Title:
U.S. Energy Service Company Industry: Market Size and Project Performance from 1990-2008

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Abstract:
The U.S. energy service company (ESCO) industry is an example of a private sector business model where energy savings are delivered to customers primarily through the use of performance-based contracts. This study was conceived as a snapshot of the ESCO industry prior to the economic slowdown and the introduction of federal stimulus funding mandated by enactment of the American Recovery and Reinvestment Act of 2009 (ARRA). This study utilizes two parallel analytic approaches to characterize ESCO industry and market trends in the U.S.: (1) a "top-down" approach involving a survey of individual ESCOs to estimate aggregate industry activity and (2) a "bottom-up" analysis of a database of ~3,250 projects (representing over $8B in project investment) that reports market trends including installed EE retrofit strategies, project installation costs and savings, project payback times, and benefit-cost ratios over time. Despite the onset of a severe economic recession, the U.S. ESCO industry managed to grow at about 7% per year between 2006 and 2008. ESCO industry revenues were about $4.1 billion in 2008 and ESCOs anticipate accelerated growth through 2011 (25% per year). We found that 2,484 ESCO projects in our database generated ~$4.0 billion ($2009) in net, direct economic benefits to their customers. We estimate that the ESCO project database includes about 20% of all U.S. ESCO market activity from 1990-2008. Assuming the net benefits per project are comparable for ESCO projects that are not included in the LBNL database, this would suggest that the ESCO industry has generated ~$23 billion in net direct economic benefits for customers at projects installed between 1990 and 2008. There is empirical evidence confirming that the industry is evolving by installing more comprehensive and complex measures—including onsite generation and measures to address deferred maintenance—but this evolution has significant implications for customer project economics, especially at K-12 schools. We found that the median simple payback time has increased from 1.9 to 3.2 years in private sector projects since the early-to-mid 1990s and from 5.2 to 10.5 years in public sector projects for the same time period.

Keywords:
ESCO; energy efficiency; industry size; project performance; economic analysis

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Acronyms and Abbreviations

ARRA	American Reinvestment and Recovery Act
B-C Ratio	Benefit-cost ratio
Btu	British thermal unit
DOE	U.S. Department of Energy
ECM	energy conservation measure
EERE	(DOE Office of) Energy Efficiency and Renewable Energy
EIA	Energy Information Administration
EM&V	Energy measurement and verification
ESCO	energy service company
ESPC	energy savings performance contract
HVAC	heating, ventilation, air conditioning
IPMVP	International Performance Measurement Verification Protocol
LBNL	Lawrence Berkeley National Laboratory
MUSH	Municipal and state governments, universities and colleges, K-12 schools, and hospitals market sector
NAESCO	National Association of Energy Service Companies
O&M	operations and maintenance
OE	(DOE Office of) Electricity Delivery and Energy Reliability
REEP	Ratepayer-funded energy efficiency program
SPT	Simple payback time

Highlights

- U.S. ESCO industry revenues were ~$4 billion in 2008 and we estimated accelerated growth for 2011.

- U.S. ESCOs generated ~$23 billion in direct benefits at projects installed from 1990-2008.

- Industry evolution has implications for customer project economics, especially at K-12 schools.

- Payback times have increased from 1.9 to 3.2 years in private sector projects since 1990.

- Payback times have increased from 5.2 to 10.5 years in public sector projects since 1990.

Disclaimer

1. Introduction

The U.S. energy services company (ESCO) industry provides energy savings and other benefits to customers primarily through the use of performance-based contracting. This private industry, developed over the past 30 years, has largely been a successful model for the cost-effective delivery of energy-efficient technologies and services to public/institutional sector customers. Goldman et al. (2005) conducted an analysis of U.S. ESCO industry trends and performance-based contracts using empirical project-level and industry survey data. Other studies of the U.S. ESCO industry have described ESCO project activity in specific market sectors, such as state government markets (Bharvirkar et al. 2008), institutional markets (Hopper et al. 2005) or reported survey results on U.S. ESCO market activity levels in aggregate and growth prospects (see Hopper et al. 2007; Satchwell et al. 2010).

This study builds on Goldman et al. (2005) and was conceived primarily as a snapshot of the ESCO industry circa 2008, prior to the economic slowdown and the introduction of federal stimulus funding mandated by enactment of the American Recovery and Reinvestment Act of 2009 (ARRA). This study utilizes two analytic approaches: (1) a "top-down" method involving a survey and interviews with ESCOs to estimate aggregate market activity and identify emerging trends (Satchwell et al. 2010) and (2) a "bottom-up" analysis of a large database of ~3,250 projects provided by ESCOs and their customers (i.e., the LBNL/NAESCO database). The database includes projects implemented between 1990 and 2008 representing over $8 billion (2009$) in total project investments.[1] We use the database to characterize long-run trends in typical ESCO project characteristics, investment and savings levels as well as overall economic

[1] The terms "costs" and "investments" are used interchangeably throughout this article with project costs being borne by customers of ESCOs and project investments being made by ESCOs. Thus, we define total ESCO project investment as the turnkey costs associated with project development and installation (excluding the costs of project financing over the contract term after the project has been accepted by the customer).

performance. Our examination of U.S. ESCO industry and market trends provides insights into the distinctive features and enabling policies for a relatively mature private sector energy efficiency services industry, which may be useful to policymakers in other countries interested in promoting similar business models.

We report that U.S. ESCOs typically prefer guaranteed savings contracts. In contrast, Da-li (2009) report that the shared savings model is still preferred in the buildings sector in China, although the guaranteed savings model may be gaining momentum for projects currently being undertaken in the industrial sector. Murakoshi and Nakagami (2009) report that installation costs (and payback times) are increasing at ESCO projects much faster than the rate of inflation in Japan, which is consistent with the analysis of installation cost and economic performance trends of the U.S. ESCO industry reported in this paper. Lindgren (2009) surveys Swedish ESCO industry executives and reports some similarities to our findings for the U.S. ESCO market − a small number of ESCOs generating a majority of industry revenue and most activity occurring in the public sector. In 2010, the European Commission confirmed strong ESCO industry growth for Sweden as well as several other countries, but reported a “common trend” of slower or decreasing growth across Europe since their last survey was conducted in 2007 (Marino et al. 2010). The global economic downturn was identified by Marino et al. (2010) and Satchwell et al. (2010) as a factor that contributed to slower than anticipated growth in the ESCO industry for a number of countries, including the United States. ESCO industries are at various stages of development in other countries (Vine 2005).

There are also a number of relevant issues that have important policy implications in the U.S. and abroad including: (1) the monetization of non-energy benefits; and (2) the collection of and access to project-level benchmarking information. In addition to the direct financial benefits (e.g., energy-related dollar savings), indirect financial benefits (e.g., O&M savings, avoided capital costs) from ESCO projects may be monetized and included as part of a performance-based contract. However, there are other indirect societal benefits that are not typically considered within the contractual framework between the ESCO and their customer (e.g., dollar value of reduced pollution, worker "happiness"). Gillingham et al. (2006) report on the literature detailing environmental externalities and found that reducing electricity use provided societal benefits that were approximately 10% of the dollar value of the electricity savings. Sorrell (2005) notes that an ESCO customer has a range of motivations for entering into an energy service contract, but the majority of these reasons cannot be incorporated into a benefit-cost (i.e., contractual) framework. Unfortunately, one of the challenges with benefit-cost analysis is the difficulty inherent in monetizing the impacts of a project, especially the benefits (Boardman et al. 2006).

There is also evidence that ESCO project installations are becoming more complex at the same time that reporting requirements for some U.S. public/institutional projects are also increasing (SEP 2010). Sorrell (2005) noted that ESCO project transaction costs are partially a function of the complexity of the energy services included within the contract, the competitiveness of the market, and the difficulties in monitoring the contractual terms and conditions. Unfortunately, there has been a general lack of collection and access to past project-level benchmarking information including data detailing typical building consumption, retrofit costs, estimated savings, types of measures installed, interest rates, and energy price escalation rates. Bertoldi et al. (2006) discuss several strategies for fostering the development of the ESCO industry in Europe including a strategy to increase information about the performance of ESCO projects. Goldman et al. (2005) indicated the importance of developing tools to "standardize methods to report project characteristics, costs, and savings…to understand industry and market trends".

Given its relative maturity, a comprehensive analysis of ESCO industry and market trends in the U.S. may provide insights to policymakers that are interested in facilitating the development of a private sector energy efficiency services industry. This article is organized as follows. Section 2 summarizes information about our sources and methods. We define the market and provide size and growth estimates from a recent survey of ESCO industry executives in Section 3. Section 4 describes ESCO market and overall project-level performance using information from both the survey and database. In Section 5, we analyze market trends over time for ESCO projects in public and private sector markets, drawing from the LBNL/NAESCO project database. In Section 6, we discuss the role of enabling policies to facilitate ESCO industry growth and transparency. Finally, we summarize conclusions and identify future research areas in Section 7.

2. Approach and Data Sources

In this section, we discuss data sources and methods used in the (1) "top-down" survey of the U.S. ESCO industry and (2) "bottom-up" analysis of project-level information. A more detailed discussion of the survey approach can be found in Satchwell et al. (2010) and methods used to collect, compile and analyze ESCO project data is described in Hopper et al. (2005) and Larsen et al. (2012).

2.1. Survey of aggregate U.S. ESCO industry activity

We identified 53 companies that appeared to offer performance contracting as a service and conducted interviews with senior management between October 2009 and February 2010.[2] ESCOs were asked to provide information on their annual revenues from energy services in 2008, projected growth in annual revenues from 2008 to 2011, activity in various market segments, types of contractual arrangements, revenues obtained from various types of technologies (e.g., energy efficiency, renewable energy, and onsite generation projects) and services (e.g., consulting, master planning), and their views on trends in project installation costs, payback times, and operation and maintenance (O&M) savings. Initially, 29 companies responded to our request; our estimated response rate was 55% among active ESCOs (29 out of 53). We then estimated annual revenues for 15 of the remaining ESCO non-respondents, which were all small companies, using a Delphi approach similar to the approach reported in Hopper et al. (2007). Accordingly, our estimates of aggregate revenues for the ESCO industry are based on a sample of 44 companies; the combined survey and Delphi revenue estimates provide information on nearly all ESCOs that are actively operating in the United States.

2.2. LBNL/NAESCO project database

LBNL has collected information about performance-based energy projects from various sources for more than fifteen years.[3] About 2,800 projects (87% of database) were provided by individual ESCOs as part of NAESCO's voluntary accreditation process. During the accreditation process, ESCOs are asked to submit information on a sample of their performance-based projects (up to 50) completed within the previous three to five years. Projects submitted

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[2] Our initial target list was 109 companies. Based on market research of company websites, 53 companies were eliminated either because they did not meet our definition of ESCOs or were not currently offering performance contracting as a service. We contacted senior executives that would be knowledgeable about their company's revenues and market activity, and would also have the authority to release the requested information.

[3] See Goldman et al. 2000; Goldman et al. 2002; Osborn et al. 2002; Hopper et al. 2005; Goldman et al. 2005; and Bharvikar et al. 2008.

by ESCOs are reviewed by members of an accreditation committee, which includes interviews with a sample of customers to verify project information submitted by ESCOs and allow customers to provide feedback on the performance of ESCOs in various areas (e.g., project design, construction, operation and maintenance of savings, ability to arrange financing).

Twelve state agencies that administer and oversee performance contracting programs also provided information on 271 projects completed by ESCOs (~8% of database projects) after being contacted by LBNL: Florida, Hawaii, Kentucky, Illinois, New York, Pennsylvania, Michigan, Washington, Kansas, California, Maryland, and Missouri.

We also obtained project information for projects completed as part of the Department of Energy's (DOE) Energy Savings Performance Contract (ESPC) program (i.e., DOE Super-ESPC), which account for ~5% of the projects in the database.

ESCOs are asked to submit a representative group of projects by NAESCO in the accreditation process, although LBNL has no way of determining the extent to which this guidance is followed by individual ESCOs. *Thus, in reporting results, we do not assume that ESCO project data represent a random sample from the entire population of U.S. ESCO projects.* Instead, we use similar analysis methods described by Hopper et al. (2005) and report "typical" project information (i.e., median values and inter-quartile ranges) that highlight both the central tendency and variation in project results.

Information requested for each project is shown in Table 1; note that ESCOs do not always collect or provide all relevant project information on customer projects. For example, information on project costs and installed retrofit measures is available for 98% and 93% of the projects, respectively (see Table 1). In contrast, only about 62% of the projects provided information on actual energy savings or the dollar value of savings in the year after the project was completed; thus we utilize predicted energy savings values when this data field is missing.[4] About 65% of the projects provided information on baseline energy usage prior to the retrofit, which reduces our sample size when we report percent savings for different types of projects. In addition, we calculate project net benefits and benefit cost ratios only for those projects that provide information on project installation cost, annual savings, and contract length (or average measure lifetimes). ESCOs also provide information on features that are optional (shown in italics in Table 1) and only offered by certain utilities (e.g. rebates for energy efficiency measures funded by utility customers which offsets a portion of the capital cost of projects) or are unique to specific projects (e.g., operational savings).

Table 1. Key project data fields and ESCO response rate

Category	**Details**	**Percent of ESCO projects that provided information for data field (n=3265)**
Project Location	City, state, zipcode, country	> 99%
Customer Contact	Name, phone, email	> 99%
Project Characteristics	Date of completion	95%
	Floor area	72%
	Number of buildings	72%
	Market segment	99%
	Facility type	94%
Project Economics	Project cost (including or excluding financing charges)	98%
	Project agreement type	79%
	Contract term	75%

[4] ESCOs provide predicted energy savings for projects that are recently completed and for which there is not one year of measured data.

