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EVALUATION OF THE SUPER ESPC PROGRAM:

LEVEL 2 — RECALCULATED COST SAVINGS

August 2007

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Engineering Science and Technology Division

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EXECUTIVE SUMMARY

This report presents the results of Level 2 of a three-tiered evaluation of the U.S. Department of Energy Federal Energy Management Program's Super Energy Savings Performance Contract (Super ESPC) Program.

Level 1 of the analysis studied all of the Super ESPC projects for which at least one Annual Measurement & Verification (M&V) Report had been produced by April 2006. For those 102 projects in aggregate, we found that the value of cost savings reported by the energy service company (ESCO) in the Annual M&V Reports was 108% of the cost savings guaranteed in the contracts. We also compared estimated energy savings (which are not guaranteed, but are the basis for the guaranteed cost savings) to the energy savings reported by the ESCO in the Annual M&V Report. In aggregate, reported energy savings were 99.8% of estimated energy savings on the basis of site energy, or 102% of estimated energy savings based on source energy.

Level 2 focused on a random sample of 27 projects taken from the 102 Super ESPC projects studied in Level 1. The objectives were, for each project in the sample, to:

- repeat the calculations of the annual energy and cost savings in the most recent Annual M&V Report to validate the ESCO's results or correct any errors, and
- recalculate the value of the reported energy, water, and operations and maintenance (O&M) savings using actual utility prices paid at the project site instead of the "contract" energy prices — the prices that are established in the project contract as those to be used by the ESCO to calculate the annual cost savings, which determine whether the guarantee has been met.

Level 3 analysis will be conducted on three to five projects from the Level 2 sample that meet validity criteria for whole-building or whole-facility data analysis. This effort will verify energy and cost savings using statistical analysis of actual utility use, cost, and weather data. This approach, which can only be used for projects meeting particular validity criteria, is described in Shonder and Florita (2003) and Shonder and Hughes (2005).

To address the first objective of the Level 2 analysis, we first assembled all the necessary information, and then repeated the ESCOs' calculations of reported annual cost savings. Only minor errors were encountered, the most common being the use of incorrect escalation rates to calculate utility prices or O&M savings. Altogether, our corrected calculations of the ESCO's reported cost savings were within 0.6% of the ESCOs' reported cost savings, and errors found were as likely to favor the government as they were the ESCO.

To address the second objective, we gathered data on utility use and cost from central databases maintained by the Department of Defense and the General Services Administration, and directly from some of the sites, to determine the prices of natural gas and electricity actually paid at the sites during the periods addressed by the annual

reports. We used these data to compare the actual utility costs at the sites to the contract utility prices.

For natural gas, as expected, we found that prices had risen much faster than had been anticipated in the contracts. In 17 of the 18 projects for which the comparison was possible, contract gas prices were found to be lower than the average actual prices being paid. We conclude that overall in the program, the estimates of gas prices and gas price escalation rates used in the Super ESPC projects have been conservative.

For electricity, it was possible to compare contract prices with the actual (estimated) marginal prices of electricity in 20 projects. In 14 of these projects, the overall contract electricity price was found to be lower than the marginal price of electricity paid to the serving utility. Thus it appears that conservative estimates of electricity prices and escalation rates have been used in the program as well.

Finally we calculated the value of the reported energy savings using the prices of utilities actually paid by the sites instead of the contract prices. In 16 of the 22 projects (where this calculation was possible), the recalculated annual cost savings were greater than the annual cost savings reported by the ESCO. In the aggregate for the 22 projects analyzed, the annual cost savings calculated using actual energy prices were found to be 111% of the ESCO-reported savings. Using statistical methods to expand this estimate to the entire 102-project population of Super ESPC projects, we estimate that the total annual cost savings calculated using actual energy prices instead of contract energy prices are about 110% of the reported annual cost savings.

We can combine the results of the Level 1 and Level 2 studies to estimate overall cost savings realized by the government for the entire 102-project population of Super ESPC projects examined in Level 1. For the entire population, we estimate that the total annual cost savings calculated using actual utility prices instead of contract utility prices are about 110% of the reported annual cost savings. In Level 1 we determined that reported annual cost savings were on average 108% of guaranteed annual cost savings. Given these two figures, we can estimate by multiplying 1.08 by 1.10 that the annual cost savings realized by the government are about 19% higher than the guaranteed annual cost savings for the entire 102-project population of Super ESPC projects. An important caveat is that ESCO-reported energy savings have not yet been independently verified in this evaluation. That analysis will be completed in Level 3.

1 INTRODUCTION

This is the second of three planned reports presenting results of an evaluation of the Super Energy Savings Performance Contract (ESPC) program managed by the U.S. Department of Energy's (DOE's) Federal Energy Management Program (FEMP). The evaluation uses a three-tier, nested design (Figure 1), with increasingly intensive and rigorous methods applied to smaller and smaller samples (Schweitzer et al. 2006). This report presents the results of Level 2 of the evaluation.

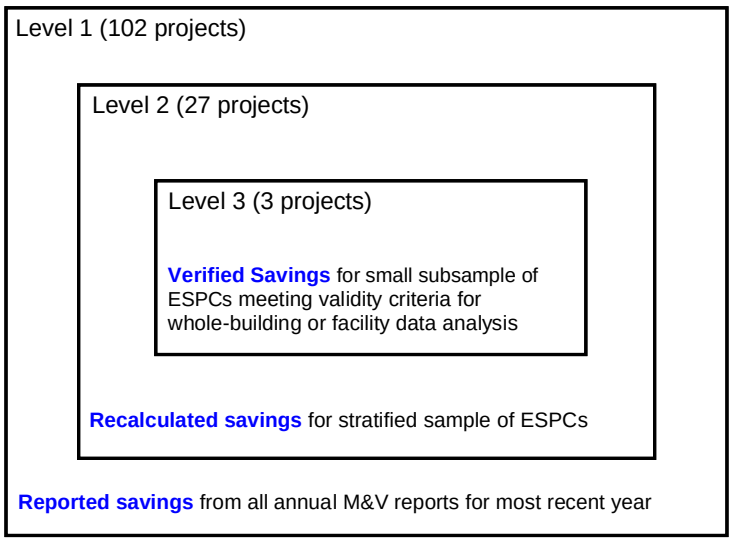

Figure 1: Graphic representation of nested evaluation design

A previous report (Shonder and Hughes 2007) described the results of Level 1 of the evaluation, which compared reported and guaranteed cost savings, as well as energy savings estimated and reported, for all 102 Super ESPC projects that were in the performance period and for which at least one Annual Measurement & Verification (M&V) Report had been produced by April 2006.

Level 2 focused on a random sample of 27 projects taken from the 102 Super ESPC projects studied in Level 1. The objectives were, for each project in the sample, to:

- repeat the calculations of the annual energy and cost savings in the most recent Annual M&V Report to validate the ESCO's results or correct any errors, and
- recalculate the value of the reported energy, water, and operations and maintenance (O&M) savings using actual utility prices paid at the project site instead of the energy prices that are established in the project contract as those to be used by the ESCO to calculate the annual cost savings.

We begin by describing the methodology used to draw the Level 2 sample from the population of 102 Level 1 projects. This is followed by a description of the techniques used to recalculate savings for the Level 2 sample based on actual utility prices, and discussion of the results of the recalculations. Conclusions and recommendations are provided at the end of the report.

2 LEVEL 2 SAMPLE SELECTION

2.1 Project Population and Strata

The original intent of the Level 2 analysis was to select a sample of 25 projects for the Level 2 analysis. However, to provide a sufficient number of projects meeting the validity criteria for the Level 3 analysis, two additional projects were added to the Level 2 sample so that in all, the final sample consisted of 27 projects.

The population of ESPC projects eligible for inclusion in the Level 2 sample consisted of all 102 projects examined in Level 1. These are all of the Super ESPC projects that were in the performance period as of April 30, 2006, and for which at least one annual M&V report had been produced. A complete list of the projects is provided in Appendix A.

Two main categories were used to assure that all important strata in the sample were represented: U.S. census region, and whether the project was awarded before or after the August 2001 modifications to the Super ESPC indefinite-delivery, indefinite-quantity (IDIQ) contracts.

The census region in which a project is located affects project economics because of the way escalation rates used in calculating energy cost savings in ESPCs are chosen. The ESCO and agency generally agree to calculate utility energy cost savings based on utility rates in effect at the time the project contract is awarded, multiplied by a fixed escalation factor in each succeeding year of the contract. These escalation rates affect the valuation of energy savings in each year of the contract, which in turn affects whether the guaranteed cost savings are delivered.[1]

The other consideration in selecting the Level 2 sample is whether projects were awarded before or after the August 2001 modifications to the Super ESPC IDIQ contracts. These contracts were awarded in a series beginning in 1998, and improvements resulting from lessons learned while establishing the earlier contracts were incorporated into the later Super ESPC IDIQs. The modifications made to the Super ESPCs after August 2001 eliminated the differences between the regional contacts, making them all consistent across the program. The resulting standardization and uniformity of the contracts and project documents, especially the financial schedules, were intended to improve quality assurance and administration of the Super ESPC program.

2.2 Determining a Statistically Valid Sample Size

Although sample size objectives were not formulated explicitly for the individual strata, an overall sample size was determined and then allocated to the strata. Because large projects have a disproportionately large effect on net savings for the entire population,

[1] Projections of utility prices published by the National Institute of Standards and Technology (NIST) are commonly used to determine the annual escalation rates for energy cost savings used in ESPC projects. In April of each year, NIST publishes the Annual Supplement to NIST Handbook 135 (Rushing and Lippiat 2007). In addition to discount factors for life cycle cost analysis, the annual supplement contains 30-year price projections made by DOE's Energy Information Administration (EIA) for electricity, natural gas, and other fuels for residential, commercial, and industrial buildings. These projections are made for each of the four U.S. census regions.

project size was also used as a basis for sample selection. However, rather than stratifying by project size, projects were selected using probability-proportional-to-size (PPS) sampling, with the probability of selection being proportional to the total guaranteed cost savings over term (2006 dollars) for the strata.

In choosing a size for the Level 2 sample, the goal was to be able to estimate recalculated cost savings as a proportion of reported cost savings to within 5% of the mean value for that parameter for the entire population of Super ESPC projects at a 90% confidence level. Although stratification and PPS sampling lead to a more efficient sampling design, they also complicate the problem of reckoning a necessary sample size. Therefore, several simplifying assumptions were made to determine an overall sample size. As an approximation, the sample size was determined for a design with simple random (as opposed to PPS) sampling without any stratification. This sample size should exceed the sample size necessary for the stratified and PPS-sampled design. As an additional approximation for reckoning sample size, it was assumed that recalculated savings (using actual rather than contract energy prices) for individual projects would be within a certain percentage of the guaranteed savings, and that a specific confidence interval was desired. Calculations were performed using a variety of assumptions (e.g., recalculated savings as a percentage of guaranteed savings being uniformly distributed between 80 and 120%; recalculated savings as a percentage of guaranteed savings being binomially distributed at 90% and 110%) and with both 0.9 and 0.95 confidence levels. Ultimately, a sample size of 25 was deemed adequate to provide accurate results.

It should also be noted, however, that when the sample size was determined, the total number of ESPC projects eligible for inclusion in the Level 2 sample was unknown. At that time we estimated the number to be 117, and the sample size was determined on that basis. However, when ESCOs completed delivery of annual M&V reports, it was found that a number of projects had been bought out by the government, while for others, the construction period had taken longer than expected and no M&V report was yet available. Since the final number of eligible projects was found to be 102 rather than 117, a smaller sample size could have satisfied the criteria for accuracy. In addition, as mentioned above, two additional projects selected for Level 3 analysis were added to the Level 2 sample, so that in all, the final Level 2 sample consisted of 27 projects. This is more than enough to satisfy the statistical criteria of being able to estimate recalculated whole-program cost savings as a proportion of guaranteed savings to within 5% of the mean value for that parameter for the entire population of Super ESPCs at a 90% confidence level.

