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Public and Institutional Markets for ESCO Services: Comparing Programs, Practices and Performance

Nicole Hopper, Charles Goldman and Jennifer McWilliams, Lawrence Berkeley National Laboratory

Dave Birr, Synchronous Energy Solutions

Kate McMordie Stoughton, Pacific Northwest National Laboratory

Energy Analysis Department
Ernest Orlando Lawrence Berkeley National Laboratory
University of California Berkeley
Berkeley, California 94720

Environmental Energy
Technologies Division

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Principal Authors

Nicole Hopper, Charles Goldman and Jennifer McWilliams
Lawrence Berkeley National Laboratory

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Acronyms and Abbreviations

AFCESA	Air Force Civil Engineer Support Agency
Btu	British Thermal Unit
DG	Distributed Generation
DHW	Domestic Hot Water
DOD	(U.S.) Department of Defense
DOE	(U.S.) Department of Energy
DSM	Demand-side Management
EEI	Edison Electric Institute
EIA	Energy Information Administration
ESCO	Energy Services Company
ESPC	Energy Savings Performance Contract
FEMP	Federal Energy Management Program
FUPWG	Federal Utility Partnership Working Group
GAO	(U.S.) Government Accountability Office
GSA	General Services Administration
GHP	Geothermal Heat Pump
HVAC	Heating, Ventilation and Air Conditioning
IDIQ	Indefinite Delivery, Indefinite Quantity
IPMVP	International Performance Measurement and Verification Protocol
kBtu	thousand British Thermal Units
LBNL	Lawrence Berkeley National Laboratory
M&V	Measurement and Verification
MUSH	Municipal Governments, Universities, Schools & Hospitals
NAESCO	National Association of Energy Services Companies
O&M	Operations and Maintenance
OMB	Office of Management and Budget
PNNL	Pacific Northwest National Laboratory
R&R	Repair and Replacement
REEP	Ratepayer-Funded Energy-Efficiency Program
SPT	Simple Payback Time
Super ESPC	Department of Energy Super ESPC Program
UESC	Utility Energy Services Contract

Executive Summary

1. Introduction

Throughout the U.S. energy services company (ESCO) industry's history, public and institutional sector customers have provided the greatest opportunities for ESCOs to develop projects. Generally speaking, these facilities are large, possess aging infrastructure, and have limited capital budgets for improvements. The convergence of these factors with strong enabling policy support makes performance contracting an attractive and viable option for these customers. Yet despite these shared characteristics and drivers, there is surprising variety of experience among public/institutional customers and projects.

This collaborative study examines the public/institutional markets in detail by comparing the overarching models and project performance in the federal government and the "MUSH" markets – municipal agencies (state/local government), universities/colleges, K-12 schools, and hospitals – that have traditionally played host to much of the ESCO industry's activity. Results are drawn from a database of 1634 completed projects held in partnership by the National Association of Energy Services Companies and Lawrence Berkeley National Laboratory (the NAESCO/LBNL database), including 129 federal Super Energy Savings Performance Contracts (ESPC) provided by the Federal Energy Management Program (FEMP) (Strajnic and Nealon 2003). Project data results are supplemented by interviews with ESCOs.

Special focus is given to the federal government in this report. In recent years, it has become a key source of ESCO industry growth, largely due to two "alternative financing" mechanisms – ESPC and Utility Energy Services Contracts (UESC) – that overcome barriers to project development.[1] To characterize this diverse market segment, we compare 660 UESC projects from FEMP's database, managed by Pacific Northwest National Laboratory (PNNL), to 165 ESPC projects included in the NAESCO/LBNL database.[2] This side-by-side analysis examines project deployment, costs, savings and simple payback time.

2. Key Research Questions

In this report, we provide a "bottom-up" analysis of the ESCO industry based on a large sample of implemented projects.[3] These results, not otherwise available in the public domain, facilitate benchmarking of ESCO projects by market segment and retrofit strategy and provide insights into the following key questions:

---

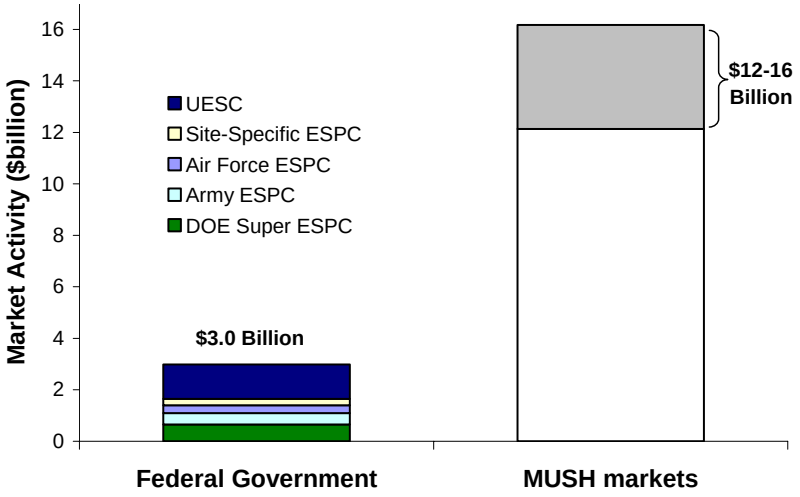
[1] The term "alternative financing" refers to using private sector investment to finance federal agency projects as an alternative to paying for projects up-front from funds appropriated by the U.S. Congress.
[2] The FEMP UESC database contains over 1000 projects; of these 660 were selected for this analysis based on criteria described in section 3.2.
[3] We also discuss federal and MUSH market enabling policies, market facilitation, contract types, and market drivers and barriers for those interested in a more detailed characterization of differences and similarities in the public institutional markets.

1. What is the size of the U.S. public/institutional market for ESCO services?
2. To what extent do ESCO projects provide value to customers?
3. What impact do financing and M&V costs have on Super ESPC economics, relative to the alternative of funding projects with congressional appropriations?
4. What are typical ranges in project investment, savings and payback times? What factors drive these results?
5. How do financial incentives and enabling policies impact project development?
6. How is ESCO deployment of energy-saving technologies evolving?
7. What are the costs of measuring and verifying project performance?

We address each of these questions with results from this study below.

1. What is the size of the U.S. public/institutional market for ESCO services?

The federal market has become a significant source of ESCO industry growth since the mid 1990s, when coordinated UESC and ESPC programs with standardized contracts and project facilitation support enabled it to flourish. Between 1990 and 2003, we estimate that at least ~$3.0 billion (nominal) was invested in ~1300 ESPC and UESC alternatively financed projects at federal facilities (see **Figure ES-1**).[4] In 2002, we estimate that federal alternative financing activity was ~$365 million.



Sources: Branch & Skumanich (2003), FEMP (2002) and Strajnic and Nealon (2003) (federal ESPC market activity); FEMP UESC database (UESC estimate); NAESCO/LBNL database projection (MUSH estimate)

Figure ES-1. Estimated Federal and MUSH Market Activity: 1990-2003

[4] Many UESC projects were not developed or implemented by ESCOs; utilities administering UESCs have often contracted out this work to other types of energy service providers (e.g., contractors, engineering firms, energy consultants).

We estimate MUSH (municipal governments, universities, schools and hospitals) market activity over the same time period (1990-2003) at ~$12.1-16.2 billion.[5] In 2002, MUSH market activity was ~$0.8-1.0 billion.

2. To what extent do ESCO projects provide value to customers?

Cost-effectiveness. We conducted a cost-benefit analysis of public/institutional projects from the customer perspective using conservative assumptions.[6] At a 7% nominal discount rate, the highest benefit-cost ratios are observed in health/hospitals projects (median of 2.6). Median benefit-cost ratios are comparable for state/local government, universities/colleges and federal government projects: 1.8, 1.9 and 1.6 respectively. The median K-12 schools project barely meets the cost-effectiveness threshold (1.1). Although some of these projects appear to be uneconomical based only on consideration of direct benefits, they also provide indirect benefits that are impossible to include in our economic analysis (see below). Overall, based on direct benefits alone, 71% of public/institutional sector projects are cost-effective using a 7% nominal discount rate.

Net Benefits. Altogether, the net benefits of ~1000 public/institutional projects in the NAESCO/LBNL database, in 2003 dollars, is over $1.7 billion using a 7% nominal discount rate. Under a 10% discount factor, net benefits are ~$850 million.

Other Benefits. In addition to directly quantifiable energy and operational cost savings, ESCO projects often provide other difficult-to-quantify yet important benefits to customers. Examples include equipment modernization, improved quality of lighting and space conditioning, enhanced worker productivity and environmental improvements. These additional benefits are essentially "free" in that they do not reduce energy or water savings and are attendant to them. For some customers, these benefits are the primary motivation to install projects. For agencies with limited capital budgets, performance contracts may be the only means available to finance needed improvements.

3. What impact do financing and M&V costs have on Super ESPC economics, relative to the alternative of funding projects with congressional appropriations?

A recent GAO report questions the appropriateness of financing government energy-efficiency projects (GAO 2004) and raises concerns about the costs of ESPC projects relative to funding projects through congressional appropriations based on a cost analysis of six ESPC projects – project benefits are not accounted for. We include both costs and benefits in an analysis of 109 Super ESPC projects, comparing net benefits of these financed projects to several alternative scenarios involving congressional appropriations.

---

[5] The MUSH market estimate is based on NAESCO/LBNL database activity projected according to previous research on database representation of industry-wide activity (Goldman et al. 2002).

[6] Direct benefits – energy cost and non-energy operational savings – are included in our analysis, but not indirect benefits, such as improved building comfort, employee productivity, environmental benefits, etc. We also do not attempt to quantify societal benefits (e.g., reduced pollution, avoided generation or transmission infrastructure costs or economic development benefits). Complete details of our economic analysis assumptions are provided in section 5.5 and Appendix C.

The results are shown in **Table ES-1** for 5% and 7% nominal discount rates. The "financed" scenario, reflecting how Super ESPC projects were actually implemented, includes debt service and M&V costs. Energy cost and O&M savings were assumed to persist over time due to contractual terms and the presence of M&V. The "appropriated" scenarios represent a range of outcomes had the *same* projects been paid for with up-front appropriations rather than alternatively financed. We model turnkey project costs as a single up-front payment, without financing or M&V costs. However, to account for the benefits of savings guarantees and ongoing M&V, we assume that energy savings decay at 1% or 2% per year in the appropriations scenarios. In addition, we examine the impact of delayed appropriations on project net benefits, incorporating the opportunity cost of lost savings. The shaded cells in Table ES-1 represent appropriations scenarios that result in reduced net benefits relative to financed Super ESPCs.

Table ES-1. Net Benefits (in 2003 $M) of 109 Super ESPC Projects Under Several Project Financing Scenarios

Discount Rate (Nominal)	Financing Scenario	Annual Savings Decay Rate	Project Delay Relative to Financed ESPC (years)			
			0	1	2	3
5%	Financed	0%	286	–	–	–
	Appropriated	1%	353	302	251	201
		2%	280	230	181	132

Discount Rate (Nominal)	Financing Scenario	Annual Savings Decay Rate	Project Delay Relative to Financed ESPC (years)			
			0	1	2	3
7%	Financed	0%	213	–	–	–
	Appropriated	1%	212	160	110	61
		2%	155	106	57	10

NOTE: Shaded cells represent appropriations scenarios with lower net benefits than were achieved using private-sector financing to implement these projects.

Even under the most conservative discount-rate assumptions, the presence of positive net benefits for the 109 Super ESPC projects *as they were actually financed* indicates that these projects are solidly cost-effective.[7] Because the benefits of financed Super ESPC projects outweigh the costs, they ultimately represent no cost to the government.[8]

GAO (2004) recommends that federal agencies use "timely, full and up-front appropriations" to fund energy-efficiency projects, yet cites several agencies that have received inadequate or no capital funding for energy-efficiency projects in recent years

[7] Our results differ from GAO's (2004) finding that financed projects cost more to implement. In reality, while debt service and M&V costs do *nominally* add to overall project costs, properly discounting future payments to reflect the time value of money offsets debt service costs, and accounting for savings decay in the absence of M&V offsets M&V costs.

[8] While GAO (2004) raises concerns about long-term financial commitments, Super ESPC contracts contain non-appropriation clauses that limit the federal government's liability should Congress cease utility and O&M budget appropriations during the life of the contract.

(e.g. GSA, Navy). Our results suggest that timely appropriated projects may provide equal or greater net benefits than financed ESPCs. However, in reality most projects do not receive timely appropriations and appropriated projects, when funded, often take longer to develop and implement. Even at the most forgiving discount rate (5%), delays of more than one year in obtaining congressional appropriations result in reduced net benefits relative to ESPC-financed projects. The longer an agency waits, the more drastic this effect.

4. *What are typical ranges in project investment, savings and payback times? What factors drive these results?*

Project Investment. Median turnkey costs[9] for federal projects are $2.04 million.[10] Median costs in other market segments range from $0.72 million for health/hospitals to $1.25 million for K-12 schools. To analyze investment intensity, we normalize turnkey project costs by the retrofitted floor space. As **Figure ES-2** shows, federal government and universities/colleges projects have the lowest median investment ($2.32/ft^2 and $2.43/ft^2 respectively). We believe these results are linked to the large facility size characteristic of these customers, possibly indicating economies of scale. Another possibility is that these large facilities simply do not retrofit all of the floor space with the same number or type of energy savings measures.[11] The highest levels of investment per square foot occur in state/local government ($3.71/ft^2 median), and health/hospitals ($3.64/ft^2 median) facilities.

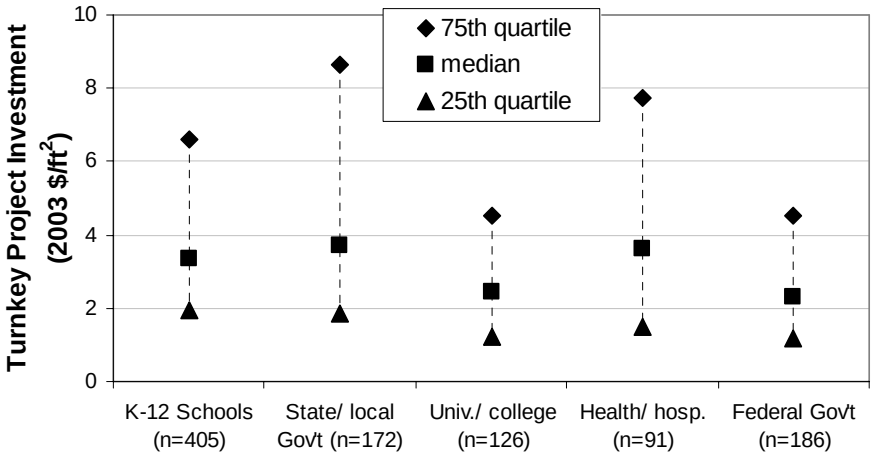


Figure ES-2. Turnkey Project Investment by Market Segment

[9] Turnkey project investment includes the total cost to install the project, including all costs related to design, construction and commissioning as well as construction-period financing and any fees related to arranging long-term financing, but *not* long-term financing (interest) costs.

[10] The large project size for federal projects reflects the dominance of ESPC projects in the NAESCO/LBNL database. Individual UESC projects tend to be smaller than ESPC projects, though the combined investment of consecutive projects at a given customer facility may be much higher (see section 6.3.2).

[11] ESCOs are requested to report floor area that encompasses the scope of the retrofit.

We classified projects according to their installed measures and found that lighting-only projects are the least cost-intensive retrofits installed in all market segments (median $1.20/ft^2). The median cost for 53 distributed generation (DG) projects is $7.43/ft^2, ~50% higher than for heating, ventilation and air conditioning (HVAC) retrofits that were deemed to be capital-intensive ($4.99/ft^2).

Energy Savings. Median energy savings are ~15-20% of the utility bill baseline in all market segments (see **Figure ES-3**).[12] While energy savings are correlated with installed technologies (e.g., lighting-only projects produce lower savings than other types of retrofits), market sector differences in per-square-foot energy consumption are best described by facility energy usage. For example, hospitals' energy usage is typically high because they operate around the clock and use specialized equipment, while schools tend to operate fewer hours and fewer end uses. On a per-square foot basis, the highest annual energy savings are observed in the health/hospitals market segment (median savings of 22 kBtu/ft^2), and the lowest in K-12 schools (12.5 kBtu/ft^2 median).

On average, reductions in electricity usage provide 78% of project energy savings; most of the remaining 22% is attributable to natural gas.

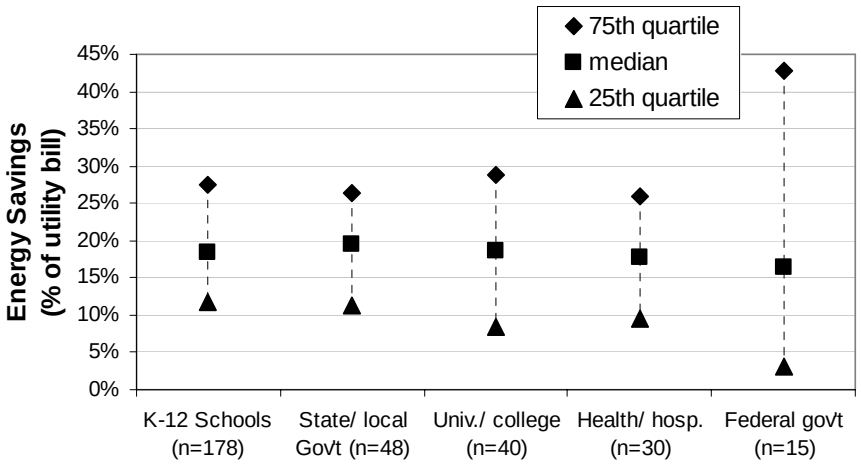


Figure ES-3. Energy Savings as Percent of Utility Bill by Market Segment

Non-energy Savings. Non-energy savings – operations and maintenance (O&M) or other economic savings[13] – are included as direct project benefits and can be an important factor in justifying a project's economics. Non-energy savings were reported most often in federal sector projects (59% of projects). In MUSH market segments, customers counted non-energy savings in 30-40% of projects. Among projects that reported them, the median share of non-energy savings relative to total project savings ranges from 14%

[12] Our analysis of energy savings is based on actual (verified) energy savings for the ~70% of projects that reported this information, and predicted savings for projects that did not. Electricity savings were converted assuming site energy conversion (1 kWh = 3412 Btu).

[13] Other non-energy savings include savings such as avoided capital costs, reduced personnel costs, and other tangible economic savings resulting from the project but not directly attributable to energy reductions.

for federal government projects to 27% for K-12 schools and 34% for state/local government projects.

Simple Payback Time.[14] **Figure ES-4** shows that the shortest payback times are observed in the health/hospitals market segment (4.9-year median). Widespread health care industry privatization has led to a closer approximation of private-sector style decision-making in this market segment. K-12 schools projects have the highest median payback times: 14.7 years. In part, this is because performance contracting enabling legislation in many states allows for contract terms of up to 20 or 25 years (see enabling policy discussion below). In addition, K-12 schools tend to bundle non-energy improvements into energy-efficiency projects. Because of the typically low investment nationwide in capital budgets for schools, the motivation to engage in performance contracting is often not strictly energy bill savings – the need to replace and modernize vital infrastructure is also an important driver. Median payback times for federal government, state/local government, and universities/colleges projects in our database are 8.5 years, 7.2 years and 6.8 years respectively. The relatively long payback for federal projects reflects the 25-year maximum contract term specified for Super ESPC projects, which dominate our dataset.

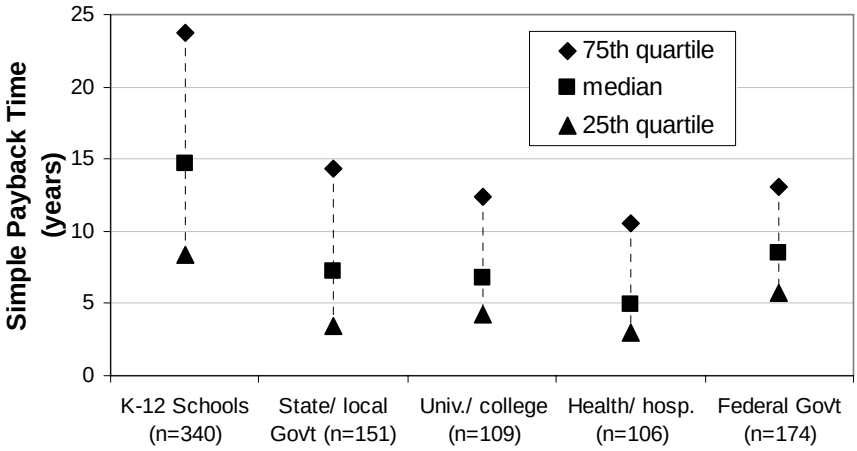


Figure ES-4. Simple Payback Time by Market Segment

Retrofit strategies also impact payback times. Lighting-only payback times show little variation around the 4.0 year median for these projects. In contrast, retrofit projects that include DG and replacement of major HVAC equipment (e.g., chillers, boilers, cooling towers) have median payback times of 11.6 and 12.7 years respectively.

[14] Simple payback time is a common measure of the cost-effectiveness of an investment, though it does not take into account the time value of money or the lifetime of the savings. For details of the data sources and assumptions made in our SPT calculation, see Appendix C.

5. How do financial incentives and enabling policies impact project development?

Financial Incentives. ESCOs and customers may leverage the cost of projects with incentives received through ratepayer-funded energy-efficiency programs (REEPs). While REEP incentives were received by at least 42% of public/institutional sector projects completed before 1996, reliance on incentives was only 22% in the years since 2000. This is largely due to reduced availability of incentives (Nadel 2000, Kushler et al. 2004). However, it also speaks to the increasing ability of ESCO projects to be sold to customers based on their fundamental economics and value, without relying on financial incentives.

Enabling Policies. ESCOs are distinguished from other service providers in their offering of performance contracting – long-term contracts with customers that involve an assumption of project performance risk by the ESCO – as a core part of their business.[15] State and federal legislation that enables agencies to enter into multi-year performance contracts along with technical support and facilitation from agencies that develop and administer program regulations are critical factors to ESCO market development. Forty-eight states have enacted enabling legislation for schools, universities or state/local governments (ESC 2005), though the scope and quality of legislation varies. In interviews, ESCOs cited absent or limited enabling legislation in some states as a major factor limiting their ability to develop projects. In the federal market, this was demonstrated dramatically when the ESPC enabling legislation sunset in October 2003. For a full year following, ESPCs were without authorization and project development was suspended until the program was reauthorized in late 2004.[16]

Impact on Contract Terms. We find a strong correlation between the maximum allowable contract term specified in applicable enabling legislation and the terms of contracts between ESCOs and customers. The average federal contract term (based primarily on ESPC projects) is 14 years compared to 9.5 years for MUSH projects.[17] In interviews, ESCOs attributed this difference primarily to performance contracting laws in a number of states that limit MUSH projects to terms of 10 years or less. By contrast, the maximum federal ESPC contract term is 25 years (FEMP 2004a).

Retrofit strategies are also correlated with contract terms. Lighting-only projects had terms of 7.8 years on average. The longest terms are observed for projects installing DG (12.9-year average); projects that primarily involved HVAC improvements had average terms of about 10 years. Project design in jurisdictions with shorter allowable contract terms is thus limited to less comprehensive or capital-intensive retrofits.

[15] See section 2.2 for a discussion of different types of performance contracts.
[16] UESC activity was unaffected by the ESPC sunset.
[17] Note that for MUSH market projects, the project financing term may differ from the term of the contract between the ESCO and customer. For federal ESPC projects, there is no clear separation of project performance and financing, so the contract term and financing term are the same (see section 2.2).

6. How is ESCO deployment of energy-saving technologies evolving?

Installed Technologies. The two most commonly installed measures are lighting (80-90% of projects, depending on sector) and HVAC controls (~80% of projects). These short-payback measures make attractive investments as stand-alone projects, but also provide a means to leverage longer-payback measures to achieve comprehensive projects within a customer's payback criteria.

Increasingly, the ESCO industry has moved away from lighting-only projects toward bundled retrofits that include more capital-intensive strategies. Lighting-only projects have dropped in database share from almost 20% of projects in the 1990s to only 7% since 2000. Moreover, the relative share of projects including capital-intensive HVAC measures has increased from 16% to 27% of projects, and the share of projects installing distributed generation (DG) has increased from 2% to 9%; these changes have occurred primarily since 2000.

Impact on Project Investment. In accordance with the trend toward more comprehensive, capital-intensive retrofits, the amount of capital investment per project is growing. Project size, as measured by turnkey costs, has been increasing over time, even after adjusting for inflation (see **Figure ES-5**). A similar trend exists in project investment per square foot, confirming this result.

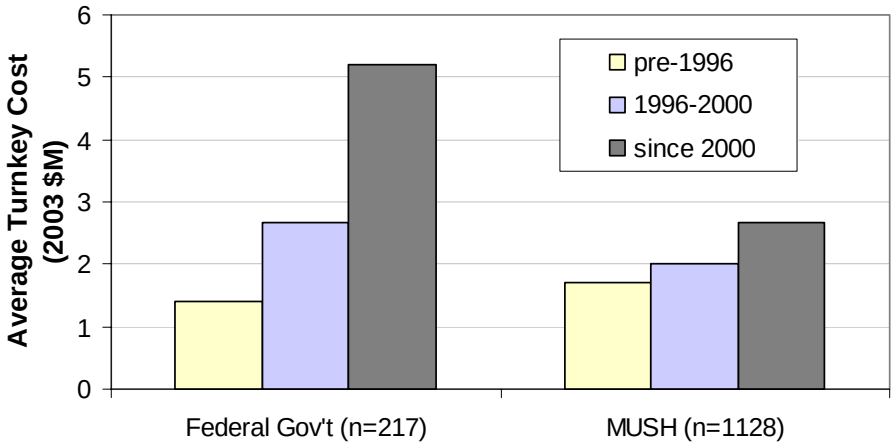


Figure ES-5. Trends in Average Project Size

7. What are the costs of measuring and verifying project performance?

Measurement and verification (M&V) of savings in a performance contract is essentially insurance against the risk that a project will fail to deliver savings as guaranteed over its economic lifetime. As with any form of insurance, the buyer must balance the cost against the risk-reduction benefits.

A sub-set of projects (federal Super ESPC) provided information on M&V costs (Strajnic and Nealon 2003). Approximately 70% of these contracts report that M&V costs are less

than 10% of turnkey costs. As a proportion of annual savings, ~70% specified annual M&V costs that were less than 5% of annual savings. These results probably represent an upper bound on M&V costs in the ESCO industry as a whole.[18]

Figure ES-6 shows the distribution of projects according to the percent difference between guaranteed energy cost savings and the actual cost savings reported to the customer.[19] Seventy-two percent of projects reported greater savings than were guaranteed by the ESCO initially. Nineteen percent encountered savings shortfalls. For 9% of projects, savings were fully stipulated.[20] The value to customers of ongoing M&V in a guaranteed savings contract lies in identifying when savings shortfalls occur and savings guarantees should be exercised.

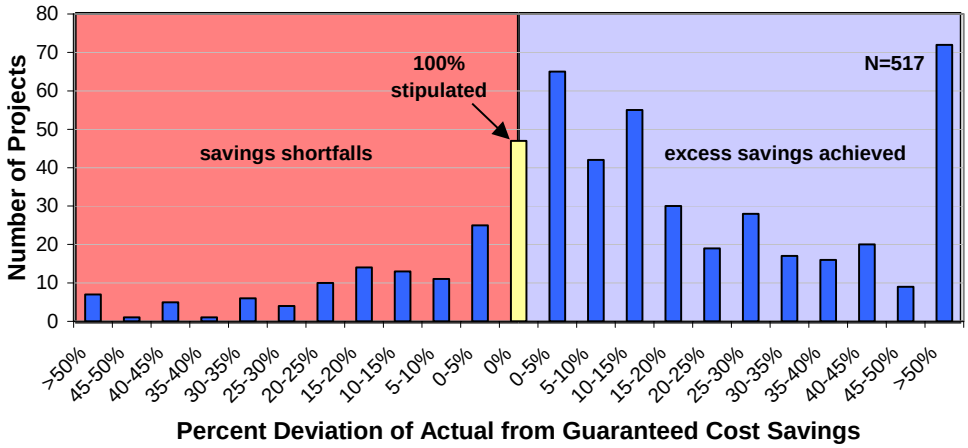


Figure ES-6. Performance of ESCO Savings Guarantees

3. Key Findings

We conclude with the following key findings that summarize how our results shed light on the questions outlined and discussed above.

