Determining The Saturation Level of Energy Savings Performance Contracts in the U.S. Army

Isaac J. Faber  
Department of Systems Engineering  
United States Military Academy  
West Point, NY 10996

James Sambor  
Department of Systems Engineering  
United States Military Academy  
West Point, NY 10996

Andrea Bagley  
Department of Systems Engineering  
United States Military Academy  
West Point, NY 10996

Abstract

Nearly two decades ago the United States Army began a program seeking to improve energy efficiency through third party contracts. Third parties would be brought on to Army bases to provide energy efficiency through improved infrastructure. The funding of and execution of these projects are the responsibility of the private enterprise. These companies would be paid in kind for any realized energy savings resulting from improved infrastructure. These contracts became known as Energy Savings Performance Contracts (ESPCs). As this program has risen in popularity, several billions of dollars in private investments have been given to it. This popularity shows that the time has come to see if performance has kept pace with cost. This study examines third party investment and cost obligation incurred as a result. Our study seeks to find the proportion of the Army’s stated energy budget that is obligated to third party energy contracts. This proportion is deemed the ‘saturation level’ and may imply a significant burden given the dynamics of pricing, cost, and the current budget environment. With uncertainty in the domains of fiscal priorities and energy prices this study is timely and important.

Keywords  

1. Background

1.1 Overview

For over two decades the United States federal government and its components have been awarding special contracts known as energy (or utility) savings performance contracts (ESPCs) to improve energy infrastructure. These contracts are specifically targeted at increasing energy or utility efficiency (reducing use). The general agreement is that a private firm, referred to as an energy savings company (ESCO), will identify and install needed upgrades to infrastructure [8]. The ESCO will carry the entire financial burden for installation of upgrades and will be compensated with the money saved on the energy bill. In other words, through ESPCs the ESCO pays an upfront cost for a known stream of income [11]. Currently there are approximately twenty prequalified contractors or companies who have been credentialed to fulfill ESPCs between the Army and the Department of Energy [10]. This approach is not a cost savings one for the government but does improve efficiency which is in line with political and environmental motivations. These types of contracts have become incredibly popular, reaching annual savings payments of hundreds of millions of dollars and infrastructure investment in the billions across the federal government [6].
A large motivator for these contracts is President Obama’s executive order mandating that the Department of Energy and other executive departments use ESPCs and utility savings performance contracts (USPC) [9]. These contracts are not only used to reduce the energy bill by decreasing energy and water consumption, but they also increase the quality of life for government employees through improvement and modernize of facilities. However, in a time of increasing budget uncertainty questions have been raised as to whether these contracts have resulted in the hoped for energy savings. There is encouraging outcomes in the literature that explain the two main contributors to cost in energy services contracts are production cost and transaction costs. Savings are primarily gained from reduced production costs which result in a profitable contract [11]. Another example of successful implementation of ESPCs comes from the Center for Medical, Agricultural, and Veterinary Entomology (CMAVE), a federal research facility, who lowered energy costs by over $131,000 in the first year [5]. Using ESPCs for new projects usually results in four to thirteen percent of production costs, which is a reasonable return given the size of the investment [4]. The following is a general list of pros and cons with typical ESPC’s:

The benefits of ESPCs are the following:

- Having private sector expertise and improved infrastructure that allows for increased quality and value
- Flexibility in contracting processes to fit individual agencies, access to experts at the Federal Energy Management Program (FEMP)
- Guaranteed savings without using appropriated funds upfront
- Minimized exposure to volatility in energy prices, weather, and equipment failures [6]
- Does not require the client to pay for the total expenses up front but in installments over the length of the contract
- The contractor guarantees a certain amount of savings through his services and work to the client and is used as a payment to the contractor
- Allows agencies to take on more expensive contracts by distributing the cost throughout the lifetime of the ESPC instead of a single, overwhelming hit to the budget [2]

The issues associated with ESPCs are:

- ESPCs that have a long term are typically inflexible [3]
- Early termination of contracts will likely incur a fee
- Newer, more efficient technologies can only be attained if specified in the initial contract
- Clients cannot see the savings or appropriate them for other projects because they are used to pay the contractor
- Lack of competition for ESPCs provokes questioning of fairness in contract awards [2]

