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ABSTRACT

This study draws upon a database of ~800 projects that have been developed by U.S. Energy Service Companies (ESCOs). These projects represent a cumulative investment of ~$1.4 billion in energy-efficiency projects and is the most comprehensive historical "snapshot" of the ESCO industry that is publicly available. We provide information on the geographic distribution of ESCO projects, analyze project development activity by ESCOs over time and in various market segments, and analyze estimated vs. actual, verified energy savings. We also summarize key project characteristics in various market sectors (e.g., project cost, floor area) and discuss the extent to which ESCOs relied on different types of utility programs in developing these projects. We also comment upon some of the major policy implications from the study: (1) markets with significant private sector energy efficiency activity, and (2) the relationship between trends in private sector activity and public purpose or ratepayer-funded programs.

Introduction

Over the last 20 years, a viable private sector energy efficiency services industry has emerged in North America whose primary business was performance contracting. The U.S. ESCO industry has attracted the interest of federal, state, and international policymakers interested in promoting successful models for energy efficiency as well as investors and potential market entrants interested in evaluating business opportunities. Although many studies of the ESCO industry have been conducted (Goldman and Dayton 1996; Dayton and Goldman 1998; Fraser and Montross 1998), few have relied on the key underlying empirical data – the actual track record of ESCOs in developing projects.

This study draws upon a database of ~800 projects that have been developed by 25 ESCOs who provided data as part of a voluntary accreditation process offered by the National Association of Energy Service Companies (NAESCO), an industry trade association. In aggregate, this project data represents the most comprehensive, historical "snapshot" of the ESCO industry that is publicly available. However, for various reasons, we do not claim that it is representative of the ESCO industry overall or performance contracting market activity over the last decade, although that is a future goal of this project. About 90% of the projects in the database are based on some type of performance contracting arrangement (e.g., guaranteed savings, shared savings); projects in which at least some portion of the ESCOs' compensation is contingent on the project's verified savings over the contract term. Because of the intrinsic features of performance contracts, these projects provide a wealth of information on the actual, installed performance of high-efficiency equipment (compared to estimated savings or performance) as well as the value to customers of energy-efficiency services provided by ESCOs.

The paper is organized as follows. We first discuss the context in which data on ESCO projects was obtained as well as data quality and representativeness issues. We then provide summary information on key characteristics of the database: geographic distribution of ESCO projects in our sample and project characteristics in various market sectors (e.g., project size, installed measures). We then explore ESCO activity in various market sectors based on reported project costs as well as the extent to which projects have utilized various types of financial incentives offered by utility DSM programs. We then focus on project outcomes: actual and estimated energy savings.

Approach

LBNL and NAESCO developed a template that requested information on projects completed by ESCOs. Individual ESCOs expressed various concerns regarding confidentiality of customer information and competitively sensitive information. In response, we developed an approach in which results will be reported in an aggregated fashion in order to ensure that company and customer confidentiality concerns are addressed adequately. As part of their biennial accreditation process, ESCOs were required to provide detailed information on ten projects completed during the prior three years as well as a summary chart that provided basic information on all projects completed over the last five years (up to a maximum of 50 projects). ESCOs were asked to provide the following information on each project: location, date of completion, structure of contract agreement, floor area, type and ownership of facility, high-efficiency measures installed, project cost, participation in a utility DSM program, energy consumption prior to the project, projected energy savings, guaranteed level of energy savings, actual energy savings reported in each year of contract, and non-energy benefits (e.g., savings in operations and maintenance costs). In practice, ESCOs provided varying amounts of information on projects. LBNL entered information *self-reported* by ESCOs in an ACCESS database; ESCOs were then asked to verify, update, and provide missing information for each project. In providing project information, ESCOs were aware that the NAESCO Accreditation Committee would be interviewing a small sample of their project references to verify project information. We received responses back to verification inquiries from companies representing 79% of the projects; in most cases, ESCOs provided some additional information although rarely was every data field completed.

To summarize, we have a database of ~800 projects that is based on self-reported information provided by ESCOs. Given the context (e.g., an accreditation process with auditing by an independent Committee), we are reasonably confident that the information provided is accurate. However, data quality and responsiveness varies significantly among individual ESCOs. Some companies, mainly smaller firms, provided information on all performance-based projects, while other companies, specifically the larger firms, provided information on a relatively small sample of completed projects (because of the reporting requirements developed by NAESCO as part of the accreditation process). In many cases, companies did not provide information on key project characteristics (e.g., floor area) or pre-retrofit energy consumption. These data limitations significantly limit our ability to generalize on the significance of certain results (e.g., percent savings, comprehensiveness of projects) because of small sample size. In selecting projects, companies were asked by NAESCO to choose projects that were "representative" of their performance contracting business activity. In practice, LBNL has not yet had a chance to assess the extent to which companies complied with this guideline.

Project Characteristics

Of the 794 projects in the database, about 93% are located in the U.S. while 52 projects were developed in Canada (see Figure 1). The Mid-Atlantic region (New York, New Jersey, Pennsylvania, and Connecticut) is heavily represented in the ESCO project database (37% of all projects), primarily because of the significant participation in the New Jersey Standard Offer Program by certain ESCOs. Over 100 projects, or 13% of our sample, are located in the East North Central region (Wisconsin, Illinois, Michigan, Indiana, and Ohio), a region where, with few exceptions, ESCOs have been implementing performance contracting projects without any financial incentives from utility DSM programs. Roughly 11% of the projects are located in the South Atlantic and Pacific census divisions respectively. Only about 8% of the projects in the database are located in New England, which is somewhat surprising given that a sizeable number of NAESCO members originated or are currently headquartered in New England. Although the Canadian market for energy services is much smaller than the U.S., Canadian projects in the database accounted for roughly 14% of the dollars invested.