1. ESCOs have invested ~$15-19 billion in projects at U.S. public/institutional facilities since the early 1990s. The federal government has become the largest source of industry growth since the mid-1990s.
2. ESCO projects provide significant economic and qualitative benefits to customers. The majority of projects are cost-effective under conservative assumptions.

[18] The federal Super ESPC program has rigorous M&V requirements relative to other ESCO markets.
[19] We used the average of the yearly actual savings provided for this analysis. For most projects, only 1 or 2 years of actual savings was reported. These results therefore do not speak to project performance several years after installation.
[20] Stipulated savings are not measured but determined based on engineering estimates agreed upon by the ESCO and customer. Projects classified as "100% stipulated" reported identical guaranteed and actual savings. For the remaining 91% of projects, the degree of savings stipulation versus measurement is unknown.

3. Super ESPC projects are cost-effective and represent a value, not a cost, to the federal government. Project delay significantly erodes net benefits. In a congressional budget environment with limited availability of capital to fund energy-efficiency projects, financed Super ESPC projects represent an attractive investment approach, in part because contractual guarantees ensure that benefits will persist over the project's economic lifetime.
4. Typical project investment, savings and payback times are as follows. Median investment ranges from ~\$2-4/ft^2, depending on market segment; large federal and university facilities have the lowest investment intensity. Energy savings are typically ~15-20% of the utility bill baseline, or ~10-25 kBtu/ft^2, depending on a customer's energy intensity. 30-60% of projects, depending on sector, include non-energy savings in their project economics. Median payback times are 5-15 years and depend on market sector decision-making criteria and customer motivation to install projects.
5. Though probably important early in the industry's development, ESCOs' reliance on financial incentives is declining. Performance-contracting enabling legislation, however, is critical to ESCO activity in public/institutional markets. Project contract terms reflect maximum allowable terms, which, if binding, can limit project scope.
6. Lighting and HVAC controls, included in 80-90% of projects, are the dominant technologies installed by ESCOs. There is a trend toward more comprehensive, capital-intensive retrofits while lighting-only projects are becoming less common. The amount of capital investment per project is growing accordingly.
7. M&V costs are modest relative to project costs and savings, and can protect customers in the ~20% of projects for which savings did not meet guarantees.

1. Introduction

Throughout the U.S. energy services company (ESCO) industry's history, public and institutional sector customers have consistently provided the greatest opportunities for ESCOs to develop projects. Despite the success of some ESCOs in developing private sector projects, public/institutional markets continue to host the majority of ESCO industry activity.[21] Generally speaking, these facilities are large, possess aging infrastructure, and have limited capital budgets for improvements; the convergence of these factors along with strong enabling policy support makes performance contracting an attractive and viable option for these customers. Yet despite these shared characteristics and drivers, there is surprising variety of experience among public/institutional customers and projects.

This collaborative study examines these markets in detail through analysis of completed project data from a database held in partnership by the National Association of Energy Services Companies and Lawrence Berkeley National Laboratory (the NAESCO/LBNL database), the Federal Energy Management Program (FEMP)'s database of Utility Energy Services Contracts (UESC), and interviews with ESCOs. Our approach is to compare and contrast the following market segments: the "MUSH" markets – municipal agencies (state/local government), universities/colleges, K-12 schools, and hospitals – that have traditionally played host to much of the ESCO industry's activity, and the federal government, the newest public sector market segment to see significant ESCO activity.

This report, which draws heavily on results from the NAESCO/LBNL database, also serves to update and expand the information published in Goldman et al. (2002). We have added several hundred new projects to the NAESCO/LBNL database and conducted interviews with ESCOs active in these markets. These new results capture recent industry trends and provide detailed information on practices and performance in individual market segments. Goldman et al. (2002) focused on comparisons between the private and public/institutional sectors; this report analyzes segments within the public/institutional markets. It also provides a rich source of information on the actual deployment of energy efficiency services (as opposed to estimates based on market potential studies or energy audits) in various market segments that can be used to support benchmarking by policymakers, program designers, ESCOs, contractors and financial institutions.

Special focus is given to the federal government, a relatively new market for ESCOs, in this study. In recent years, it has become a key source of ESCO industry growth. This is largely due to two "alternative financing" mechanisms – Energy Savings Performance Contracts (ESPC) and UESC – that overcome barriers to project development in this market.[22] These programs have been very successful at stimulating growth in the federal

[21] While private sector facilities provide significant technical opportunities for energy efficiency, a number of barriers to performance contracting in this sector have impeded ESCO industry growth (Elliott 2002).
[22] The term "alternative financing" refers to using private sector investment to finance federal agency projects as an alternative to paying for projects up-front from funds appropriated by the U.S. Congress for capital projects.

market, which has similar energy savings opportunities to other public/institutional markets but unique legal barriers to long-term financing.[23] A recent report by the U.S. Government Accountability Office (GAO) raises concerns about the treatment of ESPC projects in the federal budget (GAO 2004). Its conclusions are based on a cost analysis of six Super ESPC case studies – project benefits are not considered. In contrast, this report includes detailed performance data on over 150 ESPC projects. To address the GAO's findings directly, we include a full cost-benefit analysis that demonstrates the true costs of financing projects.

The federal government market segment is somewhat difficult to characterize because it is extremely heterogeneous. In terms of facility types, federal agencies are extremely varied, encompassing office buildings, hospitals, educational facilities, industrial facilities, and residential housing (on military bases). In addition, a broad array of contracting and financing mechanisms are currently utilized, some of which are unique to the federal market. To better understand this complex market, we devote a chapter to a side-by-side comparison of ESPC projects from the NAESCO/LBNL database and UESC projects from FEMP's UESC database. This not only allows federal program managers to understand ESPC and UESC project strategies and characteristics, but it illustrates more broadly how the design and goals of enabling policies and programs affect on-the-ground project implementation.

We begin this report with a high-level overview of federal and MUSH markets, comparing enabling legislation and market facilitation, market drivers and barriers, financing and contracting types (Chapter 2). In Chapter 3, we describe our approach and data sources. We then report estimates of overall federal and MUSH market activity and comment on the proportional representation of the data used in this study (Chapter 4). Chapter 5 presents a bottom-up comparison of public/institutional projects by market segment, focusing on project strategies, size, costs, energy savings, and customer-perspective economics, drawing on projects in the NAESCO/LBNL database. Chapter 6 explores trends within the federal alternative financing market through a comparative analysis of projects completed under the ESPC financing mechanisms in the NAESCO/LBNL database and projects in the FEMP UESC database.[24] Finally, we draw conclusions in Chapter 7.

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[23] Nonetheless, recent legal and political issues impeded efforts to renew the ESPC enabling legislation, which sunset in October 2003, stalling new ESPC project development for a full year. This report helps address this need for detailed information on project performance to support enabling policies and programs by comparing federal project performance to projects in other, comparable market segments.

[24] Because "appropriated" project activity has been very limited relative to alternatively financed projects, we emphasize the two main alternative financing mechanisms as the model under which ESCOs operate in the federal market.

2. Overview of Public/Institutional ESCO Markets

To understand the role of ESCOs in public/institutional markets, it is useful first to define the broader market for energy-efficiency in public/institutional sector facilities. For discussion purposes, we group non-federal institutional and public sector customers together, terming them "MUSH" market segments (municipal governments, universities, schools and hospitals). **Figure 2-1** defines these two broad market segments – federal and MUSH – shows the typical contracts signed by ESCOs and their customers, and indicates the entities (ESCOs and alternative service providers) implementing projects.

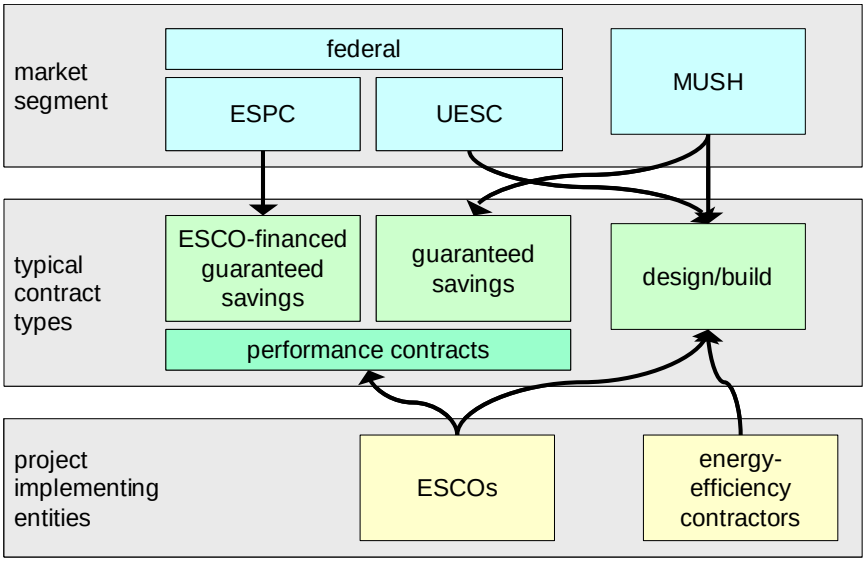

Figure 2-1. Public/Institutional Markets for Energy-Efficiency Services: Typical Practices

Within the public/institutional markets, ESCOs play an integral but not exclusive role. In the MUSH markets, ESCOs face competition, not just from other ESCOs, but from various types of energy-efficiency contractors that design and install energy-efficient equipment at customer facilities but do not engage in full-service performance contracting. ESCOs' competitive advantage may hinge on the ability to develop complex projects and offer performance contracts, primarily "guaranteed savings" agreements, but they also engage in non-performance-based work, typically "design/build" contracts that cover the design and installation of equipment but not ongoing servicing or performance monitoring, when customers desire it.[25]

Within the federal market, contracting types and the role of ESCOs depend primarily on whether an agency is using a particular type of alternative financing mechanism. The two

[25] Performance contracting has declined in importance in the ESCO industry as a whole (Goldman et al 2002 and section 5.2.1). Reasons for this decline include greater customer comfort with the technical aspects of ESCO projects as the industry has matured and the perception of certain customers that the cost of monitoring and verification (M&V) is high relative to the benefit of greater assurance of savings. See sections 5.4.4 and 5.5.4.1 for a discussion of M&V costs and benefits.

most common mechanisms are Energy Savings Performance Contracts (ESPC) and Utility Energy Services Contracts (UESC). In the ESPC market, ESCOs typically act as the prime service provider and the standardized contracts are a special type of performance contract unique to this market: "ESCO-financed guaranteed savings" (see section 2.2). UESC projects are "established-source" contracts between local regulated utilities and federal agencies. The utility typically acts as the prime service provider managing the project, although some utilities select ESCOs (often an affiliate of the local utility) to manage project design and construction. For utility-managed projects, utilities typically rely on energy-efficiency sub-contractors to design, construct and implement the recommended technical measures, though in some cases ESCOs have performed this function for UESC projects. Historically, long-term savings guarantees have not been required in UESC contracts, although efforts are currently underway to standardize performance assurance in UESC contracts (FEMP 2004b).[26]

Table 2-1. Characteristics of Federal and MUSH Markets

Attribute	Federal Market	MUSH Markets
Enabling Legislation	• 1992 Energy Policy Act • EO 13123 Greening the Government Act • 10 CFR-436 • 10 USC 2865 / 2866	• state performance contracting laws
Procurement Mechanisms	• Energy Savings Performance Contracts (site-specific, Army, Air Force, DOE Super ESPC) • Utility Energy Services Contracts • Congressional appropriations	• RFPs issued by customer agencies
Facilitating Agencies	• Army Corps of Engineers (Huntsville) • Air Force Civil Engineer Support Agency (AFCESA) • Federal Energy Management Program (FEMP) • General Services Administration (GSA)	• state energy agencies or energy offices
Primary Contract Types	• ESCO-financed guaranteed savings • design/build	• guaranteed savings • design/build
Key Market Drivers	• compliance with legislation (and goals) • need for new capital equipment	• need for new capital equipment
Market Barriers	• sales cycle time • customer preference for appropriations over ESPC • bureaucracy • financing	• lacking or limited enabling legislation in some states • sales cycle time • need to educate customers

[26] FEMP is recommending the following minimal performance assurance plan for each measure included in UESC projects: (1) start-up performance verification based on measured data, (2) performance verification at the end of the equipment warranty period based on measured data, (3) operations and maintenance (O&M) training, (4) continuing training throughout the contract period, (5) periodic inspections and verification of O&M performance, and (6) performance discrepancy resolution (FEMP 2004b).

Fundamentally, ESCOs provide the same services in federal and MUSH market segments – they act as project developers, design and install energy-efficient equipment at customers' sites and often assume a share of the associated performance risk, engaging in long-term contractual agreements in which energy (and/or operational) savings pay for the initial investment over the lifetime of the equipment. Activity in both markets can be attributed to strong enabling legislation, support from facilitating agencies, and standardized procurement and contractual mechanisms. However, the models under which ESCOs provide these services are rather different in the federal government than in the MUSH markets. As shown in **Table 2-1**, policies, procurement, market facilitation, contract types and market drivers and barriers all have parallel but different manifestations in these markets. These largely customer-driven differences, the reasons for them and their implications are explored in more detail in the remainder of this chapter.

2.1 Policies, Programs and Procurement

2.1.1 Federal Market

Historically, federal agencies have been prohibited from taking on multi-year financial obligations without prior congressional approval (so-called "anti-deficiency" regulations). This meant that energy-efficiency projects could only be implemented if congress appropriated funds to pay for the investment up-front (GAO 2004). This constituted a significant barrier to performance contracting, and also limited the number and size of projects that were undertaken by federal agencies because appropriations were often inadequate to capture the cost-effective potential for energy-efficiency improvements.

Two major policy changes have enabled the expansion of the federal market. First, the Energy Policy Act of 1992 introduced a mandate directing all federal agencies to reduce their energy consumption. The original targets were amended in Executive Order (EO) 13123, titled "Greening the Government through Efficient Energy Management" – the current goal is a reduction in energy use per square foot by 35% over a 1985 baseline by 2010 (FEMP 2001). Second, these and other legislative acts enabled and encouraged agencies to develop projects specifically through two "alternative financing" mechanisms: ESPC and UESC.

In the federal market, ESCOs developing projects primarily utilize the ESPC and UESC procurement/contractual mechanisms. In addition, projects may still be funded by direct appropriations, or appropriated funds may be leveraged with ESPC or UESC financing to develop more comprehensive projects than would be possible with appropriations alone. The ESPC and UESC programs are discussed in more detail below.

2.1.1.1 Energy Savings Performance Contracts (ESPC)

As Table 2-1 indicates, the ESPC procurement mechanism has evolved over time and agencies have developed and implemented ESPCs in a somewhat customized fashion.[27] The first ESPCs were "site-specific" contracts that were initially approved in the 1986 amendments to the National Energy Conservation Policy Act of 1978 (FEMP 2004a). They were negotiated individually by customer agencies and ESCOs, and most were contracted between 1988 and 1999, though a few customers still use this mechanism. The 1992 Energy Policy Act and 10 CFR-436 "Federal Energy Management and Planning Program" expanded the authorization for ESPC to allow the development of the Department of Energy (DOE) Super ESPC program (referred to hereafter as "Super ESPC"). The Army Corps of Engineers and the Air Force also developed their own ESPC programs, taking advantage of this legislation and further authorization under 10 USC 2865 and 2866, which govern energy savings and water conservation at military installations (FEMP 2004a).

The Super ESPC program is open to all federal agencies, as is the Army Corps of Engineers program; however use of the latter by civilian agencies is limited. The Air Force program is used solely by the Air Force.

The agency-sponsored ESPC programs are designed to facilitate and expand the market compared to the site-specific mechanism by: (1) developing standardized contractual mechanisms and best practices, (2) establishing facilitating agencies to provide technical assistance and promote the ESPC mechanism to customer agencies, and (3) setting up "Indefinite Delivery, Indefinite Quantity" (IDIQ) contracts which pre-qualify ESCOs to enter into ESPC contracts after an initial selection process. The facilitating agency for the Army program is the Army Corps of Engineers at Huntsville; the Air Force Civil Engineer Support Agency (AFCESA) serves this function for the Air Force program and the Federal Energy Management Program (FEMP) within DOE is responsible for facilitating the Super ESPC program. The Super ESPC program initially awarded IDIQ contracts to four to six ESCOs in each of six regions.[28] The Army Corps of Engineers has awarded contracts covering pre-defined regions of 4 or 46 states. The Air Force program awards region-wide contracts to a single ESCO – thus competition is effectively eliminated for the winner, so long as the contract is not re-qualified (AFCESA 2004). However, in interviews, ESCOs pointed out that competition still exists between the different financing mechanisms. Nonetheless, they all rated competition from other ESCOs in the federal market somewhat lower than in MUSH markets, which is influenced by the size of each market and its relative maturity.[29]

The Super ESPC program experienced a significant setback in October 2003, when the enabling legislation for the program sunset and efforts to renew it were stymied for a full

[27] Several other agencies have also implemented ESPC programs (e.g., U.S. Navy, U.S. Army Medical Command and the General Services Administration).
[28] The DOE program also runs three "technology specific" ESPC contracts – geothermal heat pumps, photovoltaics and biomass/alternative methane fuels – for which there are separate qualifications lists.
[29] All of the ESCOs we interviewed are IDIQ contract holders.

year as part of the larger debate over national energy legislation. During this time, no new project development was possible and the future of the program was uncertain. The other ESPC programs were also affected. Although the enabling legislation was restored in October 2004, these events demonstrated the critical need for ongoing supporting policies to enable performance contracting in U.S. public/institutional markets.

2.1.1.2 Utility Energy Services Contracts (UESC)

UESCs involve a partnership between a federal agency and its local utility for energy services ranging from rebates for energy-efficient equipment to large, comprehensive facility upgrades. Within the UESC mechanism there are a variety of contracting vehicles that may be used, but in all cases the agency contracts with the utility on a established-source basis and pays for the energy services from its utility budget (FEMP 2001). An important advantage to agencies is simplified procurement: the utility provides one-stop shopping, access to technical expertise on opportunities to improve facility efficiency and reduce energy costs, and payments for projects are included as a line item on the utility bill. The utility benefits from streamlined demand-side management (DSM) resource acquisition and the opportunity to partner with federal customers to meet high-priority customer service needs.

The oldest UESC contracting mechanism is the General Services Administration (GSA)'s area-wide contracts. Originally authorized in 1949, these contracts allow GSA to procure utility services (as defined by state regulatory commissions) on behalf of the federal government per requirements set forth in Part 41 of the Federal Acquisition Regulations (FAR 2005, GSA 2005).[30] In 1995, language was added allowing DSM services, including energy-efficiency projects, to be included in the services offered through area-wide contracts (FEMP 1997). The majority of UESC activity is implemented through area-wide contracts. A second option is a Basic Ordering Agreement (BOA), which may be negotiated either by GSA for all federal agencies or by individual agencies themselves. As part of their delegated authority, the Department of Defense (DOD) worked with a group of utilities that were members of the Edison Electric Institute (EEI) and developed an Agency Model Agreement, which was a stand-alone master agreement. DOE also developed a model agreement with EEI members (FEMP 2005). These Agency Model Agreements are often used in conjunction with a separate BOA or an existing area-wide contract, and represent a third approach. Finally, site-specific UESC contracts are also used. Because these contracts require individual sites to develop agreements from scratch, they are time consuming and have fallen out of favor as the various pre-negotiated contracts have become available (FEMP 1997).

GSA and FEMP each play important roles in promoting and facilitating UESC financing to agencies. Both provide information to federal agencies and partner to host training sessions on project development, legal authority to enter into contracts, and technical issues.

[30] Part 41 of the FAR also allows GSA to delegate this procurement ability to DOE, DOD, and Veterans Administration (VA).

In the UESC market, there is no parallel to the pre-qualifications lists that ESCOs compete for in the ESPC market. It is important to note that ESCOs are involved in only a subset of projects completed under UESC agreements. Some utilities with unregulated ESCO affiliates engage these affiliates to act as project manager and/or implement a UESC project. Typically, utilities compete various aspects of a UESC project and select contractors and ESCOs to conduct facility audits and design, construct and implement energy-efficiency measures as part of a UESC project. ESCOs are usually involved in larger, more complex UESC projects.

2.1.2 MUSH Markets

In contrast to the national enabling legislation and somewhat centralized procurement/contractual mechanisms characteristic of the federal market, MUSH projects are enabled and administered at the state level. The implication is that the existence and quality of enabling legislation and administrative support varies considerably across the U.S. Nonetheless, the basic means for enabling and supporting projects are similar. State enabling legislation typically revises existing procurement regulations to allow designated agencies to enter into multi-year contracts, utilize performance contracting, and/or engage in municipal leasing to finance projects. Designated agencies vary by state and may encompass state/local government agencies, K-12 schools, and universities/colleges. Forty-eight states have enacted enabling legislation for performance contracting (ESC 2005), though the quality of legislation varies. Most specify maximum allowable contract terms that range, depending on the state, from less than 10 years to 20 years or more.

Market facilitation in the form of promotion of performance contracting, interpretation of enabling legislation and technical assistance for customers is typically undertaken by state energy offices or agencies responsible for state facilities – here too, the quality of the assistance varies by state. State agencies or school districts typically issue RFPs for projects and ESCOs enter into a competitive proposal process. In some states, agency-wide RFQs may be issued to pre-qualify ESCOs to work on, for example, all projects in state agencies in an area or state. In states that do not prequalify ESCOs, the competitive process is open to anyone. ESCOs told us in interviews that the degree of competition in these states from other ESCOs as well as non-ESCO energy-efficiency contractors is typically very high.

2.2 Financing and Contract Types

ESCOs and their customers may enter into several types of project agreements. While the details of individual contracts may vary, the majority of project agreements fall into several broad categories which at their core are shaped by the allocation of two types of risk: project performance and financing risk. Whether ESCOs or their customers are responsible for performance risk defines whether the agreement is a performance contract or not. Within performance contracting, the allocation of financing risk has implications for determining project interest rates (though this is certainly not the sole determining factor) and also for the carrying capacity of the ESCO market to finance projects.

In this section, we define several types of project contracts and describe which market segments typically use them and why. Trends in contract types based on actual project data are presented in section 5.2.1.

The classic definitions of the two most common types of performance contract used in MUSH markets, “shared savings” and “guaranteed savings”, distinguish them according to the allocation of financing risk (Cudahy and Dreessen 1996). These two contracting models are shown conceptually in **Figure 2-2**. Both entail separate contracts for the performance agreement (between the ESCO and customer) and the financing contract.

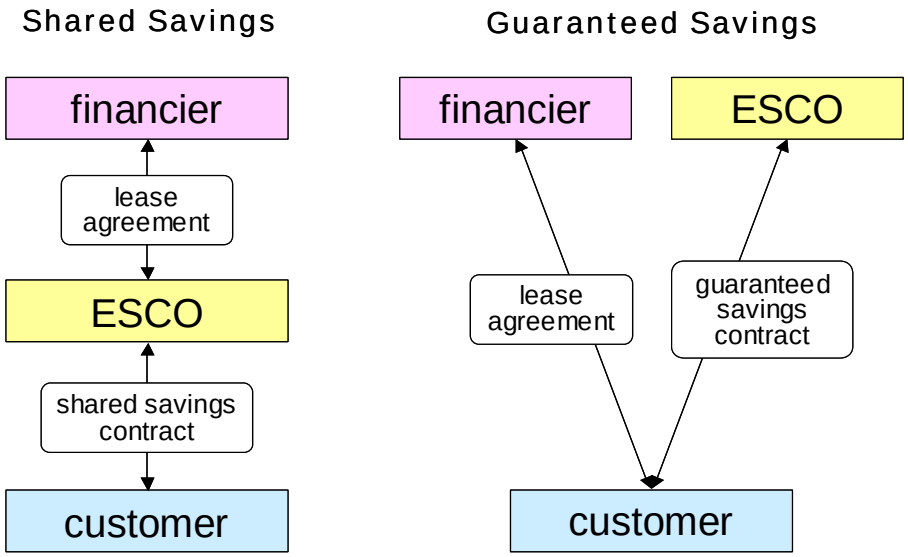

Figure 2-2. Shared Savings and Guaranteed Savings Contracting Models

In a shared-savings contract, the ESCO assumes the project financing risk, either financing projects internally or (more commonly) from a third party lender. In either case, there is a contractual agreement between the ESCO and the financier, and the ESCO thus assumes the credit liability for the project (see Figure 2-2). Turnkey project costs are paid during the performance phase of the project; the customer pays the ESCO its share of savings as specified under the shared-savings contract between the ESCO and customer from which the ESCO repays the lender (any excess is retained by the ESCO as profit). There is no contractual obligation between the customer and the financier, and responsibility for loan repayment lies with the ESCO, not the customer (e.g., if the customer should fail to pay the ESCO under the terms of the shared savings agreement, the ESCO is still responsible for paying the lender). Shared-savings contracts were common in MUSH markets in the 1980s and early 1990s, but have become less prevalent in recent years.

In a guaranteed-savings agreement, the customer assumes financing risk, usually signing a lease agreement contract with a third-party lender (see Figure 2-2). The ESCO often assists the customer in arranging project financing, but is otherwise uninvolved in the transaction and is not responsible should the customer default on its loan obligations.

Usually, the ESCO is paid up-front for the turnkey cost to install the project, with ongoing service-phase payments limited to ongoing costs such as operations and maintenance (O&M) and measurement and verification (M&V) costs. The guaranteed-savings contract between the ESCO and customer outlines the conditions of the performance guarantee as well as the terms of performance-phase services.

In addition to the financing distinction, traditional shared-savings and guaranteed-savings contracts also differ according to the type of performance agreement involved. In a shared-savings agreement, the ESCO and customer share the savings resulting from the project in proportions specified in the shared-savings contract. The ESCO makes debt service payments from its share of the savings: if the ESCO's share of actual savings is less than debt-service payments, the ESCO covers the difference, and if there is a surplus it keeps the profits. Because the customer has no financial obligations during the service phase of the contract, its share of the savings is all benefit.

In a guaranteed-savings contract, the ESCO typically guarantees a minimum level of (financial or energy) savings to the customer, who is responsible for making debt-service payments to a third-party financial institution. If there is a shortfall in savings, the ESCO reimburses the customer. If savings exceed the ESCO's guarantee, the customer typically keeps the excess.

The matrix in **Figure 2-3** shows the allocation of risk in shared-savings and guaranteed-savings contracts. In both cases, ESCOs assume project performance risk, though it is structured differently.[31] The main distinguishing feature lies in how the financing risk is allocated.

By contrast, federal government agencies undertaking ESPC contracts with ESCOs typically engage in a hybrid model. Because of anti-deficiency regulations, federal government agencies may not assume long-term debt without prior congressional approval. ESPC contracts address this issue by authorizing agencies to pay for ESCO projects over several years from utility and/or O&M budgets. In ESPCs, ESCOs assume the financing risk – government agencies do not enter into contractual agreements with financial institutions, ESCOs do. Thus, according to the classic definition, ESPC contracts resemble shared-savings contracts. However, the project performance aspect of ESPC contracts does not entail a sharing of savings. Instead, ESPCs include minimum performance guarantees. Thus from the perspective of performance risk, federal government contracts more closely resemble the guaranteed-savings model.

As a result, we define a hybrid contract type to describe the ESPC contracts between ESCOs and the U.S. federal government: "ESCO-financed guaranteed savings". This model appears as a separate element in the risk matrix in Figure 2-3.

[31] While the ESCO holds the performance risk in both types of contracts, the value to the customer is less certain in a shared-savings agreement than a guaranteed-savings agreement, because the customer's share of savings is contingent on savings being realized.