2.3 Level 2 Sample

Table 1 presents a list of the 27 projects selected for Level 2 analysis. The total guaranteed savings for the period covered in the most recent annual report for these projects is $19.4 million, which is 45% of the $43.5 million in guaranteed savings for all of the reports examined for Level 1. The total reported savings for the Level 2 sample is $21.6 million, or 111% of the guaranteed savings for the sample. In the entire population of 102 Super ESPC projects analyzed in Level 1, the total reported savings was 108% of total guaranteed savings. Thus, in that respect, the Level 2 sample is demonstrated to be representative of the population.

Table 1: List of Level 2 projects and their characteristics

FEMP Project Number	Project name	Award date	Agency	Census region	Aug 2001 mods	Reporting period for annual report	Annual guaranteed cost savings, most recent annual report	Reported cost savings, most recent annual report
5	Ft. Lewis/Yakima Firing Range	6/28/02	Army	West	After	8/1/05 – 7/31/06	$452,761	$473,153
9	Submarine Base Bangor, DO#2	9/27/01	Navy	West	After	3/1/05 – 2/28/06	$637,631	$733,558
15	Idaho Eng Lab/Lockheed	1/22/01	DOE	West	Before	3/1/05 – 2/28/06	$94,728	$97,979
17	FDA Bothell Laboratory	9/23/98	GSA	West	Before	12/1/04 – 11/30/05	$110,664	$126,736
42	Forts Gordon, Jackson, and Stewart	9/30/00	Army	South	Before	10/1/04 – 3/31/05	$828,415	$918,940
44	Fort Jackson	9/18/01	Army	South	After	2/1/05 – 1/31/06	$1,829,644	$1,829,643
46	Marine Corps Albany	9/3/03	Navy	South	After	12/1/04 – 11/30/05	$1,213,311	$1,563,613
48	Camp Lejeune Naval Hospital	11/7/02	Navy	South	After	12/1/04 – 11/30/05	$278,844	$296,923
56	Russell & Summit Buildings	9/30/99	GSA	South	Before	6/1/05 – 5/31/06	$903,010	$918,393
57	Memphis Customer Service Center	1/23/01	GSA	South	Before	1/1/05 – 12/31/05	$167,719	$179,150
61	Job Corps, Various Sites	9/26/03	DOL	South	After	8/23/04 – 8/22/05	$201,923	$204,244
67	National Animal Disease Center	11/15/99	USDA	Midwest	Before	2/1/05 – 1/31/06	$627,382	$679,086
94	Robert S. Kerr Center, Ada OK	9/27/00	EPA	South	Before	1/1/05 – 12/31/05	$253,953	$277,438
100	Albuquerque & El Paso Projects	12/4/02	GSA	South	After	2/1/04 – 1/31/05	$281,955	$313,274
120	VA Medical Center (VISN 19)	1/31/00	VA	West	Before	10/1/05 – 9/30/06	$705,960	$762,658
122	VA Medical Center (VISN 17)	7/13/01	VA	South	Before	10/1/04 – 9/30/05	$730,148	$684,109
124	Fort Hamilton	11/16/01	Army	Northeast	After	10/1/04 – 9/30/05	$377,622	$405,049
131	U.S. Merchant Marine Academy	8/31/01	DOT	Northeast	After	9/1/04 – 8/31/05	$715,951	$776,083
132	VA Medical Center (MA & CT)	9/5/01	VA	Northeast	After	2/1/04 – 1/31/05	$1,106,979	$1,106,979
159	Rock Island	2/6/02	Army	Midwest	After	6/25/03 – 6/23/04	$703,741	$736,414
162	Carlisle Barracks	7/17/02	Army	Northeast	After	4/1/05 – 3/31/06	$551,497	$627,162
167	Oceana NAS/Little Creek NAB	12/24/02	Navy	South	After	1/1/05 – 12/31/06	$929,953	$989,735
175	GSA - FDA White Oak	7/12/02	GSA	South	After	1/1/05 – 12/31/05	$995,333	$2,172,657
184	Ames Research Center DO#2	3/28/02	NASA	West	After	10/1/04 – 9/30/05	$242,030	$246,940
188	Marine Base Quantico	9/30/02	Navy	South	After	10/1/04 – 9/30/05	$3,874,795	$3,874,795
253	GSA Michigan	9/25/03	GSA	Midwest	After	10/1/04 – 9/30/05	$306,937	$330,217
262	Hill AFB Regional	9/30/03	USAF	West	After	6/1/04 – 5/31/05	$233,897	$240,322
Total							**$19,356,783**	**$21,565,250**

The objective of the Level 2 sample selection process was to draw a stratified random sample with properties similar to those of the Level 1 population in terms of the geographical distribution of the projects and whether they were awarded before or after the August 2001 consistency modifications. As shown in Figure 2, this objective was not entirely met. Because the sample includes two very large projects in the South — GSA White Oak and Marine Base Quantico, which together account for nearly 43% of the guaranteed savings in the sample — the South census region is overrepresented, and the other regions are consequently underrepresented.

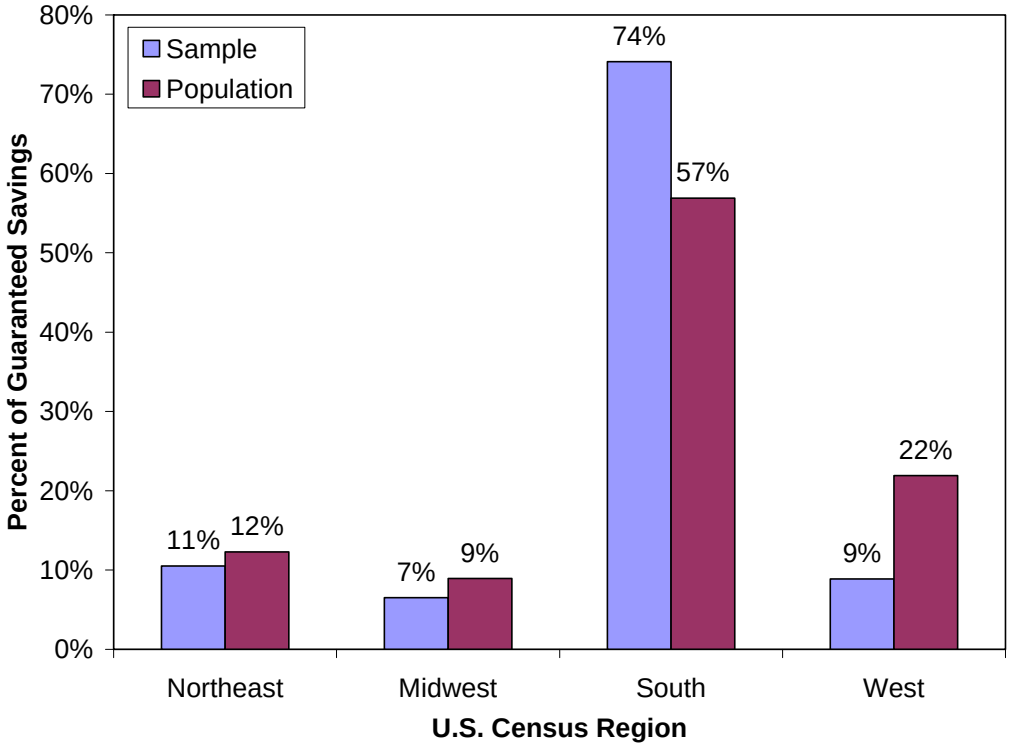

Figure 2: Distribution of total guaranteed savings by census region for the Level 2 sample and the entire (Level 1) population.

The large size of the Quantico and White Oak projects also skew the sample toward projects awarded after the August 2001 consistency modifications. In the population, projects awarded before the consistency modifications account for 28% of total guaranteed cost savings, and projects awarded after account for 72%. In the Level 2 sample, projects awarded before the consistency modifications account for 19% of total guaranteed cost savings, and projects awarded after account for 81%.

Figure 3 shows the percentage of the total guaranteed savings in projects awarded after the consistency modifications in each census region, in both the Level 2 sample and the entire population (Level 1). For example, in the sample, when only projects awarded after the consistency modifications are considered, we find that projects in the Northeast

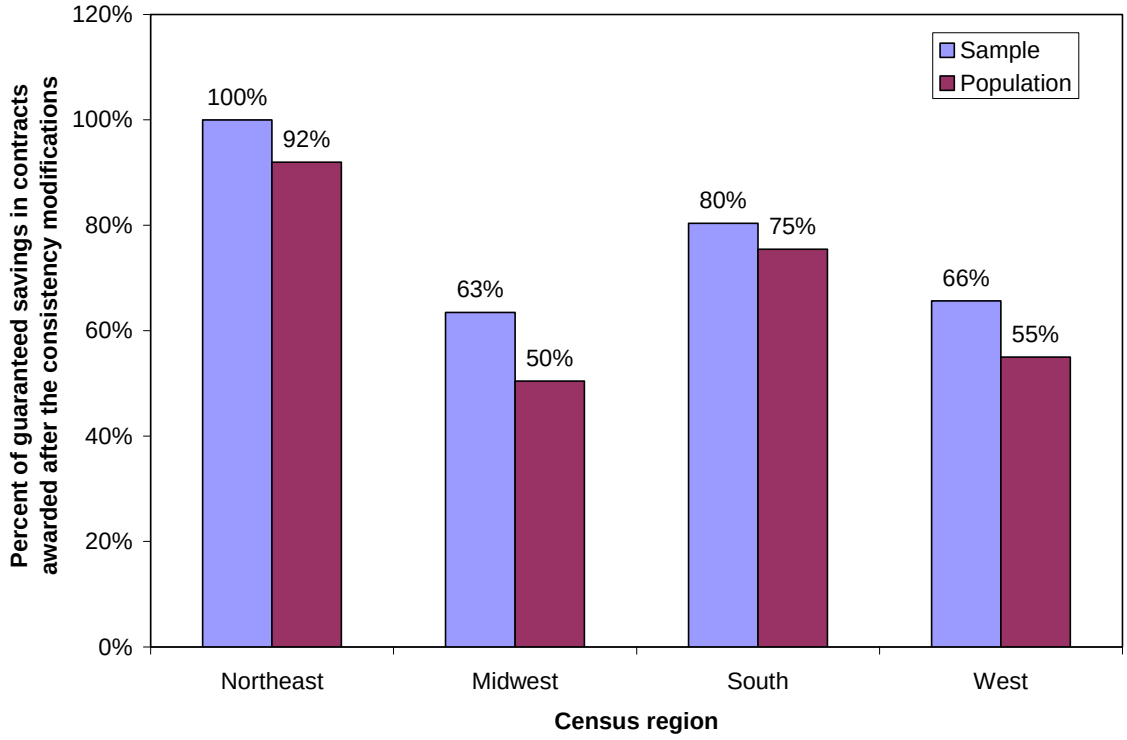

Figure 3: Total guaranteed savings in projects awarded after the August 2001 consistency modifications, by census region, for the sample and the population.

account for 13% of total guaranteed savings. In the population, 16% of guaranteed savings comes from projects in the Northeast.

Given the 300-to-1 variation in total guaranteed savings for the 102 Level 1 projects and the PPS technique used to draw the Level 2 sample, it was perhaps inevitable that some very large projects would be included in the sample, and that these would skew the percentages toward the region or regions in which these projects were located. As will be shown below, we do not believe this affects the outcome of our results.

3 METHODOLOGY FOR RECALCULATION OF REPORTED SAVINGS

The first objective of Level 2 was to check the calculations of cost savings reported in the most recent annual M&V report for each of the sampled projects and ensure that they were done according to the methods specified in the project M&V plan. The first step was the collection of documents. In accordance with FEMP recommendations for review of annual reports (FEMP 2007), we collected as many previous annual M&V reports as were available for each project in addition to the report we wished to analyze. We also

collected any available Post-Installation M&V reports, which document the potential of the installed and commissioned equipment to deliver the guaranteed energy savings. We obtained a copy of the Final Proposal for each project as well, which includes the project's M&V Plan.

3.1 Recalculating Energy, Demand, and Water Savings

The recalculation process involved several different validations. First we repeated the calculations used to determine energy, demand, and water savings. For example, in a lighting energy conservation measure (ECM), for each class of fixture replaced, an ESCO may list the number of fixtures, the operating hours, and the measured power draw in kW of the replaced and new fixtures. The energy savings in kWh for each fixture is then the product of the number of operating hours and the difference in power draw. The total energy savings for the ECM is found by summing the kWh savings for all fixtures. To the extent that such information was provided in the annual reports, we repeated the calculations to validate the energy savings figures reported.

