OAK RIDGE
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REPORTED ENERGY AND COST SAVINGS FROM THE DOE ESPC PROGRAM

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EXECUTIVE SUMMARY

The objective of this work was to determine the realization rate of energy and cost savings from the Department of Energy'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 128 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. Because the quality of the reports varied, it was not possible to determine all of these parameters for each project.

For 127 projects, there was sufficient information to compare guaranteed cost savings for the reporting periods covered. The total guaranteed cost savings was $82.4 million, and the total reported cost savings was $86.5 million. Thus, in the aggregate, the projects reported 105% of their guaranteed cost savings.

For 125 of the 128 projects, there was sufficient information to compare estimated, reported, and guaranteed savings. For this group, the total estimated cost savings for the reporting periods addressed was $84.2 million, total reported cost savings was $85.6 million, and total guaranteed cost savings was $79.7 million. This means that on average, the ESPC contractors guarantee about 98% of the estimated cost savings. Projects reported achieving about 102% of the estimated cost savings.

For 124 of the projects examined, there was sufficient information to compare estimated and reported energy savings. On the basis of site energy, those projects reported savings of 5.103 million MMBtu during the previous year, whereas estimated savings totalled 5.026 million MMBtu. Thus, in terms of site energy, these 124 projects reported 101.5% of the estimated energy savings. On the basis of source energy, the projects reported saving 10.190 million MMBtu, compared to estimated energy savings of 10.018 million MMBtu. On the basis of source energy, the projects reported saving 101.7% of the estimated energy savings.

1. INTRODUCTION

Among the most widely used vehicles to implement 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 services 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 261 projects and install more than $2.1 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 ESPC projects that were in the performance period as of July 31, 2010. 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, and
- 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 July 31, 2010, DOE's list of awarded DOE ESPCs (maintained at http://www1.eere.energy.gov/femp/pdfs/do_awardedcontracts.pdf) contained 261 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 128 projects that had produced at least one M&V report during the year preceding July 31, 2010. These 128 projects formed the study population, and their most recent M&V reports provided the data source for the evaluation.

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 9/17/2008 and the average end date is 9/14/2009. The contract year of the reports ranges from year 1 to year 10. Table 1 presents the distribution of reporting years.

Table 1. Contract years of the M&V reports received

Contract year	Number of reports
1	7
2	17
3	9
4	7
5	23
6	13
7	20
8	17
9	10
10	5

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

- The technology category of the ECM (these are specified in Attachment J-3 of the "Attachments to the IDIQ Contract," linked at http://www1.eere.energy.gov/femp/pdfs/generic_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 (kWh, therms, MMBtu, etc.)
- Reported energy savings by fuel type
- The units of the reported energy savings
- Estimated cost savings, divided into savings from reduced energy and utility bills, and savings from reduced operations and maintenance (O&M) and repair and replacement (R&R) costs
- Reported cost savings, divided into energy savings and O&M/R&R savings

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 128 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 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 task order, 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, it was 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, 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 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 estimates 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 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.

Many of the projects were found to have been modified in some way since award. In fact, in about a third of the 128 projects examined, the annual guaranteed cost savings listed in the M&V report were different from the guaranteed savings listed in the TO-1 schedule for the corresponding contract year. In these cases, the figure presented in the M&V report was assumed to be correct, but it would have been preferable to have a contract document to verify the information in the M&V report. Some M&V reports included copies of the applicable TO schedules as an appendix. Having copies of the TO schedules that apply to each M&V report would make the results for the evaluation more robust by allowing more of the missing information to be filled in.

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.

[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, October1, 2003 – September 30, 2004.*

3.1 Reported vs. Guaranteed Cost Savings

Altogether it was possible to determine reported and guaranteed cost savings for 127 of the 128 reports received. The total annual guaranteed cost savings for the 127 projects for the periods covered was $82,364,495, and the total reported cost savings was $86,521,016. In the aggregate, reported cost savings were 105% of the guaranteed cost savings.

In 12 of the 127 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. With these projects excluded, the total reported cost savings in the other 115 projects was 106% of guaranteed cost savings, and 106 of these 115 projects reported cost savings greater than the guaranteed cost savings. The average amount of the additional cost savings was 10% of the guaranteed cost savings.

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

Table 2. Percentage of guaranteed cost savings verified by M&V options A, B, C, and D for 128 ongoing DOE ESPC projects.