Category	Details	Percent of ESCO projects that provided information for data field (n=3265)
	Utility incentive program participation and amount (if applicable)	20%
Baseline Annual Energy Consumption	Baseline metric	65%
	Baseline consumption by fuel/energy source	59%
Annual Energy Savings (by fuel/energy source)	Predicted savings	79%
	Guaranteed savings	62%
	Actual savings (either annual or average annual)	62%
Other Benefits	Operations and maintenance and other non-energy savings over the project lifetime	37%
Measures Installed	Selected from a categorized list	93%

We utilize a methodological framework that is similar to previous LBNL reports (see Goldman et al. 2002, Goldman et al. 2005, Hopper et al. 2005, and Larsen et al. 2012) in order to adjust and analyze project information provided by ESCOs to ensure consistency in reporting project costs, savings and economic indicators. Comparative analysis of projects is facilitated by grouping projects by vintage, categorizing the energy conservation measures (ECMs) installed in projects into a primary retrofit strategy, and adjustments that normalize project costs and energy prices across time to account for inflation effects and express costs and dollar savings in real terms (2009 U.S. dollars).

A major focus of this article involves analyzing ESCO project trends over time; therefore, we grouped projects by vintage (i.e., the year the project was completed) into three distinct time periods: (1) 1990-1997, (2) 1998-2004, and (3) 2005-2008 (Larsen et al. 2012). During the

1990-1997 period, the ESCO industry was maturing; one key factor driving ESCO industry growth was that 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 (IRPs). During the 1998-2004 period, the ESCO industry was heavily influenced by the promise of and subsequent fallout from electricity restructuring (e.g., retail competition increased interest in energy efficiency services initially; many utilities bought or started ESCOs; and then the ESCO industry consolidated as many utilities sold off their ESCO subsidiaries after the California electricity crisis and state interest in retail competition ebbed). ESCO activity in the federal market was also affected by a sunset to legislation enabling performance contracting in the federal market (i.e., ESPC program). During the 2005-2008 period, an increasing number of states adopted policies that promote energy efficiency (e.g., Energy Efficiency Resource standards, ramping up public benefit and ratepayer-funded energy efficiency and renewable energy programs) as a lower cost alternative to electricity generation and/or as part of a carbon reduction strategy. ESCO activity in the federal market has also been influenced positively by the re-authorization of ESPCs.

In order to facilitate comparative analysis across projects, it is useful to group the ~150 energy conservation measures reported by ESCOs into generalized primary retrofit strategies (see Table 2). We developed a method to categorize each project by its primary retrofit strategy, which included the following categories: major HVAC, minor HVAC, onsite generation, lighting-only, non-energy, and all other strategies.[5]

[5] See Goldman et al. (2002) and Hopper et al. (2005) for a more detailed discussion of methods and criteria used to categorize projects by retrofit strategy.

Table 2. Primary retrofit strategies utilized in ESCO projects

LBNL-defined Primary Retrofit Strategy	Example of Energy Conservation Measures (ECMs) Included
Lighting-only	Technologies installed only include various lighting efficiency measures, controls and strategies.
Major HVAC	Technologies installed include major HVAC equipment replacements (e.g., boilers, chillers, cooling towers, HVAC dist. improvements) and may include other HVAC control, high-efficiency lighting, and motors measures.
Minor HVAC	Technologies installed only include less-capital intensive HVAC measures and controls (and exclude major HVAC equipment replacements) and may include lighting and other measures.
Onsite generation	Technologies include installation of onsite generation equipment and may include other energy efficiency measures (e.g., lighting, HVAC equipment and controls, motor efficiency measures).
Non-energy[6]	Technologies installed include roof or ceiling replacement, asbestos abatement (i.e., measures that are not installed primarily for their energy savings), and may include other efficiency measures (e.g., lighting or HVAC upgrades).
Other	Technologies installed include all other measures including domestic hot water (DHW), water conservation, and 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. These individual measures may also be included in other retrofit strategies (except lighting-only); projects categorized as “Other” retrofit strategy only installed these types of measures.

ESCOs typically estimate first-year dollar savings by valuing energy savings using existing utility tariffs at the project site; ESCOs estimate future savings using a variety of methods that involve escalating future energy prices. Because practices vary across ESCOs, we re-estimate

[6] Hopper et al. (2005) indicate that, in some cases, ESCO projects include some measures with significant costs that are not necessarily intended to produce energy savings (e.g., asbestos removal). Thus, we defined this retrofit strategy as “non-energy” to separate projects that may have relatively poor economic performance because they include some measures that provide non-energy benefits or are required for the project to move forward but whose value is difficult to monetize.

the dollar value of project energy savings in an effort to facilitate comparisons among projects across different locations, sectors, and installation years.[7]

Finally, we adjust original turnkey project cost data to current 2009 dollars using annual GDP deflator information from the U.S. Bureau of Economic Analysis (BEA 2009a). We estimated the present value of future *direct* benefits for each project by summing the discounted future monthly dollar savings for the average estimated lifetime of the package of energy efficiency measures.

3. Overview of U.S. ESCO industry

In this section, we define the ESCO market, present the most recent estimates of ESCO industry revenues and projected growth, and characterize the business ownership characteristics of ESCOs.[8]

3.1. Definition of the ESCO market

We define an Energy Service Company (ESCO) as:

> A company that provides energy-efficiency-related and other value-added services and for which performance contracting is a core part of its energy-efficiency services business. In a performance contract, the ESCO guarantees energy and/or dollar savings for the project and ESCO compensation is therefore linked in some fashion to the performance of the project.

This definition is in line with the European Commission Directive (2006/32/EC) on Energy End-use Efficiency and Energy Services (ESD) standard definition of an ESCO, in particular the

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[7] We estimated the dollar value of first-year savings by multiplying reported energy savings by average electricity, gas (or water) prices for the appropriate year, state, and sector (i.e., residential, commercial, and industrial) based on Energy Information Administration (EIA) data. In order to capture the future value of energy savings beyond 2009, we used EIA forecasts of future electricity and natural gas prices to 2030 and consumer price escalation rates from the Federal Reserve Bank of Philadelphia for water price forecasts.

[8] Some material in this section draws upon previous LBNL studies that analyzed ESCO industry trends and definitions (Hopper et al. 2007, Goldman et al. 2002; Goldman et al. 2005; Larsen et al. 2012; Satchwell et al. 2010).

delivery of energy services and that some degree of performance-based financial risk is held by the ESCO (Soroye and Nilsson 2010; Marino et al. 2010).

3.2. ESCO projects that target public/institutional sector customers tend to prefer performance-based contracts

Overall, about 68% of the 3,265 projects in our database utilized performance-based contracts. There are two general types of performance contract used in the ESCO industry−*shared savings* and *guaranteed savings*.

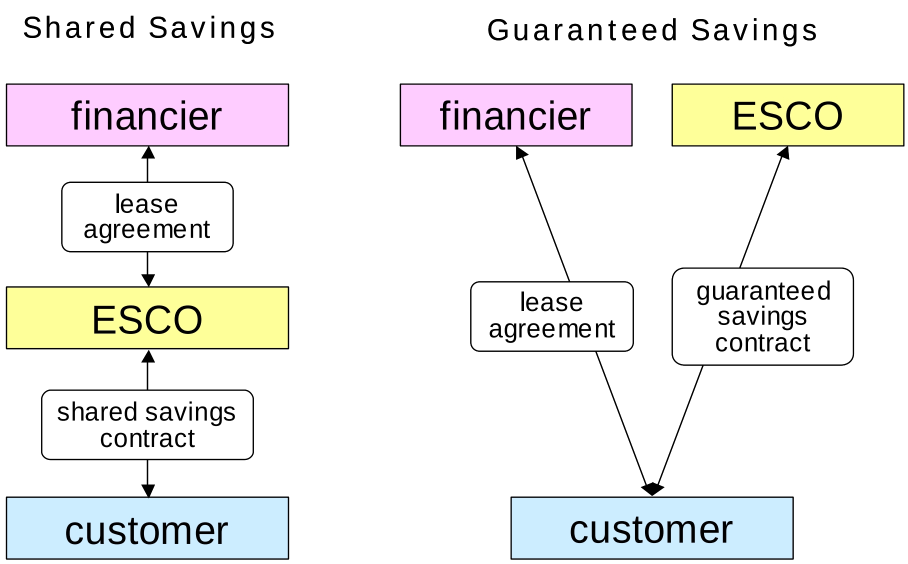

Figure 1. Shared and guaranteed savings contracting models (from Hopper et al. 2005)

Figure 1 depicts the shared and guaranteed savings performance-based contracting models. In a shared savings contract, the ESCO and customer enter into a long-term contract where there is an agreement to share future dollar savings from the installed energy conservation measures based on a specified EM&V protocol. Hopper et al. (2005) discusses how ESCOs assume the project-level financing risk, often from a third party lender, in shared savings contracts. In this case, the ESCO assumes the credit liability for the project. Alternatively, in a guaranteed savings contract, the ESCO guarantees a level of savings sufficient to cover the annual debt obligation limiting the customer's performance risk. In guaranteed savings contracts, projects are often financed by a third party financial entity and the customer repays the loan to this creditor. In this case, the lender absorbs the credit risk of the project (see Okay and Akman 2010), rather than the ESCO.

However, there are significant differences in contractual arrangements for ESCO projects in the public and private sector. About 73% of the public and institutional sector projects utilized a performance contract; in contrast, only about 40-45% of the private sector ESCO projects utilized a performance contract (see Figure 2). Among performance-based contracts, U.S. ESCOs and customers strongly favor guaranteed savings contracts; these contracts account for 67% and 32% of performance-based contracts in public and private sector markets, respectively. Public sector customers prefer guaranteed savings contracts because of greater certainty of savings, while ESCOs cite lower financing costs (most public and institutional customers can obtain tax-exempt financing) and lower transaction costs (ESCOs can focus on project performance).[9]

[9] In developing countries, shared savings contracts tend to be the preferred contract type for building retrofits (see Okay and Akman 2010). However, recent research on the rapidly growing Chinese ESCO industry indicated that there is a trend towards implementing guaranteed savings contracts, especially for the industrial sector (Da-li 2009).

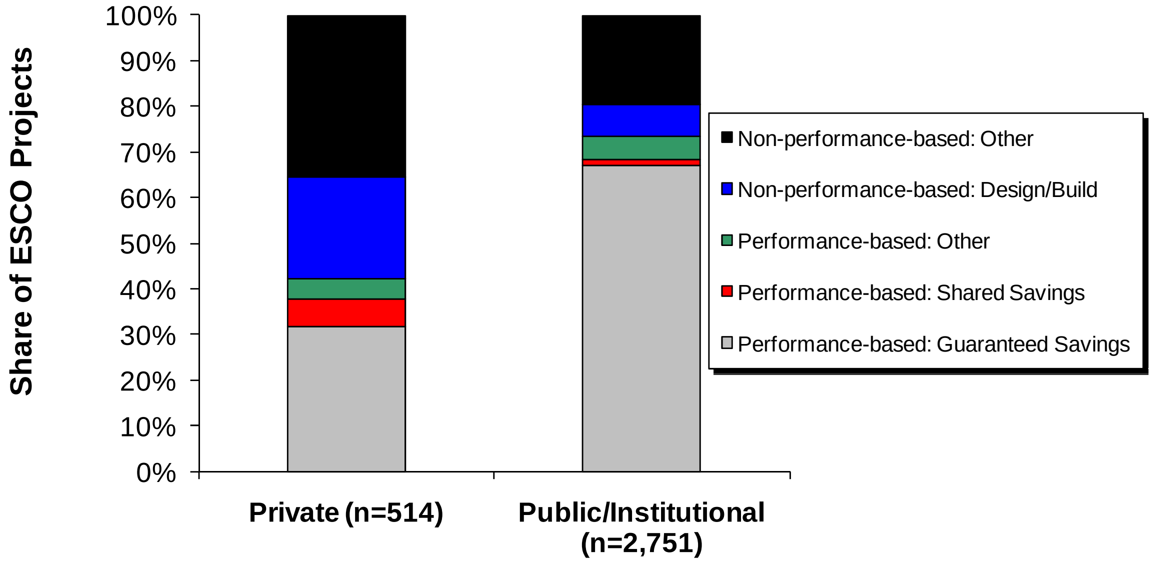

Figure 2. Contractual arrangements in ESCO projects: Public vs. private sector markets

3.3. U.S. ESCO industry: Current market size and prospects for growth

Survey respondents were asked to report their revenues from energy services in 2008[10], average annual growth rates since 2007, and projected growth in revenues for the 2009-2011 period. Aggregate revenues for the ESCO industry are estimated at about $4.1 billion in 2008 and are expected to increase significantly (see Figure 3).[11]

[10] Survey respondents were asked to exclude retail commodity sales and projects built to supply power to wholesale markets from revenues.

[11] In estimating the size of the ESCO industry, we do not include companies such as engineering and architectural firms, HVAC, lighting, windows or insulation contractors, and consultants that offer energy efficiency services on a fee-for service basis or design/build contracts but typically do not enter into long term contracts that link compensation to the project's energy savings and/or performance. We also exclude companies that only provide onsite generation or renewable energy systems and do not implement energy efficiency measures in their projects under a performance-based contract.