		Financing Risk	
		ESCO	Customer
Performance Risk	ESCO *(savings shared by ESCO and customer)*	shared savings	
	ESCO *(minimum savings guaranteed to customer)*	ESCO-financed guaranteed savings	guaranteed savings
	customer		design/build

Figure 2-3. Risk Matrix for Common Types of ESCO Contracts

A fourth model is the "design/build" contract, the most popular non-performance-based agreement. Under design/build agreements, ESCOs (or contractors) are compensated for designing and installing a project, and are typically responsible for equipment warranties and commissioning to ensure that the installed equipment works as designed. However, once the customer accepts the project, the long-term performance risk lies with the customer, not the ESCO (see Figure 2-3). Design/build contracts constitute an increasing share of activity in certain MUSH markets (see section 5.2.1). Within the federal market, UESC projects may be considered design/build contracts because the customer contracts with the utility for energy services, and the utility hires an ESCO (or other contractor) to perform the work on a fee-for-service basis. In this arrangement, the ESCO or contractor has historically not generally been responsible for long-term project performance.[32] Thus, from the ESCO's perspective, UESC projects are not usually performance-based, even though there may be a long-term agreement between the agency and the utility.

2.3 Market Drivers and Barriers

To supplement and provide interpretive context for project data results, we conducted interviews with eight ESCOs active in federal and MUSH markets in January, 2004 (see section 3.3 for complete survey administration details). In these interviews, we asked several questions designed to reveal key differences in market drivers and barriers in federal and MUSH markets. Based on these interviews, significant differences exist between federal and MUSH markets in the motivations for customers to enter into ESCO contracts and the factors limiting growth in ESCO activity or preventing cost-effective potential from being captured. Because all of the ESCOs we interviewed were primarily

[32] A current initiative is introducing more rigorous performance evaluation into UESC contracts going forward (FEMP 2004b).

active in the ESPC market, the federal market responses reported here pertain largely to ESPC rather than UESC.

In both federal and MUSH markets, a primary motivation for customers to install projects is the need, as several interviewees put it, "to get new stuff". Public/institutional facilities in the U.S. often suffer from inadequate capital budgets to replace old and/or failing infrastructure, and performance contracts are a way to finance new equipment. For the MUSH markets, all the ESCOs we interviewed agreed that this is the primary driver.[33] In the federal market, compliance with mandated energy-reduction goals was noted by several interviewees as a second important driver.

Many of the interviewees cited common barriers across both market segments, but most emphasized that their magnitude was greater in the federal market. The most often-cited barrier, particularly for the federal government, is the time to develop projects. When asked, in their experience, how long it takes to move a project from initial customer contact to award, all but one ESCO indicated at least 12 months, two of them saying a typical project takes as long as two years.[34] For MUSH markets, all ESCOs answered between 3 months and a year, with most indicating 6-9 months. While to some extent the longer project development time in the federal market may be explained simply by the fact that these projects are larger, our interviews with ESCOs revealed that other factors besides project size slow down the process. These mostly involve bureaucracy – the number of layers of approval required to award a project and the complexity of the contract requirements.

Another often-cited barrier in the federal market is customer preference for congressional appropriations over performance contracting to fund projects, even if appropriated funds take several years to be approved. From the ESCOs' perspective, this preference seriously limits growth in this market segment. Additionally, as Hughes et al. (2003) and the results in section 5.5.4.1 demonstrate, waiting for appropriations may result in significant lost savings opportunities for federal agencies.

In MUSH markets, the primary barrier mentioned is the lack of well-designed and/or supported enabling legislation in certain states. Limited contract terms were especially noted as an impediment to fully capturing the opportunities available. Other barriers cited include an aversion to off-balance sheet financing, especially in the wake of the Enron scandal, the lack of a centralized effort across states, a history of bad projects "poisoning the market" in some states, the need to educate customers, and a feeling that "the low-hanging fruit is already picked".

[33] While some states (e.g., California, New York) do have energy savings mandates that apply to state agencies, none of the ESCOs interviewed noted these mandates as a primary driver in the MUSH markets overall.

[34] This is consistent with the average ESPC project cycle time of 14.9 months reported by Hughes et al (2003), based on projects kicked off in 2000.

Finally, it is worth noting that the then-stalled ESPC program was mentioned by virtually all ESCOs as a critical barrier to federal market growth going forward, though the program has since been reauthorized.

3. Approach

This study draws together information on ESCO activity in public/institutional market segments from several complementary information sources.

3.1 The NAESCO/LBNL Project Database

Our primary source of information on completed ESCO projects is the NAESCO/LBNL database, which was developed to track ESCO industry trends based on project-level data (Goldman et al. 2002). The majority of projects in the NAESCO/LBNL database are self-reported by ESCOs as part of their applications for NAESCO's voluntary accreditation program.[35] Projects from other sources, typically state energy offices or agencies administering performance-contracting programs, are also included in this database.[36] For a detailed discussion on the scope of the industry covered (definition of an ESCO) refer to Goldman et al. (2002).

We have continued to collect data from these sources since Goldman et al. (2002) was published. In addition, with the help of the Federal Energy Management Program (FEMP) we have recently included all awarded DOE Super ESPC projects from Delivery Order schedules in the database (Strajnic and Nealon 2003). This addition greatly enhances our sample of federal market projects. However, because we have 100% coverage of these projects, versus only a sample of UESC and other ESPC projects (largely from NAESCO accreditation), our results reflect a heavy dominance of these DOE Super ESPC projects.

Altogether, 1634 public/institutional sector projects are included in this study.[37] **Table 3-1** shows the data sources of these projects.

Because project data is submitted voluntarily, certain key information is sometimes lacking. While we do follow up with ESCOs to try to obtain missing data, it is not possible to collect complete information on all projects.[38] **Table 3-2** shows the percent of projects in this study with complete information on selected data fields critical to this analysis. In recent years, the number of projects providing floor area, completion dates,

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[35] We control data quality by reviewing projects and working with ESCOs to ensure accuracy. Additionally, projects submitted for NAESCO accreditation are subject to verification by an independent committee of technical experts that conduct customer reference checks of approximately 10% of projects.

[36] Because performance contracting has been emphasized in the NAESCO accreditation guidelines and we have received projects from performance contracting programs, our database includes primarily performance contracts.

[37] Because the focus of this study is on the five major public/institutional markets in the U.S., we have omitted ~550 private sector and public housing sector projects from our sample (25% of the entire NAESCO/LBNL dataset) as well as ~50 non-US projects (2% of projects), except for a few completed on US military bases overseas.

[38] Floor space data was particularly scarce for federal Super ESPC projects, which did not often include this information in the Delivery Orders. To collect the missing data, we contacted ESCOs and FEMP project facilitators about specific projects. For other projects (including non-Super ESPC federal projects), ESCOs provided floor space data when they submitted projects for their NAESCO accreditation applications.

contract terms and contract types has increased considerably.[39] Unfortunately, reporting of energy consumption and energy savings data have not improved significantly. Only about one-third of projects may be evaluated for savings as a percentage of baseline energy consumption, primarily due to missing baseline consumption data. About one-half of projects report energy savings (actual or predicted) in *energy* units and about two-thirds of projects have enough information to be included in our economic analysis. In part, this is because the Delivery Orders for Super ESPC projects (which make up a substantial portion of newly added projects) contained neither disaggregated baseline consumption nor actual savings data (primarily due to their recent installation).

Table 3-1. Data sources of NAESCO/LBNL database projects

Data Source	Number of Projects
NAESCO accreditation applications	1312
Federal Energy Management Program (Super ESPC Delivery Orders)[40]	129
State energy offices/agencies	158
Other sources (e.g., consultants, websites)	35

Table 3-2. Completeness of Key Data Fields in the NAESCO/LBNL database

Data Field	Percent of Projects Completed (n=1634)
Project cost	97%
Year of completion	95%
Floor space	69%
Installed measures	96%
Contract term	75%
Contract type	76%
Baseline consumption:	
Energy usage	43%
Energy usage and baseline metric	36%
Predicted savings:	
Energy units	52%
Energy units and/or dollars	70%
Actual (verified) savings:	
Energy units	44%
Energy units and/or dollars	58%

[39] In Goldman et al. (2002), only 46% of projects had reported floor area, 90% had reported completion dates, 55% had provided contract terms and 53% contract types.
[40] The number of Super ESPC projects differs slightly from FEMP's tracking, because we have treated modifications to Delivery Orders that involve add-on phases as separate projects in our database.

3.2 FEMP UESC Project Database

In Chapters 4 and 6, we present results from FEMP's database of UESC projects alongside ESPC results from the NAESCO/LBNL database.

The FEMP database is the most complete source of information on UESC projects available. Pacific Northwest National Laboratory (PNNL) manages this database for FEMP and has been collecting UESC project information from utilities and federal agencies across the U.S. since the mid 1990s. Utilities and agencies report the data voluntarily to PNNL and the database contains projects at various stages of completion. Thus, it is important to understand that the database is not comprehensive, nor is it a statistically representative sample, although it is the most comprehensive source of UESC project information available.

Most of the utilities that have provided data are members of FEMP's Federal Utility Partnership Working Group (FUPWG); they are primarily investor-owned utilities, although some public utilities (e.g., municipal utilities and cooperatives) have offered UESCs to their federal customers. The projects in the FEMP UESC database have been implemented through partnerships between 80 utilities and 25 federal agencies.

For this study, the UESC database was "frozen" as of July 8, 2004. To better represent the portion of the UESC market in which ESCOs are active, we removed all projects implemented by the Bonneville Power Administration (BPA). We also excluded projects that did not have detailed information on installed energy conservation measures or that had been proposed but not awarded, leaving a dataset of 660 projects.

3.3 ESCO Market Segment Interviews

To supplement and provide interpretive context for project data results, we conducted interviews with ESCOs. Designed to reveal key differences in ESCOs' experience working in federal and other public/institutional markets, the interviews included questions about market drivers and barriers, factors influencing the cost of doing business, the level of competition, degree of market saturation, and maintaining customer satisfaction in federal and MUSH market segments.

With the help of NAESCO, we identified individuals in charge of federal market operations at nine ESCOs active in federal and MUSH markets, and were able to schedule interviews with eight of them. The hour-long telephone interviews were administered in January and February of 2004.

The ESCOs we interviewed were primarily active in the ESPC market (rather than UESC). Thus, the results of these interviews speak largely to their ESPC experience in the federal market. Almost all of the ESCOs interviewed are active in all four MUSH markets.

3.4 Data Analysis and Segmentation

Throughout this report several common methods of analyzing and segmenting data are employed. Here, we introduce these methods and comment on why they are appropriate.

3.4.1 Project Trends Over Time

When analyzing time series data, we group projects into three time periods based on completion date (the year in which project construction was completed and accepted by the customer) that reflect stages in ESCO industry development and driving factors: (1) the years up to and including 1995, in which electricity industry restructuring had not yet commenced and utilities in certain parts of the U.S. made significant investments in energy-efficiency as part of demand-side management (DSM) programs or integrated resource plans, (2) 1996-2000, in which restructuring was imminent in some jurisdictions and strongly influenced the environment in which ESCOs operated in others; this resulted in greater uncertainty, greater competition from utility-owned ESCOs and reduced utility spending on DSM programs, (3) 2001 to present, in which restructuring was stalled in many parts of the U.S. after fallout from the California electricity crisis, the Enron scandal and higher wholesale and retail market prices than anticipated, and the ESCO industry underwent considerable consolidation as many utilities sold or closed their ESCO affiliates. Goldman et al. (2002) reported trends in project data according to the first two time periods; continued data collection since that time allows us to add the most recent period in ESCO industry history.

3.4.2 Retrofit Strategies

We define several retrofit strategies according to the installation of key technologies and project investment thresholds to explore trends in the technical aspects of projects. These strategies are introduced and defined in section 5.2.3 and the methodology for coding projects is described in Appendix B.

3.4.3 Accounting for Inflation in Economic Indicators

In reporting economic and cost indicators, we adjust for inflation where possible, reporting figures in 2003 dollars. This is particularly important when comparing federal projects to other public/institutional market segments because the majority of federal projects have been completed fairly recently, while projects in other markets span the last 15-20 years. Without adjusting for inflation, the costs and savings of these earlier projects would be understated relative to the more recent federal projects. The only exception to this rule is the estimates of total market activity in chapter 4. For this portion of the analysis, we report activity in nominal dollars because we did not have yearly information for all sources and thus had no way of applying inflation adjustment factors.

3.4.4 Statistical Analysis

Both the NAESCO/LBNL and FEMP UESC databases are based on voluntary reporting of project data by ESCOs and utilities/agencies (respectively). They are **not** random

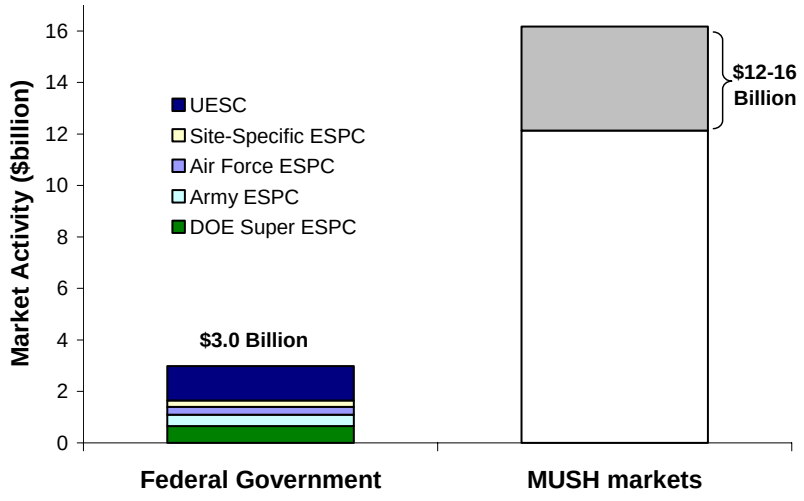
samples of ESCO industry projects. Rather, each database is best characterized as a set of case studies. For this reason, we deliberately avoid performing statistical tests that assume the data is randomized, such as tests for significance of differences of means. Instead, we focus on reporting "typical" project results, primarily medians and inter-quartile ranges (25th and 75th percentiles) that show the spread in the data. Averages are reported in some instances, but as demonstrated with project costs in section 5.3.1, a few "extreme" projects tend to dominate average results. In all cases, the focus is on demonstrating differences across project groupings, rather than making statistical inferences about the significance of results that would be misleading.

4. Institutional Market Activity

In this chapter, we compile information on federal and MUSH market activity from a variety of sources to produce top-down estimates of the size and growth in these markets over the past 10-12 years. These estimates are then compared to the project activity in the NAESCO/LBNL and FEMP UESC databases, providing context for the bottom-up analysis in Chapters 5 and 6.

4.1 Historical Market Activity

Historical activity in the federal ESPC market is relatively well known due to project tracking and reporting efforts by various agencies (FEMP, Air Force, Huntsville). For the 129 Super ESPC projects (all of which are included in our database) total project costs amount to ~$650 million (nominal) (Strajnic and Nealon 2003). As of September 2003, the Army ESPC program had awarded 91 projects with a total investment of ~$450 million (Branch & Skumanich 2003). The site-specific ESPC mechanism has produced about ~$300 million in investment, and the Air Force ESPC program had awarded ~40 projects totaling ~$250 million as of 2002 (FEMP 2002). Based on the projects in FEMP's UESC database, we estimate that almost 1000 UESC projects have been implemented since the early 1990s worth about $1.3 billion in project investment. Adding these estimates, the combined alternative financing activity in the federal market is at least 1300 projects and ~$3.0 billion in project investment over 10-15 years (see **Figure 4-1**).



Sources: Branch & Skumanich (2003), FEMP (2002) and Strajnic and Nealon (2003) (federal ESPC market activity); FEMP UESC database (UESC estimate); NAESCO/LBNL database projection (MUSH market activity estimate)

Figure 4-1. Estimated Federal and MUSH Market Activity: 1990-2003

Federal market activity has been growing over the past decade, in large part because implementation of the Super ESPC program began in the late 1990s. Combining project activity for the various ESPC and UESC alternative financing programs, total activity in

2002 (the latest year for which complete data is available) was about $365 million (Branch & Skumanich 2003, FEMP 2002, Strajnic and Nealon 2003, FEMP UESC database).

For MUSH market activity we assume, based on past research, that our database represents about 15-20% of total historical ESCO industry activity (Goldman et al. 2002). Hence, from the 1324 MUSH projects in our database, representing $2.63 billion, we extrapolate that the total industry activity in these market segments has been approximately $13.1-17.5 billion over the last 20+ years. For the 1990-2003 time period, MUSH activity was approximately $12.1-16.2 billion (see Figure 4-1).

For 2002, we estimate that our database represents about 20-25% of MUSH activity.[41] This results in an estimate of approximately $0.8-1.0 billion in MUSH market activity in that year.

Thus, while the federal market has been increasing in its share of ESCO industry activity, the MUSH markets still dominate total industry investment.

4.2 Database Representation

Figure 4-2 shows the total investment in federal and MUSH market segments in the NAESCO/LBNL and FEMP databases used in this study (see section 6.1 for a full description of the FEMP UESC database). The dataset of projects from the FEMP UESC database included in this study includes 660 projects representing ~$1.1 billion in UESC investment, which we estimate to be 85% of the total market activity as of July 2004 (see section 3.2 for details of which UESC projects were excluded from this study).[42] The NAESCO/LBNL database includes all project activity completed under the DOE Super ESPC program (Strajnic and Nealon 2003). For the other federal market alternative financing mechanisms (Army, Air Force and site-specific ESPC), the NAESCO/LBNL database contains a subset of ~$0.24 billion worth of project investment (about 25% of estimated total activity).

As already noted, the $2.4 billion of MUSH market projects completed since 1990 in the NAESCO/LBNL database are believed to represent about 15-20% of MUSH market activity over this time period. K-12 schools projects account for about half of the MUSH market activity in the NAESCO/LBNL database. Universities and state/local governments each account for ~20% of MUSH database projects, and hospitals represent the remaining ~10%.

[41] We believe that ESCO industry growth has slowed since the estimate in Goldman et al. (2002), which was based on industry revenues up to the year 2000. Since that time, there has been substantial industry consolidation, several utilities have closed their ESCO operations, and fallout from the Enron scandal has impacted industry revenues.

[42] Note, however that the FEMP UESC database was used only for the UESC results in Chapter 6. For the federal market results in Chapter 5, we employed only the projects in the NAESCO/LBNL database, because due to confidentiality constraints we were unable to merge the NAESCO/LBNL and PNNL datasets. The NAESCO/LBNL database contains only $0.14 billion of UESC projects.

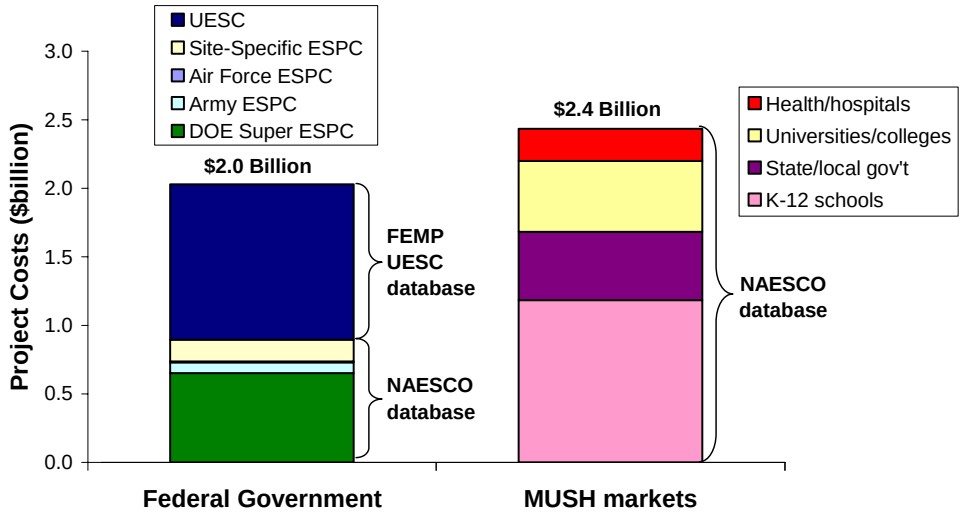


Figure 4-2. Database Representation by Federal and MUSH Projects: 1990-2003

5. Project Trends in Public/Institutional Markets

In this chapter, we examine trends in completed projects from the NAESCO/LBNL database, focusing on comparisons between market segments.

In interpreting the following results, it is important to understand the mix of federal projects in the NAESCO/LBNL database. As mentioned already, it contains 100% of awarded Super ESPC projects (Strajnic and Nealon 2003), as well as a mix of UESC and other ESPC projects (site-specific, Air Force and Army ESPC) received from ESCOs. These latter projects represent a smaller fraction of these markets. Altogether, our sample of 259 federal projects consists of 50% Super ESPC projects, 15% other ESPC, 24% UESC, and 11% are of unknown program type.[43] Thus, the results presented below reflect a heavy dominance of ESPC projects.[44]

5.1 Building Characteristics

Public/institutional facilities encompass a wide variety of building types, and thus a diversity of technical opportunities to develop energy-efficiency projects. To understand project strategies, investment and energy savings, and to characterize the facilities in our database relative to average commercial buildings it is useful to examine the types of buildings included in our dataset.

ESCOs report information on floor area and the number of buildings affected by the retrofit. Floor area is recorded in 69% of projects; of these, 82% also reported number of buildings. **Table 5-1** shows the median project floor area and the median building floor area (when number of buildings was given) for each market segment. The majority of projects (78%) covered multiple buildings.

To put these building size results in perspective, **Table 5-2** shows average building sizes for various types of buildings reported in the 2003 *Means Mechanical Cost Data* (Means 2003), a resource often used to benchmark commercial heating, ventilation and air conditioning (HVAC) equipment costs. The median building sizes in our database are reasonably consistent with the building types that we would expect in each market. For example, civilian federal government buildings are the size of an average high-rise office building and military buildings are the size of a low-rise office building. Similarly the K-12 schools and university data are similar to average buildings of their kind. Based on median building size, it appears that state/local government projects are generally

[43] ESCOs submitting federal projects for NAESCO accreditation were not asked which alternative financing mechanism was used. We coded projects using a delphi approach, asking ESPC and UESC program managers to identify projects based on the site and year. Projects that were unidentified through this process fall into an "unknown" category. They may have been performed with appropriated funds, or they may have been financed through one of the alternative financing mechanisms, but we know with certainty that they are not Super ESPC projects as we have the complete list of these projects.

[44] For this analysis (computation of medians and quartiles for the federal government as a whole, rather than for UESC and ESPC projects separately), we were unable to include the UESC projects from FEMP's database without violating data confidentiality agreements. In Chapter 6, we compare ESPC projects from the NAESCO/LBNL database and UESC projects from the FEMP database to characterize differences between these market segments not captured in this chapter.

installed in facilities larger than a typical town hall; the data more closely resemble low- or mid-rise office buildings. The greatest exception is hospitals; the median hospital in our dataset is three times the size of the average hospital in *Means*. It appears that ESCO projects are primarily installed in the largest hospitals, rather than smaller health care facilities.

Table 5-1. Floor Area by Market Segment

Market Segment	Median project floor area		Median building floor area	
	N	Sq. ft.	N	Sq. ft.
Federal government – civilian	123	665,000	35	240,000
Federal government – military	94	1,685,742	52	24,645
Health/hospitals	107	347,805	93	154,802
K-12 schools	450	238,788	423	67,543
Universities/colleges	151	605,302	139	58,824
State/local government	200	341,000	178	48,533

Table 5-2. Typical Building Floor Area (Means 2003)

Building Type	Typical size (sq. ft.)
Town Hall	10,000
College Classroom Building	50,000
College Science Lab	45,000
Hospital	55,000
Dormitory - Low Rise	25,000
Dormitory - Mid Rise	85,000
Office Building - Low Rise	20,000
Office Building - Mid Rise	120,000
Office Building - High Rise	260,000
Elementary School	41,000
Jr. High School	92,000
High School	101,000

5.2 Project Strategies

5.2.1 Contract Types

The types of contracts undertaken by federal and MUSH projects in the NAESCO/LBNL database are shown in **Figure 5-1**. Within the federal government, ESPC projects are classified as ESCO-financed guaranteed savings contracts (see section 2.2). The remaining projects – UESC projects and projects of unknown financing mechanism – were classified by the ESCOs that submitted the project data. Of these, 66% were

classified as guaranteed savings, 7% as shared savings or other types of performance agreement, and the remaining 27% are non-performance-based, design/build contracts.[45]

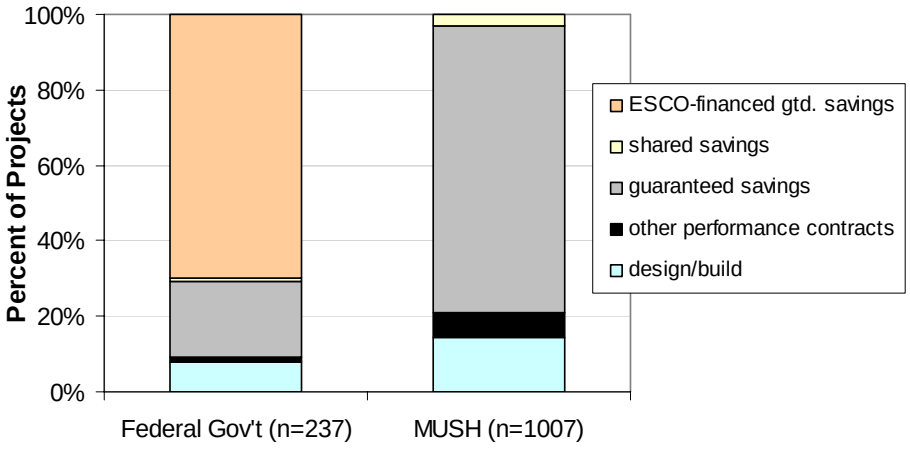


Figure 5-1. Contract Types of Federal and MUSH Market Projects

Performance contracting in the MUSH markets is clearly dominated by guaranteed savings projects (see Figure 5-1). Shared savings agreements represent a much lower share (3% of projects vs. 76% for guaranteed savings) as this type of agreement has fallen out of favor in these markets. Reasons for increasing customer preference for guaranteed savings contracts include greater certainty of savings, lower financing costs (most MUSH customers can obtain tax-exempt financing, whereas ESCOs cannot), and lower transaction costs (ESCOs can focus on project performance and need not assume financing risk).[46] While non-performance contracts appear somewhat more common in MUSH markets than the federal government (15% of MUSH projects vs. only 8% for federal government), this is primarily due to the over-representation in our database of ESPC projects within the federal market, all of which are by definition performance contracts.

In Goldman et al. (2002), we reported that performance contracting in the industry as a whole was declining. Trends in project data were corroborated by an industry survey of ESCO revenues based on performance- and non-performance-based projects; both sources of data included projects up to and including the year 2000. **Table 5-3** confirms these trends for certain public/institutional market segments and also includes data from

[45] The high proportion of guaranteed savings contracts among UESC projects is surprising to us because UESC contracts do not generally entail long-term performance agreements. We believe that ESCOs may have misinterpreted this question when providing project data. It may be that they were involved in long-term O&M or other servicing agreements for these projects, and answered on this basis.

[46] Shared savings agreements were more prevalent in the early days of the ESCO industry (1980s and early 1990s), when customers were less familiar with energy-efficiency projects and less confident that savings would materialize. Thus, ESCOs found that customers were more likely to sign contracts if the ESCO assumed financing as well as project-performance risk. As the industry has matured and developed a track record and customers have become more comfortable with the technical performance of projects, these benefits have become less compelling.

2001 to present. In the K-12 schools market segment, performance contracting has retained an almost exclusive role throughout the industry's history; this probably reflects a lack of viable financing alternatives for capital equipment in this market. For the other MUSH markets – universities/colleges, state/local governments and health/hospitals – there was a noticeable decline in the share of projects that were performance-based in the late 1990s, followed by an increase in recent years. Lower interest rates since 2001 may be responsible for the observed resurgence.[47] Nonetheless, the overall trend in performance contracting for these market segments is still downward compared to the pre-1996 period. For federal market projects, the marked increase in performance contracting is explained by the Super ESPC projects, all of which constitute performance contracts and the majority of which were completed since 2001.

Table 5-3. Trends in Performance Contracting Among Database Projects

Market Segment	**N**	**Percent of projects that are performance contracts:**		
		before 1996	**1996-2000**	**2001- present**
K-12 schools	507	95%	94%	93%
State/local government	174	89%	65%	84%
Universities/colleges	203	96%	78%	84%
Health/hospitals	117	88%	67%	74%
Federal government	234	85%	85%	98%

5.2.2 Contract Term

Strongly related to project agreement types (above), the length of the contract between the ESCO and the customer is another important project characteristic. In interviews, ESCOs consistently told us that contract terms are longer in the federal market, citing typical terms of 10-20 years compared to 10-12 years for MUSH projects, although many noted exceptions to this rule.

