

Reported Energy and Cost Savings from the DOE ESPC Program: FY 2016



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Energy and Transportation Science Division

**REPORTED ENERGY AND COST SAVINGS
FROM THE DOE ESPC PROGRAM: FY 2016**

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May 2018

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EXECUTIVE SUMMARY

The objective of this work was to determine the realization rate of energy and cost savings from the U.S. Department of Energy's (DOE's) Energy Savings Performance Contract (ESPC) program based on information reported by the energy services companies (ESCOs) that are carrying out ESPC projects at federal sites. Information was extracted from 172 measurement and verification (M&V) reports to determine reported, estimated, and guaranteed cost savings and reported and estimated energy savings for the previous contract year.

For all 172 projects, there was sufficient information to compare estimated, reported, and guaranteed cost savings. For this group, the total estimated cost savings for the reporting periods addressed were \$298.4 million, total reported cost savings were \$296.1 million, and total guaranteed cost savings were \$274.4 million. This means that, on average,

- ESPC contractors guaranteed 92.0% of the estimated cost savings
- projects reported achieving 99.2% of the estimated cost savings
- projects reported achieving 107.9% of the guaranteed cost savings.

For all 172 of the projects examined, there was sufficient information to compare estimated and reported energy savings. Based on site energy, estimated savings for those projects for the previous year totaled 12.382 million MMBtu, and reported savings were 12.077 million MMBtu, 97.5% of the estimated energy savings. For 169 of the projects examined there was sufficient information to calculate source energy savings. Based on source energy, total estimated energy savings for the 169 projects were 20.799 million MMBtu, and reported savings were 20.322 million MMBtu, 97.7% of the estimated energy savings.

1. INTRODUCTION

Among the most widely used vehicles for implementing energy savings performance contract (ESPC) projects in the federal government are the ESPCs administered by the U.S. Department of Energy's (DOE's) Federal Energy Management Program (FEMP). DOE ESPCs are indefinite-delivery, indefinite-quantity (IDIQ) contracts designed to make ESPCs as practical and cost-effective a tool as possible for agencies to use. These "umbrella" contracts are competitively awarded to energy service companies (ESCOs) who have demonstrated their capabilities to provide energy projects to federal customers. The general terms and conditions are established in the IDIQ contracts, and agencies implement projects by awarding task orders to the DOE ESPC ESCOs. Using IDIQ contracts, agencies can implement ESPC projects in far less time than it takes to develop stand-alone ESPC projects. Since 1998, federal agencies have used DOE ESPCs to award task orders for 380 projects and install more than \$5.18 billion worth of energy improvements.

The objective of this report is to determine the realization rate of savings from the DOE ESPC program based on a review of the M&V reports produced by all DOE-FEMP ESPC projects that were in the performance period and had issued a report of September 30, 2016. Information was extracted from the reports to develop a database that includes estimated and reported energy savings by fuel type and estimated, reported, and guaranteed cost savings for each energy conservation measure (ECM) in each of the ongoing projects. The database was then used to determine fundamental information about the program, such as

- the ratio of reported to guaranteed cost savings
- the ratio of reported to estimated cost savings
- the ratio of reported to estimated energy savings.

2. DATA COLLECTION AND EXTRACTION

The first step in the data collection process was to determine exactly how many projects were in the performance period. As of September 30, 2016, DOE's list of awarded DOE ESPCs (maintained at <http://energy.gov/eere/femp/downloads/doe-idiq-energy-savings-performance-contract-awarded-projects>) contained 356 projects. The more recently awarded projects were either still in construction or still in the first year of the performance period, so that no M&V report had yet been produced. Some older projects had already completed the performance period or had been terminated for other reasons. We determined that there were 172 projects that had produced at least one M&V report during the year preceding September 30, 2016. These 172 projects formed the study population, and their most recent M&V reports provided the data sources for this report.

The periods covered by the annual reports have various start dates depending on when the project's performance period began; however, the average start date is February 24, 2015, and the average end date is February 15, 2016. The contract year of the reports ranges from year 1 to year 16. Table 1 presents the distribution of reporting years.

As the M&V reports were collected, information was extracted from them to populate a database that contains a separate record for each project, as well as the following information on each ECM for each project:

- The technology category of the ECM (these are specified in Attachment J-3 of the “Attachments to the IDIQ Contract,” linked at https://www.energy.gov/sites/prod/files/2017/04/f34/2017_generic_doe_idiq_espc_contract.pdf)
- The M&V method used (FEMP Option A, B, C, or D)
- Estimated energy savings by fuel type (electricity, natural gas, oil, steam, etc.)
- The units of the estimated energy savings (kilowatt-hours [kWh], therms, MMBtu, etc.)
- Reported energy savings by fuel type
- The units of the reported energy savings
- Estimated cost savings from (1) reduced energy and utility bills and (2) reduced operations and maintenance (O&M) and repair and replacement (R&R) costs
- Reported cost savings from (1) energy savings and (2) O&M and R&R savings.

Contract year	Number of reports
1	15
2	12
3	5
4	28
5	19
6	16
7	10
8	15
9	8
10	7
11	9
12	9
13	6
14	9
15	3
16	1

The database also includes the guaranteed cost savings for the reporting period. Typically, the guaranteed cost savings are not broken down by ECM; instead, the ESCO guarantees a dollar amount for the entire project for each contract year.

The quality of the 172 M&V reports examined varied widely, and many were lacking some of the information listed above. For example, some reports were missing the estimated cost savings. In these cases, it was sometimes possible to obtain the missing information from the task order (TO) schedules for the project (also called H schedules or DO schedules in older projects). These schedules provide a concise listing of the important technical and financial aspects of the project. They are part of the final proposal and the TO, and DOE collects them separately and maintains them in a central database.