Federal agencies, including the Department of Defense, use ESPCs to improve infrastructure and implement energy saving measures with little use of appropriated funds [6]. These measures were implemented to meet the President’s goal of zero net energy in new Federal buildings by 2030 and reduce energy consumption by 30 percent from the 2003 baseline by 2015 [9]. Additionally the House of Representatives passed a bill that stresses the use of private sector investment to fund infrastructure modernization projects meant to save energy [7]. These contracts have been authorized through the end of FY 2016. However, with impending sequestration there is expected to be a ten percent budget reduction in the near future [10].

The purpose of this study is to explore how much (as a portion of installation budget) of the United States Army’s energy budget has been and may likely be devoted to third party energy contracts. The level of saturation will allow decision makers to identify or forecast a point at which paying energy related costs creates undo strain on the overall installation budget. For this paper the saturation level will be defined as a given percentage of total budget, defined as:

\[
Saturation = \frac{\text{EnergyBudget}}{\text{TotalInstallationBudget}}
\]

As a component of the United States federal government the Army has a legal obligation to allocate and utilize dedicated funds to operate and maintain its physical locations around the world. These locations are more commonly known as installations or bases. The cost to operate and maintain installations for the Army is between five and six billion dollars per year and includes all expenses a typical city would have like security, general maintenance and energy. Historically utilities (electricity, natural gas, coal, water etc.) have cost about 20% of the total budget which
was approximately one and a half billion dollars in the fiscal year 2013 (FY13). Included in this (energy) budget are
ESPCs and USPCs; the primary concern is that these contracts may not yield the projected savings even though the
payment obligation to the ESCO remains. It is believed that saturation is close if not already passed [10]. However,
the Army needs a way to test and measure if this is in fact the case.

The primary concern with decision makers is that ESPCs lock the Army into long term payments for energy savings
where costs escalate faster than budget increases are authorized. By regulation the Army’s energy budget is only
allowed to increase by 3% or less annually. However, if market prices increase in excess of this (the regulation
guidance) amount ESCO’s must still be reimbursed at the higher rate (typically) [10]. This is a concern because the
types of energy used by the Army have price growth that is highly uncertain both regionally and temporally. For
example Figure 1 shows the increase in electricity pricing over the past decade.

![Figure 1: Electricity Price Trends](image)

As shown in the figure prices have quite a large variation in this region (the New York, New Jersey and Pennsylvania
area), the most expensive by cost per kWh in the country, they also show a recent increase greater than the allowable
amount. This is quite concerning and serves as the basis of justification for this study.

1.2 Data

The primary concern when conducting this study is with the quality and origin of the data used. The Army uses
a bottom up reporting systems fed from the installations in order to aggregate energy use data. However, there are
two reporting systems; the first is done by the installation headquarters and is known as the installation status report
or ISR. The second is a database populated by the installations energy office and is known as the Army Water and
Energy Reporting System (AWERS). Previous analysis has shown that the AWERS data is greatly preferred to ISR
for both energy amount and cost [1]. When collecting data for the Army’s utilities budget six different categories of
information are aggregated. These categories are detailed in Table 1.

<table>
<thead>
<tr>
<th>Table 1: Energy Budget Cost Categories</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cost Category</td>
</tr>
<tr>
<td>-------------------------</td>
</tr>
<tr>
<td>Energy</td>
</tr>
<tr>
<td>Water</td>
</tr>
<tr>
<td>Reimbursement</td>
</tr>
<tr>
<td>Manpower</td>
</tr>
<tr>
<td>Alternative Finance</td>
</tr>
<tr>
<td>Utilities Performance Contract</td>
</tr>
</tbody>
</table>

The main sources of energy used by Army installations are electricity and natural gas. There are smaller amounts of
fuel oil, LPG/propane, coal, and purchased steam used across the army. For the purpose of this study all other (non-
electricity and natural gas) energy sources are aggregated into their own category called miscellaneous. The sources
that comprise the energy budget can be seen in the graph in Figure 2 detailing FY13 total expenditures.