M&V Option	Percentage of guaranteed cost savings
A	80%
B	13%
C	2%
D	5%

Cost savings shortfalls were reported in 9 of the 115 projects that did not appear to use Option A for all ECMs. The shortfalls range from 3% to 75% of the annual guaranteed savings, with the average being 21% of the annual guaranteed cost savings. In seven of the nine cases, the shortfall was resolved through a reduced payment to the ESCO. In the remaining two cases, the M&V reports claim that the shortfall was due to an action on the part of the agency and was not the ESCO's responsibility.

It is notable that for the group of 127 projects, 80.2% of the reported annual cost savings were due to reduced utility costs, and 19.8% were due to O&M or R&R savings, all of which were stipulated.

For the most part, the amounts by which reported cost savings exceeded or fell short of the guarantees were small in relation to the guarantee.

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 Fig. 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 2 illustrates how the 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.

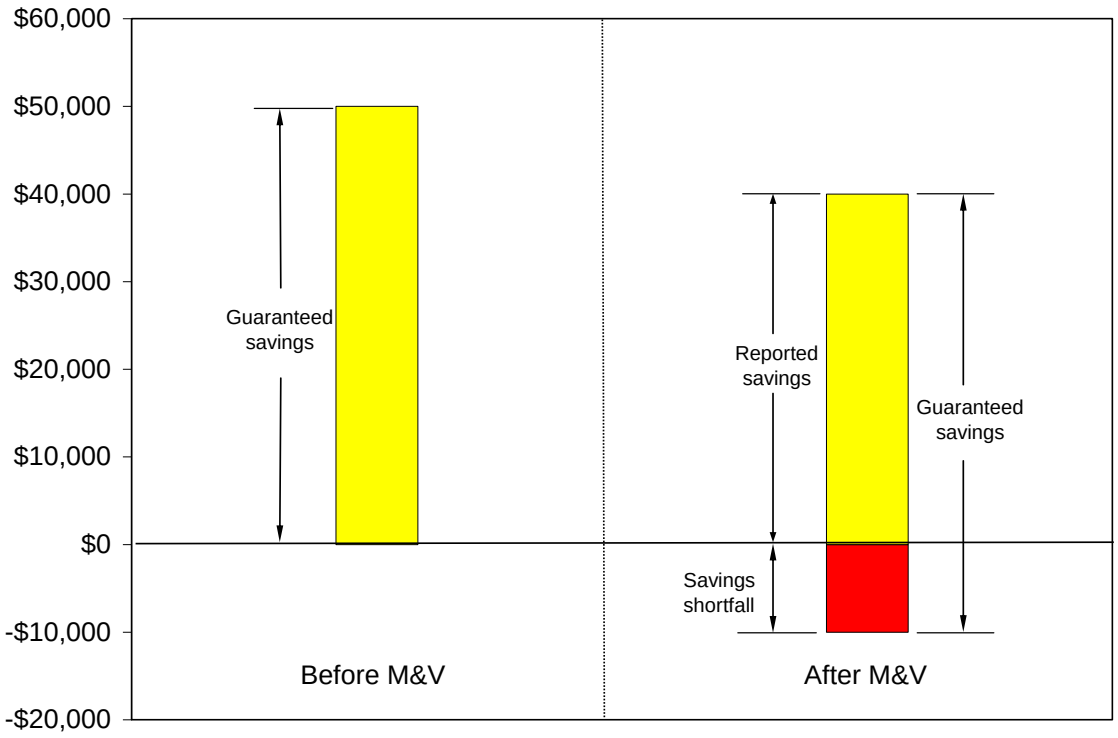

Fig. 1. Guaranteed and reported savings for a project with a savings shortfall.