In particular, schedule TO-1 lists estimated and guaranteed cost savings by contract year. If there have been no modifications to the contract, the estimated and guaranteed savings listed in the M&V report should correspond to the estimated and guaranteed savings listed in the TO schedules for that particular contract year.¹ To fill in missing information, we assumed that if the guaranteed savings listed in the annual report matched the guaranteed savings listed in the TO-1 schedule for the corresponding contract year, then the estimated savings for the year were as listed in schedule TO-1. Likewise, for reports that did not list guaranteed savings, we assumed that if the estimated cost savings listed in the M&V report matched the estimated cost savings listed in schedule TO-1 for the corresponding contract year, then the guaranteed cost savings for that year were the guaranteed cost savings listed in schedule TO-1.

Other reports were missing information on estimated energy savings. The estimated energy savings are a function of the ECMs installed and assumptions made about equipment efficiency, operating hours, weather, and other variables. The estimated energy savings are generally the same for each year of the contract. If no modifications are made to the contract, the estimates do not change. The estimated energy savings appear on schedule TO-4 for each ECM, and they are used, along with the utility rates and escalation rates specified in the contract, to develop the estimated cost savings for each year of the

¹ TO schedules list costs and savings by contract year, and M&V reports usually include the contract year in their title, for example, *Fox Army Health Center: Year 3 Measurement and Verification Report, October 1, 2015–September 30, 2016*.

contract that are listed in schedule TO-1. In the case of missing information on estimated energy savings, it was assumed that if the estimated cost savings listed in the M&V report matched the estimated cost savings listed in schedule TO-1 for the corresponding contract year, then the estimated energy savings were as listed in schedule TO-4.

3. COST SAVINGS

Although the primary objective of an ESPC project is to reduce energy use, the most important issue contractually is cost savings, which the ESCO guarantees on an annual basis. Energy use reductions are usually the largest source of the cost savings, but savings can also come from reduced demand, improved power factor (which sometimes results in lower utility rates), and reduced water use. Reduced O&M and R&R costs are another major source of savings in ESPC projects.

3.1 REPORTED VS. GUARANTEED COST SAVINGS

Altogether, it was possible to determine reported and guaranteed cost savings for each of the 172 reports received. The total annual guaranteed cost savings for the 172 projects for the periods covered were \$274,368,628, and the total reported cost savings were \$296,057,005. In the aggregate, reported cost savings were 107.9% of the guaranteed cost savings.

In 5 of the 172 projects, the reported annual cost savings were equal to the guaranteed cost savings. In these projects, M&V Option A was used for all of the savings. In the remaining 167 projects, the total reported cost savings were 108.0% of guaranteed cost savings, and 151 of these 167 projects reported cost savings exceeding the guaranteed cost savings by an average of 10%.

Table 2 shows the percentage of reported cost savings across all projects in the data set subject to each M&V option.

Table 2. Percentage of Reported Cost Savings Verified by M&V Options A, B, C, and D for 156 Ongoing DOE ESPC Projects

M&V Option	Percentage of reported cost savings
A	58%
B	29%
C	5%
D	8%

Cost savings shortfalls were reported in 14 of the 167 projects that did not appear to use Option A for all ECMs. The shortfalls range from less than 1% to 80% of the annual guaranteed savings, with the median being 7% of the annual guaranteed cost savings. In twelve of the fourteen cases, the shortfall was resolved through a reduced payment to the ESCO. In the remaining two cases, the M&V reports indicate that the shortfall was the agency's responsibility and/or was due to actions on the part of the agencies and was not the ESCO's responsibility. Agency sites experiencing shortfalls are contacted bi-annually by Oak Ridge National Laboratory to review progress in resolution of outstanding project issues as part DOE-FEMP's ongoing technical support services within the ESPC program.

It is notable that for the group of 172 projects, 68.2% of the reported annual cost savings were due to reduced utility costs, and 31.8% were due to O&M or R&R savings.

Figures 1 and 2 illustrate the graphic logic used in Figures 3, 5, 6, and 7 to show estimated, guaranteed, and reported cost and energy savings, including savings shortfalls and savings exceeding the guarantee.

Figure 1 depicts a project with annual guaranteed cost savings of \$50,000, represented on the left side of the graphic. The right side of the graphic illustrates the results of the annual M&V report, which showed

savings of only \$40,000 and a savings shortfall of \$10,000. On the right side of Figure 1, the bar is shifted downward so that a portion of it falls below the horizontal axis to represent the magnitude of the shortfall (in red). The bar remaining above the horizontal axis represents the reported savings, shown in yellow. The total height of the bar, red plus yellow, represents the guaranteed savings of \$50,000.

