements for the major components of a building were developed based on a goal of minimizing the life-cycle cost (LCC).

ASHRAE Standard 90.1-1999 is expected to be widely used by state and local code-making bodies as they update their codes. Therefore, DOE has attempted to maintain as much consistency as possible between the draft proposed rule and industry-wide practices, to help Federal agencies implement this rule.

The draft proposed rule has two main paths of compliance for Federal agencies to use. One is the prescriptive path, where minimum efficiency requirements are stated for each of the main components of a building (e.g., envelope, lighting, and mechanical equipment), all of which have to be individually met to satisfy compliance. The other path of compliance is the Energy Cost Budget (ECB) method, also known as the “whole-building performance trade-off” method. This method allows for a trade-off between the main components of a building, as long as an overall energy cost budget is met for the proposed design. Under both compliance paths, the proposed building design must meet certain mandatory requirements listed in each of the sections of the proposed rule.

The DOE rulemaking process involves publishing a proposed rule in the Federal Register, opening it up for public review and comments. Following a public meeting, where stakeholders are afforded an opportunity to offer oral and written comments as well, DOE will publish a final rule in the Federal Register, which will eventually replace what is presently in 10 CFR Part 434.

DOE Federal Energy Management Program (FEMP) Activities

FEMP’s activities in the Federal commercial buildings sector are to assist facility managers, energy managers, contractors, and others deploy energy and water efficiency technologies and methods. FEMP’s work includes providing the following assistance:

1. Training on the latest information about energy and water management improvement strategies to meet the legislative and business drivers. More information can be found at: <http://www.eere.energy.gov/femp/services/training.cfm>.
2. Technical advice and tools to identify and evaluate potential improvement projects. More information can be found at: <http://www.eere.energy.gov/femp/program/newconstruction.cfm>.
3. Alternative financing approaches to quickly fund, design, install, and operate improvement projects. More information can be found at: <http://www.eere.energy.gov/femp/financing/mechanisms.cfm>.

4. Operation and maintenance strategies to improve energy and operation efficiencies and to maintain the energy and water performance of newly installed energy technologies. More information can be found at: http://www.eere.energy.gov/femp/operations_maintenance/.
5. Guidance issued by FEMP on measurement and verification (M&V) of energy and cost savings associated with energy savings performance contracts, such as M&V Guidelines: Measurement and Verification for Federal Energy Projects (Version 2.2). The M&V Guidelines identify four general approaches to measurement and verification of savings: Options A, B, C, and D. Option A, for example, is an approach designed for projects in which the potential to generate savings must be verified, but the actual savings can be determined from short-term data collection, engineering calculations, and stipulated factors. Post-installation energy use is not measured throughout the term of the contract. It must be noted that Option A forbids the direct stipulation of savings. The accuracy of this option is generally inversely proportional to the complexity of the end-use technology or the particular energy measure. If greater accuracy is required, Options B, C, or D may be more appropriate. The document focusing on the proper use of Option A methods is available at: http://www.eere.energy.gov/femp/pdfs/detailed_guidelines_final.pdf
6. Guidance on long term improvements through sustainable design principles. The guidance includes the Greening Federal Facilities: An Energy, Environmental, and Economic Resource Guide for Federal Facility Managers and Designers, available at: <http://www.eere.energy.gov/femp/pdfs/29267.pdf> and the Business Case for Sustainability at: <http://www.eere.energy.gov/femp/pdfs/bcsddoc.pdf>.

General Services Administration (GSA) Activities

GSA is the largest landlord in the World and as such, has been extremely concerned with providing comfortable and healthy environments within the Federal buildings sector while, at the same time, making sure the building designs meet the aggressive energy consumption and energy cost goals. As such, GSA conducted several surveys and workshops in their 11 regions to determine what some of the most important concerns were with regard to energy efficiency and occupant comfort in Federal buildings. The No. 1 complaint or concern expressed by building owners as well as occupants at these workshops was “Environmental Comfort”. There was also the issue of mold and moisture problems, particularly in courthouses. GSA then instituted a Heating, Ventilating and Air Conditioning (HVAC) Advocacy program and subsequently signed a partnering agreement with ASHRAE in the Fall of 2001 to help monitor improvements in building environments as a result of the program.