As Figure 2 shows the total cost of actual energy use has been relatively constant even with the rising cost of electricity
seen in Figure 1. This is anecdotal evidence that the ESPCs may be having some positive impact. However, it should
be noted that over the decade represented the cost of natural gas has decreased significantly nationwide. This is at
least partly contributes to the total cost trend staying constant. Additionally the percent of the budget that has been allocated to the payment of ESPCs has no real trend.

As shown in Figure 3 the annual savings (payments owed) for ESPCs have grown exponentially from 2004 to 2011. However across the federal government the trend in recent years appears to be leveling off. An explanation for this might state that the easily identifiable contracts, such as replacing antiquated HVAC systems, have all been executed. Since these contracts are mostly complete companies must accept greater risk on more involved projects. Therefore, the number of new contracts is about equal to the number of closing contracts leading to a leveling of the total number of contracts in the most recent three years (FY2011-2013). [6]. Also of important consideration is the longitudinal commitment of ESPCs. All values listed after FY 2012 are future obligations that are required to be paid out even if no additional contracts are awarded. Because the contracts take so long to pay out (often over two decades) there is little incentive to replace ESCO updated equipment even if a significant innovation could save more energy. In the next section the methodology for how to predict if a saturation level will be realized.

2. Methodology
The approach this paper will use to determine the probability of a given saturation level will be Monte Carlo simulation. The model will be based on gathered historical data (detailed below). However, it will be up to the decision makers within the Army to decide what actual percentage of the installation budget is considered acceptable for spend-
In this expression the \( r_i \) are the annual rate of change of the cost categories that will be modeled using a Gaussian assumption (\( r_i \overset{\sim}{\mathcal{N}}(\mu, \sigma) \)). The \( X_i \) are the base costs given in Table 2 and Figure 3 and the \( n \) is the year in which the forecast takes place. The index \( i \) is used to indicate the year for which the model will predict. The equation’s output will give the expected energy budget for a given year. The last decade of annual information will be used to estimate these parameters (\( \mu, \sigma \)). The classical statistical estimation for mean and standard deviation will be employed as given in Equations 3 and 4.

\[
\hat{\mu}_i = \frac{\sum_{i=1}^{n} r_i}{n} \quad (3)
\]

\[
\hat{\sigma}_i^2 = \frac{\sum_{i=1}^{n} (r_i - \hat{\mu}_i)^2}{n - 1} \quad (4)
\]

Of the six categories only three have reliable historical information (energy, water and alternative financing). The other three (water, utility privatization, and reimbursement) will be modeled using a general inflation rate which is calculated using the CPI annual rates of change from 1993 to 2013. Additionally for comparison purposes the installation budget will be assumed to grow at the same inflation rate. The CPI used in the model is based in the US Bureau of Labor Statistics all-items index. This index was chosen because the installation budget is dependent on many aspects of the economy, much like the basket of goods reflected in the CPI. Energy will be modeled as dependent on the historical variation of electricity, natural gas and the constructed category of miscellaneous. The energy variable will itself be a convolution of other random variables as given in Equation 5.

\[
X_{\text{energy}} = X_{\text{Electricity}} + X_{\text{NaturalGas}} + X_{\text{Misc}} \quad (5)
\]

There a few concerns with this approach. The first is that the Gaussian assumption may not be the best description of the distribution of rates of cost growth. However, most of the current models for budgeting rely on this same assumption so this approach will be consistent with current practice. Another issue is that only a limited horizon of information is available (one decade of annual data points). While this restriction of information will speak to the power of the results it is still better to identify trends. The final issue is that ESPC’s have slowed in growth in recent years (as stated earlier) and the preliminary model will use a sampling from a time of rapid growth. This nuance will be addressed in the results as the model will be used to do a ‘what if’ approach to various ESPC’s growth scenarios (not just the statistical average).

### 3. Results

Preliminary results rely on the estimates the parameters for the simulation. Each of the cost categories from Table 1 have parameters that are statistically inferred using Equations 3 and 4.