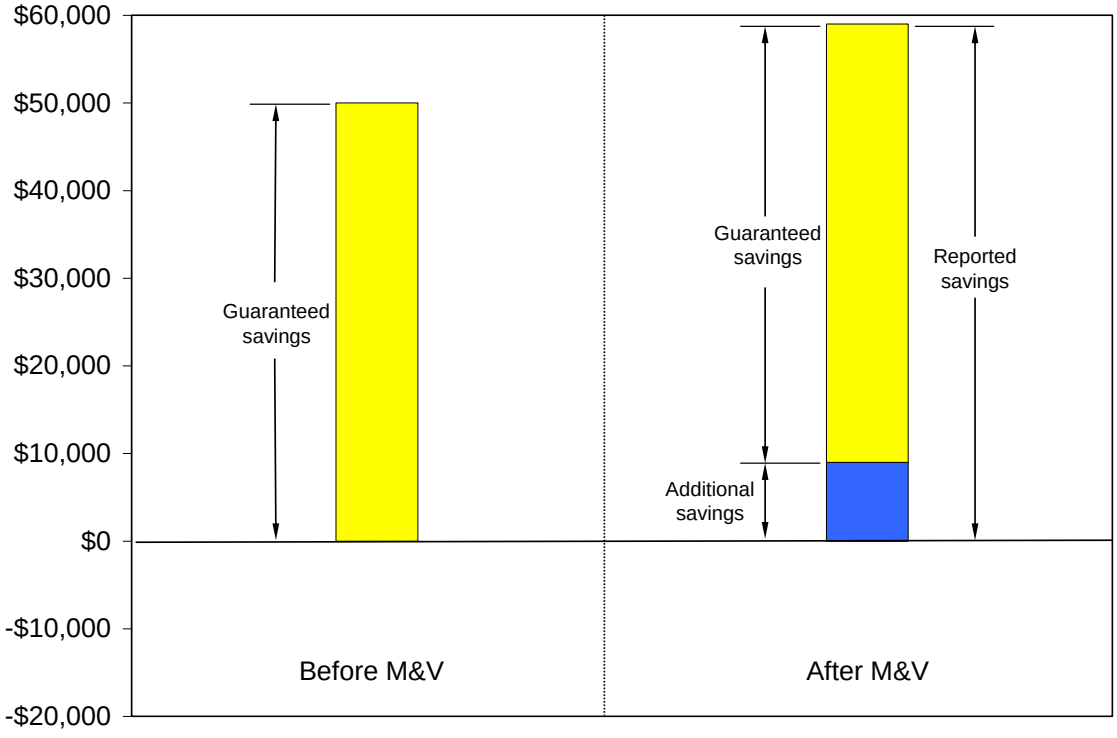

Fig. 2. Guaranteed and reported savings for a project in which cost savings exceeds the guarantee.

Using the scheme illustrated in figures 1 and 2, Fig. 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 127 DOE ESPC projects analyzed. The projects are arranged in descending order of reported annual cost savings.