Because GSA is planning to build about 140 courthouses in the near future, it decided to address the issue head-on and developed a document titled “Improving GSA Building Performance through an Integrated Approach”. The “Integrated Design” concept is one of involving the HVAC engineer right from the beginning of the building design process and then handing over the building equipment to an able and trained “HVAC operator”. The step-by-step approach in a Whole Building Design process is designed to achieve not only HVAC excellence, but also achieve commissioning goals during the life of the commercial building. As a part of the whole building design process, GSA has established an energy budget design target of 55,000 Btu/gross square foot (gsf)-year. This target goes beyond the minimum requirements in Standard

90.1 and also helps to meet the goals of E.O. 13123 for new construction. This joint GSA/ASHRAE developed program also has other participating partners, namely, Building Owners and Managers Association (BOMA), National Institute of Building Sciences (NIBS), American Institute of Architects (AIA), The Associated General Contractors of America (AGC), and industry consultants.

As part of the design criteria for all new Federal building construction, GSA has issued an agency directive requiring the use of “Facilities Standards for Public Buildings Service” (GSA 1996). This, together with the Whole Building Design Guide (WBDG), should help Federal agencies not only meet energy design targets, but also be able to occupy a building with an excellent environmental comfort.

A major study called the “GSA LEED Cost Study” will define costs associated with the LEED ratings. Two building types (new construction courthouses and Federal Building modernization) are being modeled against two scenarios for each LEED rating (Certification, Silver, Gold), identifying differential costs of construction, design, and documentation/submission requirements. Study findings along with an applications guide will be posted on the WBDG website in the Spring of 2004. The two documents of interest can be obtained from:

1. Whole Building Design Guide (WBDG) at www.wbdg.org
2. PBS P-100 (Facilities Standards for Public Buildings Services) http://www.gsa.gov/Portal/gsa/ep/contentView.do?contentId=14798&contentType=GSA_OVERVIEW

Department of Defense (DOD) Activities

Many site-specific studies pertaining to energy savings potential and evaluation of energy consumption factors at DOD sites report the energy consumption per square foot of building floor space, or the site’s “energy intensity.” U.S. Army Forces Command (FORSCOM) sites in 1998 showed that the intensity had dropped by 13.7% since 1985 (Brown and Dirks 2000). While this met the 10% reduction goal required by 1995, it was far short of the 20%, 30%, and 35% reduction goals established for 2000, 2005 and 2010, respectively. The paper goes on to evaluate certain factors that may have limited the energy intensity improvements in a specific FORSCOM site (Fort Hood located north of Austin, Texas). The evaluation was primarily conducted using the Facility Energy Decision System (FEDS) tool, which can assess energy efficiency resource potential of facilities ranging from single buildings to large Federal installations with multiple commercial buildings (PNNL 1998). The key recommendations of the study were to implement retrofits such as LED exit signs, compact fluorescents, and T-8 fluorescents in their buildings. The authors also caution that, even though significant energy and cost savings appear achievable via the recommended retrofits, the investment required is also significant. Thus the energy team at Fort Hood (and other similar sites) will likely need support from FORSCOM, and/or other organizations, and use the available financing mechanisms to obtain the necessary funding to implement the various energy efficiency improvements.

In a recently concluded study of Western Power Grid Peak Demand and Energy Reduction Program for the U.S. Army^b, the program objective was to assist selected U.S. Army

^b Parker, S.A. 2004. Final Program Summary Report, Western Power Grid Peak Demand and Energy Reduction Program – Army, PNWD-3400, Battelle-Pacific Northwest Division, Richland, Washington.

installations in identifying energy projects, to support aggressive energy management programs, and to reduce energy demand and consumption costs, primarily on the western power grid. The study approached the problem by:

- Identifying specific projects at specific installations that are cost effective and would have the greatest impact in terms of reducing energy consumption and peak demand.
- Providing the Army installations with sufficient data on each project to permit implementation either through energy-savings performance contracts (ESPC), utility financing, or through other funding methods (e.g., DD Form 1391 program input for MILCON, operations and maintenance (O&M) funding, state or local financing, etc.)
- Identifying cases where HVAC re-tuning and automated diagnostics may cost-effectively contribute to energy efficiency.