As **Figure 5-2** shows, the project data confirm our interview results. Federal contracts range in length from 0 to 25 years, with an average of 14 years, while MUSH market contracts range from 0 to 26 years and are 9.5 years on average. The zero-term projects in Figure 5-2 usually correspond to design/build type arrangements.[48] In the federal market, this practice is limited to the UESC market – all ESPC projects entail multi-year commitments.

When asked why they thought that federal contracts were longer-term than MUSH contracts, most ESCOs cited a number of state performance contracting laws that limit MUSH market contract terms to 10 years or less as the primary reason. Other factors

[47] While the collection of data through NAESCO accreditation applications biases the sample toward performance contracting (see section 3.1), there has been no change in the way data is collected over time, so this effect should not be greater in certain periods than others.

[48] Occasionally, ESCOs also report zero-length contracts for performance contracts in which the customer has opted not to pay for measurement and verification (M&V), agreeing instead to stipulate all savings.

mentioned include availability of financing (interest rates are higher for longer term projects) and less complex measures with shorter paybacks installed in MUSH market projects – this latter point is assessed in section 5.2.3.

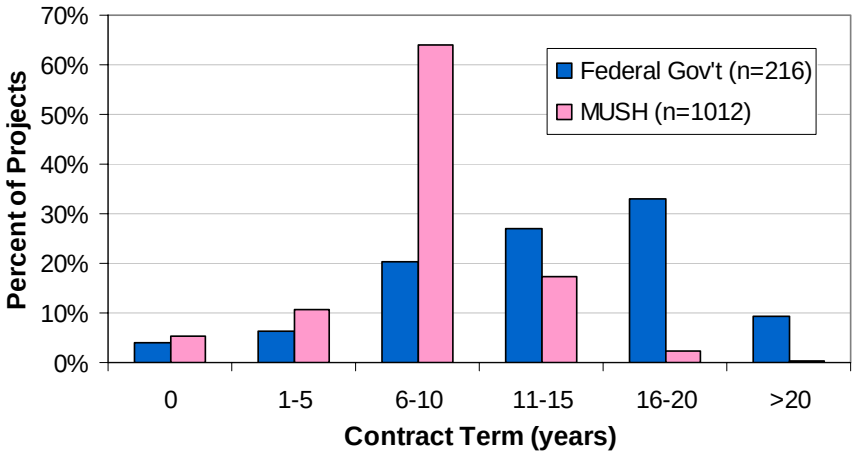


Figure 5-2. Contract Terms of Federal and MUSH Projects

Another important factor is the clear separation of financing and project performance in MUSH contracts. For MUSH customers, the term of the contract between the ESCO and customer (reported here) may not correspond with the term of the financing agreement signed by the customer and a third-party financier – in many cases it may be shorter. For federal ESPC projects, financing is a major determinant of contract term because the ESCO either provides the financing in-house (or through its parent company) or assumes debt on behalf of the customer (see section 2.2). Thus contract terms typically equal financing terms for federal ESPC projects, in part explaining the observed longer average federal contract terms.

5.2.3 Installed Measures

ESCO projects may include a wide variety of installed measures that provide energy or cost savings, reliability benefits, or even non-energy-related improvements. The range of measures installed in the federal and MUSH projects in the NAESCO/LBNL database is shown in **Table 5-4**, along with the saturation of each (percent of projects that installed them).[49]

Clearly, the key technologies in both markets are lighting (80-90% of projects) and HVAC controls (~80% of projects). The prevalence of these measures is explained by their low installation costs and high savings – the resulting short payback times make them attractive investments as stand-alone projects, but also as a means to leverage longer-payback measures to achieve comprehensive projects within a customer's payback criteria.

[49] See Appendix A for full details of the individual measures included in the categories in Table 5-4.

Table 5-4. Saturation of Installed Measures

Measure Category	Federal Government (n=253)		MUSH Markets (n=1310)	
	No. of projects	% of projects	No. of projects	% of projects
Lighting	202	80%	1146	87%
Heating, Ventilation & Air Conditioning (HVAC):				
Boilers	40	16%	384	29%
Chillers	76	30%	285	22%
Other HVAC sources (e.g., cooling towers, furnaces, steam plants)	22	9%	170	13%
Distribution/ventilation	101	40%	548	42%
Controls (e.g., thermostats, energy management systems)	199	79%	1055	81%
Other HVAC	13	5%	64	5%
Packaged/roof-top/split systems	21	8%	155	12%
Air quality	2	1%	7	1%
Building envelope (e.g., insulation, windows, doors)	18	7%	222	17%
Geothermal heat pumps	21	8%	1	0%
Motors/drives:				
High-efficiency motors	44	17%	167	13%
Variable speed drives (VSD)	57	23%	246	19%
Water heaters (DHW)	22	9%	123	9%
Miscellaneous equipment/systems (e.g., plug loads, traffic signals, office equipment)	20	8%	83	6%
Industrial process improvements	10	4%	7	1%
Other measures/strategies (e.g., fuel conversion, staff training, peak shaving)	62	25%	347	26%
Water conservation	67	26%	152	12%
Distributed generation (DG):				
Renewables (e.g., photovoltaics, wind, biomass)	9	4%	3	0%
Cogeneration	8	3%	36	3%
Other DG technologies (e.g., natural gas engines, microturbines)	8	3%	15	1%
Backup/emergency generators (e.g., diesel engines)	3	1%	19	1%
Non-energy improvements (e.g., asbestos abatement, ceilings, roofs)	10	4%	246	19%

NOTE: see Appendix A for complete details of the measures included in each category.

Based on our interviews with ESCOs, we expected to find significant differences in the types of measures installed in federal and MUSH market projects. Several interviewees expressed the view that MUSH customers tend to install simpler, less comprehensive

“lighting and HVAC” projects, whereas federal customers are more likely to install innovative technologies. Reasons given for this view included differences in customer “sophistication”, limitations due to maximum allowable terms set by state performance contracting laws in MUSH markets, and a greater focus on energy (rather than economic) savings in the federal market. However, as Table 5-4 demonstrates, the penetration of most measure categories is quite similar in federal and MUSH market projects in the NAESCO/LBNL database. The most marked differences are: a higher incidence of boilers, building envelope retrofits and lighting retrofits in MUSH than federal markets, and more frequent installation of water conservation measures, chillers, geothermal heat pumps (GHP) and renewable energy production in the federal market.

The higher rates of boiler installation, building envelope improvements and lighting retrofits in MUSH projects are dominated by K-12 schools, which account for ~50% of MUSH projects and are known to use energy performance contracting as a means to pay for replacing aging HVAC equipment as well as infrastructure improvements. Evaluated alone, 36% of K-12 schools projects installed boilers, and 21% implemented building envelope improvements. Lighting replacement in K-12 schools is 91%, even higher than the 87% of projects that replace lighting in the MUSH markets as a whole. This probably reflects (1) usage of lighting to pay for other infrastructure in schools and (2) a focus on improved lighting quality in public schools.

While K-12 schools are the most extreme case, the need to replace aging equipment is a driver in all public/institutional markets. In the federal market, however, we see that it is not boilers that need replacing, but more often chillers. This may be driven in part by geography: most large military bases are located in the southern states with greater cooling needs. Additionally, chiller saturation in schools is lower than other building types such as office buildings and health care facilities (EIA 2002); this is because some schools do not operate during the summer months, and others meet their air conditioning needs with packaged/rooftop systems or window A/C units rather than central chillers. Because schools account for roughly half of the MUSH projects in our sample, this influences the relatively low rate of chiller retrofits in MUSH markets.

The higher rate of GHP and renewable energy generation in federal government projects reflects targeted policy support for GHP, photovoltaics and biomass technologies. The Super ESPC program includes specialized contracts and specialized ESCO pre-qualifications lists for these three technologies. Thus, while the overall penetration of renewable energy technologies in our database is still very low, the impact of these efforts is visible.

Finally, the relatively high rate of water conservation measures in the federal government (26% of projects) is driven by high domestic water usage in military housing. We would expect to see a similar trend in dormitories on college campuses. Indeed, water conservation measures are installed in 19% of universities/colleges projects (compared to 12% in MUSH markets as a whole).

5.2.4 Retrofit Strategies

To examine project trends according to the technical aspects of projects, we define six "retrofit strategies" that characterize projects according to the key technologies installed (see **Table 5-5**).[50] Appendix B provides an in-depth explanation of these retrofit strategy definitions and how projects were coded.

Table 5-5. Retrofit Strategies of Database Projects by Market Segment

Retrofit Strategy	Percent of Projects				
	K-12 schools (n=634)	**State/ local gov't (n=262)**	**Univ./ colleges (n=210)**	**Health/ hospitals (n=204)**	**Federal gov't (n=253)**
Lighting Only	9%	26%	13%	25%	13%
DG	4%	3%	4%	2%	10%
Major HVAC	21%	21%	24%	25%	21%
Minor HVAC	47%	35%	48%	37%	44%
Non-energy	16%	9%	6%	3%	3%
Other	2%	7%	5%	8%	9%

"Lighting only" projects installed only lighting equipment or controls. These projects are by definition not comprehensive because they only retrofit one end use.[51] Lighting-only projects are most prevalent in state/local government and health/hospitals market segments, making up about one quarter of all projects in our database. For other market segments, these retrofits are a less common strategy (9-13% of projects).

Projects that included any type of electricity generating technology (including cogeneration) were classified as "distributed generation" (DG) projects. DG equipment is highly capital-intensive and is typically installed for cost savings, capital stock replacement or reliability reasons (with energy savings often of secondary importance); DG is also recognized as an increasingly important strategy in the ESCO industry. Virtually all the DG projects in our database are bundled with more traditional energy-efficiency retrofits. Energy saving measures serve to leverage the cost of DG equipment and may also reduce the required generating capacity (smaller, less expensive DG equipment may be installed). DG projects in our database are most common in the federal government sector (10% of projects versus only 2-4% for other market segments).

Our third strategy, "major HVAC", includes non-DG projects that installed centralized capital-intensive HVAC equipment – boilers, chillers, cooling towers and piping/steam distribution. Our goal in defining this retrofit strategy was to identify projects with major HVAC equipment replacement (e.g., in which the entire heating or cooling system was replaced), as opposed to relatively minor modifications. For this reason we developed a

[50] It is important to note that, with the exception of lighting-only retrofits, projects typically contain other measures besides the key technology for which the strategy is named. Our strategies were designed to characterize projects based on the dominant measure installed in the project.

[51] Note that because lighting measures were targeted by 80-90% of projects in all market segments, lighting is bundled with the majority of the projects in all retrofit strategies, not just lighting-only projects.

cost per square foot cutoff for each of the technologies, and projects were included in this strategy only if they met these cost criteria (see Appendix B for details). Major HVAC projects represent a comparable share of projects across all market segments (21% to 25% of projects).

"Minor HVAC" projects include non-capital intensive HVAC measures as the primary retrofit technology. This characterizes a wide range of projects, from those with only HVAC controls and lighting retrofits to more comprehensive projects that still fall within the traditional end uses captured by ESCOs. As Table 5-5 shows, minor HVAC is the most common strategy implemented in all market segments (35% to 48% of projects).

Projects classified as "non-energy" retrofits contain capital-intensive measures that produce little or no energy savings, such as ceilings, roof repair/replacement, or asbestos abatement. Non-energy projects *always* contain energy saving measures as well – the non-energy savings measures "piggyback" on energy savings, which are vital to the project. Thus, it should not be concluded that these projects do not save energy; rather, we have defined this retrofit strategy to separate projects that may have relatively poor economics because the savings are used to pay for non-energy benefits. This strategy is most common in K-12 schools (16% of projects versus only 3-9% for other market segments).

Finally, our sixth, "other", strategy includes all projects that did not fit into the above strategies. These projects include measures such as domestic hot water (DHW), water conservation, installation of energy-efficient equipment such as vending machines, laundry or office equipment, high-efficiency refrigeration, industrial process improvements and strategies such as staff training or utility tariff negotiation. While these individual strategies may be included in any of the above retrofit strategies (except lighting only), the projects in this strategy possess these types of measures alone. They represent a minor share of the projects in each market segment (2% to 9% of projects).

Figure 5-3 illustrates trends in retrofit strategies in the NAESCO/LBNL database over time. Lighting-only projects have clearly become less common, dropping in database share from almost 20% of projects in the pre-1996 and 1996-2000 periods to only 7% since 2000. This is probably due to limited remaining opportunities for single-measure lighting projects. There is other evidence to suggest that ESCOs are increasingly developing more comprehensive or complex projects as well: the relative share of major HVAC and DG retrofits have increased (from 16% to 27% for major HVAC and 2% to 9% for DG), while the share of minor HVAC retrofits has diminished somewhat (from 52% to 42%). This comports with industry reports that onsite generation is becoming an increasingly important strategy for ESCOs.[52]

[52] While the recent activity in the federal ESPC market drives these results to some extent, all these trends hold true in both federal and MUSH markets.

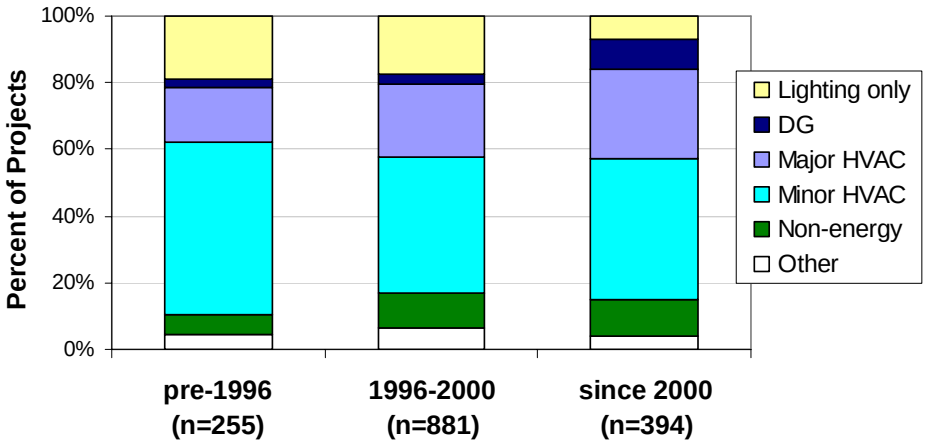


Figure 5-3. Trends in Retrofit Strategies

5.2.4.1 Contract Term and Retrofit Strategies

In interviews, ESCOs mentioned the types of measures installed in projects as a key difference driving contract terms in federal and MUSH markets (see section 5.2.2). **Figure 5-4** shows the range in contract terms for projects in each retrofit strategy – the project data supports the notion that retrofit strategies are correlated with contract terms.

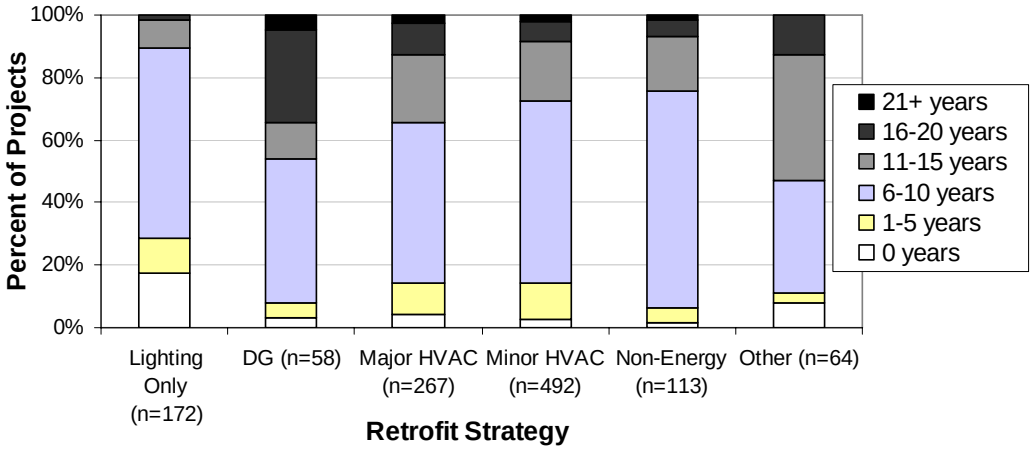


Figure 5-4. Project Contract Terms by Retrofit Strategy

Lighting only projects have the shortest terms on average at 7.8 years – this comports with the relatively short payback times typical of lighting efficiency projects. DG projects have the longest terms – 12.9 years on average – this too is intuitive as this type of equipment is capital intensive and may be installed for reasons other than energy savings (such as increased reliability), contributing to longer economic payback times. Additionally, the installation of complex generating equipment is often bundled with ongoing servicing agreements in which the ESCO is responsible for maintaining the equipment over many years. Projects dominated by non-energy improvements also tend

to have long payback times because much of the energy savings are used to pay for the non-energy equipment, thus it is not surprising that they too have relatively long contract terms (10.9 years on average). Major HVAC projects have slightly longer terms than minor HVAC projects (10.8 vs. 10.3 years on average). Finally, projects in the "other" category display a wide range of contract terms; this reflects the varied assortment of retrofits included in this category.

While the notion that retrofit strategies drive contract terms is consistent with the data, we find that the difference between federal and MUSH project contract terms is not explained by differences in retrofit strategies. As shown in **Table 5-6**, federal government projects have longer contract terms than MUSH projects *within each retrofit strategy*. Thus it appears that other factors are more likely responsible for the observed longer terms in federal government projects (see section 5.2.2).

Table 5-6. Contract Terms by Retrofit Strategy for Federal and MUSH Projects

Retrofit Strategy	Federal Projects		MUSH Projects	
	N	average contract term	N	average contract term
Lighting only	19	8.3	153	7.7
Distributed generation	24	15.9	37	10.9
Major HVAC	49	15.0	225	9.9
Minor HVAC	97	13.8	405	9.5
Non-energy	7	17.6	108	10.4
Other	17	15.1	47	10.7

5.3 Project Size and Turnkey Costs

Having characterized project strategies employed in various market segments – contract types, contract terms and installed measures – we now move on to an analysis of project costs. The results in this section all represent *turnkey* project costs – the total cost to install the project, including all costs related to design, construction and commissioning as well as construction-period financing and any fees related to arranging long-term financing, but *not* including long-term financing (interest) costs.[53]

Turnkey costs provide information on the size of projects installed and the relative contributions of projects to cumulative industry investment; this is the subject of section 5.3.1. When normalized for square footage of the retrofitted space, they also provide a means to compare the intensity of the investment (section 5.3.2).

All costs in this section are inflation-adjusted to allow comparisons across years, and are reported in 2003 dollars.

[53] While interest costs for long-term project financing represent an additional cost that customers often bear and are typically higher for federal government projects, we believe they are best addressed in the context of project economics (cost-effectiveness or value of investment). The impact of debt-service costs on the project economics of Super ESPC projects is demonstrated in section 5.5.4.1.

5.3.1 Trends in Project Size

In interviews, ESCO representatives consistently told us that federal projects are larger than MUSH market projects, and the evidence in our database supports this. **Figure 5-5** shows the distribution of projects by cost for each market segment. Median costs for federal projects are indeed higher than all the MUSH market segments at $2.04 million.[54] Median turnkey costs for MUSH market segments range from $0.72 million for health/hospitals to $1.25 million for K-12 schools.

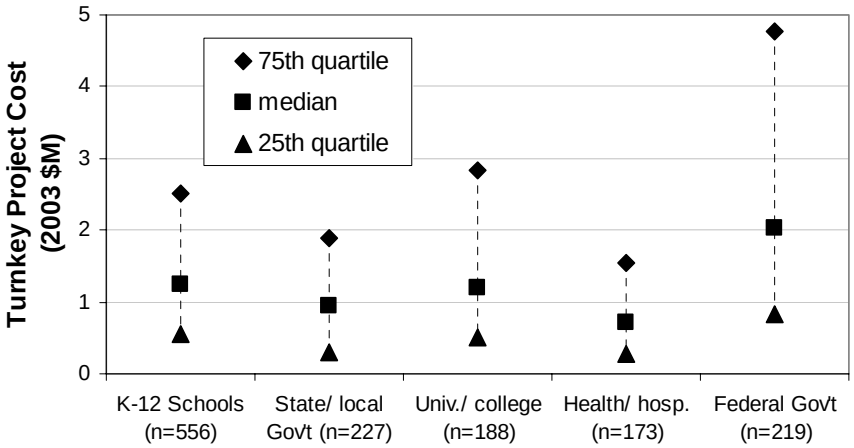
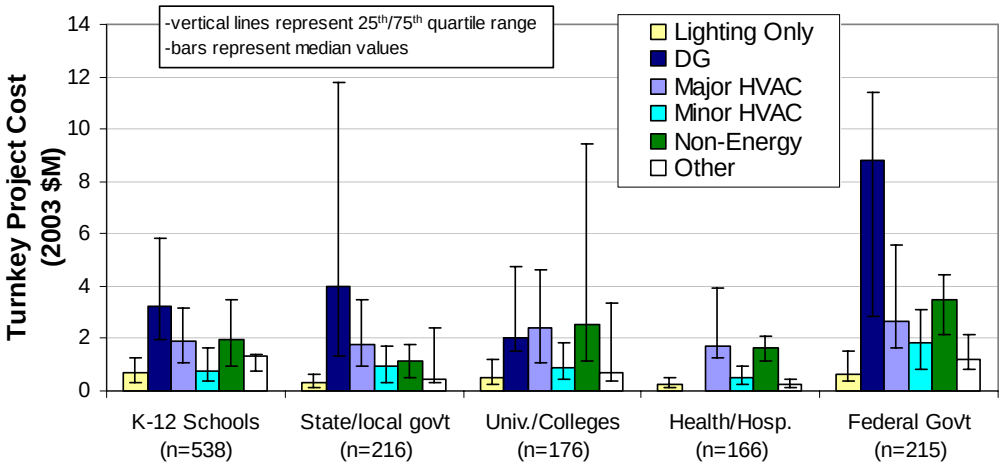


Figure 5-5. Project Size by Market Segment

Within market segments, there are distinct differences in project size among retrofit strategies. **Figure 5-6** shows the middle 50% of the range in costs in each retrofit strategy and market segment (the bars represent medians and the high-low lines bound the 25th and 75th quartiles). Lighting only projects are clearly quite small in all market segments – the majority are less than $1 million. For most other strategies, the largest projects are found in the federal government. This is particularly so for distributed generation projects: while they represent the largest projects in almost all market segments, the federal government has clearly installed some extremely large DG projects. For universities/colleges, major HVAC projects are of roughly equivalent size to DG projects and projects with non-energy improvements. As expected, major HVAC retrofits are larger than minor ones in all market segments.

There has been a significant increase in average project costs in our database over time, in both federal and MUSH market segments (see **Figure 5-7**, in which projects are grouped by completion date). This trend appears more prominent in the federal market, though this probably reflects the heavy representation by Super ESPC projects in our database, most of which have been implemented since 2000.

[54] The large project size for federal projects reflects the dominance of ESPC projects in our dataset. As demonstrated in Chapter 6, UESC projects tend to be smaller than ESPC projects.



NOTE: Groupings with fewer than five projects are not shown.

Figure 5-6. Turnkey Project Costs by Retrofit Strategy and Market Segment

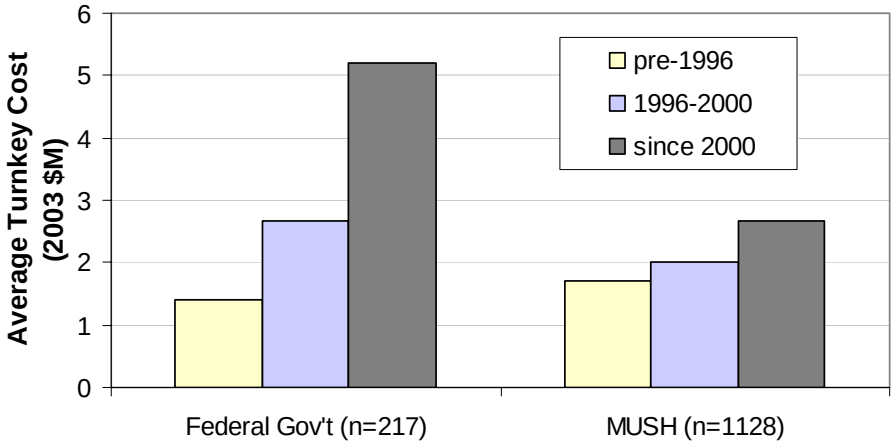
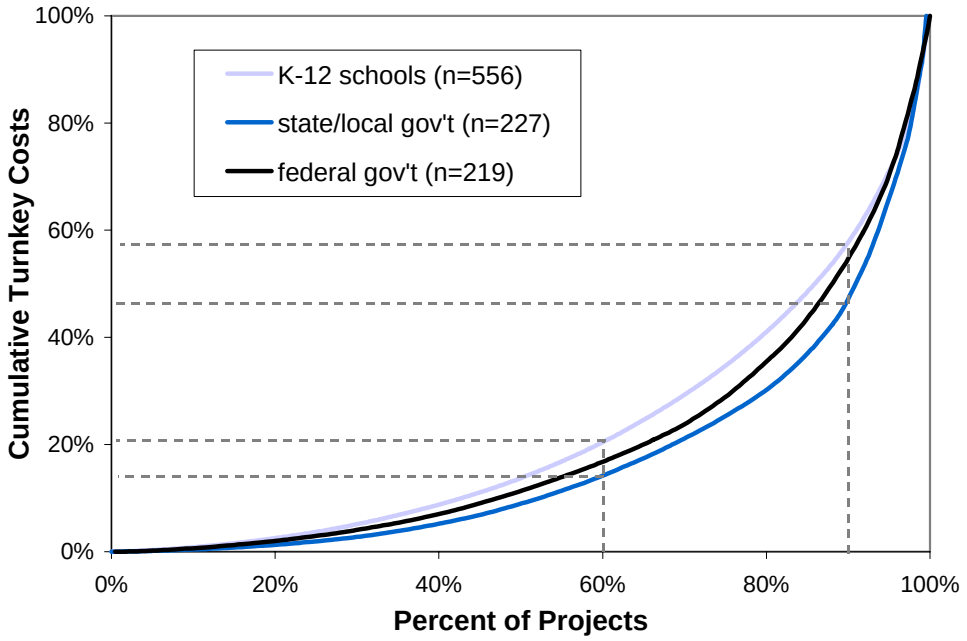


Figure 5-7. Trends in Average Project Size

In all market segments, a few large projects account for a large portion of the total activity in our database. In **Figure 5-8**, the projects in each of three market segments are ordered along the x-axis from least to greatest turnkey costs; the y-axis shows the cumulative costs accounted for by all the projects to the left of each data point. The curves for universities/colleges and health/hospital market segments are of almost identical shape to the federal government curve, thus are not shown on the graph.

Reading off the graph, it is evident that the smallest 60% of the projects account for between ~15% and ~20% of the total costs in each market segment, and the smallest 90% of projects account for roughly 50% of costs. Conversely, 10% of projects in each market segment are large enough that they contribute between ~47% and ~58% of the total costs in our database, depending on the market segment. This analysis is useful for understanding the importance of large projects to ESCOs' total revenues. It also demonstrates the great range of projects in our database and the influence that these few

large projects have on database results – this is part of the reason we emphasize median rather than average results, as averages tend to be dominated by these large projects.



NOTE: Universities/colleges and health/hospitals market segment curves are almost identical to the federal government's, thus are not shown on the graph.

Figure 5-8. Cumulative Costs of NAESCO/LBNL database Projects

5.3.2 Turnkey Project Investment

To compare the installed *cost* of projects (rather than size), we normalize turnkey project costs by the retrofitted floor space and examine trends across market segments (**Figure 5-9**) and retrofit strategies (**Figure 5-10** and **Table 5-7**). As Figure 5-9 shows, the highest levels of investment per square foot occur in state/local governments ($3.71/ft^2 median), and health/hospitals ($3.64/ft^2 median) facilities. The greatest range in project investment is also observed in these markets.