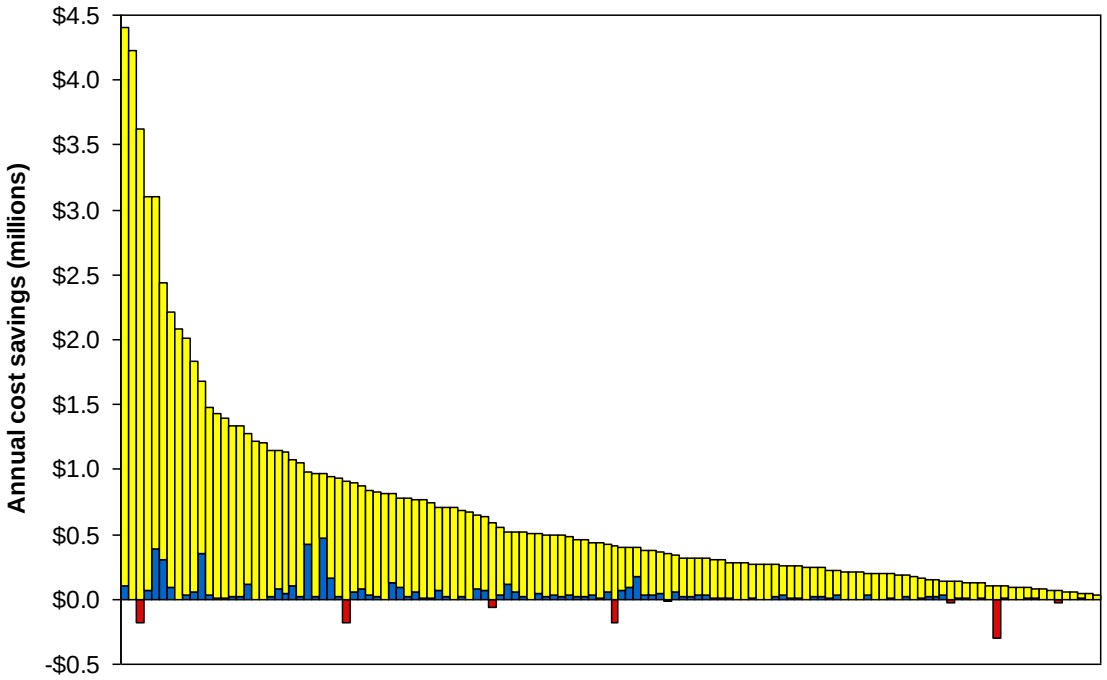

Fig. 3. Annual cost savings from 127 ongoing DOE ESPC projects. Cost savings exceeding the guarantee are shown in blue, cost savings shortfalls are shown in red. Where no shortfall occurs, the yellow bar is the amount of the guarantee. Where a shortfall occurs, the amount of the guarantee is the sum of the heights of the yellow and red bars.

One fact immediately evident from Fig. 4 is the large range in the amount of cost savings delivered by the projects: the largest is reporting more than 100 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. In fact, one of the largest projects is seen to be reporting 177% of its guaranteed cost savings. This large savings does affect the program-wide average, but not overwhelmingly. When this project is removed from the data, the ratio of reported to guaranteed savings falls from 105% to 104%.

Figure 4 presents the same information as Fig. 3 but in a different way: Here 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.

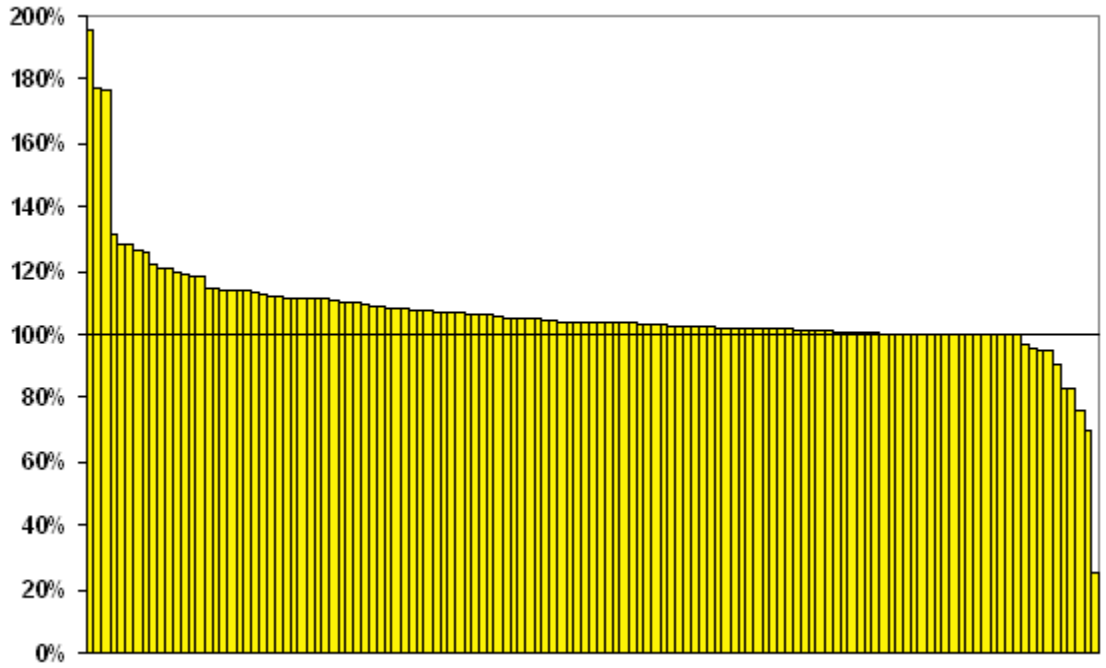

Fig. 4. Percentage of guaranteed annual cost savings reported in 127 ongoing DOE ESPC projects.

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 in Sect. 3, if estimated cost savings were not provided in the M&V report, it was possible to extract the information from schedule TO-1, *but only if the contract had not been modified since award*, because only the award TO schedules were available for all projects. In all, it was possible to determine estimated and reported cost savings for 125 of the 128 projects.

For these 125 projects, the total estimated and reported cost savings for the periods reported on were $84,187,727 and $85,554,639, respectively. Thus in the aggregate, reported cost savings were 102% of the estimated cost savings.

The total guaranteed cost savings for the 125 projects were $81,417,995. Note that the $85,554,639 in reported savings for this group represents 105% of the guaranteed savings, the same figure obtained for all128 projects.