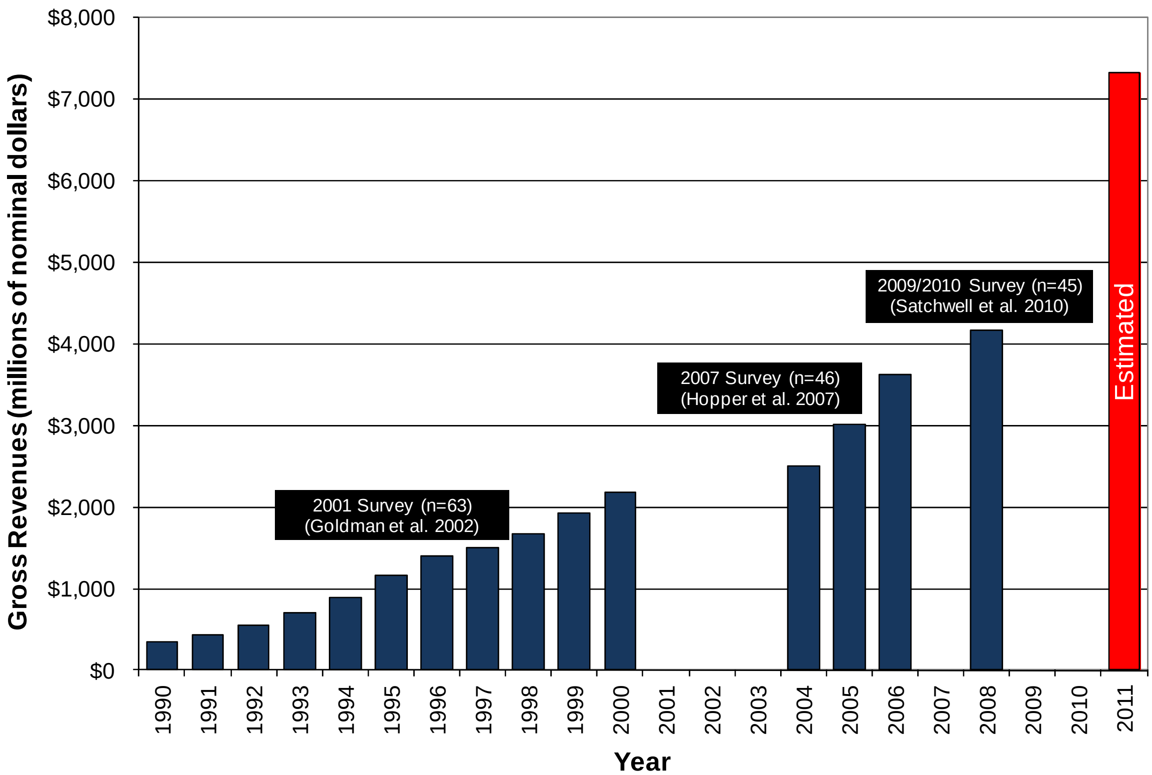

Figure 3. U.S. ESCO industry revenues with 2011 estimate

Hopper et al. (2007) estimated that ESCO industry revenues were $3.6 billion in 2006. Thus, our analysis suggests that ESCO revenues have increased about 7% per year since 2006. Based on the survey responses of individual ESCOs, we project that the ESCO industry in aggregate will have annual revenues of about $7.1 billion in 2011 (see Figure 3); this represents an average annual growth rate of 26% per year for the 2009-2011 period. It is important to note that ESCOs are quite optimistic about their business prospects, even though the U.S. economy is just beginning to recover from a severe recession.[12] ESCOs clearly hope to capitalize on energy

[12] There are several factors that may account for the gap between actual ESCO industry revenues in 2008 and the projections of 2008 revenues from the Hopper et al. (2007) study. These factors include: (1) an unexpected downturn in the U.S. economy, (2) ESCOs' projected activity level in private sector markets did not materialize, (3) tightening of customer credit markets, (4) slower than expected acceleration of the federal ESPC market, (5) industry consolidation, and (6) overly optimistic projections provided by our survey respondents.

efficiency programs initially funded by the American Reinvestment and Recovery Act (ARRA) of 2009. For example, about 51% of the $3 billion for the State Energy Program block grants is targeted at building retrofits primarily in public sector markets that have historically been receptive to ESCOs and performance contracts (Goldman et al. 2011). Some ESCOs also expect that the significant ramp-up in ratepayer-funded energy efficiency programs will improve the economics of projects for targeted customers (Barbose et al. 2009).

3.3 ESCO business and ownership characteristics

We grouped ESCO survey respondents into four categories of business ownership: (1) companies that are owned by building equipment or controls manufacturers, (2) companies that are subsidiaries of electric or gas utilities, (3) companies that are owned by other types of energy companies such as gas producers and pipelines, and (4) companies that provide engineering services and are "independent" in the sense that they are not owned by utilities, energy companies, or equipment/controls manufacturers. ESCOs that are owned by building equipment manufacturers account for nearly half of all 2008 ESCO market share, which represents a significant increase in market share compared to the early 2000s (Goldman et al. 2005). Utility-owned ESCOs have the smallest market share at 8% of 2008 revenues (see Table 3). While many utilities acquired existing ESCOs or started their own ESCO business in the late 1990s as electric industry restructuring was beginning to unfold, their relatively low market share shows that this phenomenon was short-lived as many utilities divested their ESCO businesses as the enthusiasm for retail competition waned in the U.S. after the California electricity crisis. Engineering services companies are numerous (n=25), yet tend to be smaller in size and account for a smaller proportional market share (22%).

Table 3. ESCO business type and market share in U.S. (2008)

Company Type	Number of Companies	Percent share of 2008 U.S. ESCO industry revenues
Building equipment manufacturers	4	49%
Utility affiliates	5	8%
Engineering services companies	25	22%
Other energy companies	4	21%

4. Overall performance of projects and market activity

We estimate that the LBNL/NAESCO project database contains about 20% of all ESCO industry activity since 1990, representing over $8 billion ($2009) in total project investments.[13]

4.1. ESCO project activity in states: LBNL/NAESCO project database results

In establishing regional or local offices for business development and project implementation, ESCOs may consider the following factors: market potential of targeted sectors, favorable state policies (e.g., enabling legislation that allows or encourages performance contracting in various institutional markets, ratepayer-funded energy-efficiency programs), level of economic activity, population density, and actual and projected energy costs. ESCOs reported the geographic location of each project that was completed (see Figure 4). Five states (California, New York, Texas, Pennsylvania and Maryland) account for more than one-third of the total market activity based on projects in the database, with aggregate ESCO project investments exceeding $500M in each of these five states between 1990 and 2008.

[13] We estimated the share of ESCO industry projects in the LBNL/NAESCO database (~20%) by converting aggregate real project investment levels ($8.0 billion in 2009$) to nominal dollars ($6.7 billion) and then dividing by aggregate industry revenues for the period 1990 to 2008 ($33.8B) as reported by Satchwell et al. (2010) [see Figure 3]).

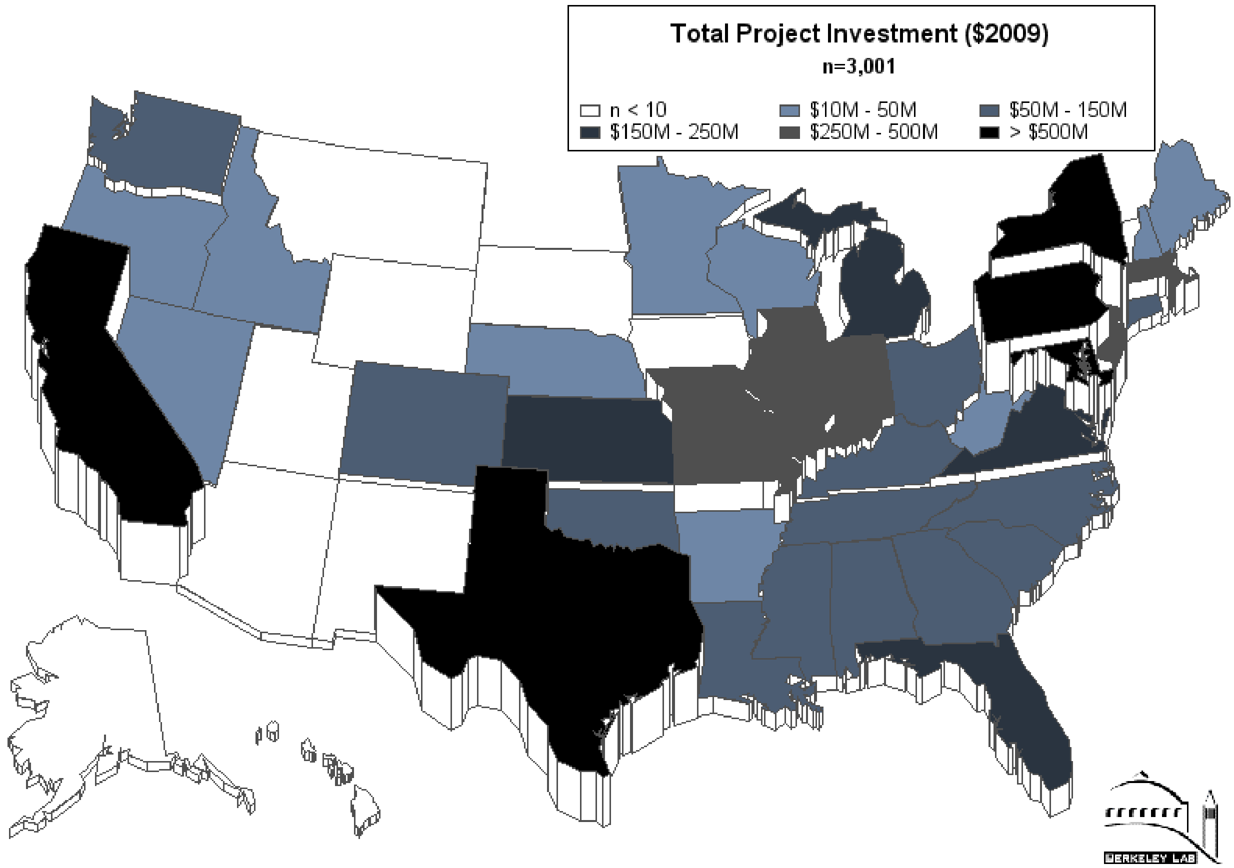

Figure 4. Aggregate ESCO database project investment levels by U.S. state

Goldman et al. (2002) ranked the top ten states in ESCO project activity in the LBNL/NAESCO database at that time and compared those rankings to economic, population, and policy factors. We have replicated this analysis with updated numbers for the top fifteen states in terms of project activity−in nominal dollars−and compare the results to the rankings in the Goldman et al. (2002) study (see Table 4).

Table 4. State-level ESCO project investments, economic activity, population, and utility incentive payments

State	ESCO Project Investment (database)		ESCO Project Investment (2002 database report)		Economic Activity (2008 GSP)[14]		Population (2009)[15]		Ratepayer Funded EE Program (REEP) Budgets (2009)[16]	
	Rank	($M)	Rank	($M)	Rank	($B)	Rank	(Million People)	Rank	($M 2009)
New York	1	773	1	328	3	1144	3	19.5	2	378.3
Pennsylvania	2	615	10	75	6	553	6	12.6	10	96.9
California	3	536	3	230	1	1847	1	37.0	1	998.3
Maryland	4	451	N/A[17]	175	15	269	19	5.7	21	38
Texas	5	447	4	199	2	1224	2	24.8	9	98.7
Missouri	6	348	N/A	97	22	229	18	6.0	27	22.7
Illinois	7	348	7	109	5	634	5	12.9	11	89.9
New Jersey	8	271	2	267	7	475	11	8.7	6	132.3
Massachusetts	9	227	5	136	13	352	15	6.6	3	183.8
Indiana	10	210	6	120	18	246	16	6.4	35	13.6
Florida	11	189	8	106	4	744	4	18.5	5	132.6
Kansas	12	184	N/A	15	32	123	33	2.8	43	3.7
Virginia	13	180	N/A	27	11	397	12	7.9	47	0.4
Michigan	14	172	N/A	131	12	383	8	10.0	16	50.1
Washington, DC	15	141	N/A	92	35	97	50	0.6	37	12.5

[14] BEA (2009b)
[15] U.S. Census Bureau (2009)
[16] Molina et al. (2010)
[17] Goldman et al. (2002) reported only rankings for the top-ten states in terms of total project investment. We calculated the project investment for Maryland, Missouri, Michigan, Kansas, Virginia, and Washington, DC for all projects prior to 2002 but could not replicate rankings by state.

The data suggests that ESCOs tend to focus on larger markets, as defined by economic activity, but not exclusively (i.e., 11 states are ranked in the top 15 in terms of Gross State Product). Several states have a large number of federal customer facilities (e.g., Washington DC, MD, VA), which help explain the relative prominence of the ESCO industry in those states given the level of ESCO activity in the federal market. ESCOs also tend to focus on states with large populations (e.g., CA, TX, and NY) as 10 states are ranked in the top 15 in terms of population (see Table 4).

We also compare ESCO project investment to ratepayer-funded energy efficiency program (REEP) budgets, as a proxy for an enabling state policy that may support the development of an ESCO industry (i.e. treating energy efficiency as a resource in the power sector that can defer and/or avoid supply-side investments). Eight states that rank in the top 15 in terms of spending on utility energy efficiency programs (CA, NY, MA, FL, NJ, TX, PA, IL) also rank in the top 15 in ESCO market activity. Several of these states (CA, NY, MA, NJ) have offered energy efficiency programs funded by utility customers for two decades; other states (PA, IL) have recently started to ramp up spending on utility energy efficiency programs, which suggests that this has not been a major factor driving ESCO market activity in those states. It should be noted that larger states tend to have larger REEP budgets. If we normalize for state population, five states that are ranked high in ESCO market activity are also highly ranked in terms of per-capita spending on ratepayer-funded energy efficiency programs (e.g., CA, NY, and MA spend ~$20-27 per person on utility energy efficiency programs).