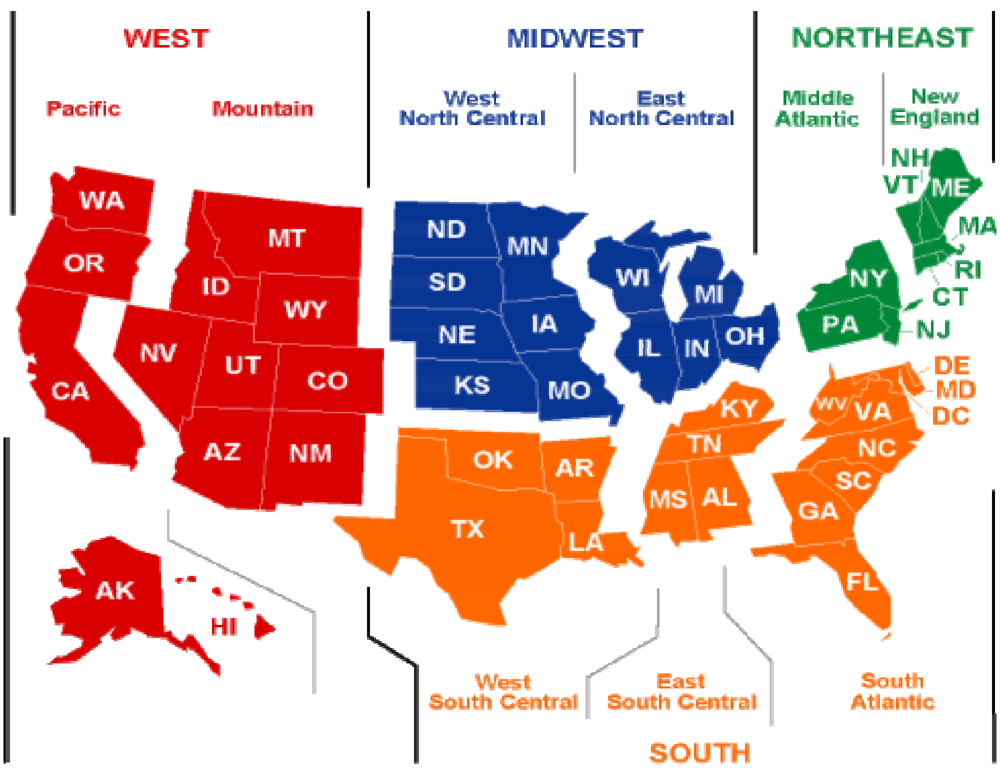

Figure 1. Project Activity by Region

US Census Division	No. of Projects (N=794)	Project Cost[1] ($M)	# proj incl in *Project Cost*
Pacific	91	$146	89
Mountain	12	$36	12
West North Central	37	$40	37
West South Central	44	$153	42
East North Central	106	$231	105
East South Central	6	$18	6
Mid-Atlantic	293	$403	270
South Atlantic	88	$118	79
New England	65	$82	51
Canada	52	$194	52

Figure 1. Project Activity by Region cont'd.

The folklore on the U.S. ESCO industry is that the majority of activity (60-65%) has historically occurred in the so-called "MUSH" institutional markets (i.e., municipal governments, universities, schools, and hospitals), with 30% in the commercial sector, and 10% among industrial customers (Cudahy and Dreessen 1996). ESCOs were asked to classify each project into one of twelve market segment categories. For projects where this information was missing, LBNL classified projects into market segment categories, where possible and obvious, based on the project name (e.g., XYZ School District). Our segments were intended to encompass key markets as well as characteristics that might affect customer activity levels (e.g., leased vs. owned space, chain account vs single site). About 780 projects in the database were classified into market segment category (see Figure 2). Roughly 27% of the projects in the database were in the K-12 schools market, followed by state/local government (16%), health and hospital (14%), and universities/colleges (10%). If the Federal government market is included, about 74% of the projects in our database are in various institutional markets. Because ESCOs are more reluctant to provide project reference information on private commercial and industrial clients, we are fairly confident that our project database results represent an upper bound on the share of ESCO activity in institutional markets.

We segmented the project database into two time periods (pre-1996 and 1996 to present) in order to examine trends in market activity in various segments.[1] Splitting the sample in this fashion also allows us to get an initial sense of the impact of increased competition in the electric utility industry with the onset of restructuring. After 1995, the share of completed projects in our database increased significantly in the Federal market (6 to 13%), K-12 schools (26 to 32%), and state/local government (13 to 21%) markets; relatively fewer projects were completed in health/hospitals, university/colleges and owner-occupied offices.

[1] About 341 projects were completed prior to 1996 and 403 projects were completed in 1996 or later.

