

DETERMINING ENERGY SAVINGS USING UTILITY BILLS: A WINNING METHOD FOR ESCOS

John Avina, Director
 Abraxas Energy Consulting
 johnavina@abraxasenergy.com

Introduction: Energy Savings Tracking Methods

After installing energy conservation measures (ECMs), Energy Service Companies (ESCOs) often determine the energy savings resulting from the project and present the savings results to their customers. A common way to calculate energy savings is to measure the flows of energy associated with the ECM, and then to apply spreadsheet calculations to determine savings. For example, a chiller retrofit would might require measurements of chilled water supply and return temperatures and kW. The benefit of this approach is that the ECM is isolated, and that only energy flows associated with the ECM itself are considered.

This method is described as Option A or Option B in the International Performance Measurement and Verification Protocol (IPMVP). Table 1 presents the different options. Option A requires some measurement and allows for estimations of some parameters. Option B requires measurement of all parameters. In both options, calculations are done (typically in spreadsheets) to determine what energy savings. Option C uses utility bills to determine energy savings.

TABLE 1. IPMVP Options

	Description	Typical Applications
A. Partially Measured Retrofit Isolation	Savings are determined by partial field measurements of the energy use of the system(s) to which an ECM was applied. Some, but not all, parameters may be stipulated.	Lighting retrofit where pre- and post-retrofit fixture Wattages are measured. Operating hours of the lights are typically agreed upon.
B. Retrofit Isolation	Savings are determined by field measurement of the energy use of the systems to which the ECM was applied.	Variable speed drive on a pump. Electricity use is measured by a kWh meter installed on the electrical supply to the pump motor.
C. Whole Facility (Utility Bills)	Savings are determined by measuring energy use at the utility meter level. Bills may be corrected for weather.	Several ECMs affecting many systems in a building. Utility Bills are used.

D. Calibrated Simulation	Savings are determined using building simulation. This option is rarely used, and is used primarily when there is no pre-retrofit utility data available.	Multifaceted energy management program affecting many systems in a building but where no base-year data are available.
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Some ESCOs Have Limited Options

There are many situations where Option A or Option B (Metering and Calculating) is the best approach to measuring energy savings, however, some ESCOs insist upon only using Option A or Option B, when clearly Option C would be most appropriate. If the ESCO was a lighting contractor, then Option A should work in all cases. Spot measurements of fixtures before and after, agreed upon hours of operation, and simple calculations can be inserted into a spreadsheet that can calculate savings. The same spreadsheet can be used over and over. However, for ESCOs that offer a variety of different retrofits, it is necessary to be able to employ all options so that the best option can be selected for each individual job. Controls Retrofits, or retrofits to HVAC systems are typically excellent candidates for Option C.

However there are drawbacks with metering and calculating savings and these can include:

- Greater expense
- Difficulties convincing the customer of the appropriateness and veracity of the method and savings numbers
- Inability to handle interactive or many difficult ECMs.

ESCOs that do not have the capacity to employ all options are at a disadvantage over those ESCOs that can employ them all. Specifically, we want to address those ESCOs that only employ Option A and Option B. These ESCOs may encounter the following problems due to their limited offerings:

- Measurement and Verification costs can be greater, which lead to higher project costs, which can limit the energy projects that the ESCO can sell. The lack of Measurement and Verification options overall can make the ESCO less competitive, and hurt the financial performance of the ESCO.

- Using Options A or B sometimes require the customer to understand and approve of complex energy calculations. These options are often difficult to explain to customers who insist upon seeing savings in their utility bills. Customer satisfaction can suffer if Option C is not made available to customers who want to see savings on their bills.
- Options A and B cannot handle difficult ECMs. The methods used to determine savings are inaccurate, and make large assumptions that cannot be borne out if a third party consultant is hired to oversee the savings determination process.

These issues are discussed in more detail below.

Cost of Utility Bill Analysis vs. Metering and Calculating

Measurement and Verification should cost between 1% and 15% of the project cost. Metering and calculating savings often has costs associated with labor and equipment. As many project configurations are different, projects typically require unique configurations of sensors, placements of sensors and savings calculations. On more complicated ECMs, only highly skilled energy professionals can determine which measurement devices should be applied, and to what components. Manipulating data, and finally creating spreadsheets with engineering calculations also requires skilled personnel who command high wages. Metering equipment also has a cost, and for many projects, metering equipment, or control points, have to be purchased, and remain on the job for years.

Of course, there are cases where metering and calculating is the least expensive and the most desirable method. If an ESCO only provides a lighting retrofit, then measuring a selection of lighting fixtures before and after the retrofit, and producing a spreadsheet that determines savings is the best option.

On the other hand, utility bill analysis is inexpensive. With specialized utility bill analysis software, clerical workers can create the Measurement and Verification analysis. Bills are entered, weather imported, a linear regression performed, and reports made. Capital need not be sunk into metering equipment or control points or into long hours of analysis and data manipulation. Typically for utility bill analysis, measurement and verification costs are a fraction of what costs for retrofit isolation savings are—ranging between 1 and 5% of project costs.

Explaining Savings Numbers to Customers

Customers understand utility bills. The reason they entered into an energy savings contract is often triggered by the desire to lower their energy bills. Retrofit Isolation methods do not address the customer's utility

bill. A project may be saving energy, but the utility bill may actually be increasing. Retrofit Isolation does not address this at all. ESCOs need to be responsive to customer's needs, and this is done through communicating in a manner that the customer's understand. They want to see the savings on their utility bills—this is a method they would trust.