State enabling policies that encourage performance contracting in the public sector may well be the single most important factor driving ESCO market activity in some states. For example, states such as Missouri, Kansas, and Indiana rank high in ESCO market activity; energy offices in these states have championed performance contracting in institutional/public sector markets, although they are not highly ranked in terms of population, economic activity or large-scale energy efficiency programs funded by utility customers. Bharvirkar et al. (2008) studied the magnitude of energy efficiency activity in the state government market, with a focus on performance contracting activity and found that Pennsylvania, Maryland, Massachusetts Missouri, Kansas, and Texas had the highest levels of performance contracting investment in the state government sector since 2000. This provides further evidence of the role of enabling policies that support and encourage performance contracting in the public/institutional sector as a driver of ESCO market activity in states.

Although closely related to population, states with significant accumulated deferred maintenance in K-12 schools appear to be another factor considered by ESCOs in selecting target markets. Crampton and Thompson (2008) discuss state-by-state accumulated deferred maintenance issues for K-12 schools.

4.2. Market activity

The "MUSH" markets—municipal and state governments, universities and colleges, K-12 schools, and hospitals—have historically been targeted by U.S. ESCOs and account for 68% of the projects in the LBNL/NAESCO database. When combined with ESCO projects that target federal customers, we observe that ~85% of ESCO projects in the database target public and institutional sector markets (see Table 5).

Table 5. ESCO activity by market sector and segment

Market Sector	Market Segment	Percentage Share of Projects (n=3,265)
Public and Institutional Sector (85%)	K-12 Schools	33%
	State/Local Government	15%
	Federal Government	14%
	Universities/Colleges	12%
	Health/Hospitals	8%
	Public Housing[18]	3%
Private Sector (15%)	Commercial Office	6%
	Industrial	4%
	Retail	2%
	Other	2%
	Hotel/Hospitality	1%
	Residential	1%

Our survey of ESCOs found very similar results: the MUSH markets account for $2.8 billion in ESCO revenues in 2008 or about 69% of total industry activity (see Figure 5). ESCOs report that the MUSH market share of total ESCO revenues has increased over 10% since 2006 and we found similar market trends within the project database.

[18] Hopper et al. (2007) described past difficulties for ESCOs in developing the U.S. public housing sector including "inconsistencies between the Department of Housing and Urban Development (HUD) and its field offices in interpreting statutes and regulations affecting housing authority project implementation details". However, these authors indicated that "revised legislation, extended allowable contract terms (from 12 to 20 years), rising energy and water costs, and aggressive marketing by ESCOs have contributed to significant expansion of the public housing market in the last few years". For these reasons, we expect to see an increase in the future share of ESCO projects completed at public housing facilities (after 2008) and reported to LBNL.

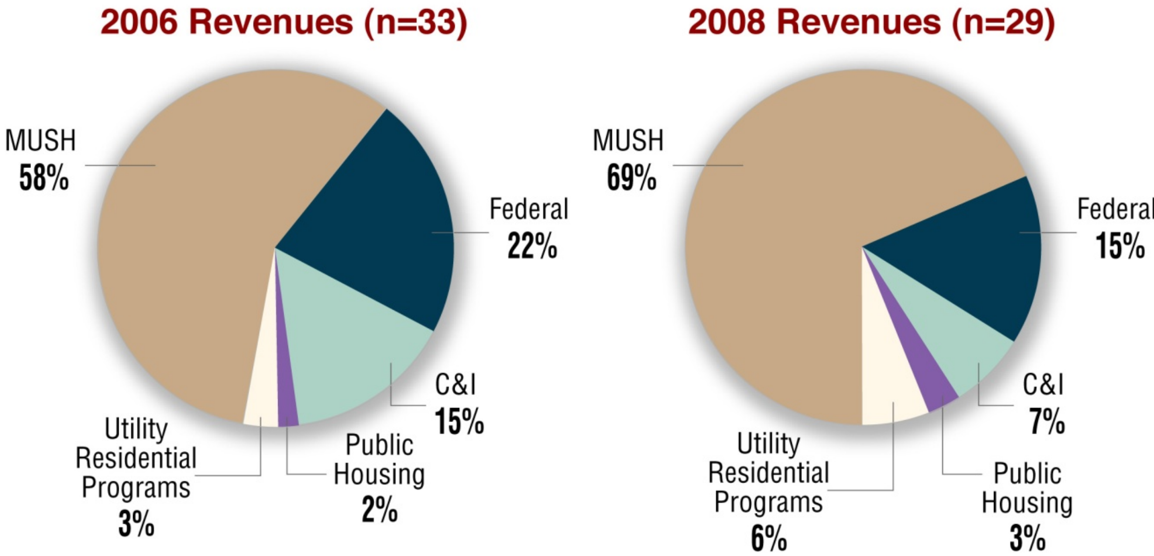

Figure 5. 2006 and 2008 ESCO industry revenues by market segment[19]

The U.S. MUSH market is relatively mature as ESCOs have actively been developing projects for more than two decades in this market. However, the remaining market potential for energy efficiency is still quite large. An analysis conducted by LBNL indicated that remaining energy efficiency opportunities in larger facilities in the MUSH market could produce annual energy savings of 160 million MMBtu, lifetime savings of 2.4 billion MMBtu and require about $35 billion in additional ESCO investment (Goldman and Bharvirkar 2007).[20]

4.3. Overall economic performance of ESCO projects from the customer's perspective

[19] Breakdown of industry revenues by market segment came from surveys conducted by Hopper et al. (2007) and Satchwell et al. (2010).
[20] LBNL assumed that ESCOs would target facilities greater than 50,000 square feet (which accounts for about 65% of the floor area), that ESCOs had achieved ~40-45% market penetration in the MUSH market based on survey responses from ESCO senior executives, and that ESCOs could achieve savings and cost per square foot levels that were comparable to completed projects in the ESCO database.

We calculate and report simple payback times and net benefits from the ESCO customer perspective.[21] Figure 6 shows the median and inter-quartile range of simple payback time for ESCO projects in K-12 schools, all other public sector markets, and private sector projects, grouped by retrofit strategy.[22] ESCO projects in K-12 schools had the longest median payback times for all retrofit strategies (i.e., 7-15 years). With the exception of non-energy projects, ESCO projects in other public and institutional markets had longer median payback times compared to ESCO projects that targeted private sector customers. The median payback times for ESCO projects in the public/institutional sector (except for K-12 schools) was 7-10 years for onsite generation, non-energy, and major HVAC retrofits. In contrast, median payback time for lighting only retrofits was 2 to 3 years in ESCO projects that target private and public sector customers, respectively.

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[21] There are a number of other ways to measure project-level investment performance. However, we limited our analysis to reporting SPT and net economic benefits, because this a follow-up article to a study that used these same metrics (i.e., Goldman et al. 2005) and the calculation of these metrics is relatively easy to explain to disparate audiences. Furthermore, other investment performance metrics (i.e., internal rate of return analysis) are only valid when a project generates no interim cash flow (e.g., see Kelleher and MacCormack 2004). ESCO customers typically receive dollar savings in excess of the guaranteed amount, so the assumption of no interim cash flow is often violated in performance-based contracts.

[22] Project simple payback times are project installation costs—with no financing charges included—divided by the dollar value of annual energy and operations and maintenance (O&M) savings.

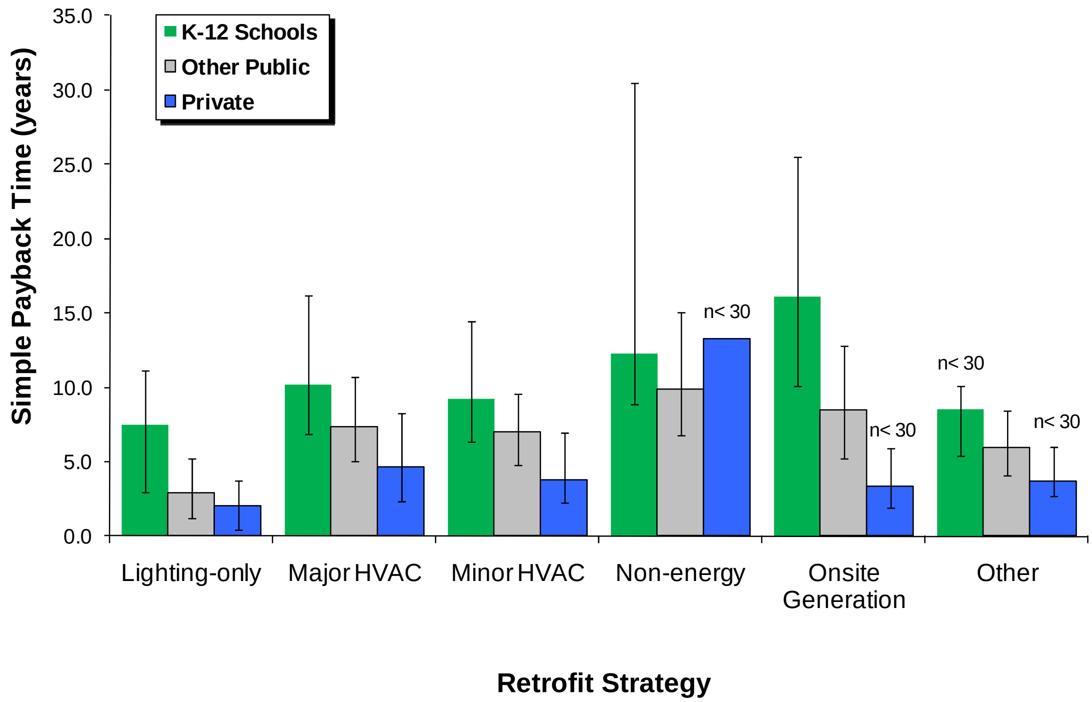

Figure 6. Simple payback times for K-12 schools, all other public, and private sector projects[23]

We also calculated net benefits for a sample of 2,484 projects that provided sufficient information and aggregated project-level results in order to report aggregate net benefits for projects in various market segments: federal government, state/local government, hospitals, public housing, K-12 schools, universities/colleges, and private sector (see Table 6). We estimate that public sector projects in our database generated over $3.4 billion (n=2,131) while private sector projects produced over $500 million (n=353) in direct net economic benefits to customers. If we assume that the net benefits per project are comparable for ESCO projects that are not included in our database sample, this would suggest that projects installed by ESCOs between 1990 and 2008 have generated nearly $23 billion ($2009) in net direct economic

[23] The top and bottom whiskers represent the inter-quartile range – the 75th and 25th percentile of the data, respectively. The height of the bar represents the 50th percentile (i.e., median) of the range of data.

benefits for customers.[24] We estimate that a typical private and public sector project had benefit-cost ratios of 2.6 and 1.4, respectively. A typical ESCO project targeting private sector customers produced $2.52 in net benefits for every square foot of floor area, while a typical ESCO public sector project generated $0.89 in direct net benefits per square foot of floor area.

Table 6. Direct net benefits[25] of ESCO projects by market segment

Market Segment	Count	Total Net Benefits (million US$)	Median Project Benefit-cost Ratio
Federal Government	319	$2,111.9	1.7
State/local Government	367	$442.3	1.5
Health/Hospitals	186	$330.5	2.6
Public Housing	68	$68.8	1.4
K-12 Schools *	910	$28.4	1.1
Universities/colleges	281	$442.9	1.4
Private	353	$512.9	2.6
Total	***2,484***	***$3,937.8***	

* Note: Discussion of performance of K-12 schools immediately follows in Section 4.4.

4.4. Deferred maintenance and the performance of projects at K-12 schools

[24] We estimated aggregate net direct benefits to customers for all projects installed by ESCOS during the 1990-2008 period by multiplying the inverse of the nominal dollar market share of projects with net benefits (i.e., 1/0.172) against the total net benefits for projects in our database ($3.94 billion; see Table 6). We determined the nominal dollar industry share for projects with net benefit information (17.2%) by dividing the nominal industry revenue estimate for 1990-2008 from our periodic surveys ($33.8 billion) by the aggregate project installation costs (nominal) for projects with net benefits ($5.8 billion).

[25] We report results assuming a 3% and 8% real discount rate for public and private projects, respectively. Direct benefits – energy cost and non-energy operational savings (when reported) – are included in our analysis, but not indirect benefits, such as improved building comfort, employee productivity, avoided capital costs, environmental benefits. We also do not attempt to quantify societal benefits (e.g., reduced pollution, avoided greenhouse gases, avoided generation or transmission infrastructure costs or economic development benefits). Complete details of our economic analysis assumptions are discussed in Larsen et al. (2012). Net benefits for each project were estimated by subtracting the project cost without financing from the discounted gross benefits. Gross project benefits were estimated by discounting future monthly dollar savings for each year through the average ECM lifetime for every project and then summing these discounted values to produce the present value of future benefits. We used a monthly discounting method, because project savings transactions are typically settled each month and not at the end of each year.

Net direct benefits were typically lowest–and in some cases negative–for ESCO projects implemented in K-12 schools (see Table 6)[26]. There are examples of K-12 schools paying for the entire cost of facility renovations using energy savings from performance-based contracts (Zorn 2006). Our results indicate that a typical K-12 school's direct benefits−over the average lifetime of the installed measures−are slightly more than the turnkey installation costs (i.e., the median value of 920 K-12 schools projects). Our analysis suggests that several factors help explain the marginal economics of many ESCO projects in K-12 schools. First, ESCO projects are being implemented to partially offset substantial accumulated deferred maintenance needs in K-12 schools and include some measures (e.g., new roofs) that do not provide energy savings but are integral to maintaining or repairing the physical infrastructure. Second, K-12 schools tend to have lower hours of operation than other public/institutional sector markets and often have minimal operations during summer months when energy costs are typically highest.[27] Third, energy efficiency savings potential may be lower in K-12 schools than other public sector markets because K-12 schools tend to be less energy-intensive and have lower baseline energy use prior to retrofits than other public/institutional sectors. We discuss these three factors in more depth in the following section.