Dividing the guaranteed savings by the estimated savings shows that ESCOs guaranteed an average of about 98% 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 Fig. 3. The projects are arranged in

descending order of reported savings. It is seen that aside from one outlier, the amounts by which reported cost savings exceed or fall short of the estimated savings are small in relation to the estimated savings.

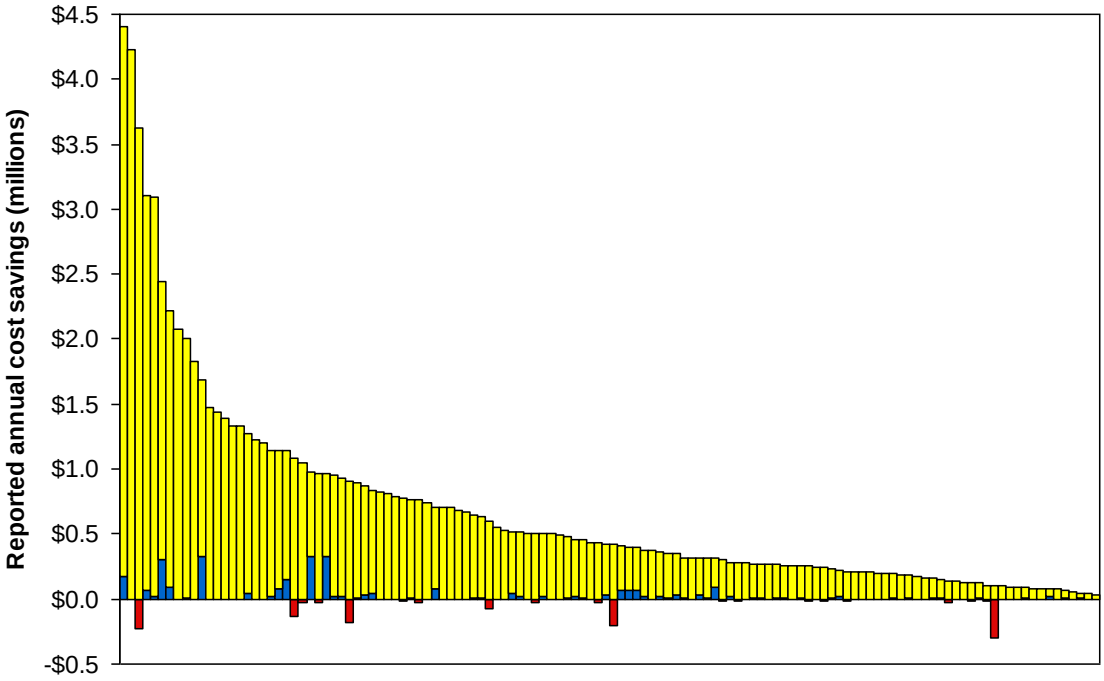

Fig. 5. Reported and estimated annual cost savings from 125 DOE ESPC projects. Reported cost savings above the estimated amount are shown in blue, and reported savings below the estimated amount are shown in red. Where reported cost savings equals or exceeds the estimated savings, the height of the yellow bar is equal to the estimated savings. Where reported cost savings is less than the estimated amount, the estimated savings is 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 (typically 90 to 98%) 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 this information was 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 was 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 was equal to the estimated cost savings listed in schedule TO-1, then it was assumed that the reported energy savings for the period was 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 per 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 on site (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 credits the 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 124 of the 128 annual reports. On a site energy basis, the estimated energy savings for the 124 projects was 5,025,990 MMBtu, and reported energy savings was 5,102,662 MMBtu, or 101.5% of the estimated savings. This is very close to the ratio of reported to estimated cost savings for these projects, which is 102%.

Since the total project investment for the 124 projects for the reporting year was $708,196,470, the reported savings represents 7,205 Btu/year for each dollar invested.

Of the 124 projects, 40 reported annual energy savings less than the amount estimated for the period. For these projects, the reported energy savings averages about 90% of the estimated energy savings.

Fifty-three of the 124 projects reported annual energy savings greater than the amount estimated for the period. On average these projects reported 116% of the estimated energy savings.

As with cost savings, in most cases the amount of energy savings above or below the estimated savings is small compared to the estimated savings. Figure 6 presents reported site energy savings, along with energy savings greater than or less than estimated energy savings.