In addition, customers are sometimes mistrustful of energy service companies that provide savings numbers that the customer cannot understand. Although the calculations in the spreadsheet may appear perfectly reasonable to the energy analyst, to a customer who is not well-versed in math, the calculations may remain incomprehensible, and the customer is thereby required to trust the energy service company, sometimes leading to mistrust. Energy savings calculations should remain as simple as possible and explained in a manner that the customer can understand. This makes the customer's job easier, and reassures the customer that the energy service company is acting in a truthful manner.

For these reason, more and more customers ask for Measurement and Verification using utility bills.

Difficult and Interactive Energy Conservation Measures

For many energy conservation measures, Retrofit Isolation is the best option. This would include lighting savings, savings from energy efficient motors, and from other non-weather dependent energy users.

However it is very difficult or impossible to measure savings for some energy conservation measures. Still, some ESCOs insist on using Retrofit Isolation for these difficult measures. For example, engineering calculations can be made estimating the savings to be had by shutting down air handlers at night. But, assuming that the air handlers receive chilled water from a chilled water loop shared with other air handlers, how is one to measure energy savings? Fan savings are easy (assuming the unit is constant volume), but in order to calculate savings, several estimations need to be made, which result in an estimate of energy savings, just as accurate before the retrofit took place as after it took place. Suppose the unit is a VAV system, at what percentage would the fan have been running? Suppose the cooling coil and/or heating coil modulated to meet a changing supply air set point—how are the fan CFM, cooling and heating loads to be calculated if the unit is not running and measurements can not be made?

Controls retrofits are difficult to measure and quantify directly. Usually, however, when a controls or commissioning measure is enacted, more than one item is adjusted, which further complicates an already difficult task. Suppose a partially working economizer was fixed, in addition to putting the fan on a variable speed drive, in addition to shutting off the air handler during unoccupied hours, and finally upgrading the chiller plant. Each of

these measures would interfere with the savings calculations of the other. How can one calculate chiller savings, when the loads have changed so dramatically via the economizer, reduced hours and reduced air flow? This is a very difficult task, that most likely cannot be done with an acceptable degree of certainty.

Complicated cases like this require utility bill analysis to measure and quantify savings. The procedure is very simple, inexpensive, and easy to explain relative to many Retrofit Isolation methods.

Benefits of Utility Bill Analysis

The benefits of utility bill analysis to calculate energy project savings are as follows:

- Utility Bill Analysis, by its nature, is relatively simple, and does not require complicated engineering analysis.
- Utility Bill Analysis is relatively inexpensive, as it requires less skilled workers, less time and no dedicated equipment.
- Utility Bill Analysis provides savings numbers in a format and method that makes sense to the customer.
- Utility Bill Analysis is the best method to handle complicated energy conservation projects, or projects which interact with each other, making assessment of individual measures impossible.
- ESCOs can use the fact that energy savings is determined using the customers' utility bills as a selling point.

Utility Bill Analysis and Changes in Weather

Unfortunately, a simple comparison of pre-retrofit and post-retrofit utility bills is usually not an effective method to determine energy savings from ECMs. Weather varies from year to year, and affects the amount of heating or cooling energy usage, which can interfere with actual utility savings numbers. For a fair analysis, utility bills should be "corrected" for weather data, which results in a reasonable savings determination. Linear regression is applied to utility usage versus degree days to determine pre-retrofit utility usage patterns, which are then compared to post-retrofit utility usage to determine savings. Unfortunately, the scope of this paper is limited, and cannot present the method in detail. Weather-correcting for weather is easy, however, as specialized software, used by ESCOs around the world, simplifies the weather correction process and presents savings reports.

Drawbacks of Utility Bill Analysis

Facilities may change their energy usage patterns, by installing more equipment, building additions, occupancy changes, etc. This upsets the existing utility bill comparison of pre-retrofit to post-retrofit usage.

These changes need to be monitored and accounted for with Baseline Modifications.

There is a certain amount of randomness in utility bill comparison. So many factors influence the amount of energy usage in any given month, and they cannot all be accounted for. As a result, if you are trying to show savings that is less than 10% of the total electricity load, then the randomness in the bills may seriously interfere with the accuracy of your savings calculations.

If you track savings by comparing utility bills, you will only be able to track total savings for a given meter, but you will not be able to separate out the savings for different Energy Conservation Measures (ECMs). For example, if you installed a lighting retrofit, an energy efficient chiller and a control system in a hospital, you will not be able to tell how much energy is being saved by the control system. Energy analysts try to do break out the savings for each ECM occasionally, but they are only making educated guesses.

Conclusion

When an ESCO approaches a performance contract, there are several measurement and verification options available. Those ESCOs that only have at their disposal a limited set of options are often spending too much money on measurement and verification, and therefore are held back from selling larger projects, and limit their own success.

Customer satisfaction may suffer when ESCOs only offer Retrofit Isolation approaches to Measurement and Verification, as customers may want to see savings in their utility bills. ESCOs who refuse to speak in the same language or terms as the customer may suffer decreased customer satisfaction.

ABOUT THE AUTHOR

John Avina, Director of Abraxas Energy Consulting, has worked in energy analysis and utility bill tracking for over a decade. In prior positions, Mr. Avina performed M&V for Performance Contracting, taught hundreds of M&V seminars to energy professionals, and has managed software development projects. Currently, Mr. Avina heads Abraxas Energy Consulting. Mr. Avina has a MS in Mechanical Engineering from the University of Wisconsin-Madison. He is a member of the Association of Energy Engineers (AEE), the American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE), the American Solar Energy Society (ASES), and a Certified Energy Manager (CEM). Mr. Avina has written chapters for two books, and several papers on energy analysis.

Abraxas Energy Consulting provides M&V services and software solutions to ESCOs and energy managers worldwide. Services include M&V for performance contracts, energy audits, utility bill audits and custom software applications. Abraxas Energy Consulting represents several utility bill tracking software programs used by ESCOs and energy managers.