Crampton and Thompson (2008), Bello and Loftness (2010), and ASCE (2009) report that U.S. public schools are the oldest buildings that typically have the largest backlogs of deferred maintenance compared to all other public facilities and infrastructure. Crampton and Thompson (2008) estimate that K-12 schools in the U.S. have a total backlog of infrastructure

[26] We estimate that ~50% of all school projects in our database (n=415) had negative net benefits, while less than 20% of projects in other markets had negative net benefits (n=306).
[27] Lower operating hours during times when energy prices are high means that payback times are longer for schedule-driven measures (e.g., lighting, air-conditioning).

upkeep that exceeds $250 billion.[28] Underfunding K-12 school facility upkeep and maintenance is not a new issue or unique to the United States (OECD 1992). For example, Mahoney and Thompson (1998) suggest using performance contracting to address capital improvement needs in lieu of budget shortfalls; their report focuses on how the ESCO business model can be used to upgrade facilities without relying on public debt (i.e., bonds). ESCO projects in K-12 schools are using performance-based contracting to partially−but not fully− offset substantial accumulated deferred maintenance needs, which impacts project performance. First, the types of measures being installed by K-12 schools (Figure 7) to address the backlog of infrastructure upkeep typically cost more to install per square foot (see non-energy projects in Figure 8).

[28] Crampton and Thompson (2008) focused on identifying the top ten states in terms of K-12 school infrastructure funding needs. Their list of top ten states is closely aligned with our database results showing ESCO project activity by state (see Table 4).

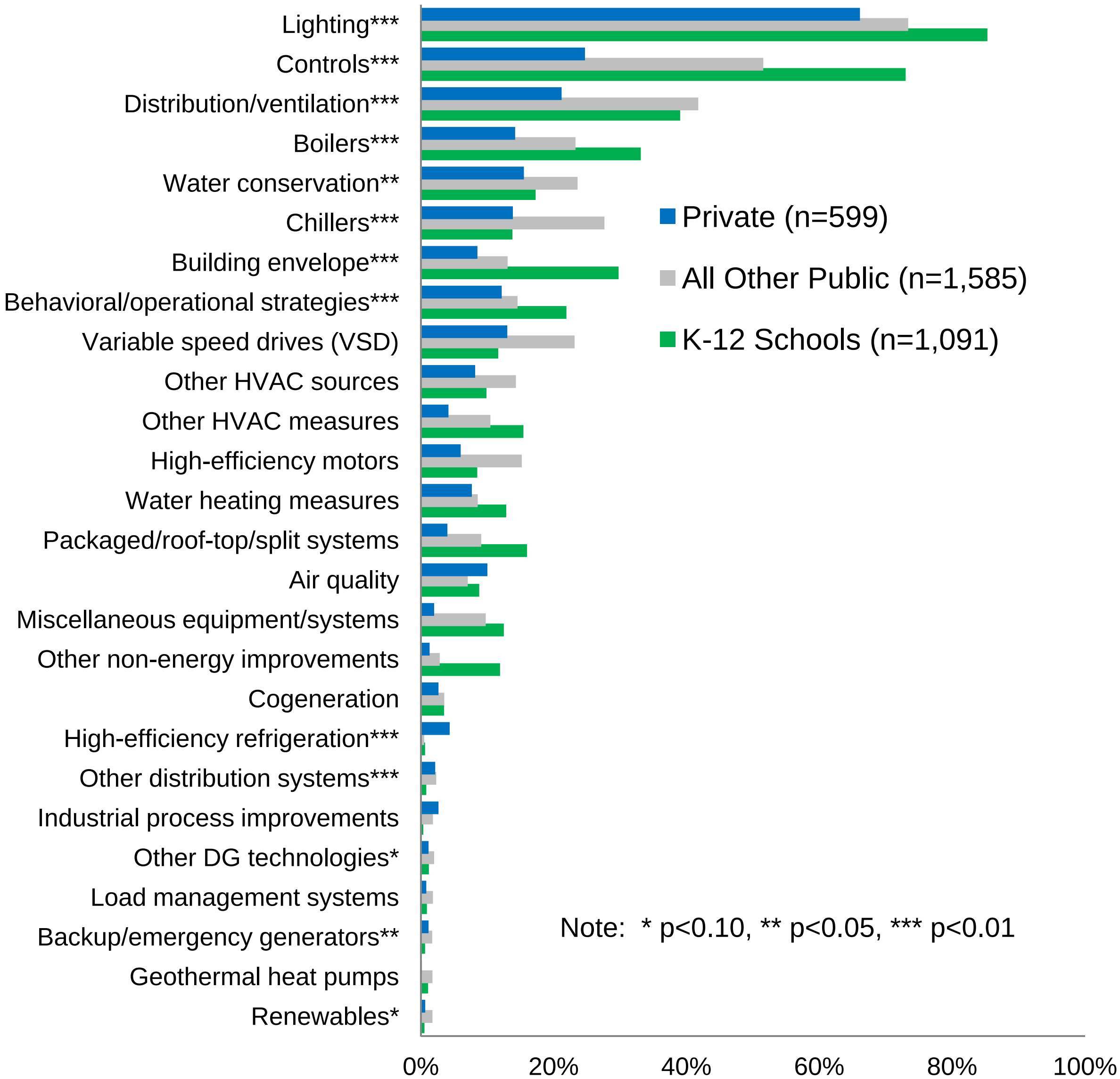

Figure 7. Percentage of projects installing different types of measures

K-12 schools projects installed the greatest share of "non-energy improvements" (e.g., asbestos, wiring) and miscellaneous equipment systems" (e.g., exit signs, alarm systems).[29] Non-energy retrofits at K-12 schools typically cost more to install per square foot relative to other retrofit

[29] There is a statistically significant difference in the share of projects reporting certain measures among K-12 schools compared to other public and private sector projects (see Figure 7). The Kruskal-Wallis test was used to test for differences among groups of data with the assumption that the underlying data is not normally distributed.

strategies and at other types of public and private projects (see Figure 8). We found that ~40% of all K-12 schools projects installed non-energy related retrofits between 2005 and 2008. Over the same period, less than 15% of projects from other public and private market segments reported undertaking non-energy retrofits. Hopper et al. (2005) noted that non-energy measures often "piggyback" on energy savings measures, which are vital to the project. Thus, it should not be concluded that these types of projects do not save energy, but they may have relatively poor economic performance because the savings are used to partially offset non-energy-related infrastructure upkeep.

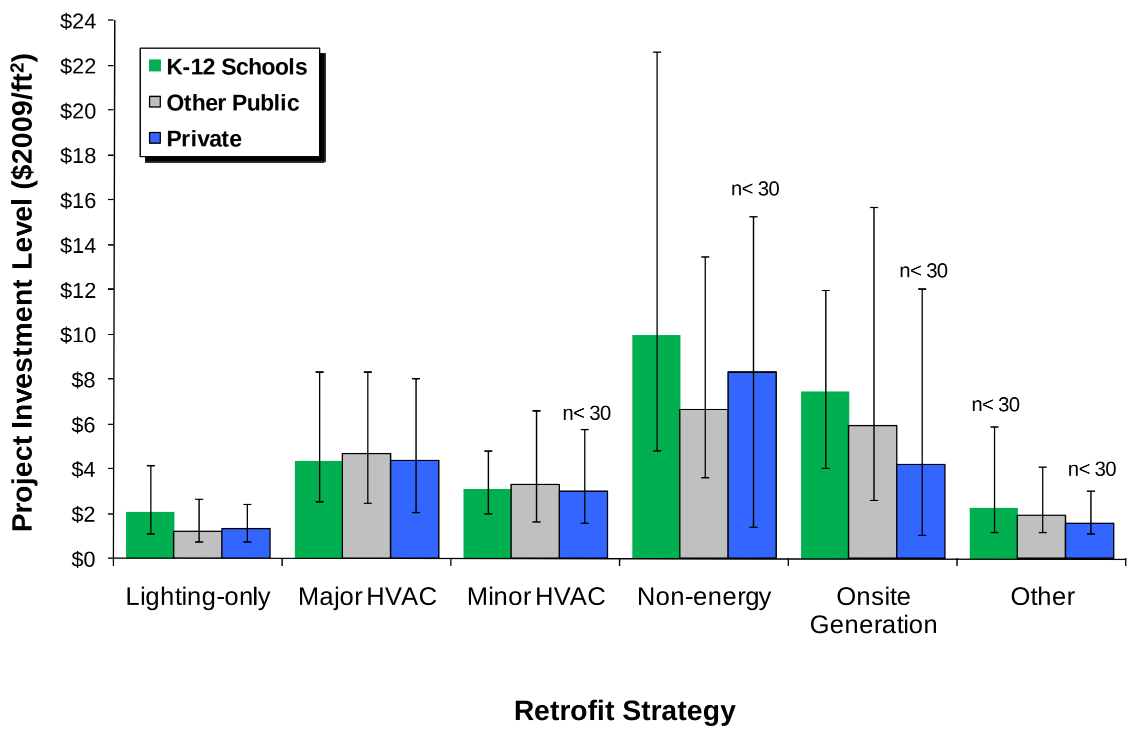

Figure 8. Normalized project investment levels for K-12 schools, other public, and private projects

Median annual electricity and fuel (i.e., blended) usage before and after retrofit is lower in the typical K-12 schools project compared to other public sector and private sector projects (see

Figure 9).[30] One contributing factor is that schools are typically open fewer hours in the year compared to other types of facilities and, in some cases, K-12 schools do not operate at full capacity during the summer months when electricity prices are typically higher.

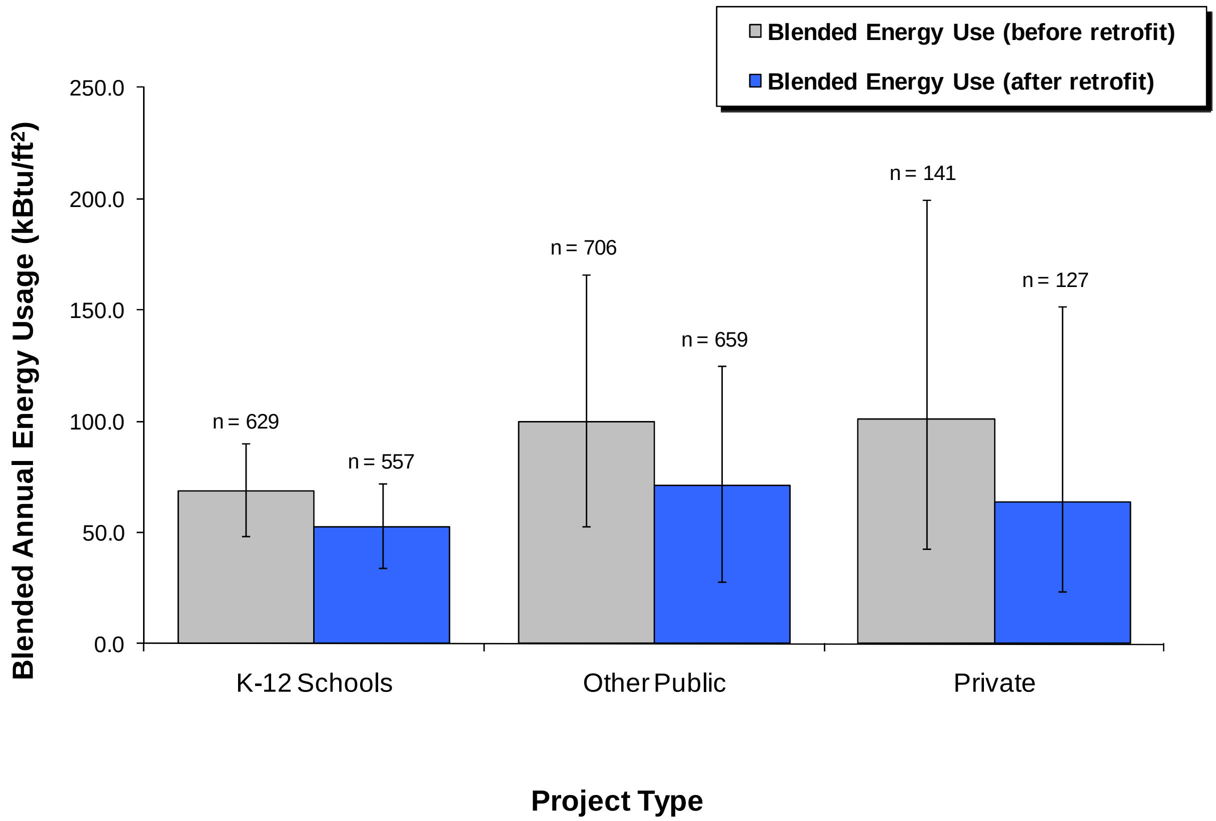

Figure 9. Blended annual energy usage before and after facility retrofit by project type

Thus, the median value for reported annual dollar savings at K-12 schools lag behind other market sectors (see Figure 10) and K-12 schools report the largest share of non-energy savings to overall savings.[31]

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[30] Blended means use and savings associated with electricity, gas, oil, and other fuel types. Results are typically reported in $kBtu/ft^2$.