3.2 Recalculating Reported ("Contract") Cost Savings

To calculate the annual cost savings they report, ESCOs multiply the reported annual savings in energy, demand, water, and other utilities by the corresponding contract utility prices — values agreed to in the contract for calculating cost savings. The reported annual cost savings can also be termed "contract savings," because they are determined by multiplying contract utility prices with measured (or stipulated) energy or water savings. Contract utility prices are often based on prices that were current during project development and escalated by a fixed percentage per year. The escalation rate is usually based on projections by the EIA/NIST. (See Footnote 1.) This approach is not universal, however. Some contracts base the first-year price on an average of prices for a number of years in the past. Historical utility prices at the site are also sometimes used to determine an average annual rate of increase. Some contracts do not include an escalation rate at all, meaning that the contract energy prices for determining savings are the same each year throughout the contract term.

To ensure that the correct escalation rates were used to calculate cost savings, we calculated the contract utility prices independently using the first-year prices and the escalation rate specified in the ESPC contract. We then multiplied the energy, demand, and water savings by the proper contract prices to recalculate the utility cost savings.

A significant portion of the savings in the reports we examined were based on fixed, stipulated values for usage and performance. In this case, ESCOs sometimes do not apply different rates for utility savings from year to year, but merely escalate the first year's cost savings by a fixed factor. Where this technique was used, we checked to see whether the proper escalation rate had been used.

Reductions in the cost of O&M are another source of cost savings in ESPC projects. Analysis of annual M&V reports from the 102 projects carried out in Level 1 of the evaluation found that 20.7% of reported cost savings were O&M savings. All of the reported O&M savings were stipulated. ESPC contracts normally specify the level of O&M cost savings for the first year of the performance period and use a fixed escalation

rate to determine savings in subsequent years. For each annual report examined, we used the first-year O&M savings and the escalation rate specified in the contract to determine the correct O&M savings for the reporting year, and compared it with the reported O&M savings.

For each project in the sample we then summed the cost savings from energy, demand, water, and O&M for all ECMs to check the ESCO's calculation of total annual cost savings. It should be noted that not all of the calculations outlined here were possible for each annual report examined. As described below, because of a lack of information it was not possible to make all of the calculations for all projects.

3.3 Recalculating Cost Savings Using Actual Utility Prices

After completing our check of the ESCO's calculations, we gathered information on utility usage and actual utility prices at the project sites during the periods addressed by the annual reports. We calculated actual utility prices for the period, and compared them with the contract utility prices. We then used the average actual utility prices to recalculate the annual cost savings. This provides an estimate of the actual cost savings being delivered in the projects, based on the reported savings in energy, demand, water, other utilities, and O&M. More information on this part of the evaluation is given in Section 3.5 and Section 5.

3.4 Availability of Information

The quality of the annual M&V reports and the availability of information required to perform these calculations varied widely in the sample we examined. Many of the reports were well-written, and seemed designed to assist the agency customer in stepping through all of the calculations made to derive the reported annual cost savings from the measured or stipulated parameters and the contract energy prices. These reports contained informative tables that gathered the necessary parameters in one location. In 5 of the 27 reports, however, we were unable to check the ESCO's calculations because key parameters such as energy savings and utility prices were not reported. In some other reports it was necessary to set up and solve algebraic equations to determine some of the parameters used.

Even where all information was available, it was sometimes scattered through various other documents including the Final Proposal/Detailed Energy Survey, the Post-Installation M&V Report, and delivery order (DO) schedules. The DO schedules are contract documents, and a new set is issued each time a modification is made to the ESPC contract. The 2004 modifications to the Super ESPC IDIQs tightened and specified the requirements for the content of Annual M&V Reports, and these improvements are evident in reports from more recently awarded contracts.

Our goal was to collect both award DO financial schedules issued at the time of contract award and the schedules that applied to the most recent M&V report. While we obtained copies of all award schedules, we were able to collect only a few of the schedules that apply to the recent annual reports. One major improvement to the annual M&V reports would be to require them to include copies of the DO Schedules that apply to the current

report. This would make it easier to verify that the calculations are in accordance with the contract.

3.5 Reconciling Utility Rates

Aside from missing information, another problem we encountered in attempting to recalculate savings was reconciling utilities' seasonal, on-peak/off-peak, and block electricity rates. The tables FEMP specifies require the ESCOs to provide only total electricity and demand savings in the annual reports. More complicated rate structures can have different demand and energy charges based on the time of day, the day of the week, and the time of year. Block rates generally charge one rate for energy and demand up to a certain fixed threshold, then charge lower rates for energy and demand beyond that. Three of the contracts in the Level 2 sample used electricity rates like these to calculate cost savings. The ESCO used the specified rates to calculate electricity cost savings, but reported only total energy and demand savings in the annual M&V report. Without knowing how many kWh of energy and kW of demand occur in each block (or each season, or each time of day) it is impossible to use the specified rates to check the ESCO's calculation of cost savings.

In some cases it was possible to set up algebraic equations and solve them for quantities that were not provided in the M&V report. For example, when there are only two different electricity prices (summer and winter rates, for example) and the total kWh savings and total cost savings are known, it is possible to solve for the number of kWh saved in winter and summer.

Two of the reports we examined used building energy analysis software to determine energy cost savings. In both cases, the ESCO's estimated energy savings is based on the output of pre- and post-retrofit building and equipment models. The models incorporate the electricity tariff and calculate the pre- and post-retrofit utility bills directly. Even when simulation models are used, it would be possible for the ESCO to provide the model outputs (in this case, the number of kWh billed at each seasonal rate). In these cases, however, the M&V reports did not contain sufficient information to redo the calculations.

Most of the difficulties involved calculation of electricity cost savings, but we encountered problems with other utility cost savings as well. One report included cost savings only and did not report energy savings at all. In this case, however, the reported cost savings were equal to the guaranteed savings, and the Final Proposal contained enough information to determine the energy savings. In the Level 1 analysis, we noticed several annual reports that provided cost savings only.

Another report in the Level 2 sample provided total cost savings and energy savings for each ECM in MMBtu, but did not provide a breakdown of electric, gas, and steam savings. In this case there were too many unknowns for an algebraic solution.

4 ASSESSMENT OF ANNUAL REPORTS

Our assessment of the Level 2 sample of annual reports found that for the most part ESCOs are following the procedures specified in the M&V plans they negotiate with the agencies. Where measurements are called for in the M&V plan, the ESCOs generally perform them.

4.1 M&V Options

The M&V plans in the sample we examined were dominated by Option A verification methods, which stipulate one or more parameters to determine savings. On a percentage basis we found the following.

- 73% of the cost savings reported in the most recent M&V reports of the Level 2 sample were verified using Option A.
- 17% of reported cost savings were verified using Option B, which includes spot measurements.
- 1% of reported cost savings were verified using Option C, analysis of metered interval data on energy use.
- 9% of reported cost savings were verified using Option D, calibrated simulation.

4.2 Quality of Annual M&V Reports

The quality of the annual M&V reports and the quantity of information they contained varied widely. In general, reports from more recently awarded projects were of higher quality than older projects. As the program has progressed, FEMP has tightened the requirements for the content of annual M&V reports, and these improvements are evident in the reports from more recently awarded projects. They include all or most of the information required to replicate the calculations made to determine energy and cost savings. As more projects are awarded under the Super ESPCs, and more annual reports are produced according to their specifications, we expect it will become easier to recalculate savings.

4.3 Typical Calculation Errors

After assembling all of the required information, we followed the procedures specified in the M&V plan to check the ESCOs' calculations of cost savings. For the reports for which we were able to repeat the calculations, the most common error was the use of incorrect utility rates. Most often, these errors stemmed from using the wrong escalation rate to inflate the previous year's rate to the current year. We note that in the contract documents, utility escalation rates appear only as a footnote on schedule DO-4, and so could be easily misread. Since the escalation rates are small — generally less than 4% — using the incorrect rate to inflate utility rates from one year to the next causes only small errors in calculating the cost savings, if the correct utility rate was used in the previous year. In the projects we examined the errors did turn out to have only a small effect on the total reported savings. However, if the wrong escalation rate is used consistently, over

time the utility rates will diverge from the contracted values, and errors in calculating reported annual cost savings will grow larger.

As stated above, in the projects we examined we found that O&M savings were universally stipulated and increased by a fixed percentage each year. We encountered a few cases of using the wrong escalation rates to calculate O&M savings as well. As with energy rates, the escalation rates used to inflate O&M savings are small, so errors are not large if the rate used in the previous year was correct.

We suspect that some of the differences in O&M costs that we encountered may have been due to contract modifications rather than calculation errors, because in some cases the amount of O&M savings was *less* than it had been in the previous annual report. However, since we did not have access to the applicable financial schedules for those projects, we could not determine whether any modifications had been made.

4.4 Results of M&V Report Validation

In all, we were able to check the ESCO's cost savings calculations in 22 of the 27 Level 2 projects. The remaining five did not contain sufficient information. For 12 of the 22 projects our independent calculation of the annual cost savings was within about 0.5% of the ESCO-reported savings. For the remaining projects, only small differences between recalculated and ESCO-reported savings were found, in the range of ±2% of the reported annual savings.

For the 22 projects that provided adequate information to perform all the calculations, we calculated an aggregate annual cost savings of $15,516,191. This is 99.1% of the total reported annual cost savings of $15,641,074 for the 22 projects. If we assume that the reported annual cost savings are correct for the five projects for which we could not perform the calculations specified in the M&V report, the total of our calculations is $21,380,587. This is 99.4% of the $21,505,470 in reported savings from the entire Level 2 sample of 27 projects. In general, we conclude that the ESCOs made only minor mathematical errors in calculating the annual cost savings they reported in this sample of M&V reports, and the errors were as likely to favor the government as the ESCOs.

Table 2 lists the reported annual cost savings for each project, our corrected calculation of the annual cost savings, and the main reason for any discrepancy. For reports in which it was not possible to make the calculations specified in the M&V report, the reported annual cost savings is repeated in the column for corrected annual cost savings, enclosed in brackets.

Table 2: Reported annual cost savings, corrected annual cost savings using the techniques prescribed in the M&V plan for the Level 2 projects, and the reasons for any discrepancies

FEMP Project Number	Project Name	Reported annual cost savings, most recent annual report	Corrected annual cost savings	Comments
5	Ft. Lewis/Yakima Firing Range	$473,153	$479,988	Incorrect gas rate used for one ECM.
9	Submarine Base Bangor, DO#2	$733,558	$742,068	Rates escalated incorrectly. Contract rates were actually higher than the ones used.
15	Idaho Eng Lab/Lockheed	$97,979	$99,608	Incorrect escalation of O&M savings for one ECM.
17	FDA Bothell Laboratory	$126,736	$126,736	All calculations appear correct.
42	Forts Gordon, Jackson & Stewart	$918,940	$862,276	No rates provided in M&V report. Can follow some of the calculations. Savings for one ECM calculated incorrectly.
44	Fort Jackson	$1,829,643	$1,822,370	Annual report presents MBTU and cost savings for each ECM, but not broken down by gas and electric. Recalculation required some assumptions.
46	Marine Corps Albany	$1,563,613	$1,563,612	All calculations appear correct.
48	Camp Lejeune Naval Hospital	$296,923	$313,925	O&M savings omitted for one ECM.
56	Russell & Summit Buildings	$918,393	[$918,393]	Not possible to recalculate savings. Cost savings are based on seasonal demand and energy rates for electricity, but annual report and Final Proposal include total energy and demand savings only.
57	Memphis Customer Service Center	$179,150	$179,646	Essentially correct, difference may be due to roundoff error.
61	Job Corps, Various Sites	$204,244	$197,223	Information in table entitled "Verified savings for Year One" conflicts with the information provided in Attachments A2, B2a, B2b, B3a, B4a.
67	National Animal Disease Center	$679,086	$670,982	Incorrect rate used for one ECM.
94	Robert S. Kerr Center, Ada OK	$277,438	$269,247	Incorrect rate used for demand savings.
100	Albuquerque & El Paso Projects	$313,274	$313,274	All calculations appear correct.
120	VA Medical Center (VISN 19)	$762,658	$762,658	All calculations appear correct.
122	VA Medical Center (VISN 17)	$684,109	$691,810	Reported cost savings are DO-4 cost savings escalated to year 6, with certain reductions. No explanation of how these reductions were derived, but assuming they are correct, the calculations are correct.
124	Fort Hamilton	$405,049	$405,049	All calculations appear correct.
131	U.S. Merchant Marine Academy	$776,083	$776,083	All calculations appear correct.
132	VA Medical Center (MA & CT)	$1,106,979	[$1,106,979]	Not possible to recalculate savings. For Northampton, rates are missing from the annual report and the Final Proposal. For Westhaven-Newington cost savings are based on seasonal demand and energy rates for electricity, but only total energy and demand savings are reported.
159	Rock Island	$736,414	[$736,414]	Not possible to recalculate savings. Reported savings in total MMBtu only, although