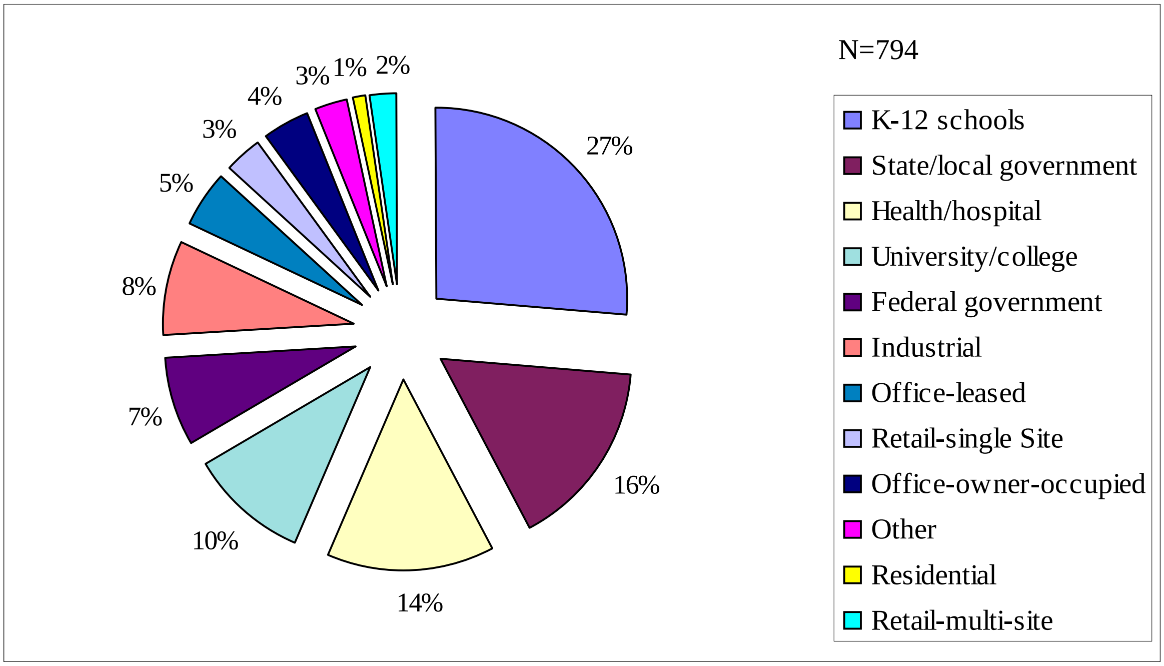

Figure 2. ESCO Projects by Market Segment

Table 1 reports summary information on floor area for ESCO projects in various market segments. ESCOs were asked to report the floor area of building space that was included in their retrofit project and/or was consistent with the area covered in baseline energy consumption; floor area information was received on 331 projects, or 42% of the projects in the database.[2] The average projects implemented by ESCOs in universities and colleges and Federal government buildings were undertaken on sites that ranged between 1.2 – 1.6 million ft^2. Typical projects at sites in K-12 schools, state/local government facilities, health and hospitals, and industrial facilities averaged between 520-740,000 ft^2. The typical project in a leased office space was implemented at a site with ~480,000 ft^2. Within most market segments, there is significant variation in the floor area of projects. The coefficient of variation (COV), which is the standard deviation divided by the mean, is an indicator that helps understand this phenomenon in relative terms. Among the five market segments that most frequently reported floor area, the COV in floor area ranged from 0.96 in universities and colleges to 1.76 in Federal government projects. . Given the wide variation in floor area within market segments, the differences in average floor area across market segments are not significant in most cases.

Types of Measures Installed

ESCOs reported information on installed measures for 88% of the projects in the database. Information was provided in one of two ways: (1) for each project, ESCOs checked off measures that were included from a pull-down menu or hard-copy list of common measures, or (2) ESCOs described installed measures in a project summary, which

[2] ESCOs often do projects in phases at a large site (e.g., replacing a boiler at one or more buildings on a large site); so we were hoping to obtain project cost, energy consumption, and building characteristics data (e.g., floor area) that would be internally consistent.

was then coded by LBNL). Based on data reported by ESCOs, an average of ~3.1 measures were installed in each project. However, it is important to note that several of the measure categories were quite broad (e.g., lighting retrofits). About 31% of the projects in the database installed only lighting measures, while 57% of the projects including lighting plus other measures.

The most frequently listed measures were lighting retrofits (645), energy management systems (350), boiler and chiller replacements (158 and 130 respectively), variable speed drives (117), high-efficiency motors (97), insulation and weather proofing (73), new water heaters (56), piping (56), steam traps (49), pumps and priming systems (49), motion sensors (44), cooling towers (39), and water conservation (38). Based on our review, it appears that there is ample evidence that ESCOs do in fact convince customers to do comprehensive projects that address energy efficiency opportunities across multiple end uses, with an emphasis on major capital equipment replacements of HVAC systems.

Project Costs

ESCOs were also asked to provide information on project costs, based on a definition that focused on the notion of a turnkey project. Project costs included development, construction, financing costs and profits as of date of acceptance by customer (e.g., audit, design, construction, equipment, labor, & overhead). Ongoing project service costs, such as monitoring and verification of savings and maintenance are typically excluded. Some ESCOs included the cost of financing the project over the entire contract in addition to "turnkey" project costs. These additional financing-related costs were reported in about ~140 projects and would typically increase project costs by 15-30% depending on contract term and interest rate compared to projects that reported only "turnkey" costs.