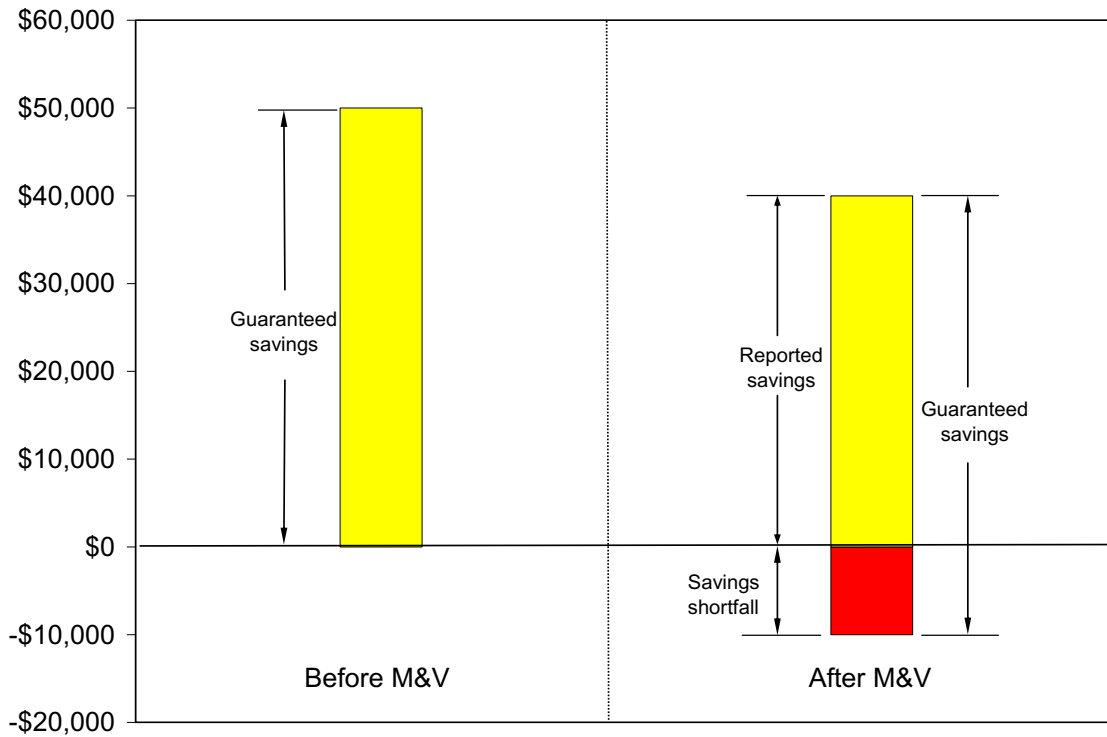


Figure 1. Guaranteed and reported savings for a project with a savings shortfall

Figure 2 illustrates how Figures 3, 5, 6, and 7 show reported savings exceeding guaranteed or estimated savings. Here, annual guaranteed savings are again \$50,000, but the M&V report shows a savings greater than \$50,000, and the bar from the left side of the figure moves upward on the right side by the amount of the surplus, which is shown in blue. The height of the yellow bar, which represents the guaranteed savings, does not change. The combined height of the yellow and blue bars represents the reported savings.

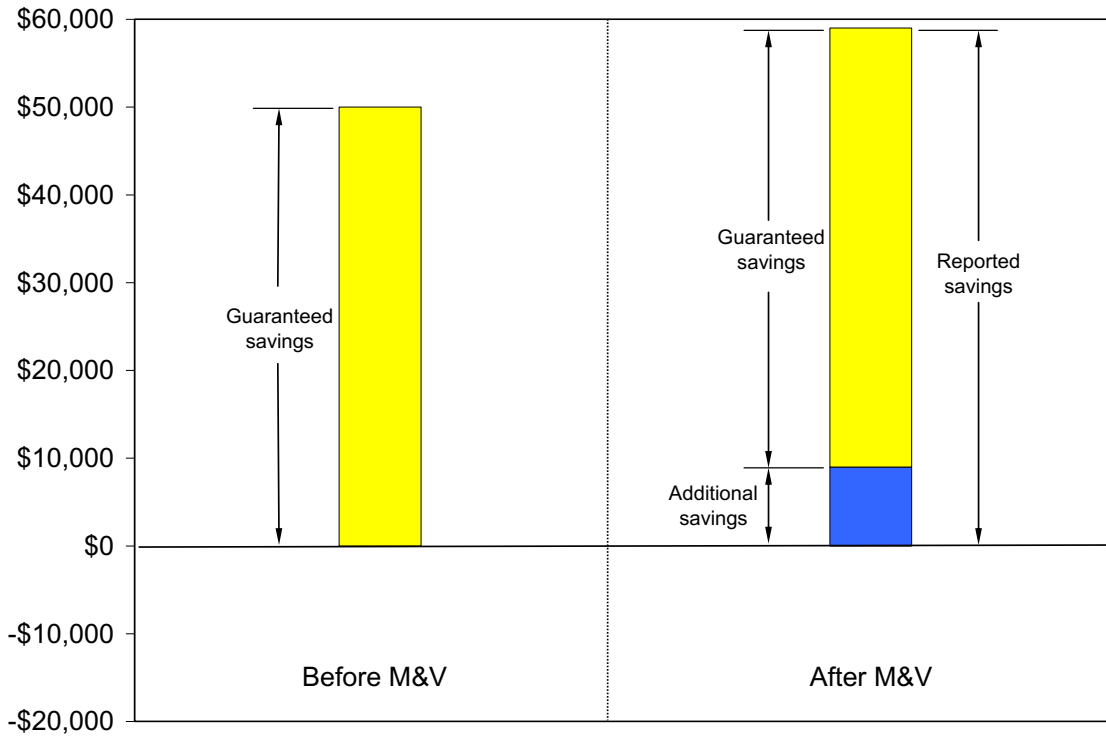


Figure 2. Guaranteed and reported savings for a project in which cost savings exceeds the guarantee

Using the scheme illustrated in Figures 1 and 2, Figure 3 presents the annual cost savings—along with shortfalls and reported savings exceeding the guarantee—as reported in the most recent M&V reports for the 172 DOE ESPC projects analyzed. The projects are arranged in descending order of reported annual cost savings.

One fact immediately evident from Figure 3 is the large range of cost savings delivered by the projects: the largest is reporting more than 900 times the cost savings of the smallest. This means that program averages can be dominated by the performance of a small number of large projects, but it turns out not to be an overwhelming influence. When removing the 10 projects with the largest reported total cost savings from the data, the ratio of reported to guaranteed savings falls from 107.9% to 106.1%.