				project has electric, gas and steam savings. No rates provided in report.
162	Carlisle Barracks	$627,162	$627,114	All calculations appear correct. Differences due to roundoff error.
167	Oceana NAS/Little Creek NAB	$989,735	[$989,735]	Not possible to recalculate savings. Cost savings are based on seasonal demand and energy rates for electricity, but only total energy and demand savings are reported.
175	GSA - FDA White Oak	$2,172,657	[$2,172,657]	Not possible to recalculate savings. Annual report includes electrical savings only, whereas Final Proposal has increased gas use due to cogeneration system.
184	Ames Research Center DO#2	$246,940	$247,117	All calculations appear correct. Difference due to roundoff error
188	Marine Base Quantico	$3,874,795	$3,781,197	No energy savings reported. However, since reported cost savings is the same as the guaranteed savings from the DO schedules, recalculation is based on Final Proposal.
253	GSA Michigan	$330,217	$330,181	All calculations appear correct. Differences due to roundoff error.
262	Hill AFB Regional	$240,322	$240,322	All calculations appear correct.
Total		**$21,565,250**	**$21,417,662**	

5 CALCULATING SAVINGS USING ACTUAL SITE UTILITY PRICES

5.1 Required Data and Available Data

A major objective of this evaluation was to determine how reported annual cost savings compare with the value of the reported savings when calculated using actual utility prices paid by the site. The ease with which this comparison can be made depends on the way in which electricity is billed. Electric utilities use a variety of rate structures for commercial customers, and both energy and demand charges can vary by season (winter/summer rates) and by time of day (on-peak/off-peak rates). Some utilities use block rates, in which the price per kilowatt hour varies based on the amount of energy the customer uses. M&V reports from Super ESPC projects usually report total annual electrical energy and demand savings. Estimating the cost savings from these energy and demand savings based on actual electricity prices requires, at a minimum, the following information:

- Electricity bills from the period in question
- A copy of the electricity rate schedule
- Some knowledge of how the energy and demand savings are distributed throughout the year, and in some cases throughout the day

Given this information, it is possible to add the monthly energy and demand savings to the amounts billed for that month, and then recalculate the bill with the higher demand and energy use. The amount of the actual bill is subtracted from the amount of the recalculated bill to determine the cost savings.

It was not feasible to estimate savings in this manner for the Level 2 sample. Although some assumptions could be made about the way the savings are distributed (the simplest being to assume that 1/12 of the savings occurs in each month), the problem comes in obtaining utility bills and rate schedules. First of all, many of the projects cover multiple sites. For example, the Albuquerque and El Paso project (FEMP No. 100) involves 45 buildings in Texas and New Mexico. GSA Michigan (253), includes ECMs in nine buildings in seven different cities. After attempting to collect electricity bills for several projects, we determined that it would not be possible to obtain them for all of the sites included in the Level 2 sample within the time allowed for the evaluation.

Fortunately, some agencies do collect data on facility energy use and cost. Each of the U.S. Armed Services maintains its own database of monthly usage and cost of electricity, natural gas, and other utilities at each of its facilities (Navy 2007, Army 2007, Sisk, 2007). GSA maintains a database containing similar information for its buildings and facilities (Curran 2007). From these databases we were able to obtain information on utility usage and cost for each Army, Navy, Marine Corps, Air Force, and GSA building or facility included in the Level 2 sample for the period covered by the M&V report we were analyzing. Since 18 of the 27 Level 2 projects involve sites owned by DOD or GSA, this covered a majority of the projects. We obtained similar information from other Level

2 sites by calling them directly and speaking with energy managers and utility managers. In all, we obtained data for 24 of the 27 Level 2 projects.

The data we gathered has some limitations. In the case of electricity, GSA and the Armed Services collect information on monthly electrical energy use only; no information is available on peak monthly demand. Furthermore, while gas and electricity use are tracked at all sites, not every site tracks lesser-used fuels such as propane and fuel oil. Only a few of the DOD sites we examined track information on potable water, and GSA does not track it at all.

We used the data we gathered to calculate average utility rates for each building or site during the period covered by the M&V report we were analyzing. We compared these rates with the contract rates for each project. In some cases, the ESPC contract specifies different utility rates for different ECMs. In these cases we calculated an average contract rate, dividing total cost savings from the particular utility by the total number of units saved.

5.2 Comparing Contract and Actual Natural Gas Prices

Figure 4 presents the actual gas prices paid at the project sites and the ESPC contract prices during the reporting periods of the projects examined. This data is shown numerically in Table 3. Only 18 of the 27 Level 2 projects are shown because not all of the projects included savings from natural gas, and for some projects no data were available to determine actual gas prices. In 17 of the 18 projects, the contract gas price was lower than the actual price paid to the utility, indicating that conservative estimates of gas price escalation were used in the contracts.

In most cases, there is a benefit to the government when the contract price is lower than the actual utility price. For example, consider a project that installs more efficient boilers in a boiler plant, resulting in a guaranteed savings of 10,000 therms of natural gas per year. If the contract rate is $0.60 per therm, the site will pay the ESCO $6,000 per year for the guaranteed savings. But if the actual price of natural gas at the site is $1.00 per therm, the 10,000 therms of savings are actually worth $10,000. The government realizes an additional savings of $4,000 beyond the guaranteed savings.

It is not always an advantage to the government when the actual gas price is higher than the contract price. For example, combined heat and power (CHP) projects generally result in increased use of natural gas and decreased use of electricity. Savings are determined by subtracting the cost of the additional natural gas use from the avoided cost of electricity. This means that if the contract gas price is lower than the actual price (all other things being equal) the value of the savings will be overstimated. In the case of CHP projects, the price of electricity must be considered as well.

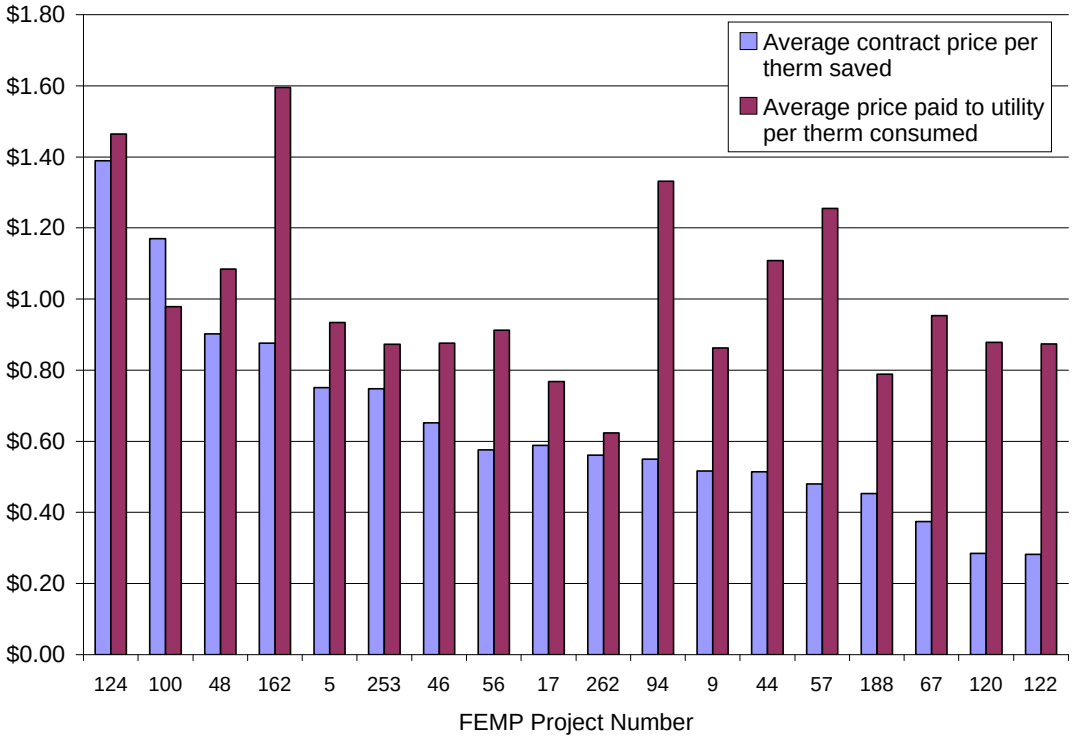

Figure 4: Average contract natural gas prices during the periods addressed by most recent annual M&V reports, and average actual prices paid to the utility for natural gas use for the same periods, in 18 Super ESPC projects.

Table 3: Average contract natural gas prices and actual natural gas prices paid to the utility.

Project number	Average contract rate, $/therm	Average rate paid to gas utility, $/therm
5	0.7505	0.9340
9	0.5164	0.8624
17	0.5881	0.7682
44	0.5138	1.1086
46	0.6524	0.8764
48	0.9020	1.0839
56	0.6109	0.9125
57	0.4806	1.2552
67	0.3746	0.9531
94	0.5500	1.3313
100	1.1701	0.9787
120	0.2839	0.8780
122	0.2827	0.8734
124	1.3893	1.4648
162	0.8762	1.5954
188	0.4529	0.7885
253	0.7470	0.8725

5.2.1 Gas Price Results

When all 18 projects included in Figure 4 are aggregated, the total reported annual savings in natural gas is 6,577,724 therms. At contract gas prices, ESCOs reported the value of this savings as $3,787,139. This corresponds to an average contract rate of $0.5758 per therm. Given the prices paid by the sites to their gas utilities, 6,577,724 therms of savings was worth $5,864,134, which is 50% more than the savings reported by the ESCOs. This is because the aggregate consumption-weighted price of natural gas at the 18 sites was actually $0.8915 per therm.

5.3 Comparing Contract and Actual Electricity Prices

As with natural gas, our objective was to compare the prices ESPC customers paid to ESCOs for guaranteed electricity savings to the prices that would have been paid to the electric utility for the electricity saved by the project. The data we obtained on facility electricity use allowed us to calculate only blended or average electricity prices per kWh that include the effects of consumption, demand, and the actual electricity tariff. This is a limitation of the data, because electricity cost savings occur at the marginal price rather than the average price.

Nevertheless, a study carried out by the Lawrence Berkeley National Laboratory (LBNL 1999) provides some guidelines for estimating marginal price given average electricity price. Given hourly load profiles from 1393 commercial buildings in 7 states, the study calculated annual electricity bills before and after a lighting retrofit project (conversion from T12 to T8 lamps with electronic ballasts — an ECM that was included in 16 of the Level 2 projects) under a variety of commercial electricity tariffs. The ratio of marginal to average electricity price was then calculated for each building–tariff combination. On a consumption-weighted basis, the average marginal price is 94.8% of the average price. Figure 5, which is adapted from the LBNL report, shows that although there is a wide variation in the ratio of marginal to average electricity prices for commercial customers, very little consumption (less than 20%) occurs at marginal prices lower than 90% of the average price.

Given the results of the LBNL study, we believe it is valid to compare the average contract price for guaranteed savings over a one-year period with the actual blended price for electricity paid to the utility over the same year. We recognize that the marginal price is usually lower than the average price. According to the results of the LBNL study, the average marginal price is 94.8% of the average price, and could be higher or lower, though it is unlikely to be higher, and unlikely to be lower than 90% of the average price.