About 94% of the projects included information on project costs; in aggregate, these 744 projects represent a cumulative investment of ~1.4 billion in energy-efficiency projects. If the estimates of ESCO market activity developed by Cudahy and Dreessen (1994) are reasonably accurate, then the projects in this database may represent ~10-20% of total ESCO market activity during the last decade.

The average value and standard deviation in project costs in each market segment, which are shown in Table 1, provide important insights into the typical size and cost range for projects that are successfully developed by ESCOs (i.e., about 67% of the projects fall within one standard deviation of the average).

Table 1. Project Cost and Floor Area

Market Segment	Code	Number of Projects	Average Project Cost (million $)	Average Floor Area (thousand ft^2)	Ave Project Investment ($\$/ft^2$)
K-12 schools	SC	202 (113)	$2.66 +/- $5.38	742 +/- 801	4.34
State/local government	GO	119 (60)	$1.71 +/- $3.73	544 +/- 590	4.80
Health/hospital	HH	100 (33)	$0.99 +/- $1.47	639 +/- 768	3.12
University/college	UC	75 (38)	$2.62 +/- $3.23	1,240 +/- 1,196	3.46
Federal government	FG	56 (35)	$2.78 +/- $4.72	1,604 +/- 2,831	2.92
Industrial	IN	59 (11)	$0.79 +/- $2.29	521 +/- 834	1.47
Office-leased	OL	37 (20)	$0.71 +/- $0.70	477 +/- 465	3.70
Retail-single Site	RS	23 (6)	$0.65 +/- $1.33	372 +/- 478	1.07
Office-owner-occupied	OO	26 (4)	$1.42 +/- $2.72	1,268 +/- 1,258	2.71
Other	OT	21 (7)	$3.06 +/- $9.70	192 +/- 212	4.78
Residential	RE	10 (2)	$1.48 +/- $3.57	205 +/- 251	9.01
Retail-multi-site	RM	16 (2)	$1.08 +/- $2.41	757 +/- 627	0.99

Note: Number of projects with project costs and floor area (shown in parentheses)

The average project in the Federal government, K-12 schools, and university/college markets is about $2.6-2.7 million. The average project in state/local government market is about $1.7 million while health/hospital project costs averaged about $1 million. The average project in owner-occupied commercial office building is twice as large as leased commercial office ($1.4 vs. $0.7 million). The typical project in our database tends to be larger in the public sector (~$1.7 – 2.8 million), compared to private sector commercial office buildings, retail, or industrial sites (~$0.6 – 0.7 million). However, there is tremendous variation in project costs *within* a particular market segment. For example, the standard deviation of project costs within a market segment is comparable to the average value and, in many cases, is two to three times greater (e.g., industrial, K-12 schools, state/local). A number of factors explain this huge variation in project costs, including differences in project scope & installed measures as well as varying development practices and reporting differences among ESCOs (e.g., projects developed in multiple phases for customers vs. aggregated reporting of all activities at a site). Thus, in most cases, differences in average project costs among market sectors are not statistically significant.

Average project costs vary by a factor of four among market segments, although some of this variation can be easily explained by differences in project size and building characteristics as evidenced by floor area. We divided project costs by floor area for the ~330 projects that reported floor area. One way to think about this indicator is that it is one measure of project investment intensity, which can be compared to a facility's energy costs per unit floor area. If we focus only on the six market segments with reported floor area for more than 20 projects (i.e., K-12 schools, state/local or Federal government, health/hospital, university/college, and commercial office-leased), we observe that average project investment ranges from $\$2.9$- $4.8\ \$/ft^2$. Thus, when we normalize for floor area, variation in average project costs decreases from a factor of four to 1.7. Conventional wisdom is that building owners typically pay about $\$1/ft^2$ in annual energy costs. In our sample, the average values for project investment intensity in market segments with at least 20 projects ranges between $\$2.9 – 4.8/ft^2$.

We segmented the project database into two time periods (pre-1996 and 1996 to present) in order to examine time trends in project costs in various market segments.[3] After 1995, average project costs increased by at least 50% in health/hospitals, industrial facilities, and universities/colleges. Average project costs increased by 15% in K-12 schools and decreased in state/local government projects. Overall, it appears that the average size of projects is increasing faster than the underlying inflation rate, which suggests that ESCOs are developing larger and possibly more comprehensive projects.

Role of Utility Incentives in ESCO projects

We were also interested in analyzing the extent to which ESCOs utilize utility DSM programs as they develop projects. For each project, ESCOs were asked to indicate whether they, or the customer, had taken advantage of some type of ratepayer-funded DSM program. Major program categories included rebate, loan, DSM bidding, standard performance contract (SPC) or standard offer programs, energy audit programs, design/technical assistance, or none. In cases where financial incentives were utilized, ESCOs were asked to estimate the value of payments made to either the ESCO or customer directly by the local electric or gas utility or, more recently, energy efficiency programs funded by public purpose funds.

We believe that this project data can provide some insights on several broader public policy issues that center on the relationship between ratepayer-funded public purpose programs and the development of a vibrant, private sector energy efficiency services industry. For example, historically, to what extent have ESCOs depended on ratepayer-funded DSM incentives? In relative terms over time, are more projects being developed without financial subsidies from ratepayers? Do ESCOs tend to rely more on financial incentives from utility DSM or public purpose financial incentives in particular market segments or is their use conditioned more by the availability of programs offered by utilities?