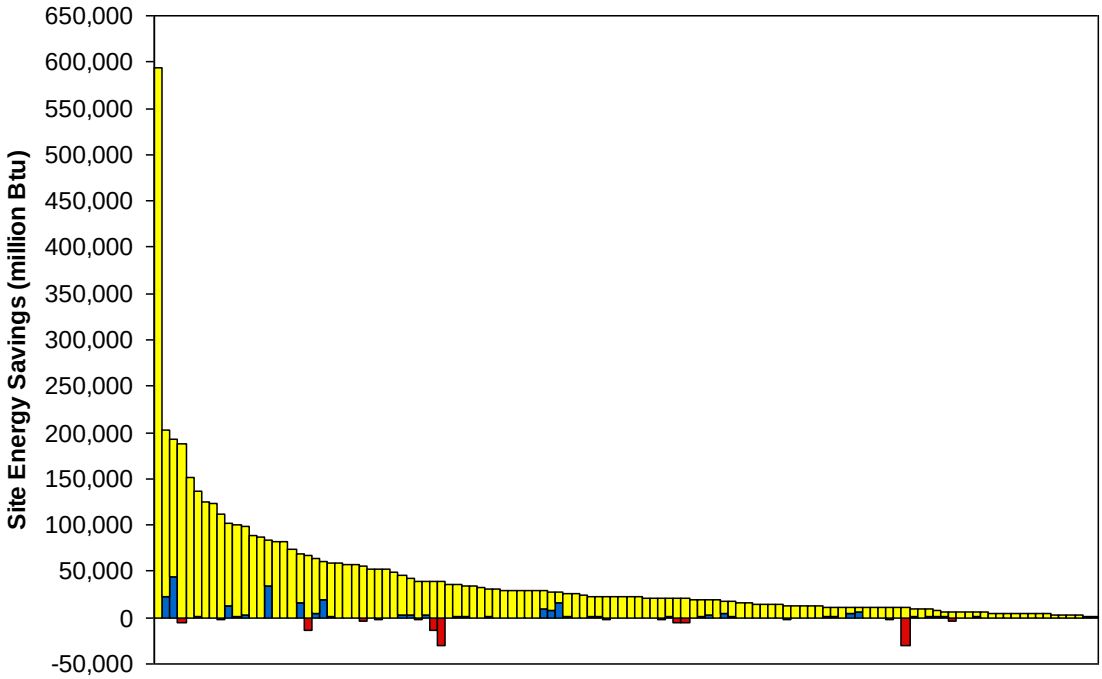

Fig. 6. Annual site energy savings from 124 ongoing DOE ESPC projects. Reported energy savings greater than the estimated savings are shown in blue, and reported energy savings less than the estimated savings are shown in red. Where no shortfall occurs, the yellow bar is the amount of the estimated energy 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 124 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 93% of the estimated chilled water savings, but 104% of the estimated steam savings.

Table 3. Aggregate net annual reported and estimated energy savings by fuel type for 124 DOE ESPC projects

	Reported		Estimated		Ratio of reported to estimated
	Savings (MMBtu)	Percentage of total	Savings (MMBtu)	Percentage of total	
Electricity	1,978,327	38.8%	1,942,541	38.6%	1.02
Natural gas	1,650,498	32.3%	1,635,581	32.5%	1.01
Fuel oil	162,889	3.2%	161,664	3.2%	1.01
Steam	500,628	9.8%	482,906	9.6%	1.04
Coal	550,971	10.8%	550,971	11.0%	1.00
Chilled water	11,013	0.2%	11,851	0.2%	0.93
Other	248,337	4.9%	240,477	4.8%	1.03
Total	5,102,662		5,025,990		1.02

Energy use can also be reported on the basis of 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 reported and estimated source energy savings resulting from the 124 projects are 10,190,383 and 10,018,296 MMBtu, respectively. Thus on a source energy basis, reported energy savings is more than 100% of the estimated energy savings — about 101.7%. Since source energy savings correlate directly with reductions in greenhouse gas emissions, this is a more meaningful comparison, and it shows that on the whole, DOE ESPC projects exceed their estimated energy savings.

Figure 7 presents the source energy savings for each project, along with any additional savings above or shortfalls below the estimated source energy savings. Again, the amounts by which reported savings exceed or fall short of the estimated savings are relatively small compared with the estimated savings.