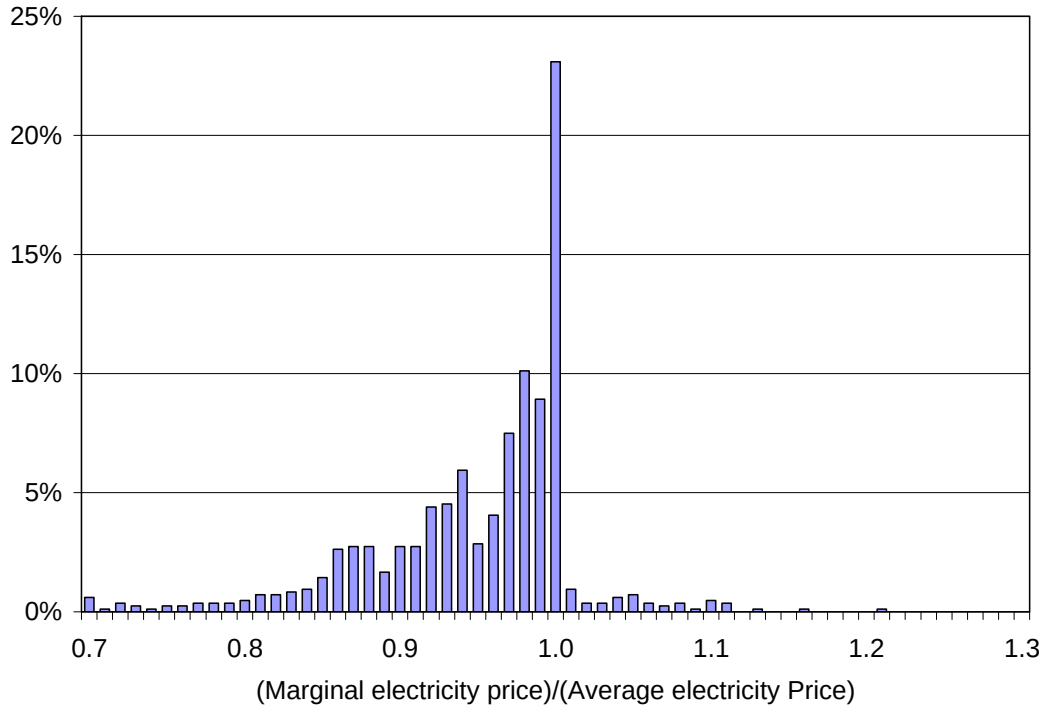

Figure 5: Histogram of the ratio between marginal electricity price and annual average electricity price for 29,133 annual utility bills representing 1,323 buildings in 7 states under a variety of electricity tariffs. Source: LBNL (1999).

5.3.1 Blended and Marginal Electricity Prices

To determine the average contract electricity price for each project, we added the annual reported cost savings due to reductions in electrical demand and electrical energy use for all the ECMs together, and divided by the total number of kWh saved for the project. Thus this price can be thought of as a blended contract price. It is the average price per kWh saved, which is used by the ESCO to calculate annual electricity cost savings during the reporting period. Likewise, the actual blended electricity price is the total amount the site paid to the serving electric utility during the reporting period divided by the number of kilowatt-hours consumed.

We were able to calculate actual blended electricity price paid to the utility and the average contract price for electricity savings for 20 of the 27 Level 2 projects. The prices are shown in Table 4 and presented graphically in Figure 6. In the majority of cases — 13 out of 20 — the contract price of electricity is lower than the average price paid to the utility. In Figure 7 we have multiplied the average prices paid to the utility by 0.948, which given the LBNL study may be a better estimate of the marginal price of electricity at the site. These prices are also included in Table 4. The bottom line is the same when using marginal rather than the average rates: in 13 out of the 20 cases, the site is still paying a lower price to the ESCO for the electricity savings than it pays to the utility for electricity consumed.

Table 4: Average blended contract electricity price, average actual price paid to the utility, and 94.8% of the average electricity rates paid to the utility, which is an estimate of the marginal price of electricity.

Project number	Average blended contract rate, $/kWh	Average blended rate paid to utility, $/kWh	94.8% of average blended rate, $/kWh
5	0.0316	0.0375	0.0355
9	0.0350	0.0311	0.0295
15	0.0367	0.0591	0.0560
17	0.0482	0.0720	0.0682
44	0.1035	0.0499	0.0473
46	0.0318	0.0611	0.0580
48	0.0617	0.0734	0.0696
56	0.0467	0.0564	0.0535
57	0.0561	0.0601	0.0570
67	0.0533	0.0596	0.0565
94	0.0431	0.0691	0.0655
100	0.0683	0.0841	0.0797
120	0.0497	0.0404	0.0383
122	0.0569	0.0635	0.0602
124	0.1374	0.1645	0.1559
162	0.0613	0.0650	0.0616
184	0.0639	0.0496	0.0470
188	0.0620	0.0618	0.0586
253	0.0254	0.0903	0.0856

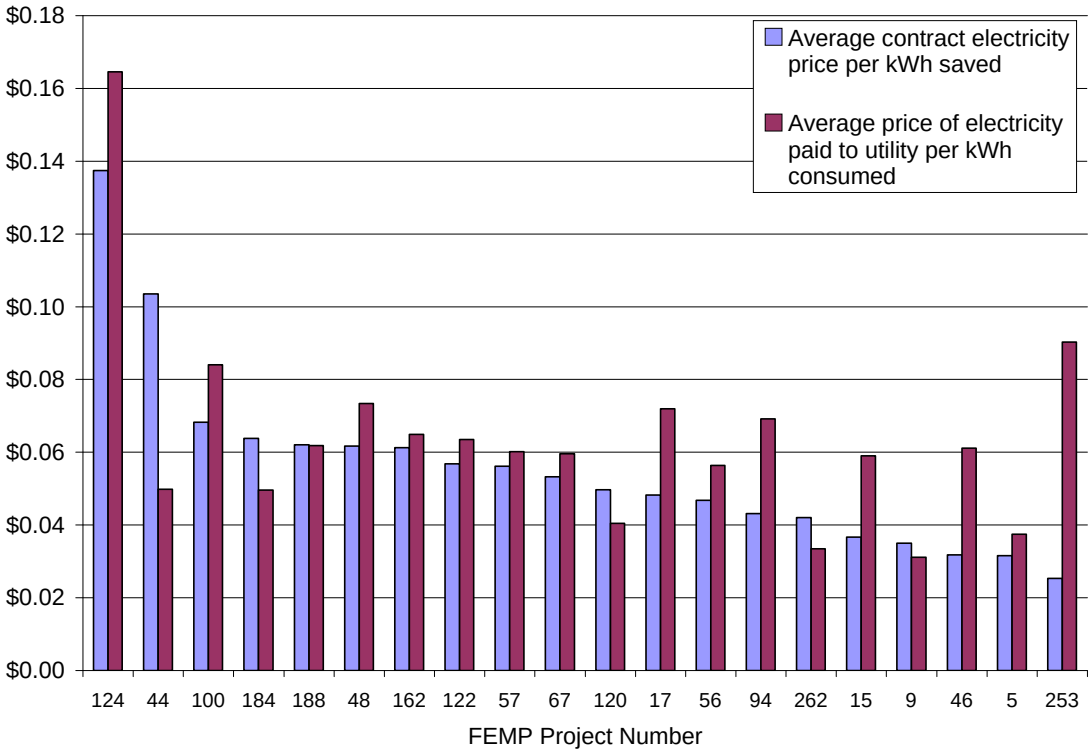

Figure 6: Average contract electricity price during period addressed by most recent annual M&V report and average actual electricity price paid to serving utility over the same period in 20 Super ESPC projects.

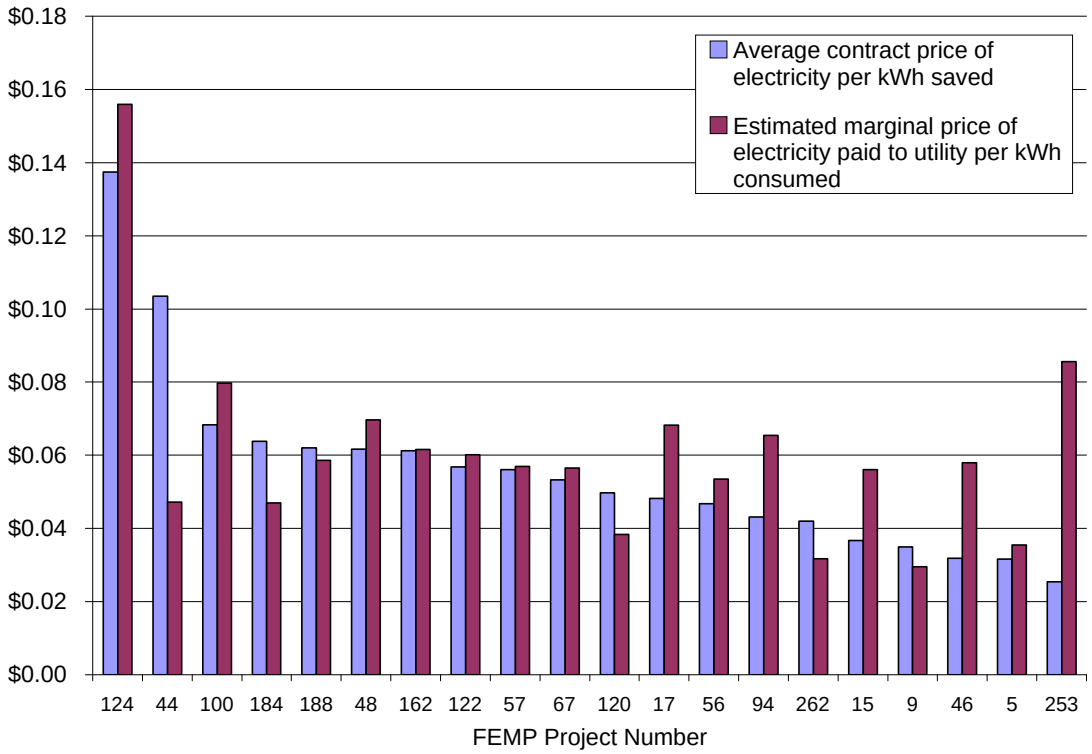

Figure 7: Average contract prices of electricity per kWh saved in 18 Super ESPC projects over the period addressed by the projects' most recent annual reports, and estimated marginal prices per kWh paid to the utility for electricity use over the same period. The marginal price is estimated to be 94.8% of the average price of electricity.

The fact that the contract price is higher than the marginal price paid to the utility in some cases does not necessarily mean that the government is receiving less than the guaranteed cost savings. First, we showed in the Level 1 analysis that reported savings were on average 108% of the guaranteed savings. For the Level 2 sample, that ratio was even higher at 111%. Thus, even if the marginal price of electricity is higher than the price paid to the ESCO, the site pays the ESCO for only 90% to 92% of the reported kWh savings. Secondly, guaranteed savings are based on the total cost savings, not on each specific form of energy saved. We have already shown that actual cost savings due to reductions in gas use were much higher than the reported values.

In addition, Figure 5 is based on the marginal cost of electricity in lighting retrofit projects and assumes a certain monthly energy and demand savings relative to the building's total energy use and peak demand. ECMs with different energy and demand savings relative to total facility energy and demand would have different marginal electricity prices. Only detailed analysis of the projects and utility tariffs can determine the true marginal price of electricity.

For the sample we analyzed, it appears that conservative electricity price escalation rates were used in the majority of cases. As with natural gas, this is usually a benefit to the government. For some ECMs, however, underestimating the escalation rate of electricity prices could overestimate the cost savings. For example, ground source heat pumps often

increase the use of electricity when they replace central air–gas furnace combinations. The annual savings is equal to the pre-retrofit cost of natural gas minus the cost of the increased electricity use. Using an electricity price lower than the actual price will overestimate the cost savings from the project. In such cases, determining the true cost savings requires consideration of natural gas and electricity prices together.

