

THE \$535 MILLION MISSED OPPORTUNITY IN FEDERAL BUILDINGS

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ABSTRACT

The metering of federal buildings, as part of a building commissioning program, produces multiple benefits by identifying retrofits, optimizing building performance, improving indoor air quality, monitoring and verification of energy service performance contracts, and increasing the persistence of savings through operations and maintenance. The mandatory requirements are described for monitoring and verification of energy savings contracts and commissioning of new buildings. Case histories of actual savings from commissioning using sub-metering by Texas A&M's LoanSTAR monitoring program and others indicate savings potential of 150 percent of engineering estimates of installed energy retrofits and continuous commissioning savings ranging from 12 to 30 percent. Although a 25.8 percent reduction in site energy use in federal buildings has been reported through FY 1998 compared to FY 1985, significant additional savings are possible through building commissioning and the increased use of metering for monitoring and verification. This paper estimates annual savings of one-half billion dollars (\$535 million) are technically possible if continuous commissioning and optimization of major retrofits were judiciously applied to all federal buildings.

Background

With an estimated 500,000 buildings, the federal government is the largest building owner in the United States with annual utility bills in Fiscal Year 1998 of \$3.5 billion dollars (DOE 2000). Energy intensive federal buildings include hospitals, schools, R&D facilities, industrial processes, and complex computer and electronic facilities.

Agencies Required to Conserve

According to the U.S. Department of Energy's Report to Congress on the Federal Energy Management Program, site energy consumption [Btu/gross square foot (GSF)] in federal buildings decreased by 25.8 percent in FY 1998 compared to FY 1985 (DOE 2000). These savings represent \$900 million a year in avoided costs or enough to fully fund DOE's energy efficiency budget in FY 2000.

In response to the 1975 Arab oil embargo, federal agencies were required to reduce energy consumption with passage of the Energy Policy and Conservation Act of 1975 (EPCA, P.L. 94-163). EPCA gave the President broad authority to establish and coordinate the energy conservation actions and policies of federal agencies. In 1977, President Jimmy

Carter issued Executive Order 11912, setting a 20 percent energy reduction goal by 1985 below the 1975 level.

In 1978, the National Energy Conservation Policy Act (NECPA, P.L. 95-619, gave primary responsibility for federal energy management to the Secretary of Energy and set new energy reduction goals of 10 percent by 1995 compared to 1985. The Energy Conservation Policy Act of 1992 (Sec. 152, EPAct, P.L. 102-486) amended NECPA energy reduction goals to require energy use in federal buildings to be 20 percent lower in 2000 compared to 1985.

In March 1994, President Bill Clinton issued Executive Order 12902 requiring agencies to reduce consumption by 30 percent in 2005 compared to 1990. Finally in June 1999, President Clinton issued Executive Order 13123 that set increased reduction goals of 35 percent by 2010 compared to 1990 and added a new greenhouse gas reduction goal of 30 percent by 2010 compared to 1990 following policy recommendations in the Alliance to Save Energy's "Leading by Example" report (Alliance to Save Energy 1998). Table 1 below summarizes the applicable laws and executive orders which set federal agency energy reduction goals.

Table 1. Chronology of Federal Building Energy Reduction Goals (Btu/GSF)

Date	Statute/Directive	Goal
1977	E.O. 11912	20 % reduction by 1985 from 1975 levels
1978	NECPA	10% reduction in 1995 from 1985 levels
1992	EPAct	20% Goal in 2000 from 1990 levels
1994	E.O. 12902	30% reduction in 2005 from 1990 levels
1999	E.O. 14123	35 % reduction in 2010 from 1990 levels

Introduction

Are taxpayers getting the optimum return from federal energy efficiency investments? The answer is, unfortunately, no. Federal agencies are spending more than ever on energy improvements but are not getting the full savings. Federal agencies have made investments of approximately \$2 billion since 1985 (DOE 1998). Additionally, \$8 billion in contracting authority for energy service performance contracts (ESPCs) and area-wide contracts are now in place (DOE 1998).¹

A study by Mary Ann Piette of 60 commercial buildings found that over 50 percent had control problems and 15 percent had missing efficiency equipment (Piette, 1994). Piette concluded that energy savings could be increased significantly if all installed retrofits worked as designed and continued to work properly over the life of the equipment.

¹ Super ESPCs contracts are delivery order contracts by non-utility energy service companies for, to-be-identified, agency retrofit projects in each of the DOE regions. Area-wide contracts are contracts by regulated utilities for energy improvements in their service area

What is even worse, agencies have no way of knowing if energy improvements are working properly due to the lack of metered building systems. It is common knowledge in the Federal Energy Management Program that a large civilian or defense facility typically has only one gas and one electric master meter. One study estimates that less than 5 percent of all new construction and 0.03 percent of existing buildings are tested to ensure new and existing systems are properly installed and operating at optimal efficiency and productivity (Energy Information Administration 1995). Unfortunately, the practice of optimizing and operating energy systems in federal buildings is probably even less than the poor performance of their private sector counterparts (Sartor, 2000).

Optimizing Federal Building Performance

What can be done to ensure that the approximately \$2 billion in energy retrofits since 1985, plus an estimated \$3.5 billion for future retrofits needed to meet the mandatory energy use goals, perform properly (DOE/Rebuild 1998). Commissioning, using sub-metered data for monitoring, diagnostics, and verification, is a very cost-effective way to ensure energy improvements in existing and new buildings operate properly.