<table>
<thead>
<tr>
<th>Cost Growth Factors</th>
<th>Base Growth Mean</th>
<th>Base Growth STDEV</th>
</tr>
</thead>
<tbody>
<tr>
<td>Energy</td>
<td>2.23%</td>
<td>5.00%</td>
</tr>
<tr>
<td>Water</td>
<td>2.45%</td>
<td>0.93%</td>
</tr>
<tr>
<td>Reimbursement</td>
<td>2.45%</td>
<td>0.93%</td>
</tr>
<tr>
<td>Manpower</td>
<td>2.45%</td>
<td>0.93%</td>
</tr>
<tr>
<td>Alternative Finance</td>
<td>9.02%</td>
<td>4.90%</td>
</tr>
<tr>
<td>UP</td>
<td>2.45%</td>
<td>0.93%</td>
</tr>
</tbody>
</table>
Faber, Sambor and Bagley

With the statistics from this table the simulation was conducted with 100,000 trials. Figure 4 is an output of frequency of a given saturation distribution after five years from baseline (n=5 from FY 2013 to FY 2018). This distribution uses the average growth of ESPC (Alternative Finance) costs of nearly 9%. This leads to a forecast of drastic saturation growth in a relatively short horizon.

Figure 4: Five Year Saturation Distribution

A fuller picture is given by Figure 5 where the saturation level distribution is given over yearly horizons of 1, 3, 5 and 10 respectively. The large variation in contracts and energy prices shows growing levels of uncertainty as the forecast horizon increases. The figure also shows that the average saturation level is increasing. This is troubling for decision makers in that it suggests that the energy budget will outstrip the installation budget quickly due, in part, to excess energy costs and the large growth in ESPCs.

Figure 5: Yearly Saturation Distributions

As mentioned earlier it seems that in the last few years the annual payments of ESPCs has seemed to level off (Figure 3). It is useful to evaluate these distributions with a restrictive assumption that these contracts are at a steady state. The analysis will be done with the alternative financing category only following the general inflation rate. The results with this restriction at a five year horizon are compared at various saturation rates shown in Table 3.

Table 3: Probabilities of A Given Saturation Level in Five Years

<table>
<thead>
<tr>
<th>Saturation Level</th>
<th>20% &lt; Saturation</th>
<th>25% &lt; Saturation</th>
<th>30% &lt; Saturation</th>
<th>35% &lt; Saturation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Using Average ESPC Growth Rate</td>
<td>0.999</td>
<td>0.805</td>
<td>0.159</td>
<td>0.005</td>
</tr>
<tr>
<td>Using ESPC Growth Rate at General Inflation</td>
<td>0.997</td>
<td>0.646</td>
<td>0.06</td>
<td>0.0009</td>
</tr>
<tr>
<td>Using No-Growth for ESPC</td>
<td>0.996</td>
<td>0.581</td>
<td>0.047</td>
<td>0.0005</td>
</tr>
</tbody>
</table>

As shown in the table the impact of the growth of ESPCs is significant. Comparing the values at a 25% or greater saturation levels there are high likelihoods observed regardless of ESPC cost growth. However, if contracts continue
the current decade’s trend the saturation level will increase significantly and will certainly have a negative impact on other installation budget demands. This has a few implications; the first is that energy costs as a whole are increasing beyond what the budget regulations currently allow so the saturation level will increase on average in every scenario. Another concern is that both rising contract commitments and energy cost create a challenging situation for decision makers to meet the stated goal of a 10% mandated by the President.

4. Conclusion
As shown in the results section the saturation level for the energy budget, specifically in regard to ESPCs has been forecasted and shown to be generally increasing over time. In particular the current level (FY 2013 ) of 20 % will very likely be surpassed. This increase is beyond both the guidance of a reduced budget and minimal cost escalation required by regulation. However, with this information decision makers can be better informed about the realities and expectations of managing the energy budget. If the rapid awarding of ESPCs continues on its ten year trend the saturation level will likely increase significantly in the future requiring possible trades for other installation services. With a challenging fiscal future in the federal government these types of forecasts can and should serve to inform choices about how to best allocate funding. The saturation level of the energy budget can be an informative piece of information about how to best manage the Army’s, and by extension the federal government’s energy programs.
References