We offer some preliminary findings based on the sample of projects in the database, however, for reasons discussed in Section 2 (Approach), it is important to recall that our sample is not representative of all ESCO industry activity during the last decade. ESCOS reported that 288 projects, about 36% of our sample, participated in some type of utility DSM program. . For ~80 of these projects, ESCOs indicated the type of DSM program, but did not provide information on the value of the financial incentive given to the customer or ESCO. *Conversely, another way of interpreting this data are that about 65% of the projects were developed by ESCOs without financial subsidies from ratepayers.*

Of the 200 projects that provided information on both utility financial incentives and type of program, about 65% participated in SPC programs, 28% in rebate programs, and 7% in DSM bidding programs. LBNL then calculated the ratio of utility financial incentives to project costs. The relative impact of utility financial incentives varies significantly among the three major DSM program categories - DSM bidding, SPC programs, or rebates (see Figure 3). For example, with few exceptions, rebates typically accounted for 10-30% of project costs. In contrast, in standard offer or SPC programs, expected payments for verified energy savings over the contract term made to ESCOs or customers typically ranged between 60 to >100% of project costs. This phenomenon is a result of the original program design in New Jersey which based standard offer payments on their resource value to the utility, rather

[3] About 341 projects were completed prior to 1996 and 403 projects were completed in 1996 or later.

than as a financial incentive (i.e., rebate) that either partially or totally offsets the higher first costs of high-efficiency measures compared to conventional equipment.

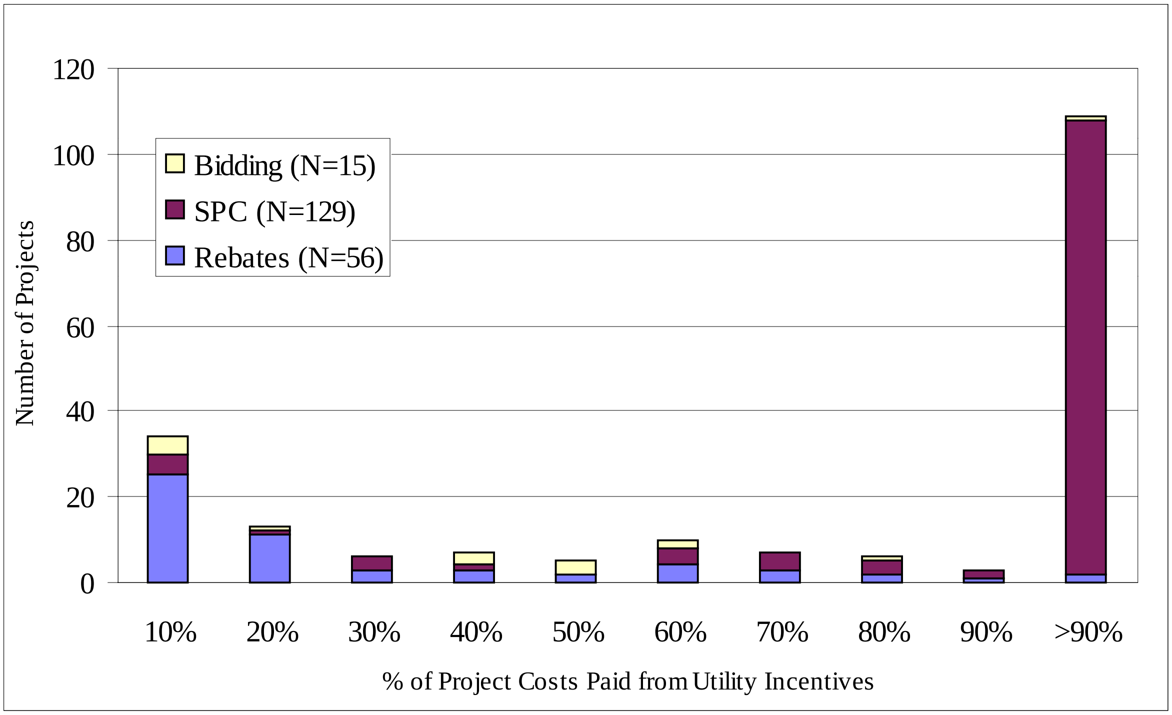

Figure 3. Impact of Utility Financial Incentives

Energy Savings

For each project, ESCOs were asked to report: (1) baseline energy consumption (i.e., defined as either baseline energy use that was used as the basis for savings calculations or pre-retrofit energy consumption); (2) predicted energy savings for various end uses; (3) guaranteed savings (i.e., the annual energy savings guaranteed by the ESCO as part of a performance contract); and (4) actual, verified energy savings for applicable energy sources in energy or dollar terms. For verified savings, ESCOs were asked to provide information on energy savings for each year of the contract or calculate the annual average of actual energy savings achieved.