[31] It is important to note that ESCOs typically estimate energy savings from projects using an accepted method from the International Performance, Measurement, and Verification Protocol (IPMVP) , but there are currently no international standards in place for collecting, estimating, and/or monetizing non-energy savings (e.g., avoided

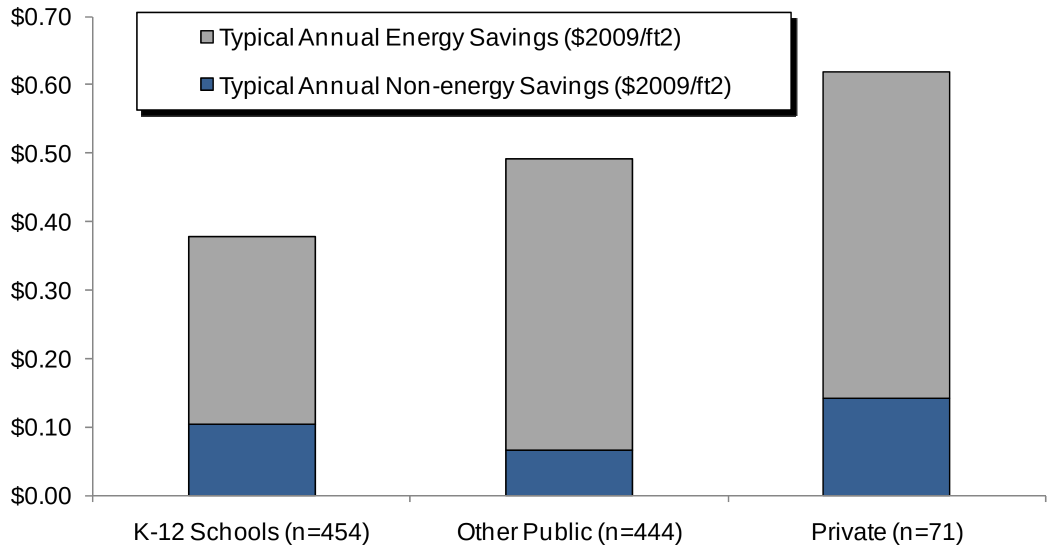

Figure 10. Median annual energy and non-energy-related annual dollar savings per square foot by project type

In summary, the combined effect of: (1) installing measures with relatively higher costs per square foot that address accumulated deferred maintenance, (2) lower overall energy savings potential, and (3) a lower dollar savings potential due to reduced operating hours during times of high energy prices leads to many K-12 schools projects having modest net direct economic benefits. Unfortunately, we have not attempted to quantify the intrinsic value of these projects to K-12 facility managers, but anecdotal evidence suggests that these projects are highly valued because: (1) they are often funded by supplemental sources (e.g., capital improvement bonds) and (2) they help address severe maintenance backlogs associated with aging equipment and deteriorating physical infrastructure.

5. ESCO project-level trends in public and private sector markets

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O&M and capital costs) despite a clear need (Birr and Singer 2008). Standardizing methods to monetize and report the value of avoided capital costs and other non-energy benefits will allow us to more accurately capture the value of these projects to K-12 schools customers.

Our analysis of ESCO project data strongly suggests that the ESCO industry is moving away from installing lighting-only retrofits and is increasingly focused on developing more complex, comprehensive and capital-intensive projects in all markets segments. In this section, we analyze retrofit strategies over time, define a comprehensive retrofit, and discuss market, cost and savings trends. We show that project installation costs per square foot are increasing faster than savings which leads to longer project payback times and lower benefit-cost ratios.

5.1. Public and private projects are installing more comprehensive retrofits over time

We explored trends over time in the comprehensiveness of ESCO projects by analyzing the relative market shares of different retrofit strategies in various market segments and by tracking counts for the number of measures installed at a typical project (i.e., the number of unique measures installed at a project).

For projects installed by ESCOs in the facilities of private sector customers, lighting-only retrofits accounted for 53% of all projects during the 1990-97 period and then decreased to 33% of all private sector projects during the 2005-2008 period (see Figure 11). However, the popularity of onsite generation projects has increased over time as they account for 24% of all private sector projects between 2005 and 2008.

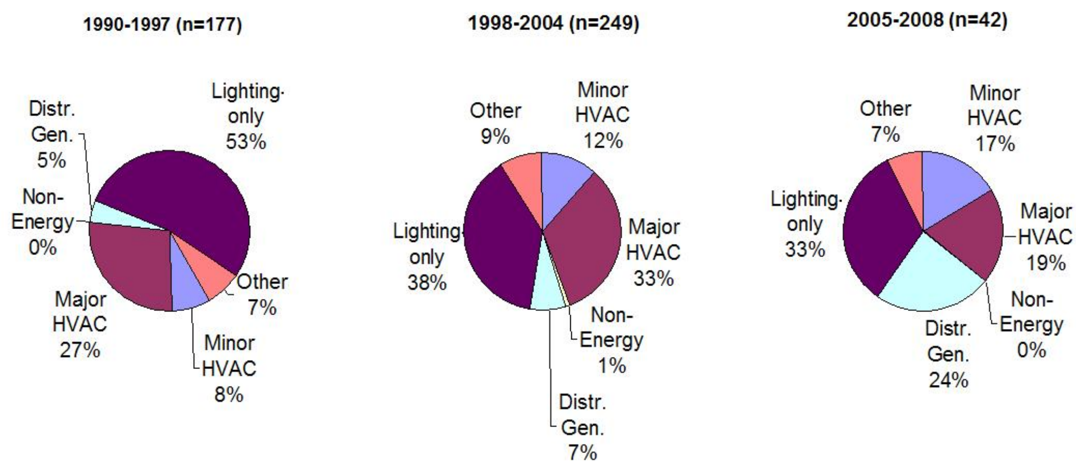

Figure 11. Types of retrofit strategies utilized by ESCOs in private sector projects: 1990-2008

A different picture emerges in the public/institutional sector where major HVAC has remained the dominant retrofit strategy since the early 1990s (46% to 54% of public sector projects were major HVAC retrofits; see Figure 12). Lighting-only projects in the public/institutional sector have decreased from 25% of all projects between 1990 and1997 to only 3% between 2005 and 2008. Onsite generation projects account for an increasing share of ESCO projects in the public sector (5% in 1990-97 vs. 11% in 2005-2008).

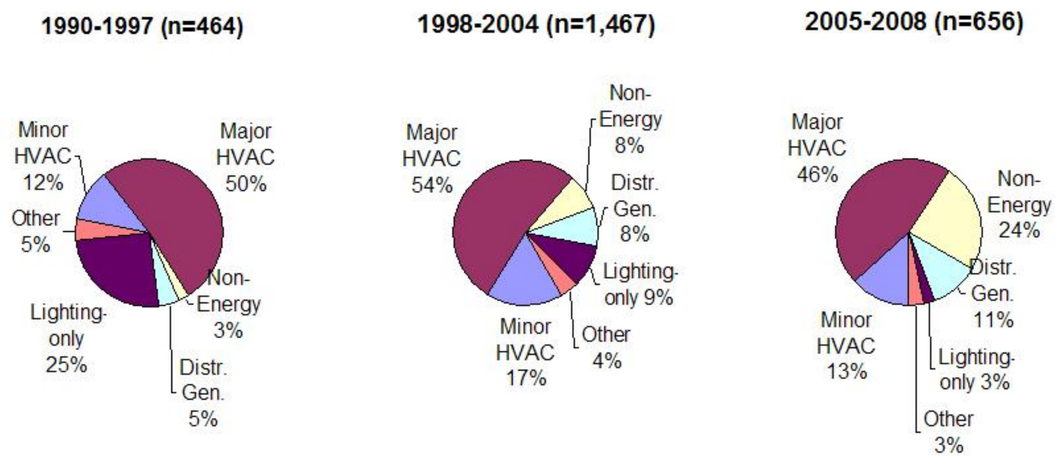

Figure 12. Types of retrofit strategies utilized by ESCOs in public sector projects: 1990-2008

We also found that the number of unique efficiency measures typically installed by ESCOs in K-12 schools projects tended to increase over time (i.e., four measures per project in 1990-1997 to ~7 measure per project in the 2005-2008 period), which is an indicator of more complex retrofits (see Figure 13). We also observed this trend of more measures installed among other public sector and private sector projects in earlier time periods (through 2004), although the typical number of ECMs installed appears to be leveling off over time since 2005.

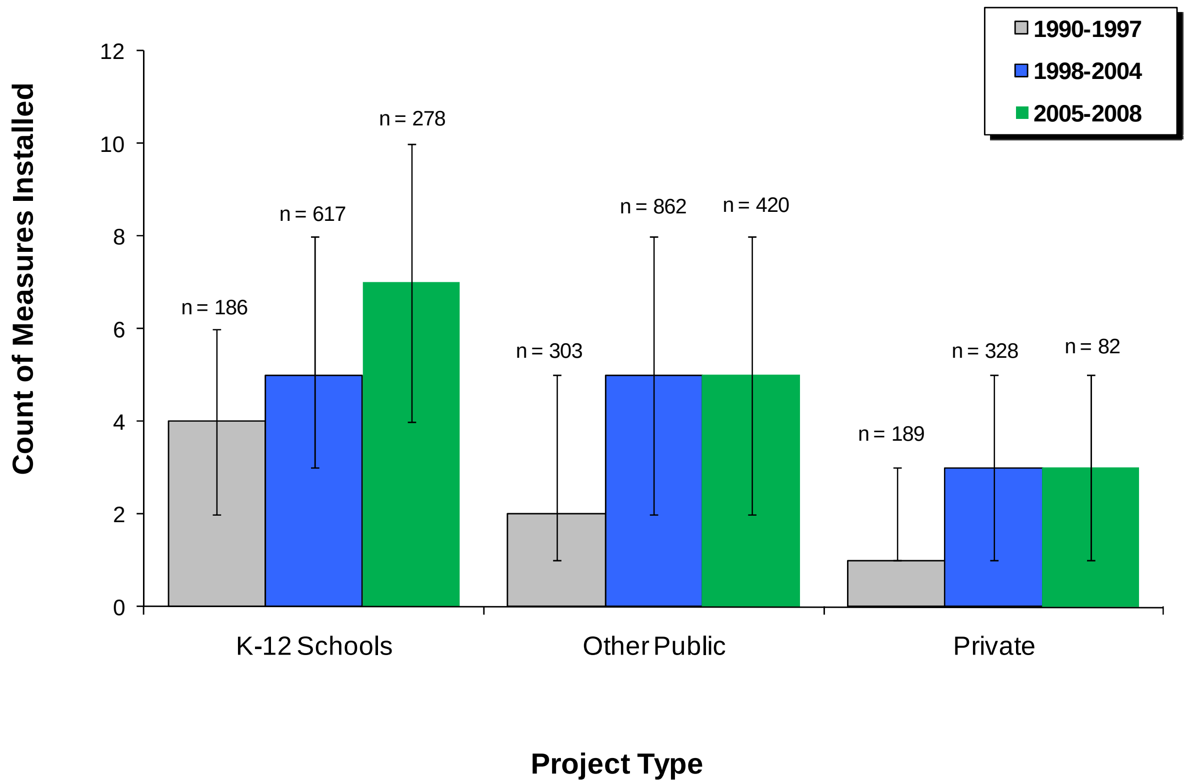

Figure 13. Median number of energy conservation measures installed per project in K-12 schools, and projects in other public/institutional and private sector markets.

5.2. Definition of a comprehensive retrofit

We build on research by Amann and Mendelsohn (2005) and define a comprehensive retrofit as the:

> Installation of multiple measures that address the full range of energy efficiency and, in some cases, supply opportunities in an individual building as well as any interactive effects among system components or building systems. For purposes of this analysis, comprehensive retrofits incorporate multiple measures and include strategies related to address (1) major HVAC, (2) onsite/distributed generation, and (3) non-energy savings.

5.3. Comprehensive retrofits typically cost more to install per square foot of floor area

In section 4.4, we reported project installation costs per square foot disaggregated by market segment (K-12 schools, all other public sector facilities, and private sector projects) and retrofit strategy (see Figure 8). We found significant variation in project costs normalized by floor area for each retrofit strategy: for projects that implement a similar retrofit strategy, costs/ft^2 vary by a factor of ~2-4 for the middle 50% of projects (i.e. inter-quartile range). Among the six retrofit strategies, we assume that projects that implemented major HVAC, onsite generation and non-energy measures (along with other measures) can be characterized as "comprehensive" retrofits. Median project installation costs per square foot were ~2-4 times higher for major HVAC projects (\$4.6/ft^2; n=1,085), onsite generation projects (\$6.8/ft^2; n=165), and non-energy projects (\$9.1/ft^2; n=253) compared to lighting only and minor HVAC projects (see Figure 7). In Figure 14, we classify projects as "comprehensive" or "non-comprehensive" based on their retrofit strategy and present results by market segment. We find that median project costs tend to be higher for comprehensive projects compared to non-comprehensive projects and that project costs tend to be higher at K-12 school projects compared to projects implemented in other public/institutional and private sector facilities.

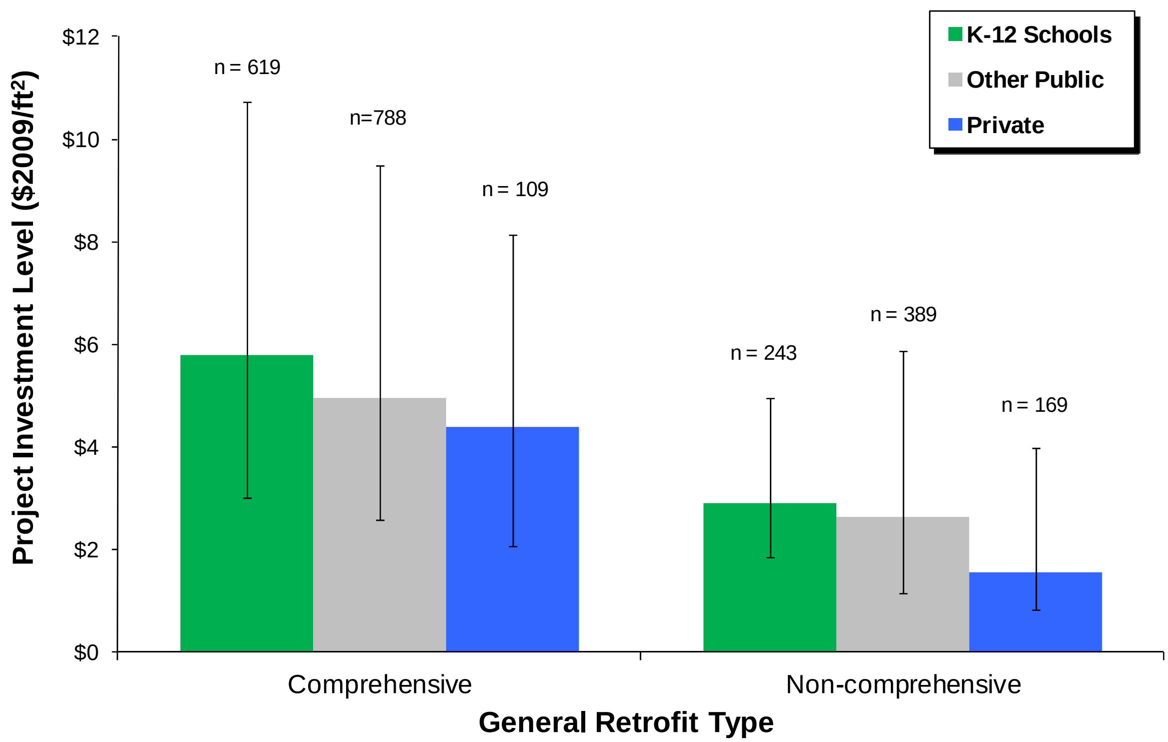

Figure 14. Project investment levels for comprehensive and non-comprehensive projects in K-12 schools, other public and institutional, and private sector markets.