Eight U.S. Army installations were identified to receive services (initial site energy assessment and a FEDS assessment) under this program. In addition, two Army installations were to receive limited services under the HVAC re-tuning specialty service. So as not to conflict or interfere with current privatization efforts, family housing facilities were excluded from the scope of this project. Table 1 identifies the number of buildings and associated gross-square footage for the scope of site facilities included in the FEDS assessment task.

Table 1. Scope of FEDS Assessments

Installation	Facilities within Scope		FY 2002 Total Energy	
	Buildings (Qty)	Total Area (gsf)	Consumption (10 ⁹ Btu)	Cost (\$M)
Site A	756	8,117,827	1,626.0	10.6
Site B	1,538	7,614,731	1,226.1	10.9
Site C	664	5,363,386	688.0	9.5
Site D	156	1,661,309	119.1	3.4
Site E	72	968,165	48.5	0.7
Site F	121	1,789,876	192.2	3.9
Site G	631	6,557,289	422.2	11.0
Site H	731	4,595,172	105.6	2.3
Total	4,489	36,667,755	4,427.8	52.3

Table 2 identifies the estimated potential impact of the program's findings to the U.S. Army installations using the FEDS assessment tool. As illustrated in the totals, the potential energy and cost reductions are significant.

This total is by no means all of the potential energy and cost reduction available to the installations. While FEDS does evaluate over 100 energy-efficiency and cost-reduction measures, it is limited to those energy measures within its database. There are many additional energy-saving and cost-reduction opportunities and technologies available today. In addition, FEDS evaluates retrofits with similar equipment categories. FEDS does not investigate complete system replacements or upgrades. For example, FEDS can not assess the potential of replacing a series of distributed air-conditioning units with a central cooling plant. In addition, FEDS does not evaluate the potential for a building automation system (BAS), energy management control system (EMCS), or other type of intelligent building controls. Nor does FEDS evaluate maintenance-and-operations-type energy-reduction measures. The application of new and emerging technologies, including intelligent control systems, in conjunction with aggressive

maintenance and operations practices, can significantly reduce energy consumption and costs at each Army installation.

Table 2. Summary of Potential Energy and Cost Savings Identified in the FEDS Assessments Reports

Installation	Potential Annual Savings		Percent Savings (of FY 2002)		Estimated Installation Cost (\$M)	Net Present Value (\$M)
	Energy (10 ⁹ Btu/yr)	Cost (\$M/yr)	Energy	Cost		
Site A	89.9	1.2	5.5%	11.0%	9.4	10.38
Site B	68.8	1.1	5.6%	9.9%	5.1	12.43
Site C	98.6	1.1	14.3%	11.5%	8.1	11.64
Site D	9.6	0.3	8.1%	8.5%	2.3	2.18
Site E	7.3	0.2	14.9%	27.8%	1.1	2.43
Site F	49.2	0.5	25.6%	11.9%	4.7	4.20
Site G	46.9	1.2	11.1%	11.1%	5.7	15.34
Site H	15.4	0.4	14.6%	16.1%	3.3	2.85
Total	385.7	5.9	8.7%	11.3%	39.6	61.45

Conclusions

To comply with Executive Orders to reduce energy consumption and environmental impact of Federal buildings, as well as to meet specific legislative energy mandates, the Federal government is aggressively working to reduce energy consumption in Federal facilities. Federal building energy codes developed by DOE-BT office and department-specific building design regulations developed by DOD are used to ensure a minimum level of energy-efficient building design. Voluntary guidelines within agencies (e.g. GSA's WBDG) and design assistance activities raise the level of efficient design above these minimum regulations, as well as promote design of more comfortable and environmentally friendly buildings. Site energy audits and other ESPC activities (by FEMP, for example) are being used to identify and cost-effectively reduce energy consumption in existing Federal facilities.

While these energy-efficiency activities have arisen from different sectors of the Federal government and often as a result of different drivers, they are largely complementary. Where not directly complementary, ongoing efforts to streamline regulations and guidelines, both between agencies and with private sector activities, such as the upgrading of ASHRAE Standard 90.1 and USGBC's LEED ratings, will result in more usable regulations and a more coherent overall Federal building energy-efficiency program.

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