Table 2. Average Annual Electricity Savings

Market Segment	N	Electricity Savings Million kWh
K-12 schools	100	2.51 +/- 6.0
State/local government	84	2.18 +/- 4.4
Health/hospital	73	1.45 +/- 1.8
University/college	39	6.84 +/- 13.5
Federal government	24	4.87 +/- 8.4
Industrial	36	2.51 +/- 6.3
Office-leased	13	1.90 +/- 1.5

Table 2 shows average annual and standard deviation of actual electricity savings for projects in the seven most represented market segments. Average kWh savings are much higher in the 24 Federal government and 39 university/college projects compared to K-12 schools, state/local government, and industrial sector projects (i.e., 4.9 – 6.8 vs. 2.1–2.5 million kWh). Average electricity savings were ~1.5 million kWh in the 73 health/hospital projects. Not surprisingly, there is significant variation among and within market segments. In all market major segments, the COV ranges between 1.0 and 2.5, which means that the variation in savings among projects is one to two times greater than the average value for that market segment.

Figure 4 is a box and whiskers plot that shows the range in values by market segment of annual average energy savings, which includes both electricity, gas, and fuel oil, normalized by floor area (Btu/ft2) among projects. For each market segment, we show the following values: median, 75% quartile, 25% quartile, minimum, and maximum energy savings. Median savings are between 14-18 Btu/ft^2 in state/local government, industrial, and leased commercial office buildings. Median savings of 9.6 Btu/ft^2 are much lower in health/hospital projects compared to the other market segments (e.g., K-12 schools at 13.1 Btu/ft2 and universities and colleges at 14.4 Btu/ft2. On a site energy Btu basis, electricity typically accounts for 80-90% of the total savings for projects. This result for projects in our database is somewhat counter to Cudahy and Dreessen (1996) who estimated that about 55-75% of the capital invested by ESCOs was for measures that reduced electricity consumption, with the remaining capital (25-45%) invested in thermal measures.[4]

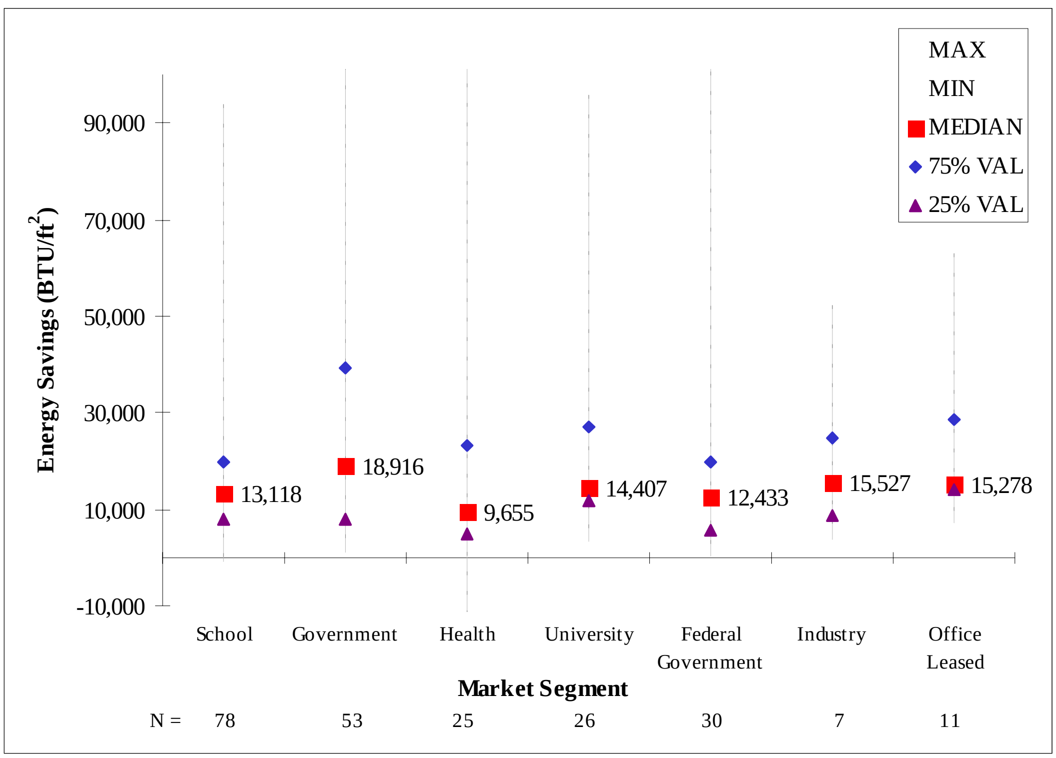

Figure 4. Annual Energy Savings by Market Segment

[4] Cudahy and Dreessen developed estimates for ESCO investment activity from 1980-1994; investment activity is not the same as share of savings but we might expect a closer correlation.

For those projects that reported baseline energy consumption, we calculated percent savings of electricity and gas (see Table 3). Average electricity savings exceed 40% in the 41 state/local government projects, and are 32 and 31% respectively in the 23 health/hospital and 66 K-12 school projects. Average electricity savings are 26% in the 19 university/college projects.

Table 3. Average Annual Electricity and Gas Savings (%)

Market Segment	N	Electricity (%)	N	Gas (%)
K-12 schools	66	31 +/- 17	43	28 +/- 27
State/local government	41	42 +/- 34	11	79 +/- 104
Health/hospital	23	32 +/- 17	5	23 +/- 21
University/college	19	26 +/- 22	10	21 +/- 20
Federal government	12	34 +/- 24		
Industrial	13	44 +/- 24		
Office-leased	6	39 +/- 22		

Notes: Average Annual or Estimated Savings

Figure 5 shows the range in actual and/or estimated electricity and gas savings on a percentage basis for the ~280 projects that reported this information. For about 15 projects, ESCOs reported very high percentage electricity savings among the affected end uses (>65%), which explains why average savings values are higher than median savings. Although many ESCOs did not provide baseline energy consumption information, our results suggest that, overall, ESCOs are significantly reducing electricity consumption in affected end uses (e.g., average savings of 26-46% among market segments).