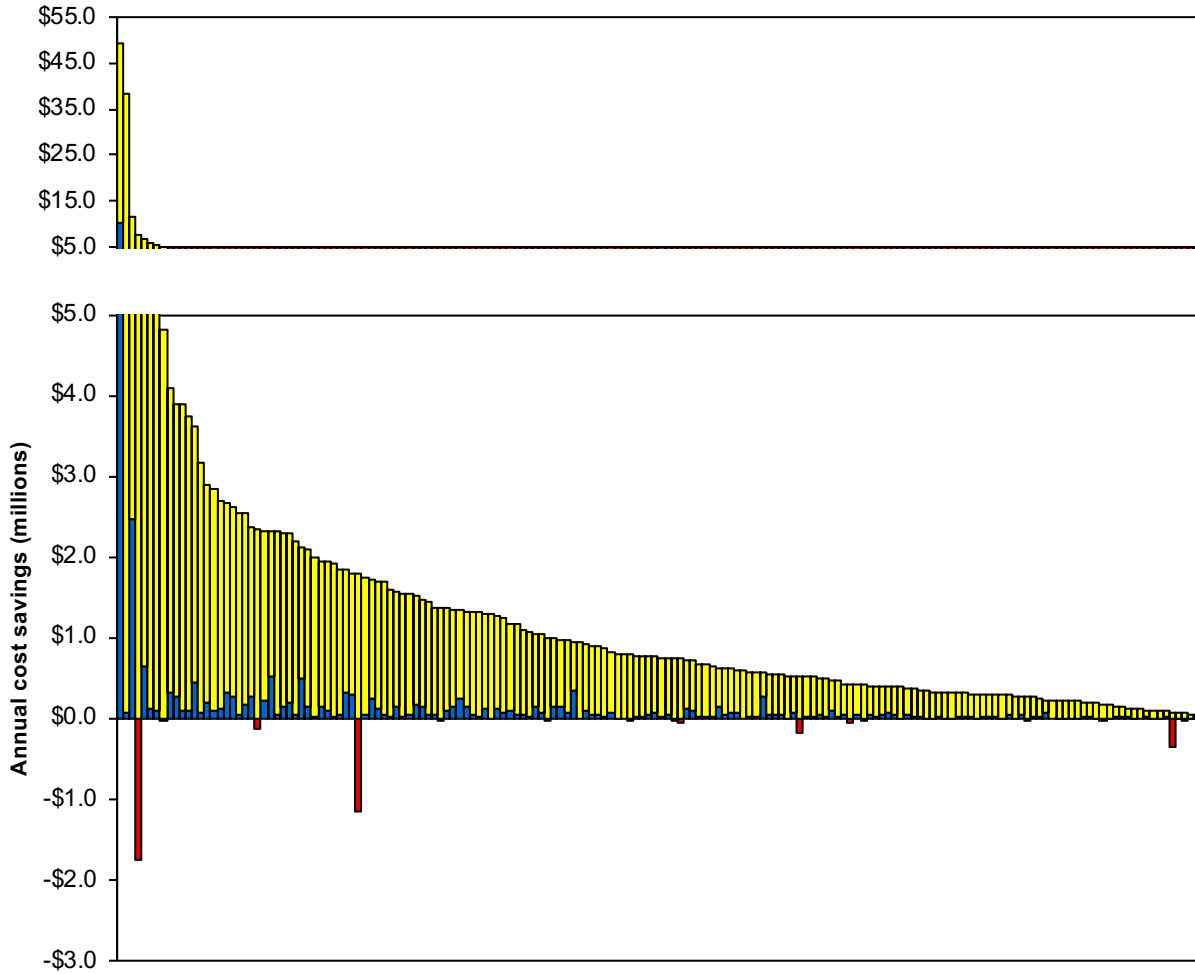


Figure 3. Annual cost savings from 172 ongoing DOE ESPC projects. Cost savings exceeding the guarantee are shown in blue; cost savings shortfalls are shown in red. Where no shortfall occurs, the yellow bar is the amount of the guarantee. Where a shortfall occurs, the amount of the guarantee is the sum of the heights of the yellow and red bars.

Figure 4 presents the same information as Figure 3 but in a different way. In Figure 4, the bars represent the percentage of annual guaranteed cost savings reported in the annual M&V reports. The bars are ordered from highest to lowest percentage of annual guaranteed cost savings. The message is the same, however: The majority of projects report cost savings greater than the guaranteed savings, and only a few projects had cost savings shortfalls.