5.3.2 Electricity Price Results

When all 20 projects for which contract and actual electricity prices can be compared (Figure 6) are aggregated, the total reported annual electricity savings is 93,851,400 kWh. At contract electric prices, ESCOs reported the value of this savings as $5,207,814, for an average contract electricity price of $0.05549 per kWh. The average price paid to the utility during the periods addressed by the annual reports was $.05573 per kWh. Assuming the marginal price of this electricity is 94.8% of the price paid to the utility, then the reported electricity savings was worth $4,917,608, which is about 5% less than savings reported by the ESCOs. However, sites pay only for guaranteed savings, which is in the range of 90% to 92% of the reported savings. Although the guarantees apply to the total cost savings and not to any particular form of energy, multiplying the $5,207,814 in reported annual cost savings by 91% gives $4,739,111. This is 96% of the estimated price of the reported energy savings at marginal electricity prices. In the aggregate it seems that the contracts in the Level 2 sample chose appropriate escalation rates for electricity prices.

5.4 Cost Savings Recalculated Using Actual Utility Prices

Given the reported annual savings in gas, electricity, and other utilities, and the average actual utility prices the site paid over the year, it is possible to estimate what the government would have paid to the utility had the project not been implemented. Comparing this estimate with the annual cost savings reported by the ESCO (based on contract utility prices) determines how well ESPC contract prices follow the actual prices paid for the utilities at the site, assuming that the marginal price for electricity is 94.8% of the average price. For natural gas and other utilities, the marginal rate is about equal to the average rate. Thus when we use the term “marginal utility prices,” we mean 94.8% of the average price of electricity, and the average price of natural gas, water, fuel oil, and other utilities.

In all, we were able to recalculate the annual cost savings using marginal utility prices for 22 of the 27 Level 2 projects. This is two more than are shown in Figure 6. For these two projects, we were unable to calculate average contract electricity prices because the annual reports did not break down the cost savings by utility. However, the reports did contain information on the total annual use of gas and electricity, so we were able to recalculate the savings using marginal utility rates at the site.

In all cases, we used average electricity and gas prices supplied by the site or derived from the DOD and GSA databases. Where available, we also used average prices from these databases for potable water and other utilities such as steam, chilled water, and fuel oil. Where prices for these utilities were unavailable, to be conservative we used the original, unescalated utility prices from the project Final Proposal. We expect that these prices were close to the prices for the utilities at the time of award, and should be less

than or equal to the actual prices for these utilities. In any case, the guaranteed ESPC savings from utilities other than gas and electricity are less than 5% of the total savings guaranteed in the 22 projects. For O&M savings, we used the values that we recalculated, which means they correct any errors we found in the annual reports.

The results of the calculations are presented graphically in Figure 8 and numerically in Table 5. When marginal utility prices are used, calculated annual cost savings are higher than the reported annual cost savings in 16 of the 22 cases. In the aggregate, reported annual savings for these 22 projects total $16,568,873, while total annual cost savings calculated using actual rates is $18,433,373, or 111% of the reported cost savings.

In the recalculations above, we assumed the marginal electricity price to be 94.8% of the average electricity price. The marginal price of electricity must be assumed to be less than 60.7% of the average price before the total recalculated annual cost savings falls below the reported annual cost savings. Based on LBNL's results reported for marginal utility rates compared to average electricity price (Figure 5), it is unlikely that the

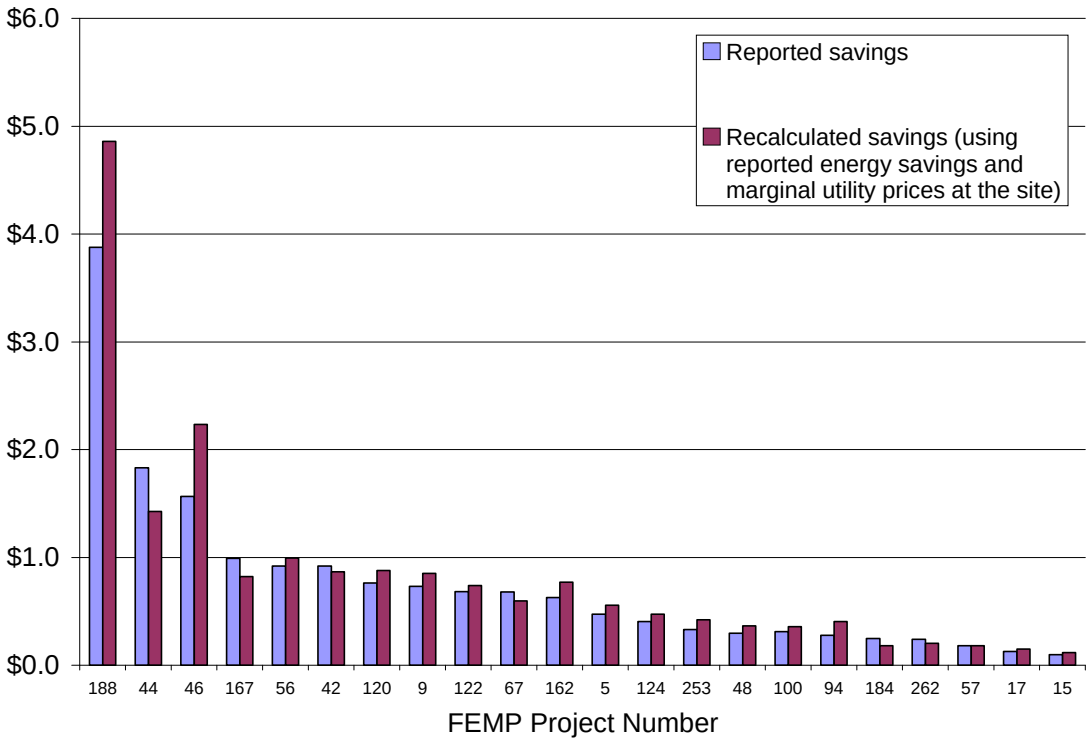

Figure 8: Reported cost savings for the most recent M&V report of 22 Level 2 projects; and recalculated cost savings, applying marginal utility prices at the site during the reporting period to the reported utility savings. Here the marginal price of electricity is assumed to be the 94.8% of the average price.

Table 5: Reported annual cost savings, recalculated annual cost savings using actual (estimated() marginal utility prices, and ratio of recalculated to reported annual cost savings.

FEMP Project number	Reported annual cost savings	Recalculated annual cost savings using marginal utility prices	Ratio of recalculated to reported annual cost savings
5	$473,153	$553,577	1.170
9	$733,558	$850,080	1.159
15	$97,979	$114,994	1.174
17	$126,736	$149,895	1.183
42	$918,940	$865,316	0.942
44	$1,829,643	$1,426,018	0.779
46	$1,563,613	$2,234,142	1.429
48	$296,923	$365,389	1.231
56	$918,393	$993,665	1.082
57	$179,150	$180,014	1.005
67	$679,086	$595,920	0.878
94	$277,438	$403,675	1.455
100	$313,274	$354,939	1.133
120	$762,658	$876,393	1.149
122	$684,109	$740,973	1.083
124	$405,049	$473,442	1.169
162	$627,162	$769,215	1.227
167	$989,735	$821,821	0.830
184	$246,940	$181,658	0.736
188	$3,874,795	$4,859,987	1.254
253	$330,217	$420,722	1.274
262	$240,322	$201,538	0.839
Total	$16,568,873	$18,433,373	1.113

marginal, regardless of the tariff used. Hence we conclude that for this sample of projects, and for the periods addressed by their most recent annual reports, the value of the reported energy, water and O&M savings is substantially higher than the cost savings reported by the ESCOs — about 111% of the reported annual cost savings.

Note that 111% is *not* an estimate of the ratio of recalculated to reported cost savings for the entire population of Level 1 projects. There is a large variation in size among the reported savings for projects, and the figure we have derived is weighted by the particular projects included in the Level 2 sample. To derive an estimate for the entire Level 1 population see Section 6.

5.6 Comparing Guaranteed and Recalculated Cost Savings

Up to this point we have been comparing *reported* annual cost savings with cost savings calculated using actual (estimated) marginal utility prices at the site. However, payments in Super ESPC contracts are based not on the reported savings but on the *guaranteed* cost savings. The aggregate guaranteed savings for the 22 projects is $15,632,856. Using marginal utility rates at the sites for the periods addressed by the annual reports, the aggregate annual cost savings from the reported energy, water, and O&M savings is $18,433,373 — 118% of the guaranteed annual cost savings.

Figure 9 compares the guaranteed annual cost savings with the recalculated savings for the 22 projects. Only one project, number 122, reported a cost savings shortfall in its annual report. The annual cost savings calculated using marginal utility prices at the site for this project is in fact greater than the guaranteed savings. On the other hand, the recalculated annual cost savings is less than the guarantee for a few projects that did not report a shortfall. Since the recalculated annual cost savings exceed the guaranteed annual cost savings for the majority of projects, and the aggregate recalculated annual cost savings exceeds the aggregate guaranteed annual cost savings by a wide margin, there does not seem to be a cause for concern. Utility prices do not rise at a steady rate, so even the best possible estimate of the average rate of increase would overpredict prices half the time, and underpredict in the other half. In our sample, contract gas prices were lower than actual prices at the site in 89% of the cases, and contract electricity prices were lower than the assumed marginal prices in 65% of the cases. This suggests that appropriately conservative assumptions are being made for fuel price escalation rates in Super ESPC project awards.

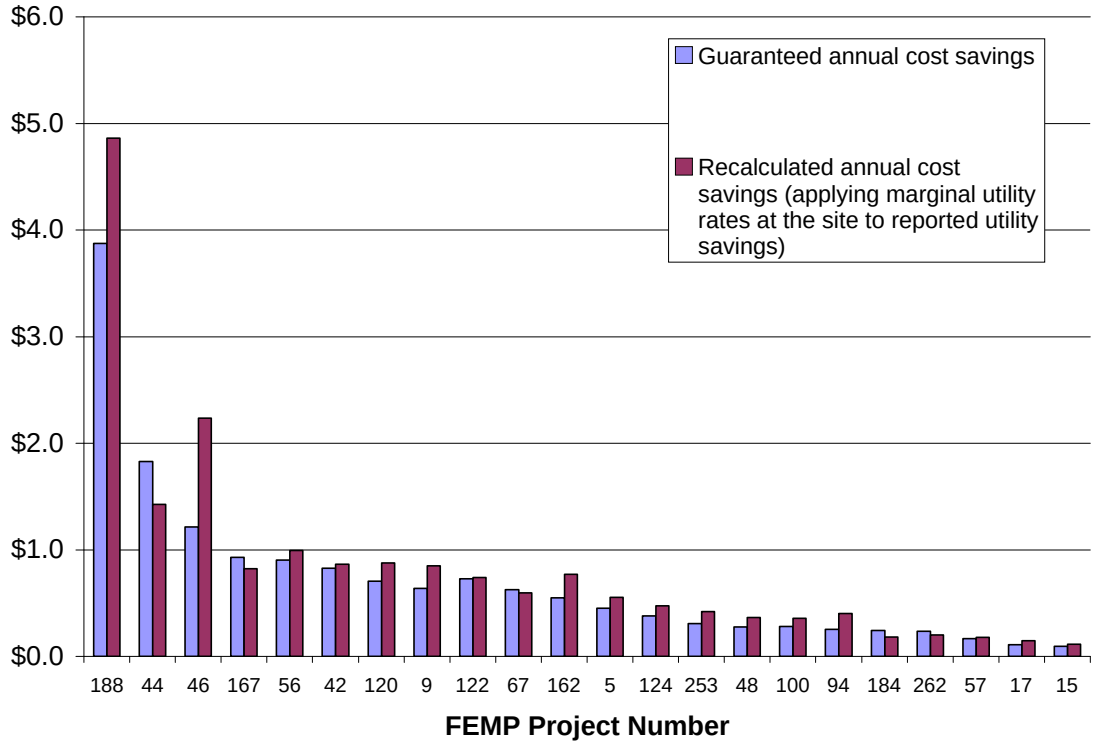

Figure 9: Guaranteed annual cost savings and cost savings recalculated using reported energy savings and marginal utility rates at the site, assuming that the marginal price of electricity is 94.8% of the average price.

6 COST SAVINGS USING ACTUAL UTILITY PRICES FOR LEVEL 1

Table 5 presents reported and recalculated annual cost savings and the ratio of recalculated to reported savings for 22 of the Level 2 projects. A histogram of the ratio of recalculated to reported annual cost savings, shown in Figure 10, suggests that the ratio is

a normally distributed random variable, and in fact when a standard statistical test is performed, the results are consistent with the data being a normal, random distribution — at least, the hypothesis cannot be rejected. Assuming then that this ratio is normally distributed, the mean of the distribution is 1.099, and the standard deviation is 0.197. The estimate for the ratio of recalculated annual cost savings using contract prices to reported annual cost savings based on actual utility rates for the entire Level 1 population of 102 projects is then about 110%.