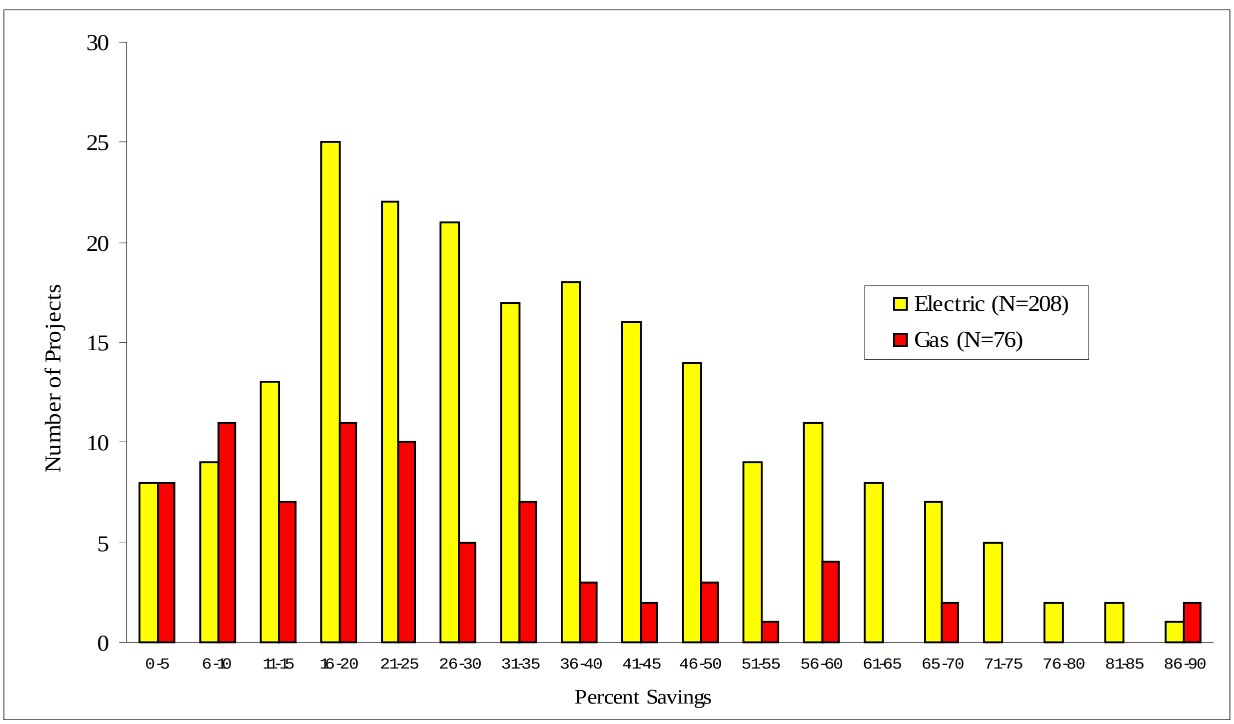

Figure 5. Project Electricity and Gas Savings: Actual and/or Estimated

Predicted vs. Actual, Verified Savings

Because ESCOs typically take performance risk on their projects, the relationship between predicted, guaranteed and verified savings is a topic with both public policy and direct financial implications. Actual savings, based on the results of post-installation M&V protocols, were within 10% of predicted savings in 47% of the 265 projects that provided this information (see Figure 6). The average value for the ratio of actual/predicted electricity savings in this sub-set of projects is 1.16; these results are driven by larger projects. Our results also suggest that ESCOs typically establish guaranteed savings levels at 80-85% of projected savings for projects. As a practical matter, this means that in virtually all cases for projects in our database, actual verified savings exceeded guaranteed savings.