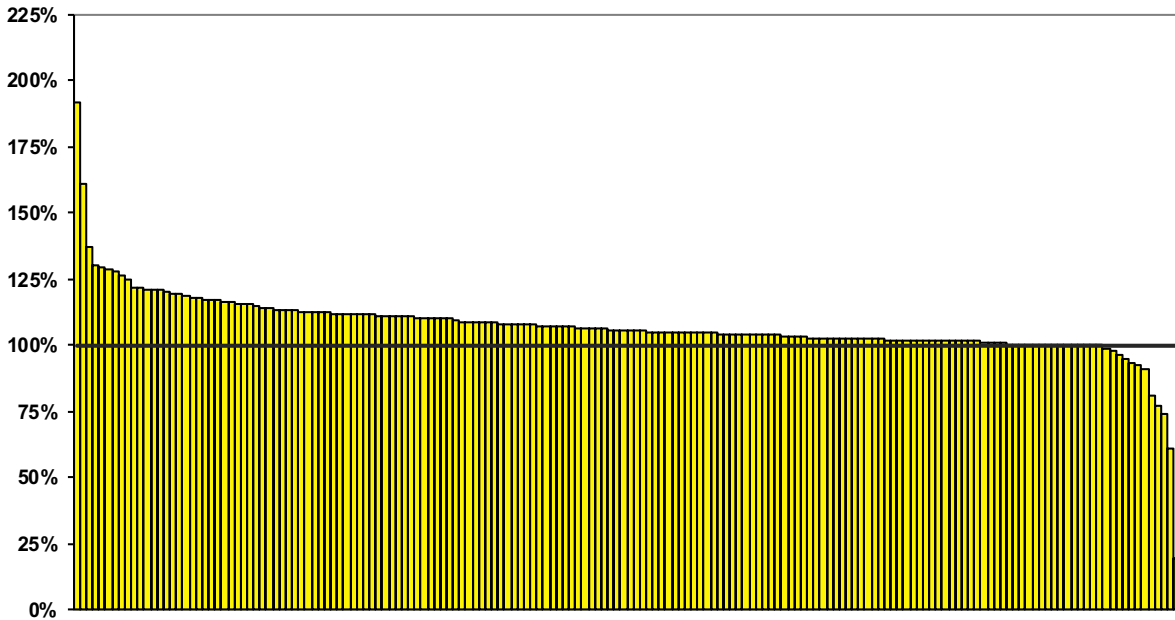


Figure 4. Percentage of guaranteed annual cost savings reported in 172 ongoing DOE ESPC projects

3.2 REPORTED VS. ESTIMATED COST SAVINGS

ESCOs use engineering models to estimate project energy savings, and then use contract utility rates and escalation rates to estimate cost savings for each year of the contract. The annual estimated (or “proposed”) cost savings are included in each project task order on schedule TO-1 and should be included in the M&V reports. As noted earlier in Section 3, if estimated cost savings were not provided in the M&V report, it was possible to extract the information from schedule TO-1. In all, we were able to determine estimated and reported cost savings for the same group of 172 projects identified previously.

For these 172 projects, the total estimated and reported cost savings for the periods reported on were \$298,376,383 and \$296,057,006, respectively. Thus, in the aggregate, reported cost savings were 99.2% of the estimated cost savings. As stated previously, the total guaranteed cost savings for the 172 projects were \$274,368,628. Dividing the guaranteed savings by the estimated savings shows that ESCOs guaranteed an average of about 92.0% of the savings estimated for the reporting period.

Figure 5 shows the amount by which the reported cost savings exceeded or fell short of the estimated savings, in a manner analogous to Figure 3. The projects are arranged in descending order of reported savings.