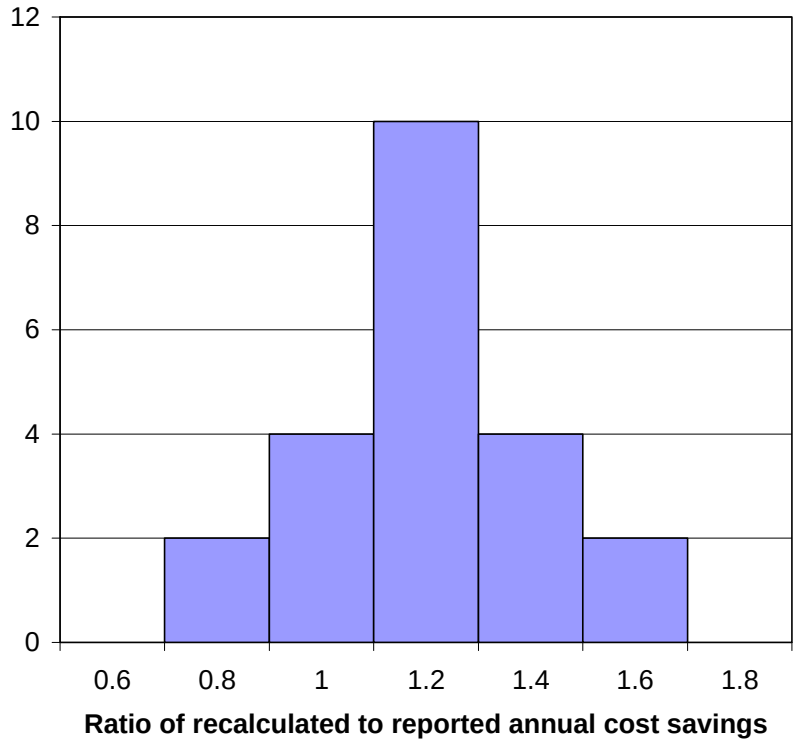

Figure 10: Histogram of the ratio of actual to reported savings for the 22 Level 2 projects where this ratio could be calculated.

Given the mean ratio, the standard deviation, and the reported cost savings for each of the Level 1 projects, we calculate the 90% confidence interval for the ratio as (1.055, 1.143). This is slightly better than our original objective of being able to estimate this parameter to within 5% of its mean value; the confidence interval is approximately +/- 4% of the mean value.

Analysis of the Level 1 data showed that the ratio of reported to guaranteed annual cost savings for the population is 1.08. We estimate that the ratio of recalculated annual savings (using marginal utility rates) to reported savings for the population is 1.11, assuming with some justification that the marginal rate was 94.8% of the mean price of electricity. Given these two figures, it is reasonable to estimate that in the aggregate, the program-wide (Level 1) value of the energy, water, and O&M savings reported in one year's annual reports is (108%)(110%) = 119% of the aggregate guaranteed annual cost savings.

Table 6: Reported annual cost savings, estimated actual annual cost savings, and the ratio of actual to reported cost savings

FEMP Project number	Recalculated annual savings	Estimated actual annual cost savings using assumed marginal utility prices	Ratio of estimated actual cost savings to reported cost savings
5	$473,153	553,577	1.159
9	$733,558	850,080	1.175
15	$97,979	114,994	1.179
17	$126,736	149,895	1.196
42	$918,940	865,316	1.047
44	$1,829,643	1,426,018	0.800
46	$1,563,613	2,234,142	1.454
48	$296,923	365,389	1.192
56	$918,393	993,665	1.115
57	$179,150	180,014	1.054
67	$679,086	595,920	0.942
94	$277,438	403,675	1.520
100	$313,274	354,939	1.189
120	$762,658	876,393	1.166
122	$684,109	740,973	1.077
124	$405,049	473,442	1.207
162	$627,162	769,215	1.234
167	$989,735	821,821	0.831
184	$246,940	181,658	0.775
188	$3,874,795	4,859,987	1.287
253	$330,217	420,722	1.287
262	$240,322	201,538	0.863

7 CONCLUSIONS AND RECOMMENDATIONS

Our objectives in Level 2 of this evaluation were to validate the ESCO's calculations of the annual energy and cost savings in the most recent annual M&V reports for a random, stratified sample of projects to correct any errors encountered, and then to recalculate the reported value of the energy, water, and O&M savings using actual utility prices at the project sites instead of contract prices to compare the recalculated savings with the ESCO's reported annual cost savings.

7.1 Assessment of M&V Reports

We began with a close reading the annual report, comparing the M&V techniques that were used with the M&V plan laid out in the Final Proposal. We found that ESCOs were following the plans approved in the contract. The majority of the reported cost savings contained in our sample, about 70%, used Option A M&V methods. Thus most of the savings reported by the ESCOs are based on stipulation of at least one parameter. M&V activities in these cases consist mainly of inspecting the equipment in the field to ensure that it is still in service. The ESCO then uses the contract prices for the reporting year,

and multiplies the stipulated energy savings by the utility rates to determine the reported annual cost savings.

The quality of the annual M&V reports and the availability of information required to check the savings calculations varied widely. In many cases key information was missing altogether or scattered throughout the report. The current Super ESPC IDIQs require that ESCOs use the Annual M&V Report Outline provided in Attachment 7 of the contract, which was added with the 2004 modifications. The outline calls for all of the information needed to verify that the ESCO has followed the M&V plan and has performed all calculations correctly. Many of the reports from more recently awarded contracts did follow the outline, but some did not. We recommend that FEMP reiterate to its ESCOs the need for annual M&V reports to follow the specified outline and to be stand-alone documents that contain all the required information.

Many Super ESPC projects, however, were awarded before the 2004 modifications. For these projects, we recommend that FEMP encourage the ESCOs to use the Annual M&V Report Outline from the current IDIQ. This should not be a hardship, because the ESCOs have all been awarded projects under the modified IDIQs and are presumably already using the outline for those projects.

We also observe that adding a few pieces of information to the executive summary of the annual report that are not specifically required there would be very helpful, especially all contract utility prices, including any seasonal or on-peak or off-peak rates. Where different prices are used for different seasons or times of day, the ESCO should be sure to present the quantity of electricity saved at each contract rate.

We also recommend that annual M&V reports include as an appendix the current delivery order (DO) schedules (or H-schedules for older projects), both from the award and from any subsequent modifications. These contract documents contain most of the information required to verify the ESCO's calculations. ESPC customers should not have to refer back to Final Proposals and Detailed Energy Surveys to follow the ESCO's calculations.

7.2 Comparing Contract and Actual Energy Prices

We found that most contracts had used conservative assumptions for escalation of natural gas and electricity prices. In 17 of the 18 projects for which it was possible to compare natural gas prices, contract gas prices were found to be lower than the average price being paid to the serving gas utility. In 14 of the 20 projects for which it was possible to compare electricity prices, contract electricity prices were found to be lower than the assumed marginal price of electricity supplied by the serving utility. To determine the true marginal price of electricity at the sites would require pre- and post-retrofit utility bills for all the sites included in an ESPC contract, copies of the electric tariffs, and other information that was not available to us. Based on LBNL research performed for DOE, we assumed the marginal price of electricity to be 94.8% of the average price at each site. It may be possible to obtain better estimates of this parameter for different ECMs or for the different census regions of the United States.

7.3 Reported Savings Are 19% Higher Than Guaranteed Savings

Finally, we conclude that if the reported energy, water, and O&M savings are being delivered, the government is achieving cost savings beyond the cost savings guaranteed for the projects. The annual cost saving calculated using the actual prices of utilities paid by the sites instead of the contract prices were higher than the annual cost savings reported by the ESCO in 16 of 22 cases. In the aggregate for the 22 projects analyzed, the recalculated annual cost savings was found to be 111% of the reported savings.

For the entire population of 102 Super ESPC projects examined in Level 1, we estimate that the recalculated annual cost savings using utility prices paid at the site are about 110% of the reported annual cost savings. In Level 1 of the evaluation we determined that reported annual cost savings were on average 108% of guaranteed annual cost savings. Given these two figures, we can estimate by multiplying 1.08 by 1.10 that the annual cost savings realized by the government are about 19% higher than the guaranteed annual cost savings for the entire 102-project population of Super ESPC projects. An important caveat is that ESCO-reported energy savings have not yet been independently verified in this evaluation. That analysis will be completed in Level 3.

8 REFERENCES

Army, 2007. Army Energy and Water Reporting System (AEWRS), https://aewrs.hqda.pentagon.mil/.

Curran, Karen, 2007. (GSA Office of Applied Science Energy Center of Expertise), personal communication, August 2007.

FEMP, 2007. *Reviewing Post-Installation and Annual Reports for Federal ESPC Projects*. February, 2007. http://www1.eere.energy.gov/femp/docs/reviewing_annual_pi_reports.doc

LBNL, 1999. *Marginal Energy Prices Report*. U.S. Department of Energy, July, 1999. http://www-library.lbl.gov/docs/LBNL/466/25/PDF/LBNL-46625.pdf

Navy, 2007. Navy Defense Utilities Energy Reporting System (DUERS) https://energy.navy.mil/duers/.

Nexant, 2002. *Review of Super ESPC Measurement & Verification Annual Reports.* June 27, 2002. http://ateam.lbl.gov/mv/docs/MV-Annual-Review-June-2002.doc

Nexant, 2004. *Evaluation of Super ESPC Performance Reports*. http://ateam.lbl.gov/mv/docs/Performance-Report-Evaluation-Executive-Summary-September-2004.doc

Nexant, 2006. *3rd Party Post-Installation Savings Verification for NASA Ames Super ESPC Projects #1 & 2: Final Report.* April 15, 2006.

Rushing, A. S., and B. C. Lippiat, 2007. *Energy Price Indices and Discount Factors for Life-Cycle Cost Analysis – April 2007*. U.S. Department Of Commerce, May 2007. http://www1.eere.energy.gov/femp/pdfs/ashb07.pdf

Schweitzer, M.; J. A. Shonder, P. J. Hughes, and R. L. Schmoyer, 2006. *Methodology for Recalculating and Verifying Savings Achieved by the Super ESPC Program.* ORNL/CON-496. Oak Ridge National Laboratory, July 2006.

Shonder, J.A., and P.J. Hughes, 2007. *Evaluation Of The Super ESPC Program – Reported Energy And Cost Savings: Interim Report*. ORNL/TM-2007/065, May 2007.

Sisk, Linda, 2007. (Air Force Civil Engineering Support Agency), personal communication, July 2007.