Federal government and universities/colleges projects have the lowest median investment ($2.32/ft^2 and $2.43/ft^2 respectively). This result does not appear to be driven by the types of retrofits installed, as costs for federal and university projects are lower than most other markets *in each retrofit strategy* (see Figure 5-10). Rather, we believe these results are linked to facility size – projects in both these market segments tend to cover significantly more square footage than projects in other markets (see section 5.1). There are two ways to interpret this: (1) they reap economies of scale by installing large projects, or (2) these large facilities simply do not retrofit all of the floor space with the

same number or type of energy savings measures.[55] The former explanation, that these projects are achieving economies of scale, is supported not only by their large physical size, but also by their high total investment (see Figure 5-5) relative to other market segments. This is most obvious for the federal market, though universities/colleges projects are also somewhat larger than most other MUSH market segments. An example of the latter would be a project that installed multiple measures, but only applied one or a few measures to the entire retrofitted space (e.g., lighting only for most of the floor space), with the more intensive measures covering a smaller area. In smaller facilities (such as found in other market segments) the impact of this disparity of investment would not be as great.

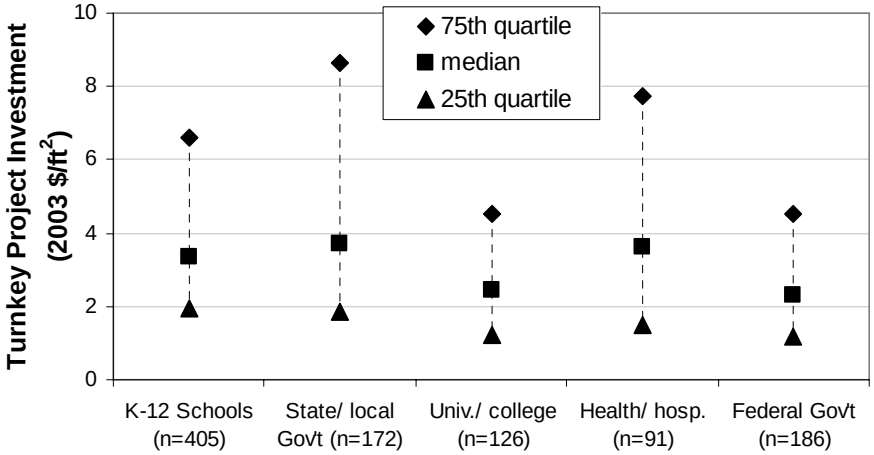
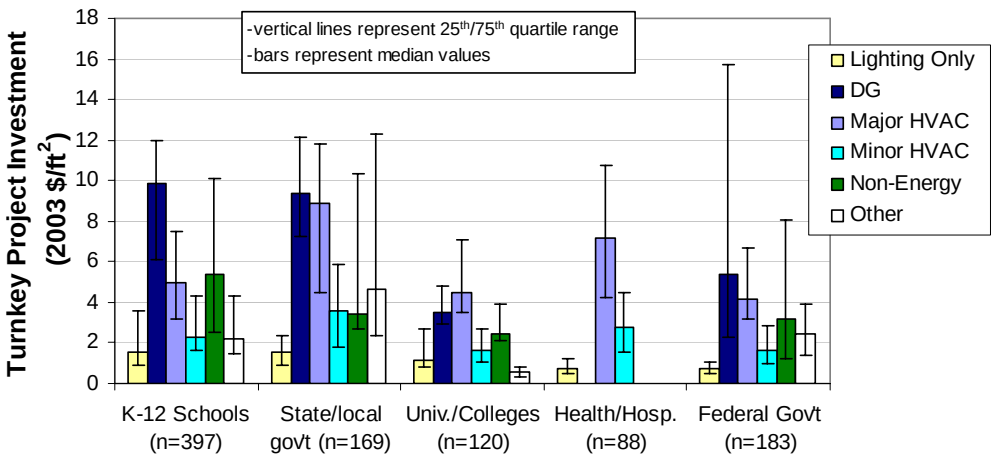


Figure 5-9. Turnkey Project Investment by Market Segment

While K-12 schools projects tend to have slightly higher total costs than universities/ colleges (Figure 5-5) and therefore might also be expected to achieve economies of scale, their costs are higher on a per-square-foot basis ($3.33/ft^2). This is in part explained by the tendency of schools to install non-energy improvements (such as new ceilings, roofs and asbestos abatement) in addition to energy-saving measures. Because such investments are capital intensive, they add greatly to the cost of projects. Indeed, not only do schools employ this retrofit more often than other market segments, but as Figure 5-10 shows, they also tend to spend more on these types of projects.

From Figure 5-10 and Table 5-7, it is clear that lighting-only projects are the least cost-intensive retrofits installed in all market segments. This partly reflects the quick payback of lighting retrofits, but is also due simply to the fact that only one measure was installed. In all other retrofit strategies, the majority of projects included lighting as part of the retrofit (recall that over 80% of projects contain lighting), thus about $1.00/ft^2 of the observed investment for most projects within these strategies is probably attributable to lighting.

[55] ESCOs are requested to report building characteristics (floor area and number of buildings) that encompass the scope of the retrofit.



NOTE: Groupings with fewer than five projects are not shown.

Figure 5-10. Turnkey Project Investment by Retrofit Strategy and Market Segment

While DG projects are clearly much larger than other retrofits (see Figure 5-6), on a per-square-foot basis, they are comparable in investment intensity to major HVAC retrofits (Figure 5-10 and Table 5-7). This suggests that there is a critical minimum size of facility for which current DG technologies are installed. The K-12 schools market appears to be an exception – DG projects are considerably more cost-intensive than major HVAC projects in this market. In all markets, as expected, minor HVAC retrofits are less costly than major HVAC retrofits.

Table 5-7. Turnkey Project Investment by Retrofit Strategy

Retrofit Strategy	N	Turnkey Project Investment (2003 $/ft^2)		
		25th quartile	Median	75th quartile
Lighting only	116	0.71	1.20	2.37
Distributed generation	53	3.01	7.43	13.31
Major HVAC	260	3.38	4.99	8.97
Minor HVAC	390	1.39	2.15	4.13
Non-energy	99	2.44	4.65	9.97
Other	39	1.35	2.40	4.39

5.4 Energy, Water and Operational Savings

In this section, we examine project benefits: energy, water and operational savings.

5.4.1 Annual Energy Savings

ESCO projects may produce savings of several energy sources; electricity and natural gas are the most common types of fuel saved, though several projects in the NAESCO/LBNL database have also saved fuel oil, coal, steam, chilled water, propane or kerosene. In this analysis, we convert savings from all sources to British Thermal Units (Btus) and

combine them for each project.[56] For electricity, we assume site energy conversion (1 kWh = 3412 Btu).

ESCOs applying for NAESCO accreditation are required to provide their engineering predictions of annual energy savings as well as at least one year of actual (realized) savings for all projects that were completed at least one year previously. In this analysis, where available, we use averaged actual annual savings. For projects lacking this information, we report predicted savings instead (~30% of projects). For the majority of Super ESPC projects, only predicted savings were available.

Like project costs, we report energy savings per square foot of retrofitted space to account for differences in project size. Reductions in electricity usage provide the majority of project energy savings: 78% on average, with the remaining 22% attributable to savings of other fuels, primarily natural gas.

As **Table 5-8** shows, the highest savings are observed in the health/hospitals market segment (median savings of 22 kBtu/ft^2), and the lowest annual savings are found in K-12 schools (12.5 kBtu/ft^2 median).

Table 5-8. Annual Energy Savings by Market Segment

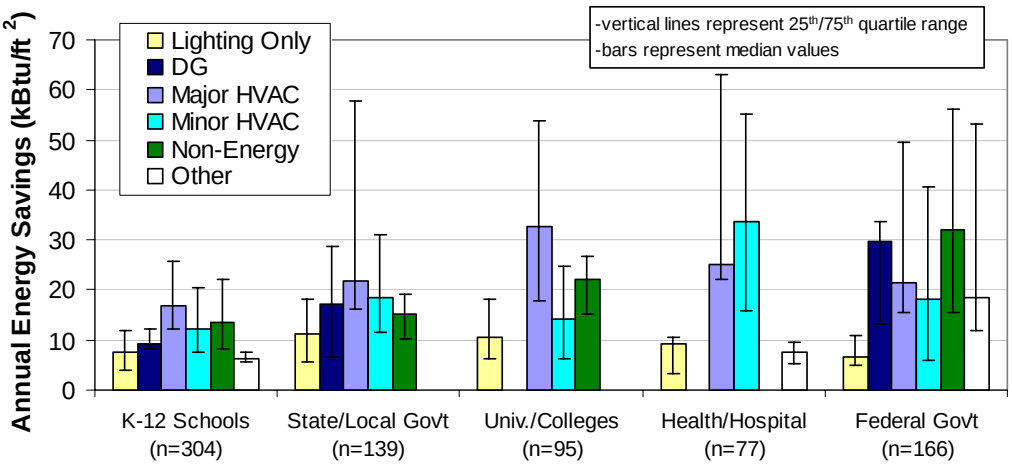
Market Segment	**N**	**Annual Energy Savings (kBtu/ft^2)**		
		25th quartile	**median**	**75th quartile**
K-12 schools	311	7.6	12.5	20.6
State/local government	141	9.9	17.0	28.6
Universities/colleges	100	6.4	16.0	29.8
Health/hospitals	79	9.6	22.0	49.3
Federal government	169	7.5	18.2	38.1

A number of factors may explain the differences in energy savings between market segments. First, investment intensity may drive savings (e.g., if you spend more you get more). This explanation is plausible for hospitals, which had high investment intensity relative to other markets (see Figure 5-9) and also has the highest energy savings. However, it does not explain all markets – the federal government, for example, has low investment levels but high savings – as mentioned earlier, this may reflect economies of scale from the large size of these projects.

Another possible explanation is installed retrofits. For example, the moderate levels of energy savings observed in state/local government facilities may be explained by the fact that they install lighting-only projects more often than other markets (see Table 5-5). As shown in **Figure 5-11**, lighting-only projects do indeed produce lower energy savings

[56] In our energy savings analysis, we excluded a few projects that consisted of fuel conversion or cogeneration exclusively (no other measures were included in the project) because the main motivation for these projects was not energy savings but economic savings or reliability. These projects are, however, included in our economic analysis.

than other retrofit strategies, across market segments. That is not to say that lighting retrofits do not produce significant energy savings – they do, and at a relatively low cost. Rather, this result reflects the fact that lighting-only projects only installed one measure. Recall that the majority of projects in the other retrofit strategies also included lighting retrofits (see sections 5.2.3 and 5.3.2). Thus, it is likely that 5-10 kBtu/ft^2 of the savings in the other strategies are attributable to lighting.



NOTE: Groupings with fewer than five projects are not shown.

Figure 5-11. Annual Energy Savings by Retrofit Strategy and Market Segment

The high HVAC savings in the health/hospitals market segment is probably due to unique operating conditions. First, hospitals tend to have long operating hours relative to other types of buildings. Second, hospitals in the U.S. are required to bring in 100% outside air (rather than recycling indoor air) in certain areas such as operating rooms (ASHRAE 2001). Because outside air intake is higher than for other types of buildings, more energy is required for space conditioning. As a result, retrofits such as energy management systems or duct system improvements that improve HVAC efficiency in hospitals produce high energy savings relative to other market segments. Another factor may be the unique tendency of hospitals projects in our database to target high energy saving measures such as efficient fume hoods, waste disposal equipment and laundry equipment along with HVAC retrofits.

An interesting finding in Figure 5-11 is that projects with non-energy improvements have high energy savings relative to other strategies. This apparently paradoxical result is actually quite simple to explain: in order to pay for non-energy improvements, these projects need to derive significant savings from energy-conserving measures.

In many cases, however, retrofit strategies do not appear to drive energy savings. In K-12 schools, for example, savings per square foot are lower than other markets in all retrofit strategies, and savings in the federal government are high relative to other markets in most strategies.

A third possible explanation for variation in energy savings among market segments is the level of baseline, or pre-retrofit, energy consumption. It may be that the lower energy savings per square foot in schools, for example, are explained by lower energy usage per square foot to begin with (e.g., due to previous retrofits or operational practices, such as school vacations). **Figure 5-12** shows energy savings as a percent of the *utility bill* baseline by market segment. While the sample sizes are small (due to missing baseline consumption data for some projects and non-utility bill baseline metrics for others), it appears that there is no significant difference between market segments in energy savings as a percent of facility usage – median savings are all between 15 and 20%.[57] This suggests that the differences in annual energy savings reported in Table 5-8 may be attributable to differences in technical opportunities rather than a tendency to pursue energy savings more aggressively in certain market segments than others.

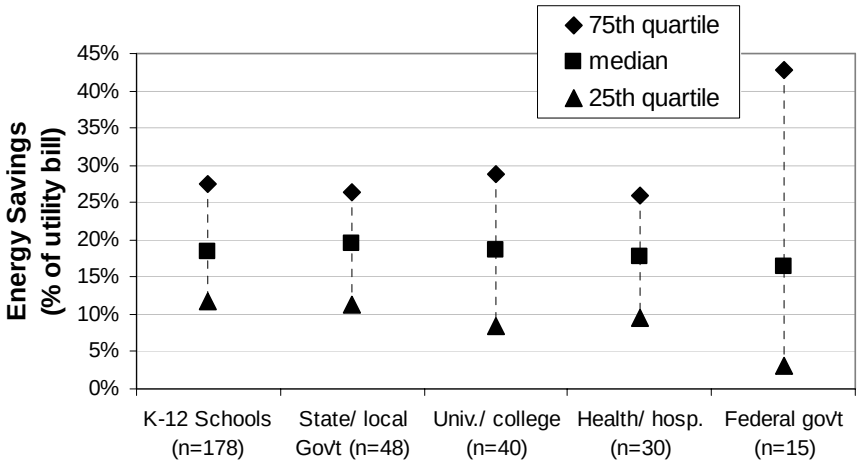


Figure 5-12. Energy Savings as Percent of Utility Bill by Market Segment

Not all ESCO projects measure baseline consumption using a facility's total energy usage (utility bill analysis). In some projects, baseline consumption is measured for only the equipment that is to be retrofitted – we call this a "targeted equipment" baseline metric. Or, the pre-retrofit consumption of an end use may be established, even though only some portion of that end use is to be retrofitted – we term this a "targeted end use" baseline metric.

In the NAESCO/LBNL database projects, metrics used to measure baseline consumption are strongly correlated with retrofit strategies (see **Table 5-9**). Lighting-only projects primarily measure pre-retrofit consumption of the targeted equipment (79% of projects). This is because lighting equipment is easily measured and/or estimated separately from other end uses. DG projects appear to be fairly evenly split between use of targeted equipment and utility bill baselines. Major and minor HVAC and non-energy retrofits mostly employ utility bill analysis; other projects also tend toward utility bill analysis.

[57] The wide range in the federal government projects is probably due to the small sample size – Super ESPC projects unfortunately did not have the baseline consumption data necessary to perform this analysis.

Overall, measuring pre-retrofit consumption at the utility bill scope is the most common baseline metric employed (56% of projects).

Table 5-9. Baseline Metric by Retrofit Strategy

Retrofit Strategy	N	Percent of Projects Measuring Baseline by:		
		Targeted equipment	Targeted end use	Utility bill
Lighting only	154	79%	13%	8%
Distributed generation	29	48%	10%	41%
Major HVAC	171	26%	9%	64%
Minor HVAC	315	19%	10%	70%
Non-energy	88	16%	9%	75%
Other	21	24%	29%	48%
All strategies combined	778	33%	11%	56%

The choice of baseline metric has implications in comparing energy savings. In Figure 5-12, we deliberately only compared projects that used a utility bill metric. Such projects will always show *lower* savings as a percent of baseline than end use or equipment targeted projects because not all of the facility's energy using loads are retrofitted, while for a targeted equipment baseline only the affected energy usage is measured. Targeted end use projects fall in between; the scope of the baseline measurement is broader than the retrofitted equipment but narrower than the utility bill.

To illustrate this difference, the distribution of projects by percent energy savings are shown for lighting-only projects that used a targeted equipment baseline in **Figure 5-13**, and for major HVAC, minor HVAC and non-energy projects in **Figure 5-14**; both figures plot the data on the same axes for comparison. The median lighting-only project saved 41% of the electricity usage of the retrofitted lighting equipment. All lighting-only projects evaluated saved between 13% and 66% of this baseline.

As expected, the three retrofit strategies that measured utility-bill baseline consumption all show lower nominal percentage savings than the lighting-only projects. However, this does not mean that such projects saved less energy – because the utility bill baseline is broader in scope, the lighting-only data are not directly comparable to the results for the other retrofit strategies. Of these three, the major HVAC category showed the highest median percent savings (21% of the measured utility bill). Fifty-seven percent of the major HVAC projects evaluated saved more than 20% of the utility bill baseline. Minor HVAC projects save slightly less (19% median savings); these less investment-intensive projects appear, as expected, to save less energy. Forty-six percent of the minor HVAC projects evaluated saved more than 20% of the utility bill baseline. Retrofits that include non-energy improvements tend to save slightly less than minor HVAC projects; the median project saved 16% of the utility bill baseline. Only 34% of the non-energy improvements projects evaluated saved more than 20% of the utility bill baseline.

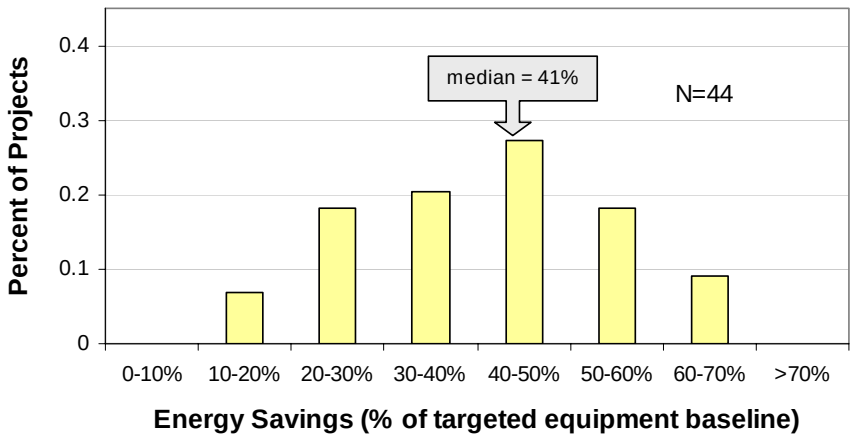


Figure 5-13. Lighting-Only Energy Savings as Percent of Targeted Equipment Baseline

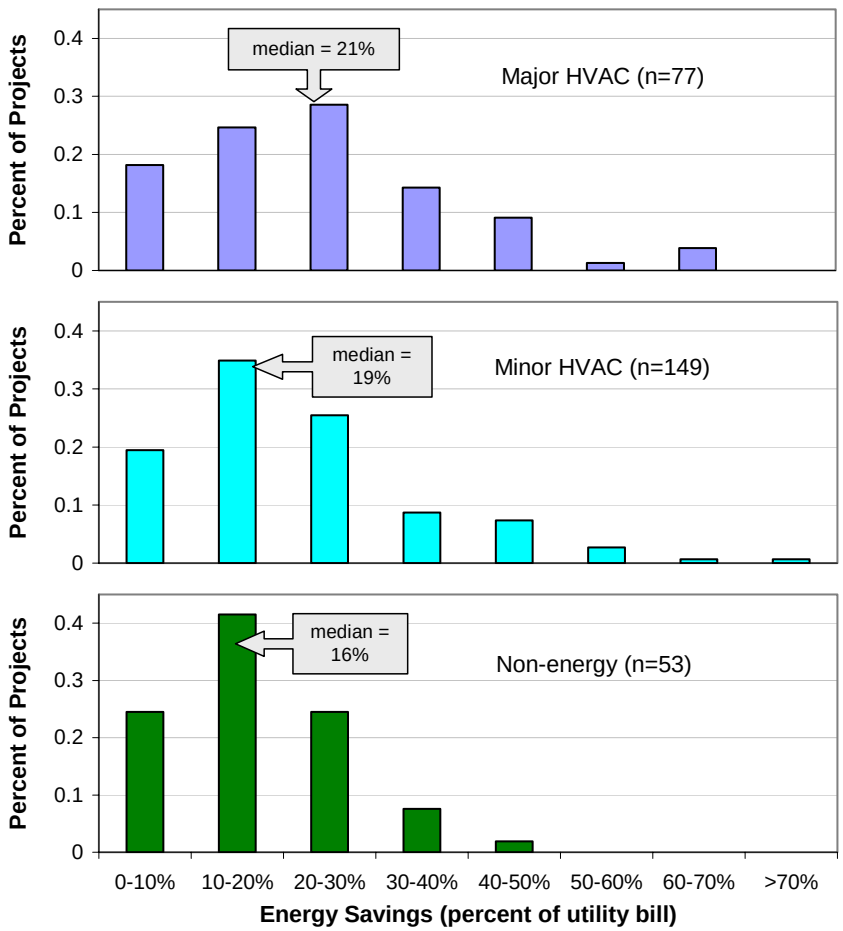


Figure 5-14. Energy Savings as Percent of Utility Bill for Selected Retrofit Strategies

The range in savings is quite wide for major and minor HVAC projects, with a few projects saving in excess of 50%. These high-savings projects tend to include conversion from thermal heating sources to air or ground-source heat pumps along with other efficiency measures. Because the relative efficiency of such measures is extremely high, while the replaced equipment may have been extremely inefficient, we see significant savings.[58]

It should be noted, however, that the range in project savings for utility-bill baseline projects may be due in part to variation in the scope of the utility bill(s) used. We do not have information on whether projects included both electric and gas (or other fuel) bills as the basis for analysis, or just one fuel account. Additionally, we don't know the scope of the utility accounts themselves. For example, all the electricity usage at an office building may be connected to a single meter and billed on one account, whereas sites with multiple buildings may have separate meters and accounts for each building or even for specific equipment (e.g., a large central plant facility may be separately metered). These factors probably contribute somewhat to the large spread in utility bill project savings observed.

5.4.2 Water Savings

In addition to energy savings, many ESCO projects also include measures that save water, either directly or indirectly. Direct water conservation measures usually consist of installing low-flow toilets, urinals, faucets or showers. While primarily targeted at water savings, such measures may also save energy by reducing the amount of water that must be pumped and/or heated. Conversely, some primarily energy-saving measures may also save water. For example, steam system retrofits that seal pipes may be implemented for the purpose of saving energy, but in the process also save water because less steam is lost. Or, an HVAC retrofit that improves overall system efficiency may reduce the need for evaporative cooling (e.g., a smaller cooling tower may be installed); this too may save substantial amounts of water.

Overall, 8% of public/institutional projects in our database reported saving water. We believe this is a lower bound on the number of projects actually saving water, because where these savings are indirect, or where water prices are very low or are based on capacity rather than volumetric consumption, the savings may not be recorded or counted. As **Table 5-10** shows, projects at federal government and university/college facilities tend to save water considerably more often than other market segments. This is probably explained by the types of facilities retrofitted: large university campuses and military bases are mixed use facilities with residential housing, thus a large number of water fixtures, and substantial domestic hot water usage.

[58] Another factor driving these high savings is an anomaly that arises from our assumption of site energy conversion for electricity (3412 Btu per kWh), a standard way of measuring project energy savings from the customer's perspective. When considering energy savings alone, this assumption is conservative – it ignores the energy losses inherent to generating and transmitting electricity. However, for the few cases in our database in which a thermal fuel source was replaced with electricity (e.g., the heat pump example given here), the increase in electricity use is counted disproportionably less than the saved thermal fuel, resulting in exaggerated overall savings.

Table 5-10. Projects with Water Savings by Market Segment

Market Segment	N	Percent of Projects Reporting Water Savings
K-12 schools	633	5%
State/local government	262	5%
Universities/colleges	219	13%
Health/hospitals	210	7%
Federal government	252	17%

The number of projects reporting water savings is somewhat lower than the number that included water conservation as a measure. For example, 26% of federal projects reported water conservation measures (see Table 5-4) but only 17% provided information on the amount of water saved. This discrepancy may simply indicate missing data, or it may be that while water was conserved, the amount was not recorded in the project, perhaps because the associated cost savings were insignificant. Because water prices vary dramatically among and within states and municipalities in the U.S., the incentive to install water conservation measures also varies.

5.4.3 Importance of Non-Energy Savings

Non-energy savings, which include operations and maintenance (O&M) savings resulting from installed equipment along with other economic benefits not directly tied to energy savings (such as capital cost avoidance or reductions in personnel costs), are often included in ESCO savings guarantees. Inclusion of non-energy savings can be an important factor in justifying a project's economics, or can allow the inclusion of measures that would not be cost effective from energy savings alone. Our interviews with ESCOs revealed a common perception that non-energy savings are more often counted in MUSH markets than the federal market. However, our analysis of project data reveals a different story.

As **Table 5-11** shows, well over half of the federal market projects in our sample (59%) reported non-energy savings, whereas MUSH market segments report such savings for between 29% and 41% of projects. Thus, based on our sample of projects, federal customers appear considerably more likely to include operational savings in project economics. O&M savings were reported much more frequently than other types of non-energy savings in all market segments.

For those projects that reported non-energy savings, we compare the relative magnitude of these savings among market segments in **Table 5-12**. While federal projects tend to report non-energy savings more frequently than other market segments, when included, these savings account for a lower share of overall project savings compared to most other markets; non-energy savings account for 14% of cost savings in the median federal sector project. The largest non-energy savings are found in K-12 schools and state/local government projects (27% and 34% respective medians).

Table 5-11. Importance of Non-Energy Savings: Frequency of Projects

Market Segment	N	Percent of projects reporting…		
		O&M Savings	Other Non-Energy Savings	Any Non-Energy Savings*
K-12 schools	515	38%	7%	41%
State/local government	220	26%	7%	31%
Universities/colleges	163	28%	7%	33%
Health/ hospitals	171	26%	4%	29%
Federal government	223	55%	13%	59%

*includes projects that reported O&M, other non-energy savings, or both

Table 5-12. Importance of Non-Energy Savings: Share of Savings*

Market Segment	N	Non-energy savings' average share of project savings
K-12 schools	209	27%
State/local government	69	34%
Universities/colleges	54	10%
Health/ hospitals	49	21%
Federal government	131	14%

*includes projects that reported O&M, other non-energy savings, or both

5.4.4 Measurement & Verification of Savings

One of the greatest controversies surrounding the ESCO industry is the issue of measurement and verification (M&V) of savings. M&Vis a tool to ensure that efficiency equipment is performing and operating as specified. It is also insurance – for an additional cost, customers and/or energy-efficiency program managers receive technical assurance that a project delivers energy savings as predicted over its economic lifetime. As with any form of insurance, the buyer must balance the cost against the risk-reduction benefits.

The International Performance Monitoring and Verification Protocol (IPMVP) was established in 1996 as an independent industry standard M&V guideline (IPMVP 2001). While its use is voluntary, it has become widespread, as ESCOs have realized the benefits of a pre-developed and widely recognized tool. IPVMP includes four basic options for measuring project performance and provides guidance on when it is appropriate to use each option.

In MUSH markets, there has been a trend toward reduced M&V in recent years. Not only are fewer projects performance-based (see section 5.2.1), but some ESCOs report that they only measure savings for the first few years after installation for an increasing number of customers. This reflects preferences of customers that wish to minimize costs

but still want one or two years of M&V to establish project performance, but it also benefits ESCOs by minimizing their liability in a guaranteed savings contract.
In the federal market, UESC projects typically do not involve ongoing M&V (savings are fully stipulated). The ESPC programs, however, have detailed M&V guidelines that are based on IPMVP but tailored for the federal government (FEMP 2000). ESPC contracts are required to include a detailed M&V plan and ESCOs are required to perform the agreed-upon M&V for the entire length of the contract. While the ESPC program probably represents the best practice in the U.S. for M&V, a report by Nexant (2004) points out that the M&V reports provided to federal ESPC customers for the first and second year of savings were nonetheless lacking critical information.