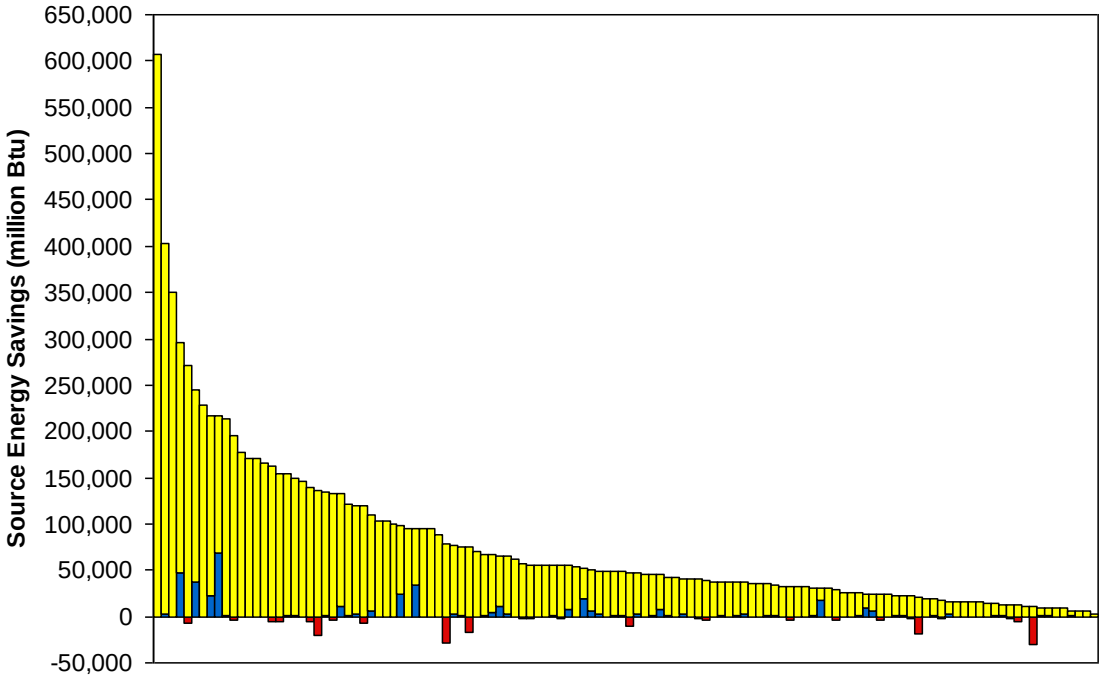

Fig. 7. Annual source energy savings from 124 ongoing DOE ESPC projects. Reported energy savings greater than the estimated savings are shown in blue, and reported energy savings less than the estimated savings are shown in red. Where no shortfall occurs, the yellow bar is the amount of the estimated 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 18.9% of program-wide site energy savings and 17.8% of program-wide source energy savings are derived from ECMs involving building automation and controls. These ECMs are responsible for 14.7% of program-wide reported cost savings.

Table 4. Percent of program-wide reported site energy savings, reported source energy savings, and reported cost savings delievered by each technology category

Technology	Site energy savings	Source energy savings	Reported cost savings
Building automation/controls	18.9%	17.8%	14.7%
Lighting	15.2%	24.4%	19.3%
HVAC	14.5%	12.3%	14.1%
Boiler plant improvements	13.5%	8.2%	8.3%
CHW/HTHW/steam distribution	6.7%	7.3%	9.4%
Distributed generation	6.6%	3.6%	4.5%
Chiller plant improvements	6.5%	5.6%	5.2%
Renewables	6.0%	5.7%	9.3%
Motors	3.4%	2.0%	0.3%
Advanced metering systems	2.9%	3.7%	2.3%
Ground source heat pumps	2.6%	6.2%	4.3%
Water/sewer	1.0%	0.7%	1.2%
Miscellaneous	0.8%	1.2%	4.8%
Envelope improvements	0.6%	0.4%	0.3%
Energy/utility distribution system	0.3%	0.4%	0.5%
Process improvements	0.2%	0.4%	0.6%
Load shifting	0.1%	0.2%	0.1%
Refrigeration	0.1%	0.1%	0.1%
Commissioning	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 current M&V reports from all ongoing projects that have completed at least one year of performance, aggregate reported savings in the DOE

ESPC program is about 105% of aggregate guaranteed cost savings. Aggregate reported savings is about 102% of the estimated savings. This means that ESCOs are guaranteeing about 98% 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 101.5% of estimated energy savings. Based on source energy use, the projects reported 101.7% of the estimated savings.

While this stage of the evaluation 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 are meeting their objectives in terms of energy and cost savings.