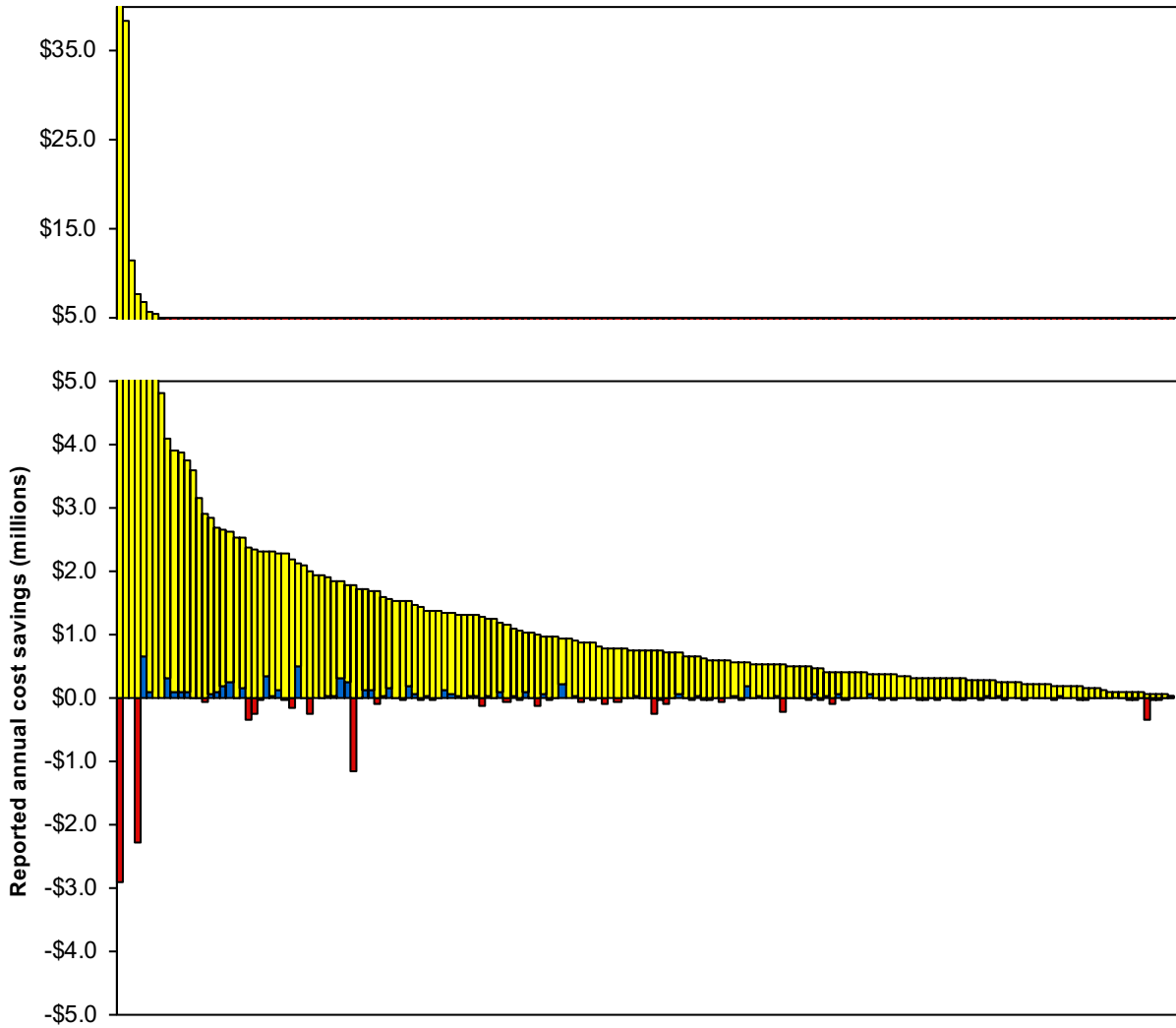


Figure 5. Reported and estimated annual cost savings from 172 DOE ESPC projects. Reported cost savings above the estimated amount are shown in blue, and reported savings below the estimated amount are shown in red. Where reported cost savings equal or exceed the estimated savings, the height of the yellow bar is equal to the estimated savings. Where reported cost savings are less than the estimated amount, the estimated savings are equal to the height of the yellow and red bars combined.

4. ENERGY SAVINGS

Annual M&V reports track energy savings as well as cost savings, since one of the primary motivations for implementing DOE ESPC projects is to meet energy use reduction goals. Energy savings are not guaranteed, but the ESCO estimates the energy savings that will occur in each reporting period, uses those savings to estimate cost savings, and guarantees some percentage of that amount. The annual M&V report should present the energy savings realized during the period, as determined by the methods described in the M&V plan.

Some of the M&V reports examined were missing information on energy savings. As with cost savings, in some cases it was possible to determine the estimated energy savings from the TO schedules. Where the estimated energy savings were missing, if the guaranteed cost savings in the M&V report was equal to the guaranteed savings listed on schedule TO-1 for the corresponding contract year, it was assumed that the estimated energy savings were as listed in schedule TO-4. Furthermore, it was sometimes possible to determine reported energy savings when this information was missing—if the reported cost savings were equal to the estimated cost savings listed in schedule TO-1, then it was assumed that the reported energy savings for the period were equal to the estimated cost savings listed in schedule TO-4.

4.1 SITE VS. SOURCE ENERGY SAVINGS

It is customary in the federal government to report energy savings on a site basis, counting electricity savings at 3,412 Btu/kWh and adding in other fuel savings in Btu. This is problematic for ECMs—such as combined heat and power plants—that offset the purchase of grid electricity through using fuel onsite (usually natural gas) because these plants typically increase site energy use, though they reduce overall energy use and cost. DOE’s guidance on Section 502(e) of Executive Order 13123 was followed in these cases. The guidance allows a federal agency to adjust the verified site energy use by 8,438 Btu for each kWh of avoided electricity use to account for the reduction in source energy use.

We determined the reported and estimated energy savings for the reporting period for 168 of the 172 annual reports. On a site energy basis and adjusted per DOE guidance on Section 502(e) of Executive Order 13123, the estimated energy savings for the 168 projects were 13,159,217 MMBtu, and reported energy savings were 12,518,758 MMBtu, or 95.1% of the estimated savings. This is relatively close to the ratio of reported to estimated cost savings for these projects, which is 99.2%.

Since the total project investment for the 168 projects for the reporting year was \$1,963,374,479, the reported savings represent 6,151 Btu/year for each dollar invested.

Of the 168 projects, 56 reported annual energy savings less than the amount estimated for the period. For these projects, the reported energy savings average about 89% of the estimated energy savings.

Ninety-two of the 168 projects reported annual energy savings greater than the amount estimated for the period. On average, these projects reported 109% of the estimated energy savings.

Figure 6 presents reported site energy savings, along with energy savings greater than or less than estimated energy savings.