The U.S. Department of Energy's Rebuild America Program defines building commissioning as "the process of ensuring that systems are designed, installed, functionally tested, and capable of being operated and maintained according to the owner's operational needs (DOE 1998). Continuous commissioning involves repeated optimization of building systems to ensure they operate properly beyond the initial installation of energy retrofits. Commissioning can also be a part of the mandatory monitoring and verification process for documenting the results of energy savings performance contracts (DOE/FEMP 1998).

Benefits of Monitoring Building Performance

The use of meters to improve building performance achieves multiple benefits. Specific examples of commissioning include shutting off equipment and lighting when not in use, installing automated controls, cleaning and tuning coils and filters, scheduling night setbacks and chilled water resets, and repairing economizer dampers and controls. The most frequently cited benefits of optimizing building performance, or commissioning, include:

- ☒ Improving energy efficiency;
- ☒ Improving building systems and equipment interactions;
- ☒ Improving employee productivity, comfort, and indoor air quality (IAQ); and
- ☒ Reducing operations and maintenance expense (DOE/Rebuild America, 1998).

Additional benefits of commissioning using metered data which are often overlooked are:

- ☒ Increasing the persistence of energy savings;
- ☒ Identifying future energy savings improvement opportunities; and
- ☒ Reducing the potential for conflict between ESCOs and federal building owners.

Commissioning Requirements

Federal agencies are required to commission new buildings by the Energy Policy Act (EPAct) of 1992. Executive Order 12902 in 1994 mandated that each agency implement a facility commissioning program and that a Buildings Commissioning Guide be developed by the General Services Administration and DOE.

Unfortunately, a mandate for commissioning the existing 500,000 federal buildings does not exist. EPAct does require that 10 percent of all federal buildings receive an energy audit annually which is an excellent opportunity to develop and implement a commissioning plan. But, little emphasis is placed on commissioning existing buildings, since energy audits are often driven by an agency's need for funding new infrastructure improvements and/or the identification of cost-effective energy retrofits.

Monitoring & Verification (M&V) Requirements

FEMP guidelines require that energy savings performance contracts contain a project-specific monitoring and verification component or plan. Agencies are required to determine the performance of ESPC contracts. FEMP guidelines also state that M&V is the second most crucial negotiation issue after pricing. Agencies and performance contractors have four options for determining performance, ranging from using engineering estimates and short-term spot checking to calibrated energy simulation/modeling using utility and end-use data. (DOE/FEMP 1998)

Savings Potential From Optimizing Building/Retrofit Performance

The potential savings from commissioning federal buildings can be estimated based upon the experiences in the private sector. Using a study of 175 commissioning cases by the Portland Energy Conservation, Inc. (PECI), the technical potential from commissioning private buildings can be extrapolated to federal buildings (PECI 1997).² In this study, the average savings per square foot was 12 percent of the total utility bill and the cost for commissioning existing buildings was \$0.17 per square foot.

This savings figure appears conservative and was based on commissioning existing buildings. An analysis by Lawrence Berkeley Laboratory [LBNL] indicated performance monitoring projects across the country have saved 15 to 30 percent through improved operations and maintenance (Piette 1992). A study by Texas A&M University of the LoanSTAR retrofit program shows metered savings from commissioning of 150 percent of engineering estimates through retrofits and shutoffs and an additional 50 percent from continuous operations and maintenance (Texas A&M 1998).³

As previously noted, the annual utility bill for all federal buildings is \$3.5 billion dollars. If you apply the conservative 15 percent savings [range is 15 - 30 percent] from the

² The buildings ranged in size from 12,500 to 2.2 million square feet with an average size of 66,000 square feet and a median age of 6 years which is a good proxy for federal buildings

³ Texas A&M estimates were based upon four case studies using metered savings in buildings with a total area of 2.2 million square feet in the LoanSTAR retrofit program

LBNL analysis, the technical potential savings from continuous commissioning of the approximate 500,000 federal buildings is \$525 million per year.

One can estimate the savings from optimizing new retrofits each year by applying the Texas A&M experience of 150 percent of engineering estimates to expected retrofit savings. On average, \$200 million per year in energy improvements are funded by federal agencies (DOE 1998). If these projects were to have an average, simple payback of 10 years [10 percent annual savings], then an additional 50 percent savings or \$10 million is possible from continuous commissioning post retrofit.

Table 2. Total Savings Potential From Commissioning Federal Buildings

Source	Savings (millions)
Commissioning existing buildings	\$525
Commissioning new retrofit projects	<u>10</u>
Total Savings from Commissioning	<u>\$535</u>

The savings from increased IAQ and employee productivity from commissioning can easily surpass the energy savings by a factor of ten, based upon a study by Dr. Joe Romm, and were not included in these figures (Romm, 1999). Even greater economic and environmental benefits are achievable if metering were used in the millions of government buildings in state and local governments and to government buildings in developing countries.

Recommendations for Achieving Commissioning Savings

Given the tremendous savings potential from commissioning using metered building data, government policy makers and federal energy managers need to fully explore the economic potential and take actions to capture one of the most cost-effective retrofit options. DOE cites commissioning studies where the paybacks range from 0.3 months to 1.6 years (Building Commissioning 1998). These paybacks are consistent with the Texas A&M experience with the LoanSTAR Program (Claridge 2000).

Three things should be done if this savings potential is to be captured:

- ☒ Perform a rigorous saving analysis by building function and type of retrofit to accurately determine the market potential,
- ☒ Issue a directive that all existing buildings with utilities of a minimum amount will be continuously commissioned, and
- ☒ Require that metering, as part of the mandatory M&V of performance contracts, be installed and used for commissioning major retrofits and the on going optimizing of major building systems.

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