5.4. Project installation costs are increasing faster than savings

Our results suggest that changes in the mix of retrofit strategies over time (e.g., more distributed generation projects, fewer lighting only projects, more projects that include non-energy measures in K-12 schools) may be influencing the observed trend of increased per-project investment levels in various market segments. We found that median project investment levels more than doubled in the last decade, even after accounting for the effects of inflation and floor area (see Figure 15).[32]

[32] In Japan, Murakoshi and Nakagami (2009) found that per-contract investment levels were also increasing due in part to trends related to project diversification, onsite generation, and a general move towards larger scale EE projects.

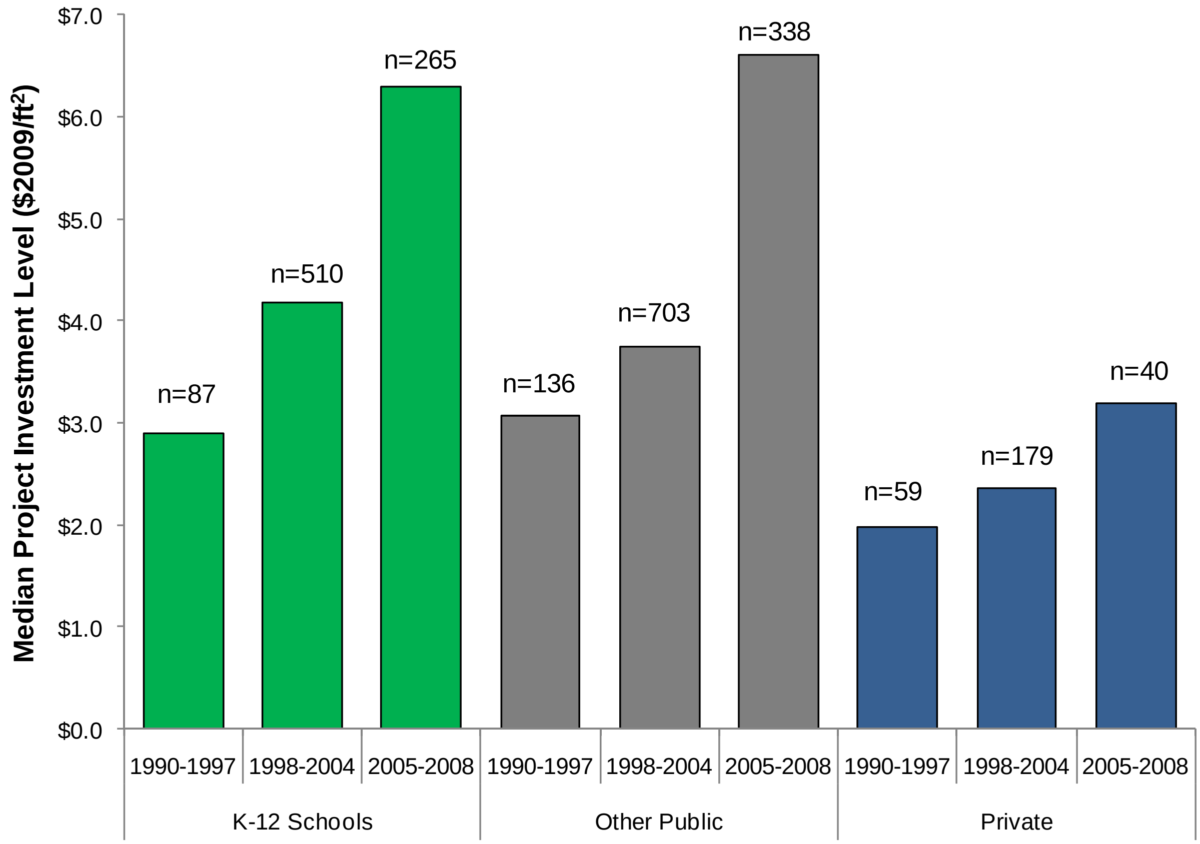

Figure 15. Median values for investment intensity over time in K-12 schools, and projects in other public/institutional and private sector markets.

Satchwell et al. (201) surveyed ESCO industry executives to learn more about their views on trends in project investment levels in an effort to better understand results from our analysis of the LBNL/NAESCO project database. Specifically, ESCOs were asked whether they believed installed project costs (i.e., per-project ESCO investment levels) have been increasing, decreasing, or staying about the same over the past decade. About 60% of the 26 ESCOs that responded to this question stated that they believed project installation costs have been increasing over the past decade, while 40% indicated that project installation costs have remained “about the same” (see Figure 16).

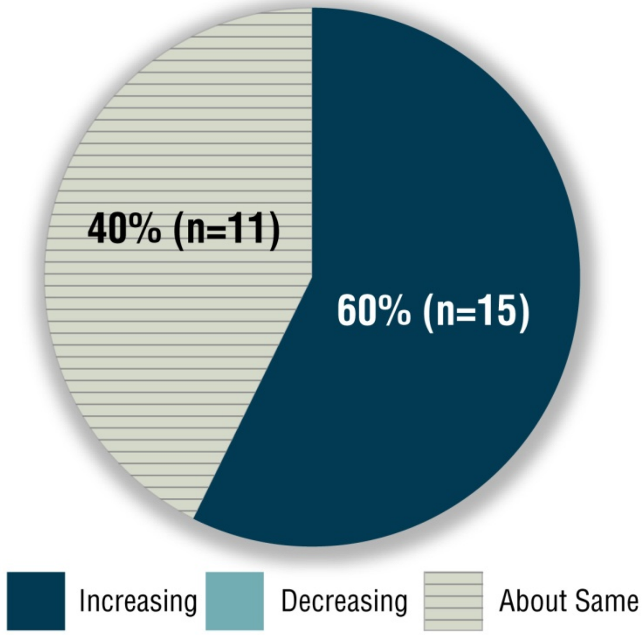

Figure 16. Have project installation costs been increasing, decreasing, or staying about the same over the past decade?

Satchwell et al. (2010) also asked ESCOs to rank factors that they believe are most influential in changing long-run project installation costs. Table 7 ranks factors listed by ESCOs in order of most influential to least influential. Not surprisingly, the most influential factor in project cost increases has been increasing costs of ESCO production inputs, including labor and material costs. This response suggests that labor and materials costs may be increasing faster than the rate of inflation, which we corrected for in our analysis of project installation costs. ESCOs ranked factors such as market barriers (e.g., transaction costs and contract rules), demand for more comprehensive (larger) retrofits, and "other factors" (e.g. outside consultant costs) as having moderate influence (scores of 5 to 6 on average) in contributing to increased project costs; these factors ranked much lower than ESCO production inputs.

Table 7. What factors most influenced increasing project investment levels (i.e., customer installation costs)?

Factor[33]	Rank	Average Score[34]
ESCO production inputs (e.g., labor and material costs)	1	2.6
Market barriers (e.g., transaction costs, contract rules)	2	5.1
Demand for comprehensive/capital-intense retrofits	3	5.1
Other factors	4	6.3

5.5. Trends in project savings metrics

ESCOs typically use several M&V options included in the International Performance Measurement Verification Protocol (IPMVP) to estimate savings for energy efficiency measures installed at a project site relative to baseline usage. For some projects, including lighting-only installations, ESCOs reported baseline consumption only for the lighting equipment to be replaced. In more comprehensive projects, ESCOs typically estimate baseline consumption using total facility energy consumption from an analysis of customer utility bills. The majority of projects reported baseline values using either total (utility bill) or equipment-targeted metrics (see Figure 17).[35]

[33] The survey included nine factors for the ESCO respondent to rank and we combined the nine factors into four mutually exclusive factors for purposes of analysis and reporting.
[34] 1=most influential; 9=least influential.
[35] ESCOs report annual project savings in a number of different units of measurement including: kilowatt-hours (kWh), therms of natural gas, therms of other fuel types (e.g., coal, oil), and gallons of water.

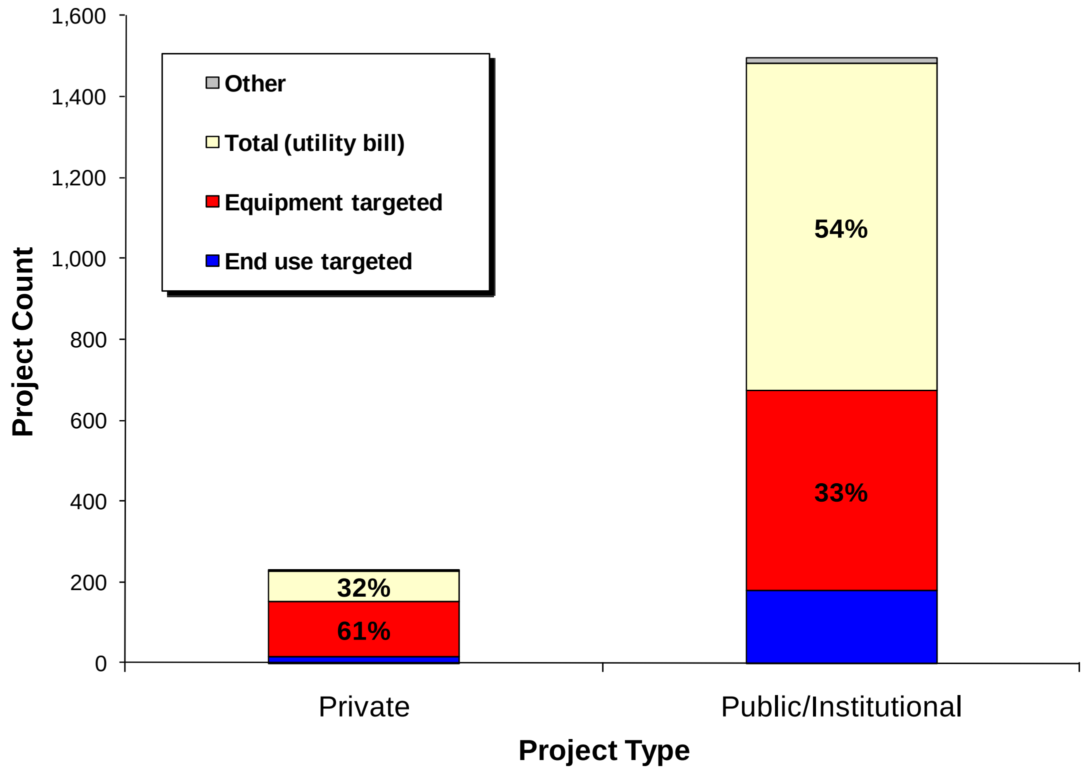

Figure 17. Share of reported baseline consumption metrics

Because ESCOs install measures that produce savings in both electricity and/or fuel consumption, we calculated the dollar value of savings for each project. We found that median values for annual dollar savings (normalized for floor area) increased since the 1990-97 period for K-12 schools, other public sector and private sector projects, but at a much slower pace than the observed rate of increase in project installation costs (see Figure 18).

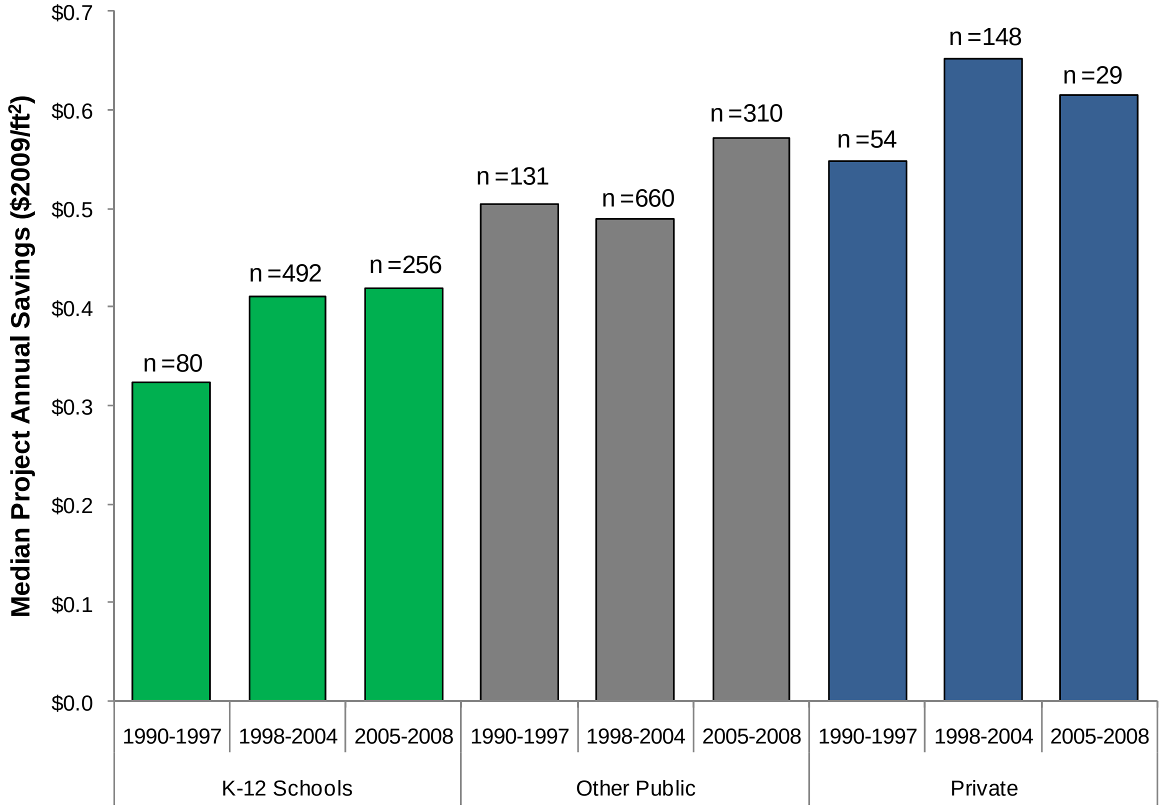

Figure 18. Median values for annual savings intensity over time for ESCO projects in K-12 schools, and projects in other public/institutional and private sector markets.