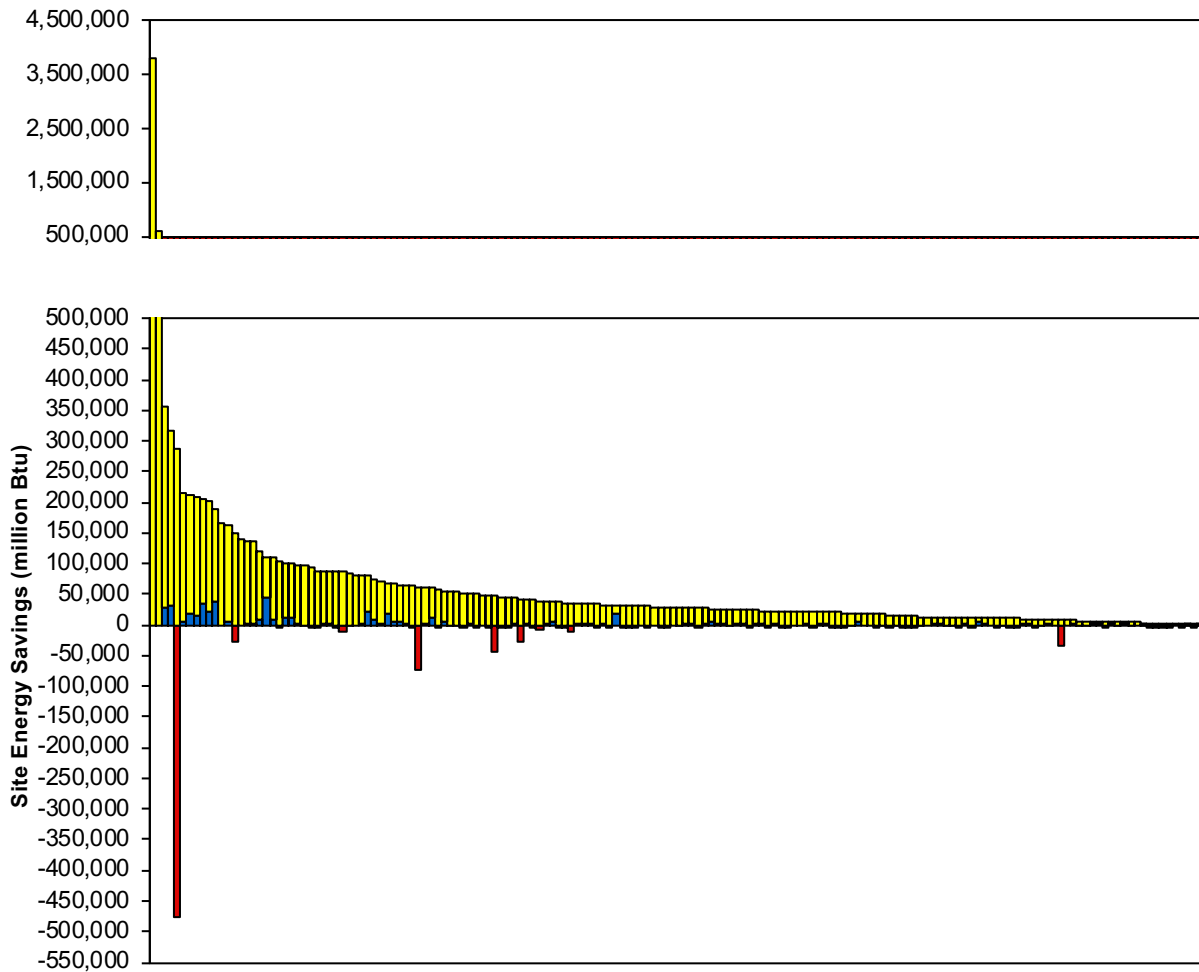


Figure 6. Annual site energy savings from 168 ongoing DOE ESPC projects. Reported energy savings greater than the estimated savings are shown in blue, and reported energy savings less than the estimated savings are shown in red. Where no shortfall occurs, the yellow bar is the amount of the estimated energy savings. Where a shortfall occurs, the amount of the estimated energy savings is the sum of the heights of the yellow and red bars.

Table 3 presents the net annual reported and estimated energy savings from the 168 projects by fuel type. “Net” savings means that no corrections were made for projects that increased site energy use while reducing source energy use. These numbers are of interest because they present the direct reductions in utility usage at the project sites. Note that the ratio of reported to estimated savings varies by fuel type. In the aggregate, the projects report 80% of the estimated natural gas savings, but 104% of the estimated electricity savings.

Table 3. Aggregate Net Annual Reported and Estimated Energy Savings by Fuel Type for 168 DOE ESPC Projects

	Reported		Estimated		Ratio of reported to estimated
	Savings (MMBtu)	Percentage of total	Savings (MMBtu)	Percentage of total	
Coal	3,978,008	33.3%	3,978,008	33.0%	1.00
Electricity	3,095,003	25.9%	2,965,765	27.6%	1.04
Natural Gas	1,918,205	16.0%	2,385,167	19.8%	0.80
Steam	1,098,210	9.2%	980,207	8.1%	1.12
Fuel Oil	582,587	4.9%	596,612	4.9%	0.98
Chilled Water	221,939	1.9%	219,056	1.8%	1.01
Other	1,059,386	8.9%	933,051	7.7%	1.14
Total	11,953,337		12,057,866		0.99

Energy use can also be reported based on source energy, which accounts for all the energy used at the power plant to produce the electricity delivered to the site. In general, source energy provides a better measure of the environmental impacts of energy efficiency and renewable energy measures than does site energy use. Given the data in Table 3 and an average 28.8% electric conversion efficiency (as specified in DOE’s guidance on Section 502(e) of Executive Order 13123), the estimated and reported source energy savings resulting from the 168 projects are 20,731,794 and 20,322,549 MMBtu, respectively. Thus, on a source energy basis, reported energy savings are essentially equal to the estimated energy savings—at 98.0%.

Figure 7 presents the source energy savings for each project, along with any additional savings above or shortfalls below the estimated source energy savings.