APPENDIX A: LEVEL 1 POPULATION OF PROJECTS

FEMP Project Number	Project Name	Award date	Agency	Census Region	Aug 2001 mods	Reporting period for annual report	Annual guaranteed cost savings, most recent annual report
1	Corvallis Forestry Lab	9/28/1998	USFS	West	Before	6/1/04 – 5/31/05	$74,817
2	Defense Manpower Data Ctr	6/21/1999	DOD	West	Before	5/15/04 – 5/14/05	$353,998
3	Def Lang/Presidio and Annex	12/23/1999	Army	West	Before	6/15/04 – 6/14/05	$273,366
5	Ft. Lewis/Yakima Firing Range	6/28/2002	Army	West	After	8/1/05 – 7/31/06	$452,761
7	Pt. Mugu	8/12/1999	Navy	West	Before	2/1/05 – 1/31/06	$262,586
9	Subase Bangor, DO#2	9/27/2001	Navy	West	After	3/1/05 – 2/28/06	$637,631
11	SW Region, DO #1	3/1/2001	Navy	West	Before	7/1/04 – 6/30/05	$719,325
12	SW Region, DO #2	9/26/2001	Navy	West	After	4/1/04 – 3/31/05	$1,431,974
13	Marine Corps Air Station [Miramar CA]	9/26/2001	Navy	West	After	7/1/04 – 7/31/05	$467,228
14	Naval Air Station - Fallon	9/26/2001	Navy	West	After	7/1/04 – 6/30/05	$236,370
15	Idaho Eng Lab/Lockheed	1/22/2001	DOE	West	Before	3/1/05 – 2/28/06	$94,728
16	North Las Vegas	11/30/2001	DOE	West	After	9/1/05 – 7/31/06	$137,591
17	FDA Building - Bothell	9/23/1998	GSA	West	Before	12/1/04 – 11/30/05	$110,664
18	Wyatt-Green Fed Bldg.	2/21/2001	GSA	West	Before	1/1/05 – 11/30/05	$96,368
21	Sherman Indian High School	6/29/2000	BIA	West	Before	4/1/04 – 3/31/05	$217,008
24	Job Corps Centers	10/8/1999	DOL	West	Before	3/1/05 – 3/31/06	$29,267
25	Reagan Library	3/21/2002	NARA	West	After	3/1/04 – 2/28/05	$180,115
26	Ames Research Center DO#1	8/21/2000	NASA	West	Before	9/1/05 – 8/31/06	$226,444
27	Integrated Support Command, Kodiak, AK, DO#1	6/8/1998	USCG	West	Before	4/1/04 – 3/31/05	$224,322
28	Integrated Support Command, Kodiak, AK, DO#2	7/30/1999	USCG	West	Before	5/1/04 – 4/30/05	$647,760
29	Integrated Support Command, Alameda, CA	4/19/1999	USCG	West	Before	4/1/05 – 3/31/05	$127,037

30	ARTCC, Seattle, WA	7/29/1998	FAA	West	Before	6/1/05 – 5/30/05	$54,115
33	San Francisco VAMC (VISN 21, DO #1)	9/28/1998	VA	West	Before	2/1/05 – 1/31/06	$588,419
34	VA Medical Center San Francisco (VISN 21, DO #2)	8/21/2003	VA	West	After	10/1/05 – 9/30/06	$382,974
36	VA Medical Center (VISN 22)[San Diego]	9/30/2003	VA	West	After	2/1/05 – 1/31/06	$1,494,587
37	VA Medical Center - Fresno (VISN 21)	8/21/2003	VA	West	After	11/1/04 – 10/31/05	$476,618
42	Fort Gordon, Fort Jackson & Fort Stewart Medical Commands	9/30/2000	Army	South	Before	10/1/04 – 3/31/05	$828,415
44	Fort Jackson	9/18/2001	Army	South	After	2/1/05 – 1/31/06	$1,829,644
46	Marine Corps Albany	9/3/2003	Navy	Northeast	After	12/1/04 – 11/30/05	$1,213,311
48	Camp LeJeune	11/7/2002	Navy	South	After	12/1/04 – 11/30/05	$278,844
49	Y-12	3/26/2001	DOE	South	Before	8/1/05 – 7/31/05	$297,000
51	Oak Ridge National Laboratory	8/6/1999	DOE	South	Before	11/15/04 – 11/14/05	$531,098
54	Columbia, SC - 11 sites in TN and SC	11/22/2000	GSA	South	Before	11/1/05 – 10/31/06	$208,836
55	Raleigh NC - Bundled Sites	9/29/2000	GSA	South	Before	11/1/04 – 10/31/05	$177,888
56	Atlanta - Richard Russell & Summit	9/30/1999	GSA	South	Before	6/1/05 – 5/31/06	$903,010
57	Memphis, TN Customer Service Center and 8 bldgs in 4 states	1/23/2001	GSA	South	Before	1/1/05 – 12/31/05	$167,719
58	Courthouse and New Construction - Gulfport	9/28/2001	GSA	South	After	10/1/05 – 9/30/06	$391,351
60	Center for Disease Control	5/31/2001	DHHS	South	Before	3/1/05 – 2/28/06	$85,658
61	Job Corps various sites	9/27/2003	DOL		After	8/23/04 – 8/22/05	$201,923
66	VA Medical Center (VISN 7)	5/19/2003	VA	South	After	3/1/05 – 2/28/06	$1,629,943
67	National Animal Disease Center, Agricultural Research Services	12/16/1999	USDA	Midwest	Before	2/1/05 – 1/31/06	$627,382
69	Marine Corps Support Activities Center - Richards-Gebaur Memorial Airport	2/1/2001	Navy	Midwest	Before	4/1/05 – 3/31/06	$124,365
70	National Imagery & Mapping	6/5/2000	DOD	Midwest	Before	8/1/04 – 7/31/05	$179,650

	Agency						
71	Argonne ntl LAB	12/19/2003	DOE	Midwest	After	2/1/05 – 1/31/06	$291,699
77	Des Moines Federal Bldg	5/24/2001	GSA	Midwest	Before	2/1/05 – 1/31/06	$72,511
78	GSA Bannister	9/30/2003	GSA	Midwest	After	6/1/05 – 5/31/06	$210,506
80	Glenn Research Center @ Lewis Field	8/5/1999	NASA	Midwest	Before	1/1/05 – 12/31/05	$243,705
82	Des Moines VA Medical Center (VISN 14)	8/8/2001	VA	Midwest	Before	4/1/05 – 3/31/06	$85,086
83	VA Medical Center (VISN 23):	12/12/2002	VA	Midwest	After	10/1/05 – 9/30/06	$708,432
84	Iron Mountain	8/21/2003	VA	Midwest	After	7/1/04 – 6/30/05	$396,096
91	Pantex Plant	6/1/2000	DOE	South	Before	5/22/05 – 5/21/06	$508,547
94	National Risk Management Research Laboratory	9/27/2000	EPA	South	Before	1/1/05 – 12/31/05	$253,953
95	Denver Federal Center	6/29/2000	GSA	West	Before	9/1/04 – 8/31/05	$210,451
96	Denver Federal Center #2	9/11/2001	GSA	West	After	10/1/04 – 9/30/05	$274,828
97	Austin Project - Ft.Worth Office, TX	12/29/1999	GSA	South	Before	4/30/05 – 4/29/06	$369,311
98	Project in South Texas Sites - Ft. Worth Office	5/4/2000	GSA	South	Before	2/1/05 – 1/31/06	$112,628
99	Denney Federal Building/Courthouse, Lincoln NE (Kansas City GSA Office)	7/25/2000	GSA	Midwest	Before	5/1/05 – 4/30/06	$119,193
100	Albuquerque & El Paso Projects - Ft. Worth Office, TX	12/4/2002	GSA	South	After	2/1/04 – 1/31/05	$281,955
102	Houston GSA Buildings (Ft. Worth GSA Office)	4/15/2003	GSA	South	After	3/31/05 – 3/30/06	$144,188
103	Denver Downtown Buildings	8/22/2002	GSA	West	After	10/1/05 – 9/30/06	$153,339
104	Projects in TX, LA, AR - Dallas/Ft. Worth Office	6/28/2002	GSA	South	After	4/1/05 – 3/31/06	$82,477
105	Kansas City Regional Office - Wichita, Topeka, KS sites	9/6/2002	GSA	Midwest	After	1/14/05 – 1/13/06	$53,330
106	IHS - Aberdeen Area Office	8/1/2001	I.H.S.	Midwest	Before	10/1/04 – 9/30/05	$355,372
109	Southwest Indian Polytechnic Inst.	4/20/2001	BIA	West	Before	10/1/04 – 9/30/05	$164,160

110	Haskell Indian Nations University, Riverside Indian School	9/14/2001	BIA	South	After	11/1/03 – 10/31/04	$271,513
112	Gary Job Corps Center	12/22/1999	DOL	South	Before	1/1/05 – 12/31/05	$209,674
113	Bundle - LA, TX, NM, OK, KS	9/15/2003	DOL	South	After	2/1/05 – 1/31/06	$247,702
114	Eisenhower Museum and Library	7/31/1999	NARA	Midwest	Before	10/1/04 – 9/30/05	$35,727
117	Denver/Salt Lake City ARTCCs	8/30/2002	FAA	West	After	9/1/05 – 8/31/06	$86,358
118	VA Medical Center (VISN 19)[Denver]	5/16/2001	VA	West	Before	6/1/04 – 5/31/05	$260,487
119	VA Medical Center (VISN 19)[Grand Junction]	5/28/1999	VA	West	Before	3/31/04 – 3/30/05	$74,732
120	VA Medical Center (VISN 19)[Salt Lake City]	1/31/2000	VA	West	Before	10/1/05 – 9/30/06	$705,960
122	VA Medical Center (VISN 17)[San Antonio/Kerrville]	7/13/2001	VA	South	Before	10/1/04 – 9/30/05	$730,148
124	Ft. Hamilton	11/16/2001	Army	Northeast	After	10/1/04 – 9/30/05	$377,622
125	Leo O'Brien Federal Building	6/8/2000	GSA	Northeast	Before	8/1/04 – 7/30/05	$211,203
129	JFK/FDR Library	10/17/2002	NARA	Northeast	After	1/1/05 – 12/31/05	$651,865
131	U.S. Merchant Marine Academy	8/31/2001	DOT	Northeast	Before	9/1/04 – 8/31/05	$715,951
132	VA Medical Center [3 sites 1 MA & 2 CT]	9/5/2001	VA	Northeast	After	2/1/04 – 1/31/05	$1,106,979
133	VA Medical Center [Providence]	3/2/2001	VA	Northeast	Before	2/1/05 – 1/31/06	$111,939
135	DOA/USDA/ARS:NatlAgricLib,Beltsville,MD-MA	2/1/2000	USDA	South	Before	5/1/05 – 4/30/06	$105,471
138	National Institute of Standards and Technology (NIST)	11/26/2002	DOC	South	After	7/29/04 – 7/28/05	$860,462
146	Boggs Federal Building and Courthouse	3/3/2003	GSA	South	After	2/1/05 – 1/31/06	$67,700
147	Nix Courthouse and Customs House	6/26/2003	GSA	Northeast	After	3/1/05 – 2/28/06	$144,017
150	National Gallery of Art	11/2/2000	NGA	South	Before	11/1/04 – 10/31/05	$343,588
159	Rock Island	5/31/2002	Army	Midwest	After	6/25/03 – 6/23/04	$703,741
162	Carlisle Barracks	7/17/2002	Army	Northeast	After	4/1/05 – 3/31/06	$551,497

163	Aberdeen Proving Grounds	9/14/2001	Army	South	After	1/0/00 – 1/0/00	[incomplete information]
164	Yongsan Garrison	4/23/2003	Army	N/A	After	2/1/03 – 1/31/04	[incomplete information]
166	Patuxent River Naval Air Station	9/28/2000	Navy	South	Before	4/10/05 – 4/9/06	$319,614
167	Oceana Naval Air Station/Little Creek Naval Amphib. Base	12/24/2002	Navy	South	After	1/1/05 – 12/31/06	$929,953
169	Embassy Facilities - Seoul, Korea	3/19/2001	DOS	N/A	Before	7/1/04 – 6/30/05	$585,217
175	GSA - FDA White Oak	7/12/2002	GSA	South	After	1/1/05 – 12/31/05	$995,333
184	Ames Research Center DO#2	3/29/2002	NASA	West	After	10/1/04 – 9/30/05	$242,030
188	Marine Base Quantico	9/30/2002	Navy	South	After	10/1/04 – 9/30/05	$3,874,795
233	National Capitol Region - HOTD	7/12/2002	GSA	South	After	10/22/04 – 10/21/05	$175,817
234	North Central States Courthouse, 2 Fed. Bldgs.	4/22/2002	GSA	Midwest	After	7/9/04 – 3/30/05	$269,192
253	GSA Michigan	9/25/2003	GSA	Midwest	After	10/1/04 – 9/30/05	$306,937
262	Hill AFB Regional	9/30/2003	Air Force	West	After	6/1/04 – 5/31/05	$233,897
263	Fort Drum	9/22/2003	Army	Northeast	After	1/1/05 – 12/31/05	$401,055
264	VA Medical Center (VISN 23) Phase II:	8/21/2003	VA	Midwest	After	9/1/05 – 8/31/06	$686,611
272	Hill AFB BAMF Project	9/30/2003	Air Force	West	After	1/20/05 – 1/19/06	$827,571
273	MMA Kings	9/25/2003	DOT	Northeast	After	9/1/04 – 8/31/05	$706,674