5.6. Trends in project economics and net benefits

Table 8 shows median simple payback times and benefit-cost ratios for K-12 schools, all other public sector, and private sector projects disaggregated by time period: 1990-1997, 1998-2004, and 2005-2008.

Table 8. Median payback times and benefit-cost ratios for ESCO projects by market segment

Market segment	Installation Year	Simple Payback Time (years)	Benefit-cost Ratio
K-12 Schools	1990-1997	8.2 (n=125)	1.5 (n=121)
K-12 Schools	1998-2004	9.6 (n=540)	1.1 (n=536)
K-12 Schools	2005-2008	13.1 (n=263)	0.9 (n=263)
Other Public	1990-1997	3.9 (n=225)	3.0 (n=220)
Other Public	1998-2004	7.0 (n=724)	1.6 (n=708)
Other Public	2005-2008	9.0 (n=353)	1.2 (n=339)
Private	1990-1997	1.9 (n=138)	4.3 (n=138)
Private	1998-2004	3.7 (n=197)	2.2 (n=185)
Private	2005-2008	3.2 (n=33)	2.7 (n=31)

Median payback times for ESCO projects are increasing over time in all market segments. For example, the median payback time in private sector project increased from 1.9 years to 3.7 years after the initial installation period (1990-1997), but the most recent time period—with a smaller sample size—shows a slight reduction in payback time. Payback times are much longer in other public sector and K-12 schools projects, ranging from 9 to 13 years in the 2005-2008 period. Not surprisingly, the median benefit cost ratio value has generally decreased over time in these market segments (with the exception of private sector projects in the 2005-2008 period). The median benefit cost ratio is very attractive for ESCO projects installed in private sector facilities (2.7 in the 2005-2008 period) and is 1.2 for other public sector projects in recent years. Direct benefits from K-12 school retrofits—completed after 2005— do not typically cover turnkey installation costs over the lifetime of the project. As discussed earlier, K-12 schools are using performance-based contracts to partially pay for asbestos removal, building envelope, wiring, and other non-energy-related improvements and this trend is being reflected in the economic performance of these projects.

6. Enabling policies

The following section discusses several enabling policies that could be explored in order to provide more transparency for the ESCO industry, evaluate the effect of accumulated facility depreciation issues at public facilities, and ultimately facilitate additional growth for this important industry.

6.1. Promote international EM&V standards to quantify and report relevant non-energy benefits

We reported in Section 4 that significant non-energy-related economic benefits are being accrued in ESCO projects in the public and institutional sector–including avoided O&M and capital costs. However, unlike existing international protocols that standardize how energy and water-related savings are computed (EVO 2010), there are no international standards in place to collect and then monetize information about avoided O&M and capital costs and other non-energy benefits specifically related to ESCO projects (Birr and Singer 2008; Larsen et al. 2012b)[36].

Existing methods to quantify the value of ESCO projects to their customers were built on the assumption that nearly all of the installation costs are covered by the energy-related savings. It is clear that new methods–including a deeper analysis of the lifecycle costs of infrastructure replacement–are needed to more accurately quantify the value of ESCO projects, especially in the K-12 schools market. Larsen et al. (2012b) note that "successful incorporation of non-energy

[36] In evaluation measurement and verification (EM&V) guidance provided to the U.S. Department of Energy's Federal Energy Management Program (FEMP) it was noted that non-energy savings are typically comprised of O&M savings and/or reduced water consumption (Nexant 2008). However, there is no mention in the FEMP EM&V protocol of other types of non-energy project benefits that are occasionally included in other public facilities' performance-based contracts, including benefits related to avoided capital costs.

benefits into performance metrics will: 1) increase benefit-cost ratios; 2) result in more ESCO projects moving forward; and 3) generate deeper energy savings and other non-energy benefits for schools and other government agencies."

Therefore, we recommend that the International Performance Measurement and Verification Protocol (IPMVP) team; government agencies at all levels; and private energy service companies and contractors; promote EM&V documentation and practices that include standards for the collection, verification, and monetization of certain types of non-energy benefits.

6.2. Require collection of project-level performance data

In section 5, we reported that median project installation costs more than doubled in the last decade, even after accounting for the effects of inflation and normalized by floor area. ESCO executives who were surveyed cited increasing labor, material, and transactional costs related to comprehensive retrofits as possible reasons that might explain this significant trend in project investment levels.

In order to more accurately characterize factors driving trends in the ESCO industry, administrators of ESPC programs should require the collection, organization, and release of performance data on energy savings performance contracts (ESPC) and programs. In a typical ESPC, customers receive any savings that exceed the guaranteed-level. Government facility managers may be making important retrofit decisions based on installation costs, available technologies, and ESCO predictions of project performance. Increasing access to historical information about ESCO project (and program) performance will help government officials streamline their reporting processes, improve industry transparency, and help stakeholders estimate future market potential. ESCO who receive government incentives or other public sector support should be required to submit basic information about the project including: (1)

location; (2) completion date; (3) floor area; (4) number of buildings; (5) market segment; (6) facility type; (7) installation cost; (8) contract type and term; (9) incentive program participation and amount; (10) baseline consumption by fuel type; (11) annual savings and EM&V method; and (12) the types of technologies installed.

6.3. Provide access to project-level performance benchmarking information

Public and institutional facility managers are looking for ways to benchmark project feasibility and success against ESCO and other commercial building industry benchmarks[37], but publicly available information for this purpose is often dated or not available. This information gap can lead to poor decisions that ultimately affect project energy savings performance and cost-effectiveness. It is important that public funding sources be put to good use in order to meet rigorous state energy savings targets and new federal SEP reporting requirements. For example, Lindgren (2009) reported that there was little incentive for ESCOs to push savings levels beyond the guaranteed amount in guaranteed savings contracts in Sweden; results from the LBNL project database provide some evidence of this phenomenon in the United States. For example, the share of public and institutional projects that exceed the guaranteed level is decreasing over time (see Figure 19). However, it is important to note that nearly 85% of all public and institutional projects *met or exceeded* the guaranteed level of savings.

[37] The most recent Commercial Building Energy Consumption Survey (CBECS) in the U.S. was released nearly ten years ago and another survey is needed to understand facility characteristics about the existing stock of commercial buildings (CBECS 2011).

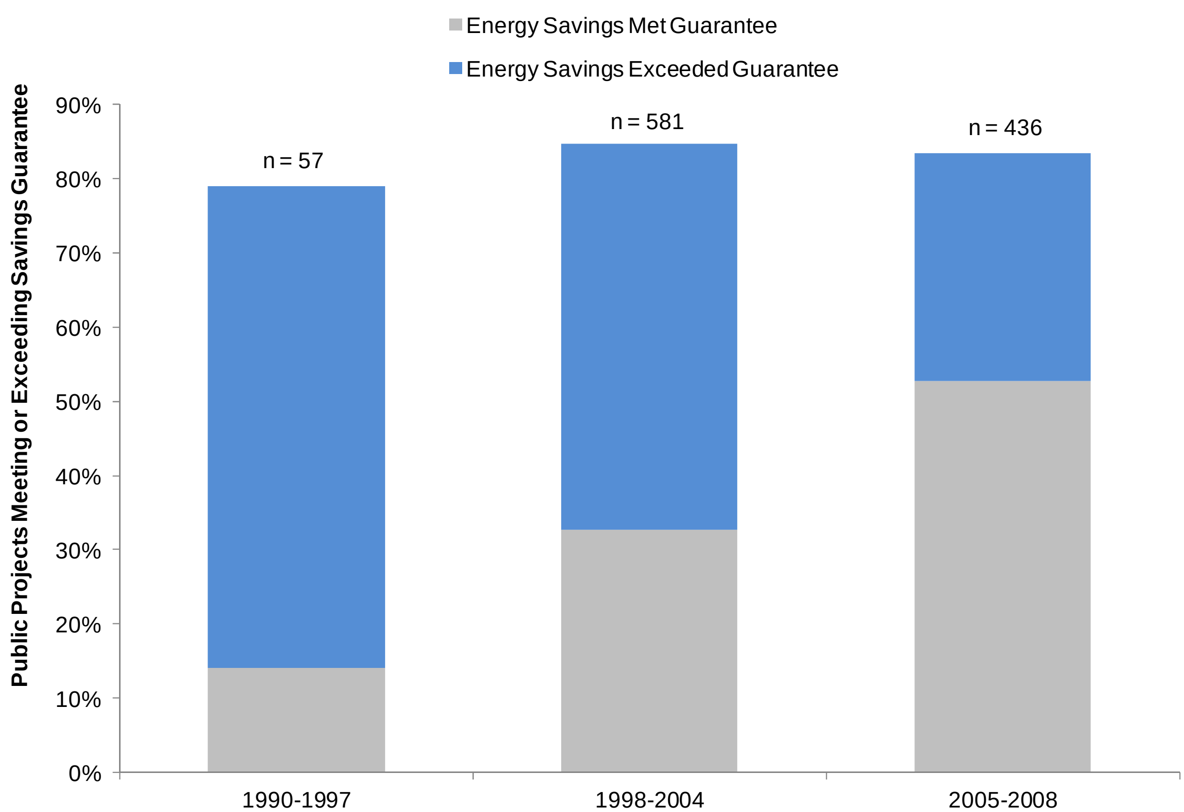

Figure 19. Public and institutional projects meeting[38] or exceeding savings guarantee

In a typical performance-based contract, ESCO customers receive any savings that exceed the guarantee, so facility managers may be making retrofit decisions based on ESCO predictions of future performance. Therefore, improved access to historical information about how often ESCOs exceed savings guarantees−at non-stipulated savings projects−could improve the decision making process at the facility being retrofitted. It is clear that public/institutional sector project benchmarking, along with additional ESPC education and outreach, can help all parties avoid situations where there are large differences between projected, guaranteed, and actual savings. To address this need, LBNL has developed a project input and benchmarking tool that

[38] Note: Projects that meet, but not exceed savings guarantees are typically stipulated savings projects.

shows typical project performance of ESCO projects by market segment (e.g., installation costs, annual savings, payback time) and retrofit strategy (LBNL 2011; LBNL 2012).

7. Summary and future research

This study discusses results from a recent survey of U.S. ESCO executives and a parallel analysis of project-level data going back to 1990. Despite the onset of a severe economic recession, the U.S. ESCO industry managed to grow at about 7% per year between 2006 and 2008. We estimate that ESCO industry revenues were about $4.1 billion in 2008. While ESCO industry growth was slower than anticipated, the industry continued to deliver energy efficiency services to many market sectors even when facing higher financing costs. In aggregate, we estimate that 2,484 projects in the database generated approximately $4 billion in direct net economic benefits to customers. If we assume that the net benefits per project are comparable for all ESCO industry projects that are not included in our calculation of net benefits, this would suggest that the ESCO industry has generated nearly $23 billion ($2009) in net direct economic benefits for customers at projects installed between 1990 and 2008. We estimated that a typical ESCO project generated $1.5 dollars of direct benefits for every dollar of customer investment.

The project-level data suggests that ESCOs tend to focus on larger states, as defined by economic activity, but several other factors including budgets for ratepayer-funded energy efficiency programs, condition of existing commercial facilities, aggressive state energy programs, and the number of federal customers also influence where ESCOs conduct business. ESCOs derive about 85% of their revenues from projects in the public/institutional sector.

The LBNL project database and a majority of ESCO survey respondents – 60% – indicated that typical project installation costs have increased over the past decade. We discussed the trend of installing more comprehensive retrofits in both the public and private sector and how this relates to the increased installation costs over time. K-12 schools, which represent the largest share of projects in our database, are using the ESCO business model to address substantial deferred maintenance needs. EM&V protocols—including the measurement of indirect and non-energy-related benefits—need to be further developed to truly capture the intrinsic value of these projects to customers. In aggregate, ESCOs are still able to deliver cost-effective energy solutions to their customers as evident by significant net economic benefits generated by projects in our database.

We believe that an important new area of research involves supporting benchmarking and standardization efforts to quantify non-energy (and other indirect benefits) for energy efficiency projects. Finally, it is important for industry analysts and researchers to explore the factors that contribute to the dramatic increase in inflation-adjusted project installation costs over time. Specifically, additional research should be undertaken to disaggregate and report the capital, O&M, and transactional costs associated with complex building retrofits.

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