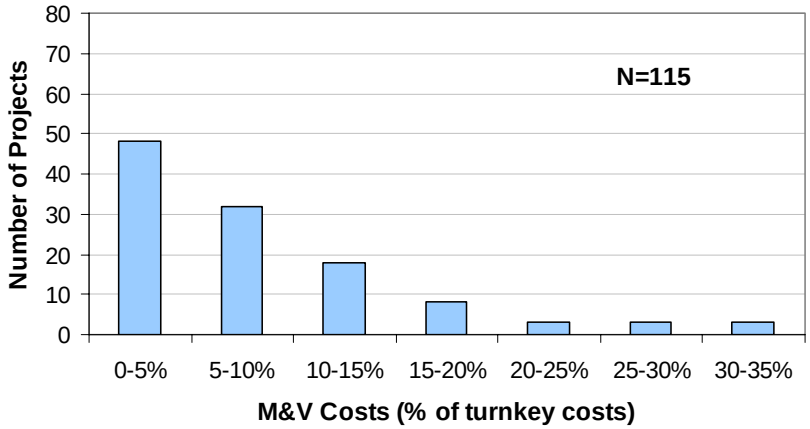


Figure 5-15. M&V Costs of Super ESPC Projects as Percent of Turnkey Costs

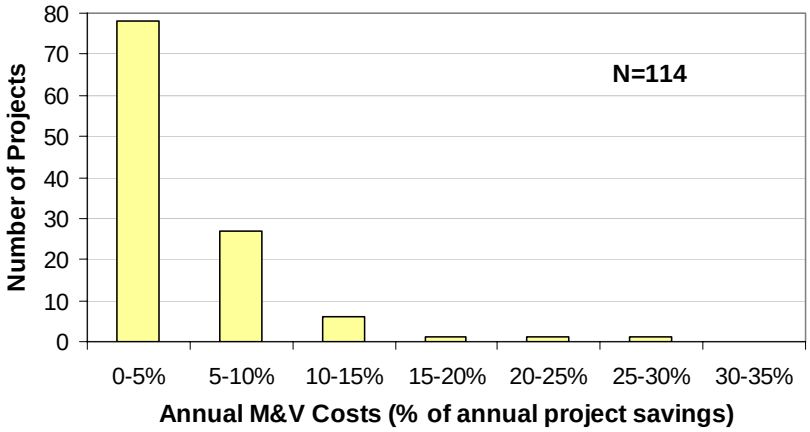


Figure 5-16. M&V Costs of Super ESPC Projects as Percent of Project Savings

Central to the debate about how much M&V is necessary or appropriate is the issue of how much it actually costs. The majority of projects in the NAESCO/LBNL database project do not include information on M&V costs. For the Super ESPC contracts, for which this information is available, we find that total M&V costs over the life of the contract (not discounted) are between 1% and 34% of turnkey project costs. As **Figure**

5-15 shows, ~70% of Super ESPC contracts specified M&V costs equal to or less than 10% of turnkey costs. As a proportion of annual savings, annual M&V costs of Super ESPC projects range from less than 1% to 29%; ~70% of projects specified annual M&V costs less than 5% of annual project savings (**Figure 5-16**). Because the Super ESPC program places heavy emphasis on M&V, these results probably represent an upper bound on M&V costs in the industry as a whole. This demonstrates that for most projects, M&V costs, even if performed for the life of the contract, are usually not significant relative to project costs and benefits.[59] Super ESPC M&V costs and benefits are further explored through a scenario analysis of project net benefits in section 5.5.4.1.

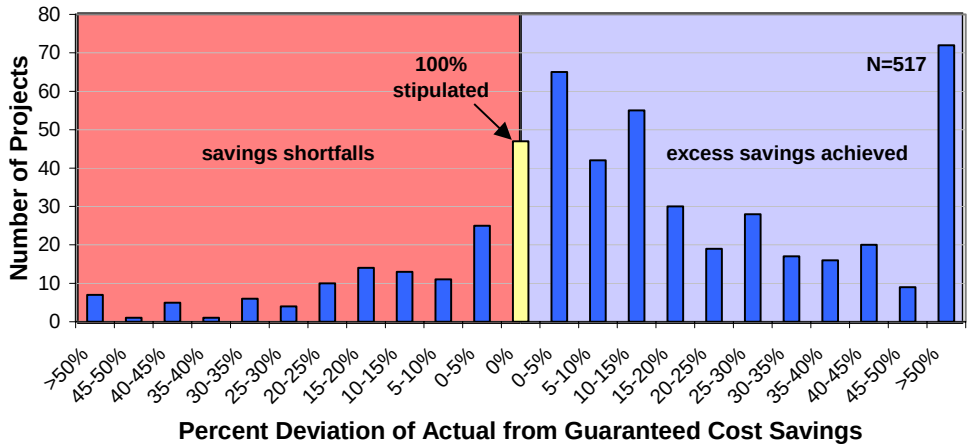


Figure 5-17. Performance of ESCO Savings Guarantees

Projects in the NAESCO/LBNL database that reported actual (verified) savings provide insights into the degree of project performance risk inherent to ESCO projects. First, we examine the performance of ESCOs' savings guarantees.[60] **Figure 5-17** shows the distribution of projects according to the percent difference between guaranteed energy cost savings and the actual cost savings reported to the customer.[61] Seventy-two percent experienced greater savings than were guaranteed by the ESCO. Nineteen percent encountered savings shortfalls, of which 63% reported shortfalls greater than 10%. The remaining 9% of projects are known to be "100% stipulated" because the reported actual

[59] In addition to the direct costs of M&V, customers may experience additional financing costs where rigorous M&V is performed. In interviews, ESCOs told us that financiers evaluating projects prefer stipulated savings because the payment stream from the project is, at least on paper, constant.

[60] For many projects, it was not clear if the guaranteed cost savings reported included O&M or other non-energy cost savings or not. We took a conservative approach and assumed that the guarantee only included energy-related cost savings. However, we note that 28% of projects with large savings shortfalls (>25%) included non-energy savings that amounted to more than 50% of total project savings, whereas only 16% of projects that exceeded guarantees had such high non-energy savings.

[61] We used the average of the yearly actual savings provided for this and the subsequent analysis. For most projects, only 1 or 2 years of actual savings was reported. These results therefore do not speak to project performance several years after installation.

savings were identical to savings predictions[62] – these projects are highlighted with the yellow bar in **Figure 5-17**.[63]

Figure 5-18 shows the distribution of projects according to the percent difference between predicted and actual energy savings. About 54% of projects had actual energy savings that exceeded predictions. Thirty-four percent experienced shortfalls relative to predicted savings (57% of these were shortfalls greater than 10%), and 12% of projects were 100% stipulated.

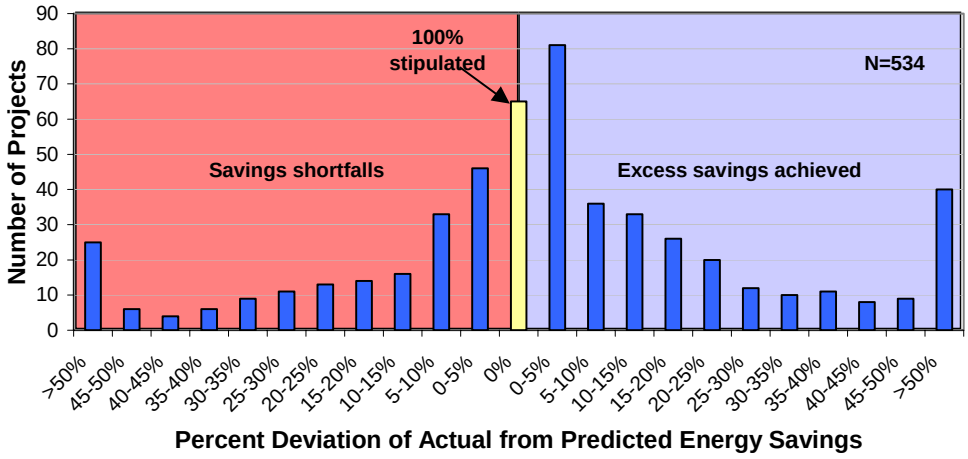


Figure 5-18. Accuracy of Energy Savings Predictions

These findings demonstrate the risk of project under-performance. The value to customers of savings guarantees combined with long-term, reliable M&V lies in minimizing this risk by allocating responsibility for project performance to the ESCO and by identifying when savings shortfalls occur and savings guarantees should be exercised.

5.5 Project Economics from a Customer Perspective

In this section, we report project economics based on three indicators calculated from project data: simple payback time, benefit-cost ratio and net benefits. We also discuss reliance on financial incentives for energy-efficient equipment offered by public benefits or utility DSM programs and explore the impact of financing costs on project benefits.[64]

This analysis is customer centric – we evaluate costs and benefits of projects as seen by the customer. We do not attempt to quantify the economic benefits of ESCO projects from a societal perspective (e.g., the environmental benefits of reduced energy

[62] Partial savings stipulation is allowed for Option A, "Partially Measured Retrofit Isolation", under guidelines clearly laid out in IPMVP, but at least one of the parameters must be measured. The 100% stipulated projects in our sample, therefore, do not adhere to IPVMP protocols.
[63] For the remaining 91% of projects, the degree of savings stipulation versus measurement is unknown.
[64] Turnkey costs (not including long-term financing) are used for all economic measures, however indicators that account for the time value of money are computed using very conservative assumptions. The impact of financing on project economics is demonstrated in section 5.5.4.1.

consumption, the avoided cost of electricity generating or transmission infrastructure or economic development benefits).

Our analysis of project economics is conservative. It includes all direct economic benefits from energy, water and operational savings. But it does not include indirect benefits, such as improved comfort (e.g., from better lighting or space conditioning), increased worker productivity, equipment modernization and environmental improvements, in our calculations due to lack of information. Nonetheless, indirect benefits are often valued by customers and may even provide greater motivation to install projects than energy cost savings. For example, for public agencies, equipment modernization is often the primary goal of a project; performance contracting is a tool for financing the investment when other alternatives are not available. In other cases, customers may value reduced worker health care and occupational illness liability costs (through improved building comfort conditions) or lower environmental compliance costs. Also important is the avoided cost of project delay afforded by performance contracting. Financing energy-efficiency investments can allow customers to capture years of energy savings that could be lost waiting for alternative means of financing to materialize.

For our base-case benefit-cost and net benefits calculations, we employ conservative discount rates of 7% and 10% (nominal). The 7% rate is consistent with the Office of Management and Budget (OMB)'s guidance on internal federal government investments, such as energy-efficiency investments, that result in increased federal revenues or decreased federal costs. In such cases, OMB (2002) requires "using a comparable-maturity Treasury rate as a discount rate". Nominal treasury rates have varied somewhat over the 20+ years during which our database projects were completed, but average around 7% (BPD 2005). Our higher discount rate (10% nominal) is consistent with OMB's required real discount rate of 7% for evaluating public investments and projects that provide benefits and costs to the general public (OMB 2002).[65] Because state and federal performance contracting regulation often allows projects with terms of 20 years or longer, our choice of discount rates is conservative.

In section 5.5.4.1, we use a third discount rate of 5% (nominal) to evaluate federal Super ESPC projects. Treasury rates between 1999 and 2003, the time period during which Super ESPCs were implemented, have averaged about 5% (BPD 2005), so we adopted this rate as being more consistent with the specific requirements faced by federal agencies evaluating these particular investments.

Details of our data sources, calculations and assumptions are provided in Appendix C. Our treatment of financial incentives is addressed below.

[65] OMB (2002) requires a high discount rate for this type of investment because "in general, public investments and regulations displace both private investment and consumption". A real discount rate of 7% "approximates the marginal pretax rate of return on an average investment in the private sector in recent years" (OMB 2002).

5.5.1 Reliance on Ratepayer-Funded Energy-Efficiency Program (REEP) Incentives

ESCOs and customers may leverage the cost of projects with incentives received through ratepayer-funded energy-efficiency programs (REEPs). Until the mid 1990s, REEPs were DSM programs offered by utilities to encourage load reductions that were indirectly funded by ratepayers; more recently, program funding in many states that have restructured their electric industries has shifted to direct public-benefits surcharges on customers' bills. In either case, REEP incentives may be structured as one-time, up-front rebates on energy-efficient equipment, or may consist of payments per measured kWh saved over the course of several years (e.g., standard performance contract and DSM bidding programs).

We find that the decreasing reliance on REEP incentives presented in Goldman et al. (2002) has continued in recent years. As **Table 5-13** shows, while REEP incentives were received by at least 42% of public/institutional sector projects completed before 1996 (federal and MUSH combined), reliance on incentives was down to only 22% in the years since 2000. This is due in large part to reduced availability of incentives; decreased spending by utilities on energy-efficiency programs since restructuring has not been fully made up for by public benefits funded programs (Nadel 2000, Kushler et al. 2004). However, it also speaks to the increasing ability of ESCO projects be sold to customers based on their fundamental economics and value, with less reliance on financial incentives. The ESCO industry has continued to grow despite the decline in available incentive dollars.

In our economic analyses, we account for the impact of REEP incentives in reducing project costs. Rebate incentives are typically used to buy down initial project costs (often reducing the amount of the capital cost that must be financed). Based on discussions with ESCOs, the customer often receives the rebate directly from the utility, though the ESCO may assist in identifying programs that the project may qualify for and, in some cases, may collect the rebate on the customer's behalf. In performance-based programs (DSM bidding and standard performance contract), ESCOs typically contract with utilities (or other administering agencies) and are paid based on project performance. In our dataset, we have information on the type of program and the level of incentives received, but we do not know to what extent they were passed on to the customer.

Table 5-13. Trends in Public/Institutional Market Project Reliance on REEP Incentives

Time Period	N	REEP Incentives Received?		
		yes	no	unknown
before 1996	275	42%	41%	17%
1996-2000	914	29%	63%	8%
2001 - present	409	22%	76%	3%

Because our analysis of economic benefits is customer centric, we therefore need to make an assumption about how much of these incentives were seen by customers. For rebates, we assume that 100% of the incentives were seen by the customer, and for DSM bidding

and standard performance contract programs, we assume that only 50% of incentives were passed through to the customer.[66]

5.5.2 Simple Payback Time

Simple payback time (SPT), defined as turnkey project costs divided by annual savings, is a common, easily computed measure of the cost-effectiveness of an investment, though it does not take into account the time value of money or the lifetime of the savings.[67] Projects with short paybacks are easily justified because the benefits will be seen earlier and, in uncertain environments, the necessary financial commitment is relatively short. However, longer payback projects may still be economical investments – they just require a greater commitment before the economic benefits are realized. Moreover, projects with longer paybacks may include measures that provide significant benefits, but that are too capital intensive to be included in a quick-payback project. Thus, SPT does not fully describe the value of the investment; it is a better indicator of the ability and willingness of customers to engage in long-term financial commitments and of the technical aspects of projects.

SPT results based on our project database are presented by market segment in **Figure 5-19** and by retrofit strategy in **Figure 5-20**. As Figure 5-19 shows, the shortest payback times are observed in the health/hospitals market segment (4.9 year median). This is not surprising given the widespread privatization and cost cutting that have swept the health care industry in recent years. The observed shorter-term investment horizon more closely resembles the private sector than other public/institutional markets. This result may also be attributable to hospitals operating around the clock, allowing them to realize more savings from measures such as lighting than would, for example, schools or offices.

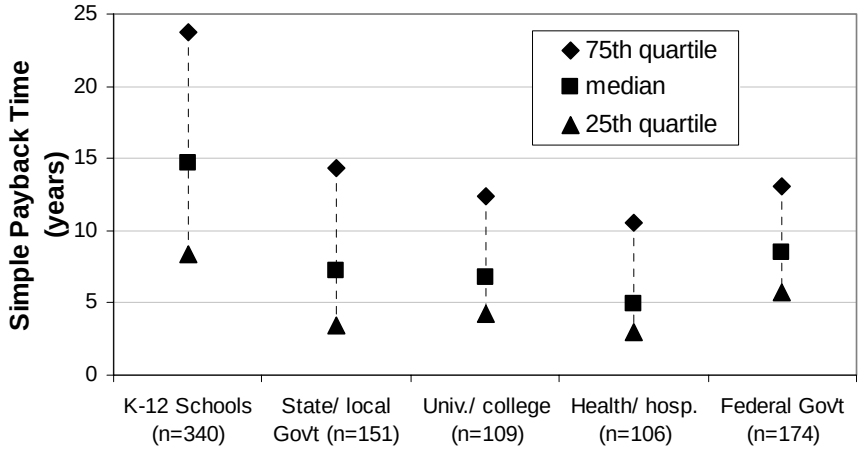


Figure 5-19. Simple Payback Time by Market Segment

[66] In Goldman et al. (2002), incentives were ignored in the base-case economic analysis, but were tested using the same assumptions outlined here in a sensitivity analysis of simple payback time.
[67] For details of the data sources and assumptions made in our SPT calculation, see Appendix C.

At the other end of the spectrum, K-12 schools projects have the highest median payback times: 14.7 years. This is explained in part by enabling legislation for performance contracting in many states that allows for long contract terms (up to 20 or 25 years in some states). However, the technical aspects of projects also drive this result. K-12 schools tend to bundle non-energy improvements into energy-efficiency projects more frequently than any other market segment; because these measures do not contribute to project "benefits" but are included in project costs, they lengthen the computed SPT considerably (see Figure 5-20). Because of the typically low investment nationwide in capital budgets for schools, the motivation to engage in performance contracting is often not strictly energy bill savings, but the need to replace vital infrastructure and to derive significant indirect benefits (non-energy improvements as well as better quality of lighting, space conditioning, etc.). Low operating hours that correspond to low energy savings relative to other market segments may also contribute to longer payback times.

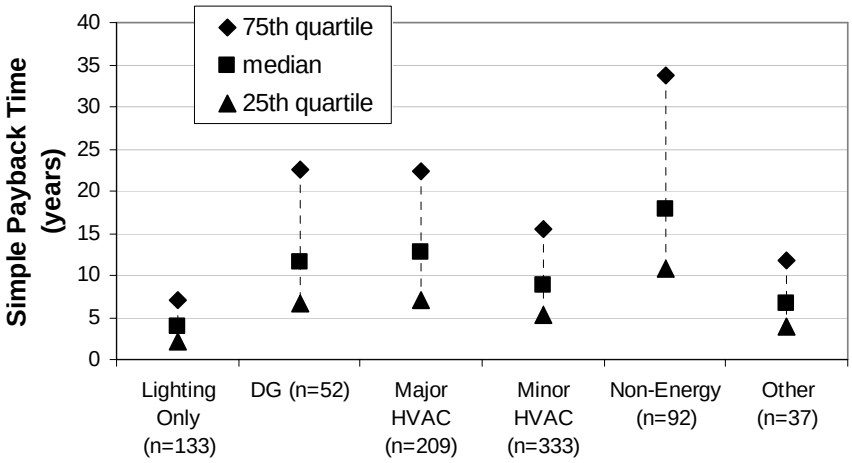


Figure 5-20. Simple Payback Time by Retrofit Strategy

Median payback times for federal government, state/local government, and universities/colleges projects in our database are 8.5 years, 7.2 years and 6.8 years respectively.

The results in Figure 5-20 demonstrate that lighting-only projects are quick-payback investments (little variation about the 4.0 year median). Retrofits including non-energy improvements clearly have longer payback times (17.8 year median). DG and major HVAC retrofits have similar median payback times (11.6 and 12.7 years respectively) and are typically longer-term investments than minor HVAC projects (median value of 8.8 years).

5.5.3 Benefit-Cost Ratio

The benefit-cost ratio is an economic indicator used to evaluate the cost-effectiveness of an investment based on the present value of all up-front and future payments and benefits associated with a project (see Appendix C). Investments with a benefit-cost ratio greater than one are by definition cost-effective.

Figure 5-21 shows benefit-cost results by market segment, under the 7% nominal discount rate assumption. **Table 5-14** demonstrates the impact of the higher (10% nominal) discount factor on project cost-effectiveness.

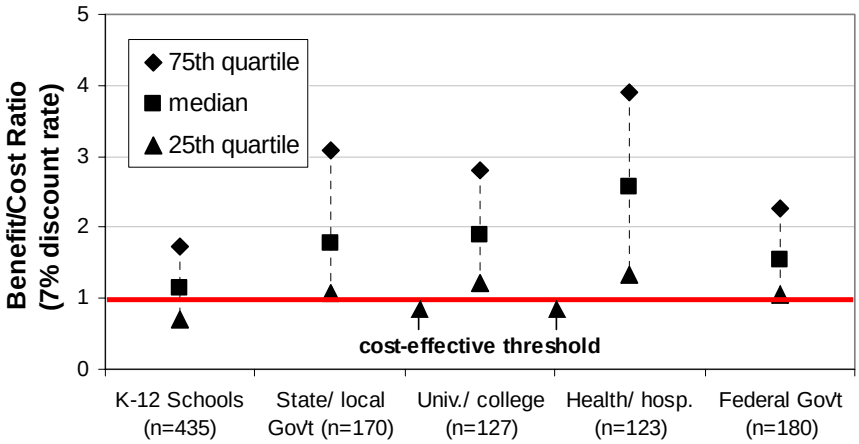


Figure 5-21. Project Benefit-Cost Ratio by Market Segment

Overall, 71% of projects were cost-effective at the 7% discount rate. However, it is clear that K-12 schools, with relatively poor economics (discussed below), dominate these results. If we remove these projects, 82% of projects are cost-effective. The discount rate used also has a significant bearing on the results; about 10% fewer projects meet the cost-effectiveness threshold at the higher 10% discount rate than at the 7% discount rate.

The highest benefit-cost ratios using the 7% discount rate are observed in health/hospitals projects (median of 2.6). Median benefit cost ratios are comparable for state/local government, universities/colleges and federal government projects: 1.8, 1.9 and 1.6 respectively. In each of these market segments, ~65-80% of projects are cost-effective at both discount rates.

Table 5-14. Cost-Effectiveness of Public/Institutional Database Projects

Market Segment	**N**	**Percent of Projects that are Cost-Effective (benefit-cost ratio >1)**	
		7% nominal discount rate	**10% nominal discount rate**
K-12 schools	435	56%	46%
State/local government	170	81%	69%
Universities/colleges	127	83%	72%
Health/ hospitals	123	85%	77%
Federal government	180	79%	67%
All institutional projects	1035	71%	60%

The median K-12 schools project barely meets the cost-effectiveness threshold at a 7% discount rate (1.1). At the more stringent 10% discount rate, the median benefit-cost ratio is 0.9 and only 45% of projects are cost-effective. Although some of these projects appear to be uneconomical, they do provide value to the schools that undertook them. First, it should be noted that our assumptions in this analysis are very conservative (e.g., high discount rates for benefits, no discounting of costs; see Appendix C) and may not reflect the criteria actually used in deciding to undertake these projects. Second, many schools benefit from indirect benefits (such as improved quality of lighting and space conditioning) as well as non-energy benefits (such as asbestos abatement) that we are unable to account for in our economic analysis. Thus our analysis of benefits probably underestimates the true value of these projects.

5.5.4 Net Economic Benefits

A third economic test for ESCO projects is whether or not they produce net benefits.[68] The overall magnitude of benefits may also be used to estimate the value of the investments.

Table 5-15. Net Economic Benefits of ESCO Projects (Customer Perspective)

Market Segment	**N**	**Net Economic Benefits (2003 $M)**	
		7% nominal discount rate	**10% nominal discount rate**
K-12 schools	436	236	(19)
State/local government	170	286	172
Universities/colleges	127	427	264
Health/ hospitals	123	244	165
Federal government	179	537	271
All institutional projects	1035	1730	853

Altogether, the net value of the public/institutional projects in the NAESCO/LBNL database is over $1.7 billion, in 2003 dollars, using a 7% nominal discount rate (**Table 5-15**). Under the more conservative 10% discount factor, these benefits are about $850 million (2003). Differences in the net benefits per project in the various market segments reflect differences in the economics as well as the size of projects.

5.5.4.1 Impact of Project Financing Scenarios on Super ESPC Net Benefits

A recent GAO report questions the appropriateness of financing government energy-efficiency projects (GAO 2004) and raises concerns about the costs (particularly financing and M&V costs) associated with ESPC projects as compared to funding projects through timely, up-front congressional appropriations. The report's assertion that third-party financing is more costly than appropriations is based on a cost analysis of six ESPC projects – project benefits are not accounted for.

[68] See Appendix C for details of how we calculated net benefits.

In this section, we explore the impact of several project financing scenarios on the net benefits of 109 Super ESPC projects.[69] We compare third-party financing (how these projects were actually implemented) to several scenarios that assume projects are funded by up-front congressional appropriations. We include both costs and benefits in a time-discounted analysis of these 109 projects in order to provide a more comprehensive comparison between financed ESPC projects and the alternative of using congressional appropriations.

Table 5-16 describes our scenarios in terms of several key inputs. The "financed" scenario reflects how Super ESPC projects were actually implemented. Debt service costs, calculated from the actual interest rate and term over which the projects were financed, are modeled as payments over the life of the contract.[70] M&V costs, taken from project delivery orders, are also included as payments over time. Together, these payments are discounted over the term of the contract. Energy cost and O&M savings are assumed to persist over time due to the contractual terms of ESPC projects and the presence of M&V.

The "appropriated" scenarios represent a range of possible outcomes had the *same* projects been paid for with up-front appropriations rather than alternatively financed. To achieve this, we model turnkey project costs as a single up-front payment, with no cost to finance the project (a conservative assumption).[71] Additionally, since appropriations projects are not typically performance contracts, we do not include M&V costs in these scenarios. However, to properly account for the benefits of M&V and savings guarantees in identifying and rectifying savings shortfalls over the project's lifetime, we assume a level of savings decay occurs in the appropriations scenarios. Very little information is available regarding actual savings decay rates in the absence of M&V; we chose two conservative scenarios of 1% and 2% annual decay.[72] [73] In addition, we examine the impact of delayed appropriations, combined with the fact that appropriated projects, when funded, often take longer to develop, on project net benefits, incorporating the

[69] Complete project financing and M&V cost information are included in the delivery orders, making this analysis possible. In our base-case benefit-cost and net benefits calculations (sections 5.5.3 and 5.5.4), we model projects as if they were paid for up-front (e.g., by congressional appropriations or other capital budgets). We do not include long-term debt service or M&V costs, but neither do we discount debt service payments over time, because we do not have complete financing or M&V cost information for most projects. We assume that any bias introduced by not accounting for these costs is conservative because the up-front project cost payments are not discounted, while benefits are (see Appendix C).

[70] Several Super ESPC projects applied appropriated funds to some portion of up-front project costs, reducing the amount of the project that was financed. We account for these project buy-downs in our "financed" treatment, leaving this portion of the costs undiscounted and not applying interest costs to them.

[71] GAO's (2004) argument that third party financing is more costly than appropriations is premised on the fact that the federal government's cost of capital is less than the interest costs associated with third-party financing. By not including the government's cost of capital in our analysis, we under-estimate the cost of appropriations-funded projects.

[72] Hughes et al. (2003) chose similar rates in their analysis of ESPC life-cycle costs.

[73] It may be more accurate to think about these decay rates in terms of differences in decay relative to ESPC projects, rather than absolute levels of savings decay.

opportunity cost of lost savings for each year of project delay into the net benefits calculation.[74]

Table 5-16. Treatment of Inputs to Super ESPC Project Financing Scenarios

Scenario	Treatment of Input to Net Benefits Calculation				
	Turnkey cost	**Interest cost**	**M&V cost**	**Project benefits**	**Opportunity cost of delay**
Financed	Debt service (capital + interest) payments over contract term*		Payments over contract term	Energy, O&M and other direct cost savings**	—
Appropriated (timely)	Single payment in year zero	—	—	Energy, O&M and other direct cost savings**, reduced annually to account for savings erosion (of 1% and 2%) for the second and subsequent years of project implementation	—
Appropriated (with delay)	Single payment in year of project implementation	—	—		Utility bill/ O&M payments reflected as costs for each year of delay

NOTE: Shaded cells represent inputs that were discounted to reflect the time value of money (i.e., that occur subsequent to turnkey project implementation).
* Up-front buy downs (if applicable) were removed from debt service and treated as payments in year zero.
** See Appendix C for details of energy cost calculations and savings inflation over time.

In all scenarios, project benefits (energy and O&M cost savings) are modeled in the same way as our base-case analysis in sections 5.5.3 and 5.5.4 (see Appendix C).[75] We did not include O&M or repair and replacement (R&R) costs in any scenario because facilities would have had to maintain and replace equipment whether the project was implemented or not.[76]

We use three discount rates in this analysis: 5%, 7% and 10% (nominal). The 5% rate reflects OMB's (2002) specific guidance to use Treasury rates as the discount rate for internal investments made by the federal government (see section 5.5). Over the half-decade during which the Super ESPC projects were completed, nominal rates averaged roughly 5% (BPD 2005).