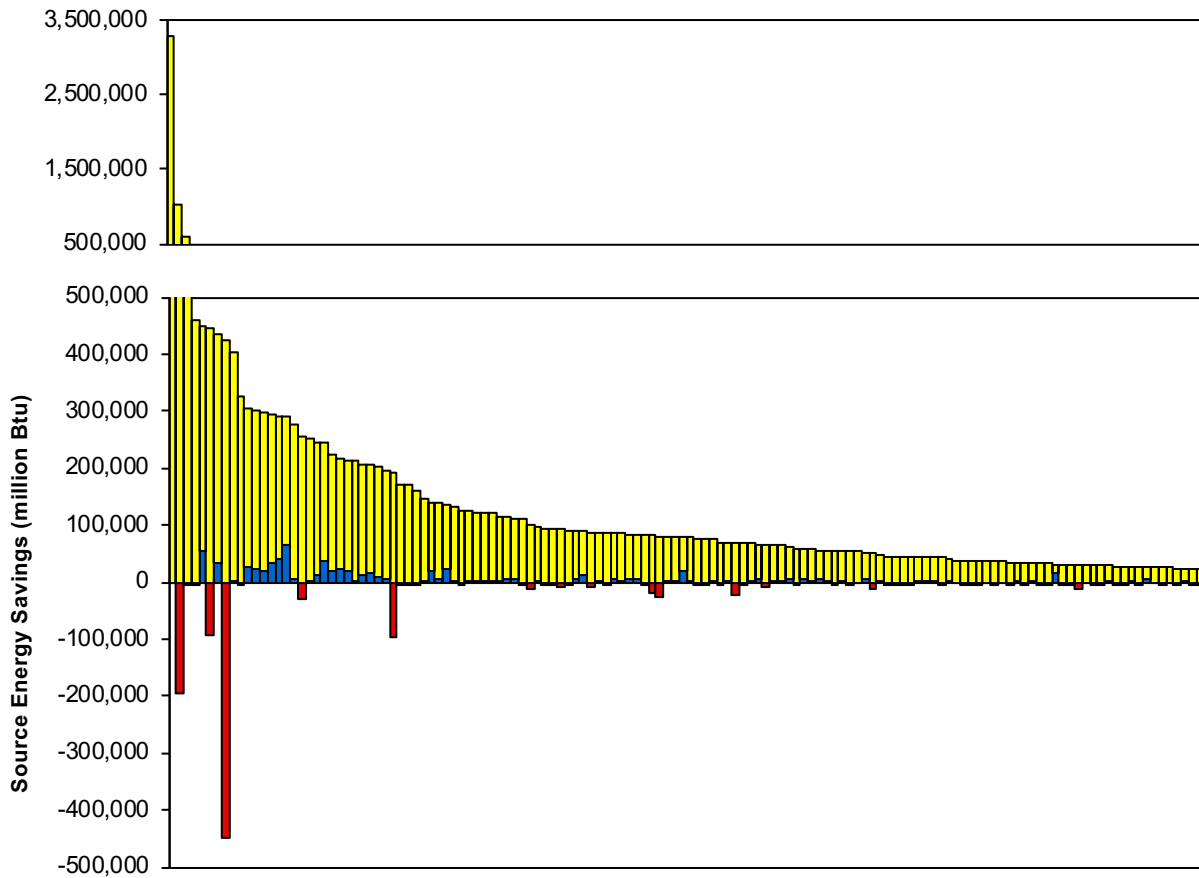


Figure 7. Annual source energy savings from 168 ongoing DOE ESPC projects. Reported energy savings greater than the estimated savings are shown in blue, and reported energy savings less than the estimated savings are shown in red. Where no shortfall occurs, the yellow bar is the amount of the estimated savings. Where a shortfall occurs, the amount of the estimated savings is the sum of the heights of the yellow and red bars.

5. ENERGY AND COST SAVINGS BY ECM

Table 4 presents information on the source of energy and cost savings by ECM technology category. The table shows, for example, that 35.0% of program-wide site energy savings and 25.1% of program-wide source energy savings are derived from ECMs involving distributed generation. These distributed generation ECMs are responsible for 15.7% of program-wide reported cost savings.

Table 4. Percent of Program-Wide Reported Site Energy Savings, Reported Source Energy Savings, and Reported Cost Savings Delivered by Each Technology Category

Technology	Site energy savings	Source energy savings	Reported cost savings
Distributed generation	35.0%	25.1%	15.7%
Heating, ventilation, and air conditioning	14.1%	14.0%	15.8%
Building automation/controls	13.7%	16.2%	13.3%
Chilled water, hot water, and steam			
Distribution systems	10.7%	7.6%	7.9%
Lighting	8.1%	17.9%	13.5%
Boiler plant improvements	6.9%	6.8%	16.0%
Water and Sewer Conservation Systems	3.5%	2.3%	6.6%
Chiller plant improvements	2.6%	4.1%	4.8%
Ground source heat pump	1.7%	1.4%	2.0%
Renewable energy systems	0.9%	1.0%	1.2%
Commissioning	0.7%	0.8%	0.7%
Advanced metering systems	0.7%	0.8%	0.9%
Motors and drives	0.4%	0.8%	0.4%
Building envelope modifications	0.3%	0.4%	0.3%
Rate adjustments	0.3%	0.2%	0.1%
Process improvements	0.2%	0.3%	0.6%
Energy/Utility Distribution Systems	0.1%	0.2%	0.2%
Refrigeration	0.1%	0.1%	0.1%
Load Shifting	0.0%	0.0%	0.0%
Appliance/plug-load reductions	0.0%	0.0%	0.0%

6. CONCLUSIONS

In federal ESPC projects, ESCOs use engineering formulas and other techniques to estimate the energy savings that will result from the conservation measures installed. Contract energy prices are then used to estimate the cost savings that will result from the estimated energy savings in each year of the contract. Other cost savings, including those that result from O&M or R&R savings, are added in to determine the total estimated annual cost savings. ESCOs then guarantee a percentage of the estimated cost savings. In the M&V report, the ESCO reports both the energy savings and the cost savings that occurred during the reporting period.

Based on an analysis of the most recent year's M&V reports from all ongoing projects that have completed at least 1 year of performance, aggregate reported savings in the DOE ESPC program are about 108% of aggregate guaranteed cost savings. Aggregate reported savings are about 99% of the estimated savings. This means that ESCOs are guaranteeing about 92% of the estimated annual cost savings.

Energy savings can be calculated in terms of site energy use and source energy use. Based on site energy use, the projects analyzed reported 95.1% of estimated energy savings. Based on source energy use, the projects analyzed reported 98.0% of estimated energy savings.

While we did not attempt to verify the energy or cost savings in any way, these results do serve as a first-level measure of the overall performance of the DOE ESPC program. Based on the information reported, the projects appear to be meeting their objectives in terms of energy and cost savings.

APPENDIX A. Section 502(e) Guidance Providing Credit Toward Energy Efficiency Goals for Cost-Effective Projects Where Source Energy Used Declines But Site Energy Use Increases