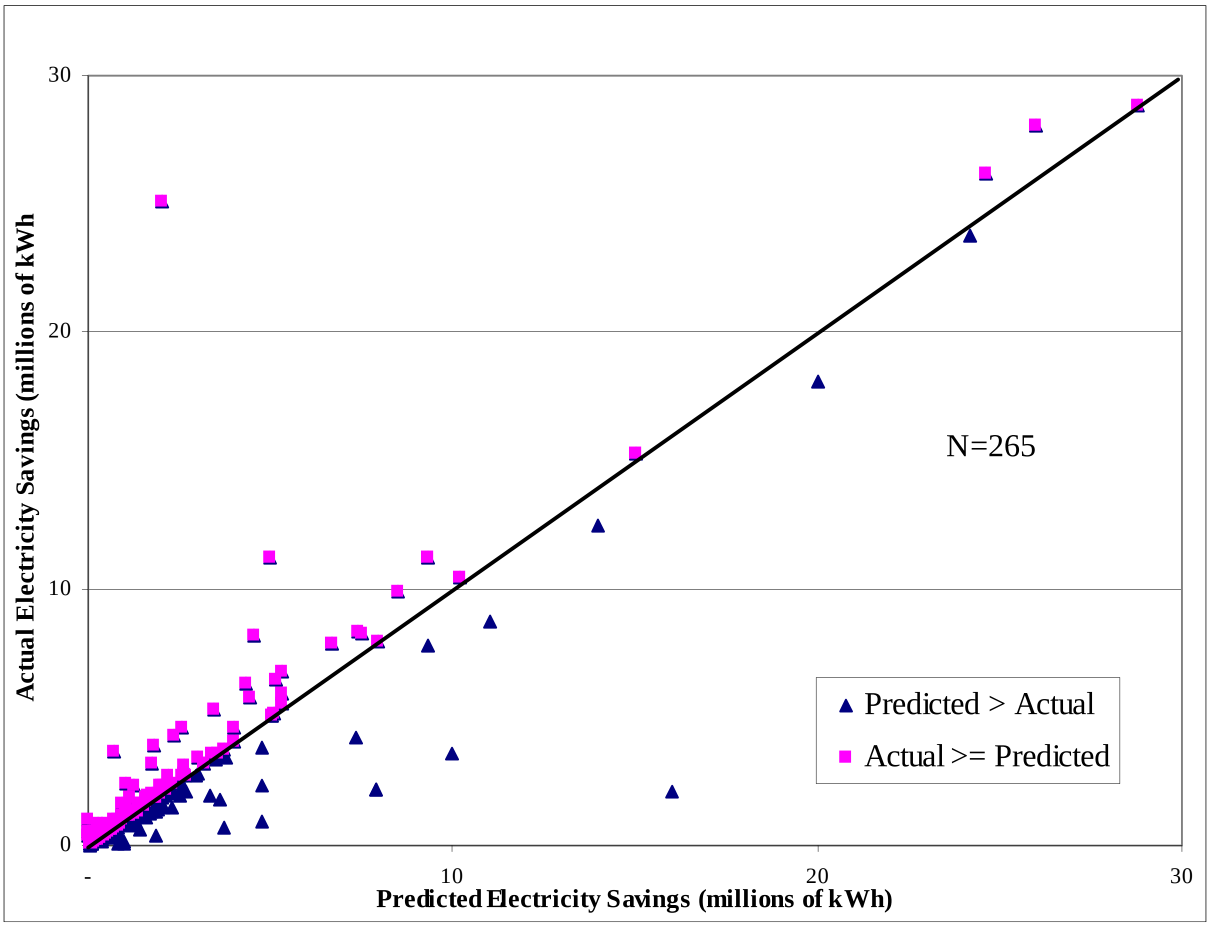

Figure 6. Actual vs. Predicted Electricity Savings

Conclusion and Future Directions

This is the initial report in an ongoing compilation of the actual performance of projects installed by ESCOs. Major findings from this initial report are:

- Market activity: 74% of the projects in this database are from public sector institutional markets, which supports the anecdotal evidence that ESCOs' historic emphasis has been primarily in the so-called MUSH markets (municipal government, university/college, schools, and hospitals). Since 1995, Federal market, K-12 schools, and state/local government projects account for an increasing share of activity compared to pre-1995 activity. Several U.S. regions are strongly represented in our database, particularly the Mid-Atlantic region, which we attribute to the significant marketing activities of several ESCOs that were very active in the New Jersey Standard Offer program.
- Types of Measures installed: Almost 60% of the projects in the database installed lighting plus other measures, which often included capital-intensive HVAC equipment replacements and controls (e.g., boiler & chiller replacements, cooling towers, energy management systems).
- Project costs: ESCOs typically develop projects in the $600,000 to 2 million cost range. Average project costs were significantly higher in K-12 schools, university/college, and Federal government projects ($2.6 – 2.8 million) compared to state/local government, health/hospital, or commercial office buildings ($ 0.7 –1.4 million). However, variation in project costs within a market segment is comparable to the differences between market segments.
- Role of Utility DSM Programs & Incentives: ESCOs reported that about 35% of the projects in the database participated in some type of utility DSM program, typically one that offered financial incentives. The relative impact of financial incentives on total project cost varied significantly by type of DSM program: rebates typically accounted for 10-30% of project costs, while expected payments for verified savings in Standard Offer programs typically ranged between 60 and >100% of project costs.
- Energy savings: On average, projects developed by ESCOs reduced electricity consumption by 26- 42% in the four market segments with at least 20 projects (K-12 schools, state/local government, health/hospital and university/colleges). Median savings vary by a factor of two across market segments, ranging from 17-18 Btu/ft^2 in state/local government, industrial, and leased commercial office to 9.6 Btu/ft$^{2\ in}$ health/hospital projects.
- Predicted vs. actual savings – ESCOs provided information on both actual and predicted savings for about 33% of the projects in the database. For these projects, actual savings exceeded predicted savings in about 51% of the projects.

In the future, we will focus on the following issues. First, this activity will have more value to policymakers and the energy services industry if we can more confidently claim that the project database is representative of the overall ESCO industry. In order to achieve that objective, we will explore various analytic and statistical methods and work to increase participation from ESCOs whose activity is under-represented. Second, we will continue to improve the quality and completeness of information provided on projects. Third, additional analysis is planned on such issues as project economics from the customer's perspective, analysis of industry trends in contracting arrangement (e.g., performance-based vs. fee-for-service, design/build), and sustainability in terms of reliance on public purpose program funding. Finally, we will explore issues related to the definition and market size of the energy services industry.

Acknowledgements

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