The results are shown in **Table 5-17**. Each table shows net benefits results for a different discount rate. The shaded cells represent appropriations scenarios that result in reduced

[74] We treat lost savings as an opportunity cost because they are dollars paid for utility bills and O&M that once paid are no longer available for investment in an energy-efficiency project.
[75] Other costs reported in the delivery orders, such as permits and licenses, insurance and management/administration costs, are included in both treatments, as these costs would be borne whether the project was financed or appropriated.
[76] Moreover, appropriated (design/build) projects frequently include O&M servicing agreements equivalent to those included in Super ESPCs, so even if the project did result in increased O&M costs, it is not clear that they would differ between a financed and appropriated project.

net benefits relative to third-party financing. We highlight the following findings from these results.

Financed projects represent a value, not a cost, to the government

The combined net benefits of the 109 Super ESPC projects *as they were actually financed* range between (2003) $138 and 286 million, depending on the discount rate used. Even under the most conservative discount-rate assumptions, the presence of positive net benefits indicates that these projects are solidly cost-effective.[77] Because the benefits of financed Super ESPC projects outweigh the costs, they ultimately represent no cost to the government.[78]

Table 5-17. Net Benefits (in 2003 $M) of 109 Super ESPC Projects Under Several Project Financing Scenarios

Discount Rate (Nominal)	Financing Scenario	Annual Savings Decay Rate	Project Delay Relative to Financed ESPC (years)			
			0	1	2	3
5%	Financed	0%	286	–	–	–
	Appropriated	1%	353	302	251	201
		2%	280	230	181	132

Discount Rate (Nominal)	Financing Scenario	Annual Savings Decay Rate	Project Delay Relative to Financed ESPC (years)			
			0	1	2	3
7%	Financed	0%	213	–	–	–
	Appropriated	1%	212	160	110	61
		2%	155	106	57	10

Discount Rate (Nominal)	Financing Scenario	Annual Savings Decay Rate	Project Delay Relative to Financed ESPC (years)			
			0	1	2	3
10%	Financed	0%	138	–	–	–
	Appropriated	1%	57	11	(33)	(75)
		2%	17	(26)	(68)	(108)

NOTE: Shaded cells represent appropriations scenarios with lower net benefits than were achieved using private-sector financing to implement these projects.

[77] Our results differ from GAO's (2004) finding that financed projects cost more to implement. In reality, while debt service and M&V costs do *nominally* add to overall project costs, properly discounting future payments to reflect the time value of money offsets debt service costs, and accounting for savings decay that occurs in the absence of M&V offsets M&V costs.

[78] Super ESPCs are paid for out of annual utility and/or O&M budgets that would otherwise have been spent on higher utility and O&M bills. While GAO (2004) raises concerns about long-term financial commitments, Super ESPC contracts contain non-appropriation clauses that limit the federal government's liability should Congress cease utility and O&M budget appropriations during the life of the contract.

Project delay significantly erodes net benefits

GAO (2004) recommends that federal agencies use "timely, full and up-front appropriations" to fund energy-efficiency projects, rather than third-party financing through ESPCs. As Table 5-17 shows, timely appropriated projects may indeed provide equal or greater net benefits than financed ESPCs, depending on discount rate assumptions. However, GAO (2004) states that:

> *"according to GSA officials, GSA's budget authority for energy efficiency projects declined from $20 million in fiscal year 1999 to $4.2 million in fiscal year 2004, and it received no funds in fiscal years 2002 and 2003. They also pointed to GSA's $6 billion backlog of identified repair and alteration needs. According to Navy officials, appropriations for its Energy Conservation Improvement Program dropped from $21.7 million in fiscal year 1999 to zero dollars in fiscal year 2000. Although funding has increased in recent years, it still remains well below 1999 levels. According to the Director of the Navy's Energy Programs Division, the department receives less than 10 percent of the estimated $140 million needed each year to meet energy savings goals. Navy officials said that other priorities in the Navy's budget had taken precedence over energy reduction projects." (GAO 2004)*

Given this reality, most projects do not receive timely, full and up-front appropriations. Table 5-17 shows that even at the most forgiving discount rate (5%), delays of more than one year in obtaining congressional appropriations result in reduced net benefits relative to ESPC-financed projects. The longer an agency waits, the more drastic this effect.

6. Project Trends Within the Federal Market

In Chapter 4, we treated federal market projects as a single group to facilitate comparisons with other public/institutional markets. In reality, the federal government is an extremely heterogeneous market segment, made up of a wide variety of facility types, agencies and two major enabling policies: the UESC and ESPC alternative financing vehicles. In Chapter 2, we discussed the UESC and ESPC programs from a high-level perspective. In this chapter, we look at the federal sector market in more detail, comparing UESC and ESPC project deployment and characteristics in light of these enabling policies.

UESC and ESPC represent two distinct models for financing energy services projects (see section 2.1.1). In the UESC model, utilities leverage their established relationships with federal agencies as regulated service providers to contract for energy-efficiency services on an established-source basis. It is common for utilities to implement several projects in succession at a single customer site. Another important feature of the UESC vehicle is that projects are contractually bound to a ten-year payback restriction, although in some cases this may be waived. In the ESPC model, ESCOs develop performance-based projects on a case-by-case basis that may pay back within 25 years. To date, there is relatively little follow-up work at specific sites.

The NAESCO/LBNL database is well represented by ESPC projects (see section 3.1) but contains a relatively small sample of UESC projects. To address this, we compare the ESPC projects in the NAESCO/LBNL database to UESC projects included in the FEMP UESC project database, managed by Pacific Northwest National Laboratory (PNNL). We begin this chapter by describing key differences between these two information sources. Then, we examine patterns of UESC and ESPC project deployment by agency, time period and geographic region. This is followed with trends in UESC and ESPC project strategies, investment, energy savings and simple payback time.

6.1 Aligning the NAESCO/LBNL and FEMP UESC Project Databases

Because the NAESCO/LBNL and FEMP databases were developed and the data collected independently, certain key differences exist in database scope and data field definitions. The most important distinctions are described in **Table 6-1**. In terms of database scope, the NAESCO/LBNL database focuses on performance- and non-performance-based projects completed by ESCOs only (Goldman et al. 2002) and includes projects in all the market segments and financing mechanisms that ESCOs work within. The FEMP database is focused on the UESC mechanism rather than the entities that implement projects. Thus, the FEMP UESC database includes projects that were developed and managed by utilities under utility-federal agency partnerships, with ESCOs and/or contractors as project implementers.[79]

Another key difference is that the NAESCO/LBNL database primarily contains projects for which construction/installation has been completed, and tracks projects according to

[79] In some cases, ESCOs owned by the local utility act as the prime contractors for UESC projects.

their completion dates, while PNNL collects information on UESC projects at various stages of completion, from initial design to award to project completion (although as noted above, we have removed un-awarded projects from the dataset).[80] Thus, the FEMP UESC database projects are subject to greater "flux" than the NAESCO/LBNL database projects as they are often entered at an early stage of development and may receive updated information at a later date. Another implication is that comparing market trends and activity between the two databases on a year-by-year basis is not entirely accurate because it may take from several months to years to actually complete a project. Thus, such comparisons, where they occur in this report, should be treated as illustrative rather than definitive.

Table 6-1. NAESCO/LBNL and FEMP UESC Databases Compared

Database Characteristic	NAESCO/LBNL database	FEMP UESC Database
Scope	ESCO industry	UESC contracting mechanism
Stage of Project Development	Completed projects	Any stage from initial design to award to construction completion
Project Tracking Date	Year completed (calendar year)	Year awarded (fiscal year ending September 30)
Project Retrofit Strategy	Projects grouped according to installed measures and investment thresholds	Projects categorized individually based on installed measures and annual energy savings per total investment

Finally, the way in which retrofit strategies were developed from project data was somewhat different for the two databases. Projects in the NAESCO/LBNL database were categorized based on installed measures and, where HVAC was the primary retrofit, investment thresholds were used to distinguish between capital-intensive and "light" retrofits. The categories were developed from extensive exploratory analysis of the data and were then applied to code projects using a standard framework (see Appendix B).

Retrofit strategy definitions were developed independently for the FEMP UESC database, thus the categories and the classification of projects are slightly different. A PNNL engineer examined each project individually and made an assignment based on the installed measures and on how much energy was saved annually as compared to the total investment. These technology groups aimed at best combining similar technologies with distinct patterns in annual energy savings per dollar invested.

[80] Including the DOE Super ESPC contracts in the NAESCO/LBNL database raised a similar issue because we received project Delivery Orders corresponding to awards, not construction. To maintain consistency with the other projects in the NAESCO/LBNL database, we collected construction completion dates from FEMP and ESCOs for those projects that were completed, and estimated completion dates based on the construction schedules in the Delivery Orders for the others. Because FEMP tracks ESPC projects by award date rather than project completion, our annual results differ somewhat from data compiled by FEMP.

To make project comparisons between the two datasets as meaningful as possible, LBNL and PNNL worked together to map their respective retrofit strategy definitions. For details of this mapping, refer to Appendix B.

6.2 Patterns of UESC and ESPC Project Development

In this section, we explore aggregate trends in UESC and ESPC project investment. For UESC activity, we report activity based on the projects in the FEMP UESC database. For ESPC, we combine estimates of Army and Air Force ESPC activity from Branch and Skumanich (2003) with site-specific ESPC activity from FEMP (2002) and DOE Super ESPC activity from the NAESCO/LBNL database (Strajnic and Nealon 2003).

6.2.1 Agency Adoption

All federal agencies are eligible to implement projects through the UESC or ESPC mechanisms.[81] **Table 6-2** shows the actual historical investment in UESC and ESPC projects, by agency where possible.[82] The four most active civilian agencies are shown: the Department of Energy (DOE), the General Services Administration (GSA), the U.S. Postal Service (USPS), the Veterans Affairs administration (VA). Other civilian agencies are reported together in an "other" category. Almost twice as many UESC projects have been implemented by military agencies than civilian; this is roughly proportional to the energy usage of military and civilian facilities. In the ESPC market, military project adoption is also high relative to civilian, though to a lesser extent than for UESC.[83] While facility size probably drives this result somewhat, the military-specific ESPC programs developed by the Army and Air Force have certainly played a role in encouraging military facilities to develop ESPC projects.

From the data in Table 6-2, it is clear that the average project size (measured by project investment) is greater for military than civilian projects and for ESPC than UESC projects, regardless of agency. These trends will be explored and interpreted in section 6.3.2.

[81] The DOE Super ESPC program is open to all agencies; as described in section 2.1.1.1, the Army and Air Force ESPC programs are offered only to certain agencies. Specific facilities may not be able to implement UESC projects if their local utility does not offer UESC services.

[82] Project investment is defined as turnkey project costs – the total cost to install the project, including all costs related to design, construction and commissioning as well as construction-period financing and any fees related to arranging long-term financing, but *not* including long-term financing (interest) costs.

[83] The number of military ESPC projects is uncertain because we did not receive this information for Air Force ESPC projects.

Table 6-2. UESC and ESPC Project History by Federal Agency (through 2002)

Agency	UESC		ESPC	
	N	**Total Turnkey Investment (2003 $M)**	**N**	**Total Turnkey Investment (2003 $M)**
Air Force	89	138	unknown	233
Navy/Marines	190	568	26	176
Army/Other military	149	155	82	413
Military Total	**428**	**861**	**108****	**822**
DOE	5	25	7	22
GSA	52	93	28	84
USPS	76	53	0	0
VA	27	79	27	162
Other	72	97	43	185
Civilian Total	232	347	105	453
Unknown agency*			77	288

Sources: FEMP UESC database for UESC projects; Branch and Skumanich (2003) for Army ESPC and Air Force ESPC projects; FEMP (2002) for site-specific ESPC projects; Strajnic and Nealon (2003) for DOE Super ESPC projects

*Agency adoption of site-specific ESPC projects was not available.

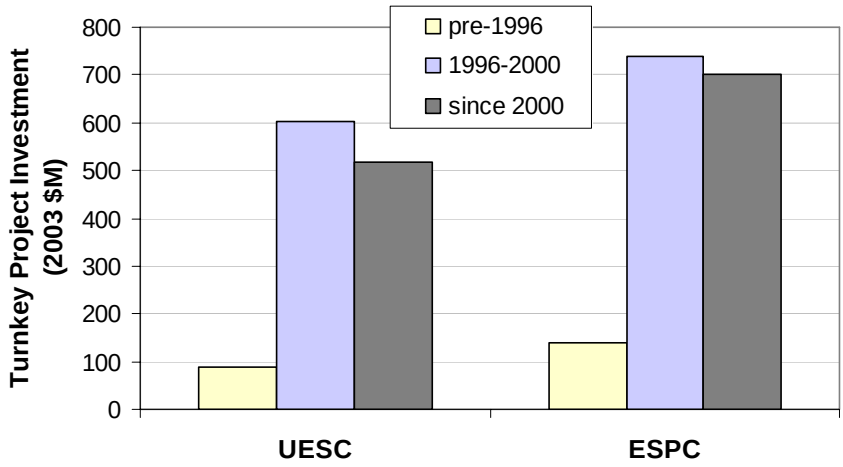
**This is a lower bound; it does not include the number of Air Force ESPC projects, which is unknown.

6.2.2 Trends over Time

Figure 6-1 shows investment in UESC and ESPC projects over time (in 2003 dollars). The data reflect the history of these programs. In the early 1990s, most UESC project activity was implemented through Basic Order Agreements or GSA Area Wide Contracts (AWC). UESC activity grew significantly in the latter half of the 1990s as standardized contracts were developed (see section 2.1.1.2) and electric industry restructuring provided an impetus for utilities to offer additional services to retain large accounts. In the most recent period, growth in UESC activity has declined somewhat, though probably not by as much as the graph suggests because the period since 2000 only includes 4 years of data (versus 5 years in the 1996-2000 period). Since 2000, military agencies have focused more attention on their core missions (e.g., wars in Afghanistan and Iraq) and privatization of utilities, and many civilian agencies have become focused on homeland security. In addition, some utilities that were previously active in offering UESCs have exited the market.

ESPC activity was also restricted to site-specific contracts in the early 1990s. In the late 1990s, projects began to be implemented through the Army, Air Force and DOE Super ESPC programs, and activity in these programs continued to grow through 2003. The most recent period only includes 3 years of data (the ESPC programs were stalled after September 2003 due to the enabling legislation sunset); clearly, *annual* project activity in 2000-2003 had increased considerably over the previous five-year period (1996-2000).

For both programs, it is clear that the development of standardized contracting vehicles, along with increased program facilitation support, had a significant impact on project deployment rates.



Sources: FEMP UESC database for UESC activity; Branch and Skumanich (2003) for Army ESPC and Air Force ESPC activity; FEMP (2002) for site specific ESPC activity; NAESCO/LBNL database for DOE Super ESPC activity

Figure 6-1. Alternative Financing Project Investment by Time Period

6.2.3 Geographic Representation

ESPC programs are available to all federal agencies regardless of location – even sites outside the U.S. are eligible. But UESC is only an option for facilities located in the service territories of the utilities that offer them. We therefore expect greater geographic variation in UESC adoption than ESPC. **Table 6-3** shows investment by DOE region.[84] Only DOE Super ESPC data are shown because geographic information was not available for other ESPC programs, so the ESPC results are not all-inclusive.

Table 6-3. Project Investment by DOE Region

DOE Region	UESC		DOE Super ESPC*	
	N	Turnkey Costs (2003 $M)	N	Turnkey Costs (2003 $M)
Northeast	70	107	12	36
Mid-Atlantic	56	186	16	141
Southeast	250	305	16	87
Midwest	39	133	12	35
Central	81	101	26	94
Western	164	377	39	166
Total	**660**	**1,208**	**121**	**560**

* projects that spanned more than one region were omitted

We find that UESC activity is concentrated in the Southeast and Western regions. Super ESPC activity is somewhat more balanced across the U.S. The variation across regions is

[84] A map showing the states included in each DOE region is available on FEMP's website (http://www.eere.energy.gov/femp/about/regionalfemp.cfm).

fairly well correlated with population density; the highest activity is found in the Mid-Atlantic and Western regions.

6.3 UESC and ESPC Project Characteristics

In this section, we compare UESC and ESPC project strategies and characteristics. UESC and ESPC projects represent two somewhat distinct models of project development at customer facilities. For UESC projects, it is common for utilities and customers to sign an area-wide contract, Basic Ordering Agreement or Model Agreement initially and then implement a series of delivery orders at the site for specific retrofit projects (each of which are typically reported as "projects" by utilities in the FEMP UESC database). For ESPC projects, it is more common for a comprehensive, single-phase project to be developed by the ESCO. While our comparison of UESC and ESPC project characteristics is necessarily at the *project* level, we caution and will demonstrate that drawing conclusions about the comparative performance of UESC and ESPC programs would be more appropriately done at the *customer site* level.

The 660 UESC projects included in this analysis are from FEMP's UESC database.[85] In interpreting UESC results, it is important to note that full-service ESCOs play varying roles in UESC project development. For some projects, utilities select ESCOs to manage project design and construction. For others, the utility manages the project and typically relies on energy-efficiency sub-contractors to design, construct and implement the recommended technical measures. In some cases, ESCOs have performed this function for UESC projects. However, many UESC projects entail no ESCO involvement (see sections 2.1.1.2 and 6.1).[86]

The ESPC results in this section are based on NAESCO/LBNL database projects; they include all 129 Super ESPC Delivery Orders[87] received from Strajnic and Nealon (2003) as well as a sample of 36 Army ESPC, Air Force ESPC, and site-specific ESPC projects provided by ESCOs applying for NAESCO accreditation.[88]

6.3.1 Project Strategies

Our starting point for comparing UESC and ESPC projects is in examining project strategies: patterns of project deployment (one-time projects versus repeat business), the number and types of measures installed and retrofit strategies. This characterization of

[85] See section 6.1 for a discussion of which projects from the FEMP UESC database were included in this analysis.
[86] Because data on the entities implementing projects were not collected, we have no way of separating ESCO-managed from non-ESCO-managed UESC projects.
[87] The number of Super ESPC projects in the NAESCO/LBNL database differs slightly from FEMP's tracking, because we have treated modifications to Delivery Orders that involve add-on phases as separate projects in our database.
[88] In this chapter, only projects known to be ESPC-financed are included. Thus, UESC and unknown financing type projects, included in the NAESCO/LBNL database sample of federal government projects analyzed in Chapter 4, are not included in this chapter.

project strategies is useful in interpreting project results: investment, energy savings and payback times.

6.3.1.1 Project Deployment Patterns

The models under which UESC and ESPC projects are implemented reflect high-level policy rules (e.g., length of allowable payback) as well as the roles and motivations of the entities responsible for developing projects for customers: utilities for UESC projects and ESCOs for ESPC projects.

Local regulated utilities typically have a long-term relationship with federal customer facilities that they serve. Additionally, the transaction costs of implementing a UESC project are often low relative to ESPC.[89] Repeat UESC business is thus easy to implement and fairly well assured, leading utilities and customers to invest in one or a few measures as discrete projects.[90] In contrast, ESCOs may not have a previously established relationship with the customer facility implementing an ESPC project. ESCOs have a greater incentive to generate as much investment as possible in a single project because the transaction costs of developing an ESPC project are relatively high and repeat business is less certain.

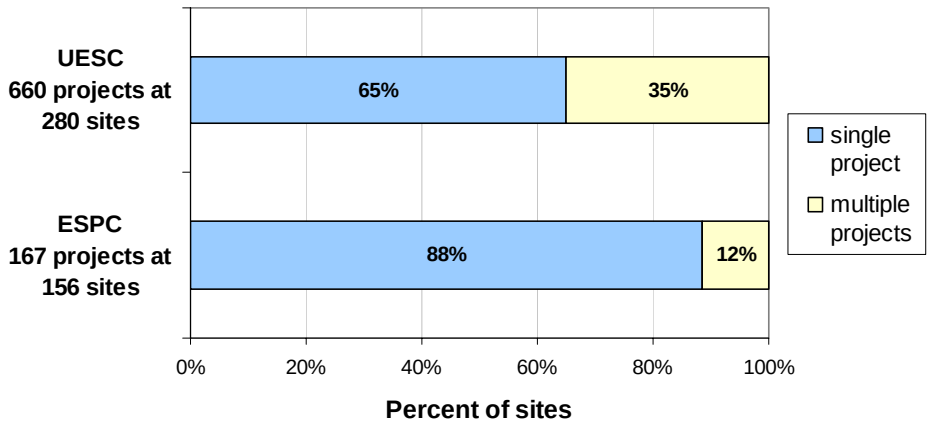


Figure 6-2. Project Deployment Patterns at UESC and ESPC Customer Sites

To illustrate this phenomenon, we present trends in project development by customer site in **Figure 6-2**. The 660 UESC projects were installed at 280 sites (2.36 projects per site on average) and 167 ESPC projects were installed at 156 sites (1.06 projects per site). As Figure 6-2 shows, 35% of UESC sites implemented more than one project, compared to only 12% of ESPC sites.

[89] Customers implementing UESC projects do not need to select a contractor, the project appears as a line item on the customer's energy bill, and there is typically no M&V requirement unless the customer site requests it.

[90] Additionally, utilities offering rebate programs may engage in single-measure UESC projects that target the rebated equipment; 28% of single-measure UESC projects included rebates, mostly for lighting efficiency retrofits.

However, these results may understate the amount of repeat business among ESPC customers for two reasons: (1) the DOE Super ESPC program has a shorter history than the UESC program, so it may be that customer sites simply haven't yet had time to implement follow-up work, and (2) for other ESPC programs, our data is not comprehensive and may not include all projects at the sites represented. Thus, the observed amount of ESPC repeat business should be treated as a lower bound on the actual amount of follow-up work that has been or is likely to be implemented.

As will be demonstrated in the next section, the presence of follow-up work among sites implementing UESC projects has a direct impact on the comparability of UESC and ESPC projects.

6.3.1.2 Saturation of Measures

The number and percent of ESPC and UESC projects that installed each of the measure categories introduced in section 5.2.3 are compared in **Table 6-4**.[91] The saturation of all measures is considerably lower for UESC than ESPC projects. Indeed, 405 UESC projects (61%) consisted of a single measure category.[92] By contrast, only 20 ESPC projects (12%) were single-measure projects. For the 39% of UESC projects that involved more than one measure category, on average 2.9 measures were installed per project, whereas multi-measure ESPC projects installed an average of 4.9 measures per project. Most technologies appear comparable in their relative importance among ESPC and UESC projects (e.g., lighting is the most common measure category in both programs), with the exception of HVAC controls (relatively less common in UESC projects) and ventilation/distribution (relatively more common in UESC than ESPC projects).

While it would be tempting to infer based on these project-level results that ESPC projects are more comprehensive in capturing opportunities for energy efficiency than UESC, this would ignore the role that follow-up work plays in developing energy-efficiency opportunities at customer sites. **Table 6-5** shows a rough analysis of project- and site-level measure penetration for UESC and ESPC. At the project level, the ESPC program appears to target considerably more measures than the UESC program, as estimated by the average number of measure categories per project (number 1 in Table 6-5). But if we combine projects implemented at specific sites and count them together, the average number of measures per site is comparable – UESC projects targeted 4.1 measures per customer site compared to 4.7 for ESPC customers. We still find that more UESC sites implemented a single measure (35% versus 11% for ESPC), but on average the number of measures implemented by sites engaging in some combination of multi-measure projects or follow-up work was higher for UESC than ESPC. Though this

[91] A list of the individual measures included in each category is provided in Appendix A. In this chapter, where we refer to "measures", we mean the categories of measures defined in Table 6-4. Thus, a "single-measure" project could have reported more than one measure that fell within a single measure category.
[92] There has been a slight decline in the share of single-measure UESC projects over time. In both the pre-96 and 1996-2000 periods, 60-61% of UESC projects were single-measure. Since 2000, this has dropped to 54% of projects.

analysis should be viewed as preliminary, it does suggest that facility site-level analysis may more fairly compare UESC and ESPC investments in energy-efficiency than a project-level analysis.

Table 6-4. Saturation of Measure Categories

Measure Category	ESPC (n=165)		UESC (n=660)	
	No. of projects	% of projects	No. of projects	% of projects
Lighting	139	84%	355	54%
Heating, Ventilation & Air Conditioning (HVAC):				
Boilers	29	18%	36	5%
Chillers	52	32%	60	9%
Other HVAC sources (e.g., cooling towers, furnaces, steam plants)	12	7%	34	5%
Distribution/ventilation	66	40%	203	31%
Controls (e.g., thermostats, energy management systems)	143	87%	171	26%
Other HVAC	6	4%	33	5%
Packaged/roof-top/split systems	14	8%	5	1%
Air quality	2	1%	0	0%
Building envelope (e.g., insulation, windows, doors)	15	9%	35	5%
Geothermal heat pumps	21	8%	25	4%
Motors/drives:				
High-efficiency motors	28	17%	50	8%
Variable speed drives (VSD)	44	27%	8	1%
Water heaters	20	12%	15	2%
Miscellaneous equipment/systems (e.g., plug loads, traffic signals, office equipment)	19	12%	22	3%
Industrial process improvements	9	5%	10	2%
Other measures/strategies (e.g., fuel conversion, staff training, peak shaving)	46	28%	26	4%
Water conservation	51	31%	36	5%
Distributed generation (DG):				
Renewables (e.g., photovoltaics, wind, biomass)	9	5%	3	0%
Cogeneration	3	2%	5	1%
Other DG technologies (e.g., natural gas engines, microturbines)	7	4%	14	2%
Backup/emergency generators (e.g., diesel engines)	1	1%	2	0%

NOTE: see Appendix A for complete details of the measures included in each category.

Table 6-5. Project Versus Site Analysis of Measure Deployment

		UESC	ESPC
1.	Number of projects average number of measures/project	660 1.49	165 4.5
2.	Number of sites average number of measures/site	280 4.1	156 4.7
3.	Single-measure sites*	98 (35%)	17 (11%)
4.	Multi-measure sites** average number of measures/site	182 (65%) 5.8	139 (89%) 5.2

* customer sites that implemented a single project targeting a single measure category
** customer sites that implemented more than one measure category through a multi-measure project and/or more than one project

In addition to the higher frequency of multiple site delivery orders for UESC projects, we identify three other factors that may partially account for the relatively low saturation of measures in UESC projects.

Differences in Maximum Allowable Payback Time

The ten-year maximum payback time for UESC projects limits comprehensiveness to some extent. For ESPC projects the maximum contract term is 25 years (FEMP 2004a); ESCOs thus have considerably more leeway to develop comprehensive projects under the ESPC mechanism. However, this does not fully explain the data because even quick-payback measures such as lighting, which could be used to leverage longer-payback measures into a bundled, shorter-payback project, are implemented less frequently among UESC projects (only 54% installed lighting).

Customer Preference

Federal agencies considering implementing projects have a choice of financing mechanism. The UESC model, offering simple procurement from a familiar entity, may be attractive to customers that prefer to engage in simple, quick projects that are minimally disruptive to their facilities and core activities, while the ESPC mechanism may be more often chosen by customers with an immediate need to replace capital-intensive equipment because the longer allowable contract length is necessary to finance the project.[93] To the extent that customer motivation and technical opportunities correlate to the choice of financing mechanism, the two programs represent different niches in the market for energy efficiency at federal facilities that meet different customer needs.

Data Collection Issues

For the DOE Super ESPC projects, detailed, comprehensive information on installed measures was obtained from project Delivery Orders. For other ESPC projects, collected through NAESCO accreditation, ESCOs were asked to select measures from a detailed list. For UESC projects, utilities and agencies were asked an open-ended question about

[93] Our ESCO interviews revealed that replacing aging capital equipment is indeed a primary driver in the ESPC market (see section 2.3).

the measures installed and it was common, especially early on in the data collection process, to receive very limited information on measures implemented.[94] Thus, it is more likely that incomplete measure information was collected for UESC projects than for ESPC projects.

6.3.1.3 Retrofit Strategies

UESC and ESPC retrofit strategies, based on project-level data,[95] are shown in **Figure 6-3**).[96] UESC projects are dominated by minor HVAC and lighting-only projects (52% and 31% of UESC projects, respectively). This is related to the high incidence of single-measure UESC projects combined with the ten-year payback limitation. The capital-intensive strategies, DG and major HVAC, are clearly less common among UESC projects than ESPC projects, but there are nonetheless a few very large UESC projects that installed DG or capital-intensive HVAC equipment. For ESPC projects, DG and major HVAC represent a more sizeable 12% and 24% of projects, respectively. The ESPC model of bundling of several measures in a single project, along with the longer allowable payback times (20-25 years) makes the installation of capital-intensive equipment more feasible in this market.

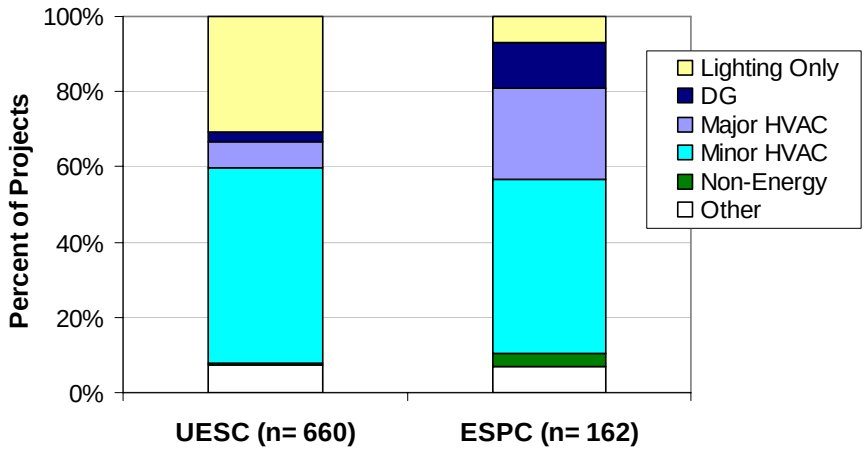


Figure 6-3. UESC and ESPC Projects by Retrofit Strategy

Trends in retrofit strategies over time are shown for UESC projects in **Figure 6-4** and ESPC projects in **Figure 6-5**. Consistent with the results for all market segments combined (see section 5.2.4), lighting-only projects are becoming less common in both UESC and ESPC projects (down to 20% of UESC projects and 4% of ESPC projects

[94] Data collection for UESC projects is particularly challenging because neither of thecontracting parties (utilities nor agencies) are required to provide data to DOE – it is collected on a voluntary basis.
[95] Were we to conduct a site-level analysis of retrofit strategies, combining the measures installed through multiple projects at each site, we would probably see fewer lighting-only and minor HVAC retrofits among UESC sites balanced by more capital intensive retrofits (e.g., DG and major HVAC) because of the priority of such measures in how our strategies are defined.
[96] Our retrofit strategies are defined in section 5.2.4. Details of how ESPC and UESC projects were coded into these strategies are provided in section 6.1 and Appendix B.

since 2000), though the trend is more pronounced for ESPC. This may indicate that much of the opportunity for single end-use projects has been captured, or it may be that project design has evolved since the early 1990s toward more sophisticated projects that capture savings opportunities in multiple end uses.

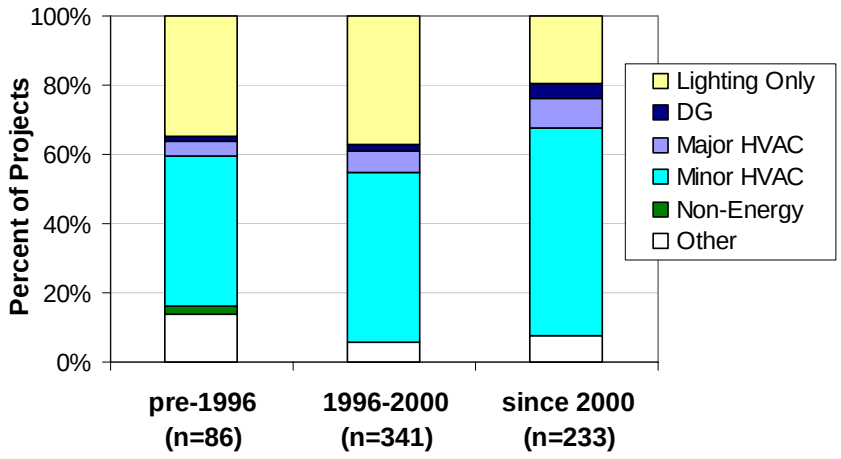


Figure 6-4. Trends in Retrofit Strategies: UESC

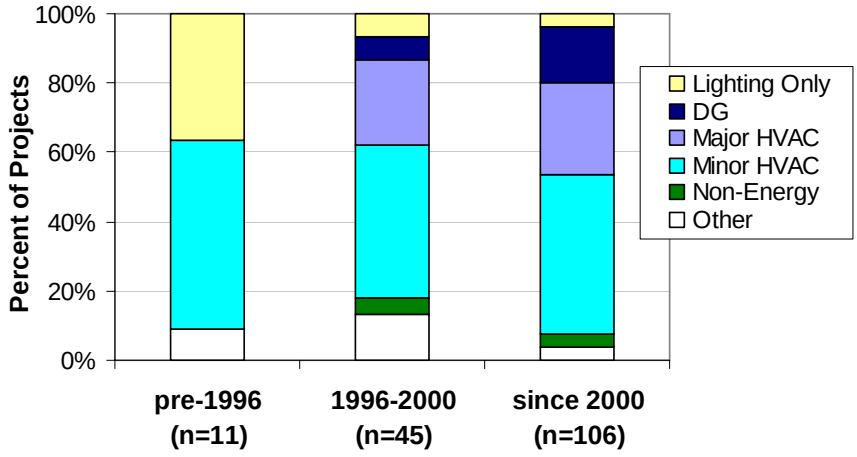


Figure 6-5. Trends in Retrofit Strategies: ESPC

DG is increasing in importance among both UESC and ESPC projects (16% of ESPC projects completed since 2000), though it is still a very rare strategy in the UESC market (4%) – it is simply much harder to make DG work within a 10-year payback horizon.

Projects targeting HVAC end uses as the primary retrofit are also becoming more common in both UESC and ESPC markets, as is the relative share of major HVAC projects. Major HVAC projects constituted 8% of UESC and 26% of ESPC projects since 2000. This, combined with the growing importance of DG, shows that both UESC and ESPC markets are shifting toward more capital-intensive projects that address other

needs besides energy savings. This is consistent with ESCO industry trends overall (see section 5.2.4).

6.3.2 Investment Trends

In section 6.2.1 we noted, based on average turnkey investment, that ESPC projects are considerably larger than UESC and that projects at military sites are larger than civilian projects. **Figure 6-6** shows median and quartile turnkey project investment results that reinforce this finding.[97] The median UESC project invested $0.55 million (2003 dollars), compared to $2.5 million for ESPC. While projects at military sites are larger than civilian sites, this is true within both ESPC and UESC markets, and the differences between financing mechanisms greatly outweigh the differences within them.

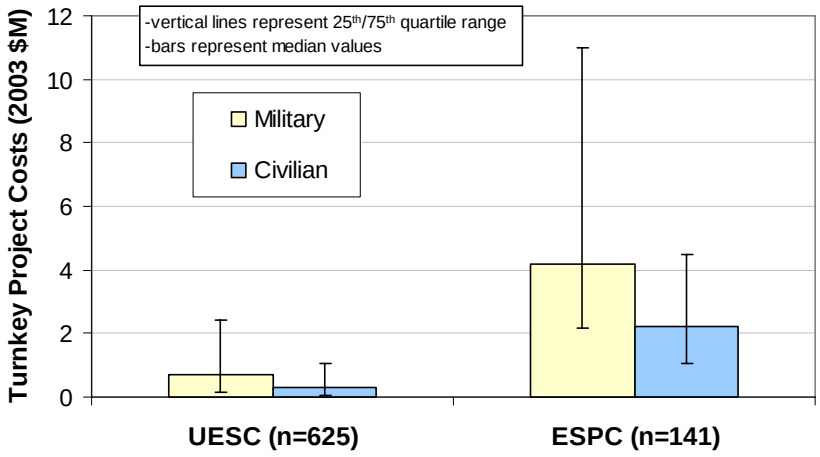
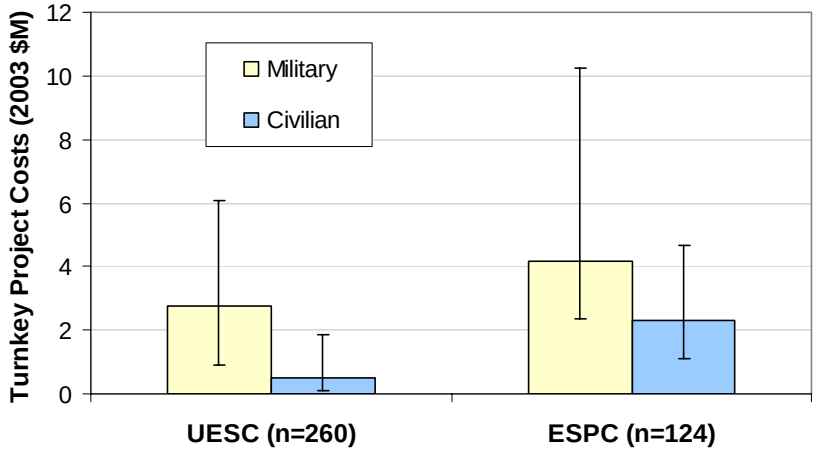


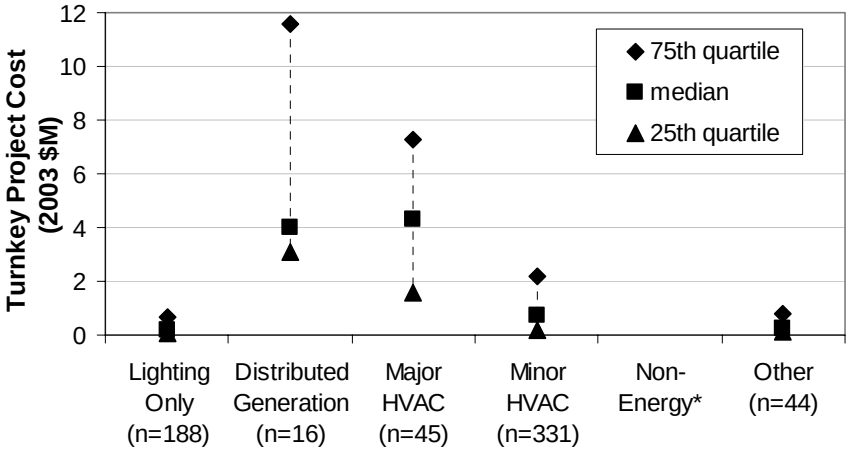
Figure 6-6. UESC and ESPC Project-Level Investment at Military and Civilian Sites



[97] Turnkey project investment includes the total cost to install the project, including all costs related to design, construction and commissioning as well as construction-period financing and any fees related to arranging long-term financing, but *not* long-term financing (interest) costs.

Figure 6-7. Site-Level Investment in ESPC and UESC Projects

The difference in UESC and ESPC project size is explained primarily by the different approaches to harvesting energy efficiency opportunities at a site. Because many sites implementing UESC projects follow up with additional projects, the combined investment at a given site is actually much higher than these results suggest. **Figure 6-7** shows project investment by customer site (the sum of the investment in all projects completed at a given site) for UESC and ESPC projects. The median investment in ESPC sites ($2.6 million) is not significantly different than for ESPC projects – this is because only a few sites completed multiple projects. However, the median UESC investment per site, at $1.4 million, is almost three times greater than the median investment per UESC project.



* insufficient sample size to report data

Figure 6-8. UESC Project Size by Retrofit Strategy

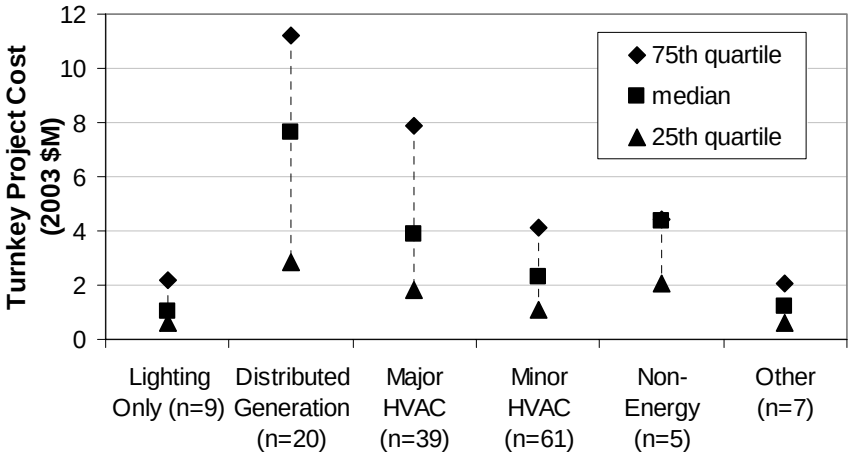


Figure 6-9. ESPC Project Size by Retrofit Strategy

The most likely explanation for the observed smaller projects at civilian than military sites is that civilian facilities tend to be physically smaller (see section 5.1).
Project size is shown by retrofit strategy in **Figure 6-8** for UESC projects and **Figure 6-9** for ESPC projects.[98] For almost all strategies, project investment is higher among ESPC projects than UESC. This is probably due to fewer bundled measures in projects within each strategy, but may also be driven by differences in retrofitted floor space (this is particularly likely for lighting-only projects).[99] Major HVAC projects appear to be an exception to this rule, being slightly larger when implemented with UESC than ESPC financing.

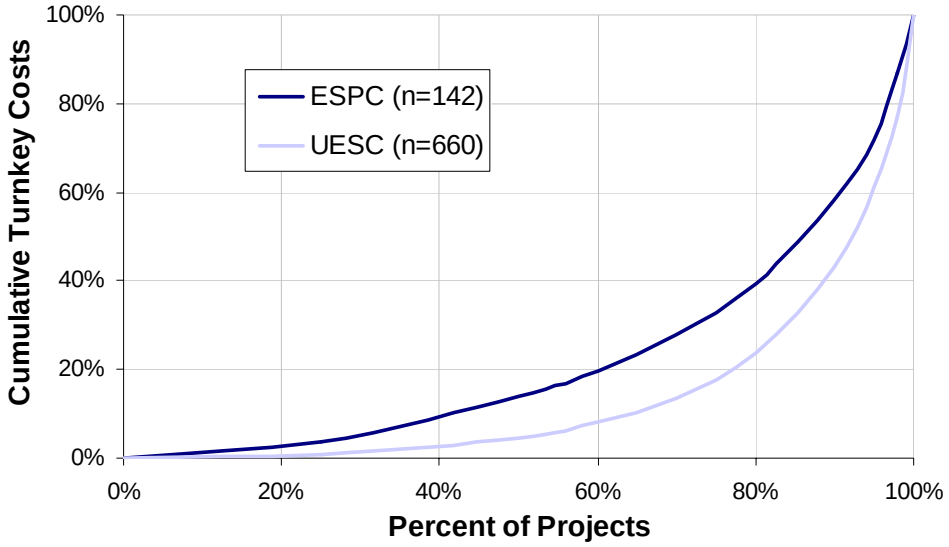


Figure 6-10. Cumulative Costs of UESC and ESPC Projects

The UESC market is also characterized by greater variation in project size. **Figure 6-10** shows the cumulative investment of UESC and ESPC projects ordered along the x-axis from least to greatest turnkey costs; the y-axis shows the cumulative costs accounted for by all the projects to the left of each data point. The UESC curve is considerably steeper than the ESPC curve, indicating that the influence of a few large projects on total investment is greater in the UESC than the ESPC market. The largest 2% of UESC projects account for 23% of total UESC investment; for ESPC, the largest 2% of projects provide 13% of investment activity. Conversely, the smallest 50% of UESC projects account for only 4% of UESC investment, while the same share of ESPC projects accounts for 14% of total ESPC investment. This demonstrates that project activity can be driven by small projects, but in terms of total investment, a few very large projects provide the majority of market activity. While this is true for ESPC and for other non-federal market segments (see Figure 5-8), it is exaggerated for UESC. Thus, the typical

[98] We did not attempt to assign retrofit strategies on a site-level basis.
[99] Unfortunately, floor space data were not available for UESC projects, so we were unable to compare project investment per square foot in this chapter.

UESC model of relatively small, quick-payback projects does have its exceptions, and these exceptions are responsible for a significant share of market investment.

6.3.3 Annual Energy Savings

Reported annual energy savings[100] (not normalized for project floor space) are shown in **Table 6-6** by project and by customer site.[101] Project-level annual energy savings are clearly lower for UESC than ESPC projects, and for civilian than military projects. This is not surprising given their typically lower per-project investment. The median energy savings for UESC projects overall is 4.2 billion Btu per year, compared to 17.3 billion Btu annual ESPC project savings. At the customer site level, UESC efficiency investments saved a median 8.6 billion Btu annually, double the median project-level energy savings. ESPC site energy savings are only nominally different from project energy savings (median 18.5 billion Btu per site).

Table 6-6. Annual Energy Savings of UESC and ESPC Projects and Sites

Alt. Financing Type	Agency	Annual Project Energy Savings (10^9 Btu)				Annual Site Energy Savings (10^9 Btu)			
		N	25th quartile	median	75th quartile	N	25th quartile	median	75th quartile
UESC	Military	265	1.6	6.6	23.2	96	5.1	17.6	51.9
	Civilian	116	0.5	2.0	6.9	77	0.7	3.5	9.5
	All	381	1.1	4.2	17.3	173	1.9	8.6	29.4
ESPC	Military	42	11.6	25.0	60.3	34	10.7	29.3	79.5
	Civilian	86	5.9	15.7	27.9	79	6.1	15.7	29.4
	All	129	8.0	17.3	39.6	114	7.8	18.5	43.1

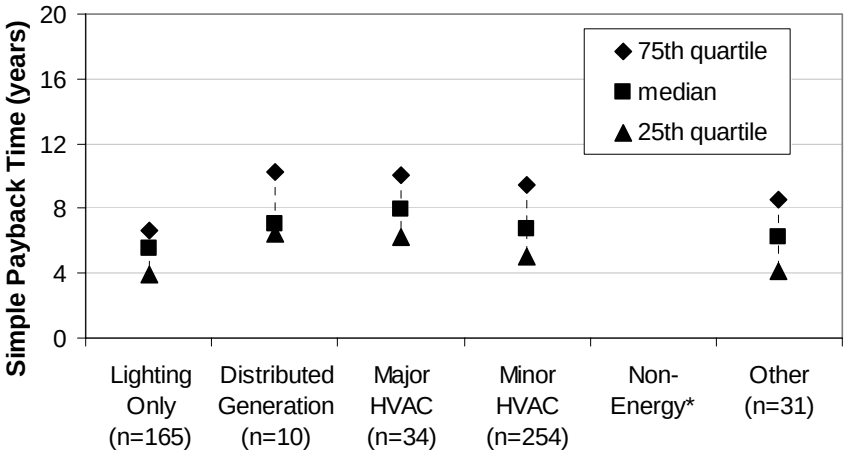
6.3.4 Simple Payback Time

To conclude our comparison of UESC and ESPC projects, we examine simple payback time at the project level.[102] Given the differences in maximum allowable payback time – 10 years for UESC and 25 years for ESPC – we expect to see significant differences in the data.

Indeed, the ten-year payback restriction for UESC projects is immediately apparent from **Figure 6-11**. The median UESC payback time, regardless of retrofit strategy, is 6.4 years, and the medians for all strategies are safely below the ten-year limitation. However, we calculated payback times in excess of ten years for 13% of UESC projects. For some projects, this may be the result of missing data. O&M savings included in project decision-making may not have been reported, resulting in artificially long computed

[100] See section 5.4.1 for details of how energy savings were reported and analyzed.
[101] Unfortunately, floor space data were not available for UESC projects, so we were unable to compare project energy savings on a per-square-foot basis in this chapter.
[102] Details of how payback times were calculated for ESPC and UESC projects are provided in Appendix C.

payback times.[103] Not surprisingly, most of the projects that exceed the ten-year payback limit are DG or major HVAC projects.



* insufficient sample size to report data

Figure 6-11. UESC Simple Payback Time

In the ESPC market, payback times appear to be driven by retrofit strategy rather than the maximum payback time, which in most cases is not binding (see **Figure 6-12**). Almost half of ESPC projects exceed ten years (48.5%); this not only reflects the 25-year limit but also the typically more comprehensive projects implemented with ESPC financing. The median ESPC project payback is 8.8 years.

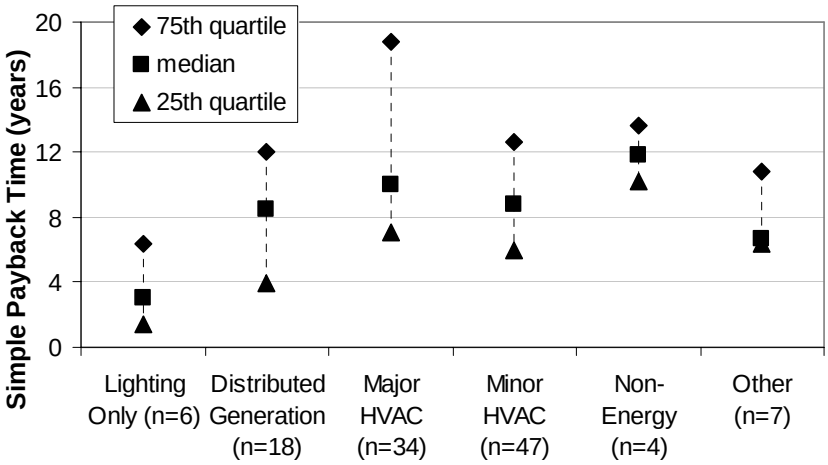


Figure 6-12. ESPC Simple Payback Time

Relative to ESPC projects, UESC projects within each strategy pay back within a narrower range – not only is the ten-year payback binding, but it appears that the lower

[103] It is sometimes allowable for UESC projects to exceed a ten-year payback on a discretionary basis if the project can be shown to be economical, but this practice is relatively rare.

bound on UESC paybacks is high relative to ESPC projects. This may reflect a greater variety of retrofits among ESPC projects, which bundle more measures in a single project. However, this does not explain the lighting-only results, which should be similar for both financing mechanisms, yet are clearly longer for UESC than ESPC projects (5.5 and 3.0 years, respectively). This may be due to missing O&M savings data among UESC projects.

7. Conclusions

This detailed analysis of public/institutional market segments demonstrates the linkages between high-level policies, market drivers and barriers, and the characteristics of implemented projects.

For example, the largest market for ESCOs in number of projects as well as total investment is K-12 schools – these customers account for roughly half of the MUSH market projects and investment in our database. This is in part due to enabling legislation for performance contracting, but is also clearly linked to the need in this market for equipment and infrastructure upgrades. Not only is this reflected in the number of projects implemented, but also in their characteristics. K-12 schools projects tend to have more challenging economics (the median payback time is 14.7 years) because they often leverage energy savings to pay for new energy and non-energy equipment. Within the MUSH markets, their reliance on O&M savings to finance these investments is greatest. Taken together, these results paint a consistent picture of the customer motivation and practices underlying these investments.

The project data results for hospitals also provide a unique and coherent story. The shift toward private ownership of hospitals in the last several years impacts the types of investments these facilities are willing to undertake, specifically by shortening the acceptable payback time for investments. This is clearly represented in our economic analysis; hospital projects pay back the quickest (4.9 year median) and are cost-effective at more stringent evaluation criteria than other public/institutional market segments. This probably limits activity in this market, as evidenced by the fact that hospitals make up the smallest public/institutional market segment in our database (only 10% of MUSH market activity). However, this is balanced to some extent by technical opportunities, demonstrated by high per-square-foot energy savings (22 kBtu/ft^2 median), which are probably attributable to unique operating conditions and equipment usage.

University/college campuses represent the largest facilities within the MUSH markets, and project investment per square foot is correspondingly low ($2.43/ft^2 median). University project results most closely resemble the federal government, probably because their large campuses share some common characteristics with military bases – large, mixed-use facilities with residential housing. This is reflected in higher adoption of water conservation strategies than other MUSH markets.

State/local government projects are perhaps the most “typical” of all market segments. For virtually every indicator – costs, savings, and economics – their performance is in the mid range compared to other public/institutional market segments.

During the last 5-6 years, the federal government has been a growth market for ESCOs. Compared to MUSH market segments, the federal government has low project investment (median investment is $2.32/ft^2) corresponding to large facilities, and comparable energy savings and project economics. Concerns about cost-effectiveness are refuted by the actual economics of Super ESPC projects – their combined net benefits range from $138 to $286 million (in 2003 dollars), depending on assumptions, and are

higher than would be produced by all but the most optimistic scenarios if projects were funded with congressional appropriations. More than other markets, the federal government is experimenting with emerging technologies such as renewable energy sources and onsite generation.

Looking within the federal government, we see that project characteristics are shaped by the two alternative financing programs: ESPC and UESC. The differences in UESC and ESPC project characteristics reflect the different policy objectives and deployment patterns of these programs. ESPC was developed to enable comprehensive ESCO projects at agencies through streamlined procurement; as a program, it is targeted at reducing agency energy usage per square foot. It also supports specific emerging technologies (e.g. geothermal heat pumps, photovoltaics) through specialized contracts. We see these characteristics in project data; ESPC projects are larger (median investment is $2.5 million compared to $0.55 million for UESC), install more measures, have longer payback times (8.8 year median compared to 6.4 years for UESC) and include more renewable technologies than UESC projects. The UESC financing mechanism, on the other hand, stems from a longer history of energy service provision through utility partnerships with the federal government. This relationship, as well as the ten-year payback restriction, shape how projects are developed – commonly, a series of smaller projects are implemented at individual facilities. Because of these distinctions, the unit of analysis matters. We suggest that site, rather than project, investment and savings levels are more appropriate when comparing UESC and ESPC investment in and savings from energy-efficiency measures. Ultimately, it is important to remember that federal agencies (at least those in areas with UESC-administering utilities) have a choice of alternative financing mechanism and probably select whichever best matches their needs. Thus, UESC and ESPC appear to enable energy-efficiency investments in two niches within the federal government with, of course, some overlap.

Our project data results also highlight the importance of lighting and HVAC controls in driving ESCO industry activity. The vast majority of projects installed these measures (80-90% for each); this is because they provide very high energy savings for the investment.[104] Increasingly, lighting is not being installed alone – instead, it and HVAC controls are being bundled to leverage the cost of capital-intensive equipment replacement, which may be the core selling point of the project. DG, though still a small portion of reported projects, is increasing in importance and, based on industry reports as well as trends in DOE and Department of Homeland Security priorities, we believe it will continue to grow.[105]

In terms of policy support, it seems clear that declining financial incentives from utility DSM or public purpose programs have apparently not impeded industry development in

[104] This phenomenon probably also reflects the fact that the largest ESCOs are owned by controls and/or lighting equipment manufacturers, though all ESCOs install these measures.

[105] It is important to note, however, that this is not at the expense of energy efficiency investments – virtually all of the DG projects in our database were bundled with comprehensive energy-efficiency retrofits. Energy efficiency complements DG by reducing the generating capacity needed and by leveraging the cost of the equipment with energy savings.

recent years, even though such incentives were undoubtedly important in the industry's early years. Vastly more important is ensuring enabling legislation to remove barriers to project development in public/institutional markets. The recent federal ESPC sunset impasse demonstrated this all too clearly, and highlighted the need for energy-efficiency or alternative-energy programs to track performance and progress. Not only does this information help policymakers assess deployment of their programs, but it also provides the analytic tools to document program impacts when needed.

We believe that making information publicly available also has broader benefits – it promotes awareness of policies, programs and energy efficiency in general, provides benchmarking tools for various parties interested in engaging in projects or developing new programs and policies, and provides a historical record of actual deployment of energy-efficiency measures that can be used to gauge the achievable potential for future investments. Such information can also be used to establish a baseline industry track record as a basis for policies to improve program performance. Finally, because the U.S. ESCO industry is often held up as an example for other countries, we hope that demonstrating linkages between policies, market drivers and project performance in the U.S. will help international policymakers make informed decisions in developing their own energy-efficiency services industries.

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