

NEW DIRECTIONS IN MEASUREMENT AND VERIFICATION FOR PERFORMANCE CONTRACTS

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ABSTRACT

Over the decades, the determination of energy savings in performance contracting has undergone an evolution from a utility bill based approach towards a more limited exercise which may sometimes be difficult to relate to actual energy savings in the later years of the contract. These limited measurement and verification (M&V) approaches can reduce the value of performance contracting in the customer's mind, and ultimately hurt the industry. The authors propose a new strategy of determining energy savings which combines the original utility bill based approach with a retrofit isolation approach and annual re-commissioning. This combined approach should address the customers' need to more easily understand how energy savings are determined, the ESCOs' need to reduce risk from increases in customer energy usage behavior which can decrease measured savings, and should help sustain energy savings over the length of the guaranteed savings period.

BACKGROUND

The Value of Measurement and Verification within Performance Contracting

Performance Contracting, when implemented properly, is an almost irresistible proposition. An Energy Services Company (ESCO) finds energy waste in your facility, installs equipment to make your facility run more efficiently, and guarantees that there will be no net cost to your organization. And if the savings do not appear, the customer still doesn't have to pay for anything. How could a potential customer refuse this? However, we have all heard stories of projects where the amount of savings delivered was in dispute. Ideally, measurement and verification (M&V) is the means by which such disputes are settled.

In a performance contract, quality M&V is like an insurance policy. It is the means by which actual savings are quantified. When M&V is performed correctly there will be no disputes, and the building owner will know whether the installed equipment produced the promised savings or not. Unfortunately

not all forms of M&V provide the same level of confidence to the owner. This paper surveys M&V techniques as currently implemented in the industry, and suggests methods by which these techniques can be strengthened in order to provide greater confidence that savings guarantees are being met.

How Performance Contracting Can Fail to Deliver Promised Results

Energy savings in a performance contract is usually defined as the difference between the baseline (i.e., energy that would have been consumed by the pre-retrofit equipment had the project not been performed) and the energy used by the installed equipment. Both quantities require mathematical models and a number of assumptions. Given the equipment to be installed, the ESCO will use these models to set the level of savings to be guaranteed. During the M&V process the ESCO performs measurements to quantify the level of savings achieved. There are many ways that the measured savings can fall below the guaranteed savings amount. These include:

TABLE 1. POTENTIAL CAUSES OF SAVINGS SHORTFALLS

Cause	Description
Improper installation	Equipment is installed in such a way that it uses more energy than anticipated
Improper commissioning	Equipment is not commissioned properly to ensure that it performs as expected.
Improper operation and maintenance	Equipment is not operated correctly and/or is not adequately maintained. For example, the equipment may be disconnected or disabled by the building occupants.
Inadequate M&V	The method of M&V does not accurately measure and verify the savings.

History of M&V within Performance Contracting

In the early years of performance contracting, M&V was performed in an ad hoc manner, and some of the

techniques used were of questionable accuracy. In the mid 1990s, to standardize industry practices, the first M&V protocol, the North American Energy Measurement and Verification Protocol (NEMVP) (US Department of Energy, 1996) was released. The NEMVP was renamed the International Performance

Measurement and Verification Protocol (IPMVP), which has gone through several versions. The most recent was released in January, 2012 (Efficiency Valuation Organization). The standards have been beneficial to the industry, as today, most practitioners of M&V are familiar with their content.

Table 2. Measurement and Verification Options

Option	Description	Applies best when:	Examples	Drawbacks
A	<p>Determine savings from ECMs that can be isolated.</p> <p>Savings is calculated separately for each measure.</p> <p>Take measurements of some variables and make assumptions about other variables.</p> <p>Use spreadsheets to calculate savings</p>	<p>A single system is affected and can be individually metered.</p> <p>Savings can be determined to a relatively high accuracy without having to monitor or measure all inputs to the savings equation.</p>	<p>Lighting system (where run hours are assumed),</p> <p>chiller retrofit (where GPM is assumed)</p>	<p>This option can be expensive, as it requires skilled engineering time to devise the monitoring plan, place loggers, and perform calculations.</p> <p>The option is often not effective when there are interactive measures, such as control system upgrades or RCx.</p>
B	<p>Determine savings from ECMs that can be isolated.</p> <p>Savings is calculated separately for each measure.</p> <p>Take measurements of all variables and use spreadsheets to calculate savings.</p>	<p>A single system is affected and can be individually metered.</p>	<p>Lighting system (where run hours are measured),</p> <p>chiller retrofit (where GPM is measured)</p>	<p>This option can be expensive, as it requires skilled engineering time to devise the monitoring plan, place loggers, and perform calculations.</p> <p>The option is not effective when there are interactive measures, such as control system upgrades or RCx.</p>
C	<p>Determine savings using utility bills. Often utility bills are normalized for weather or some other variable like occupancy, production, etc.</p>	<p>The ECMs associated with a meter should deliver savings of over 10% of total usage.</p> <p>Option C works well with interactive measures.</p>	<p>Energy Management System, RCx, or new chiller & AHUs</p>	<p>Option C cannot determine individual savings values for each measure.</p> <p>The noise in utility bills can conceal actual savings if expected savings are a small percentage of the total bill.</p> <p>Unexpected changes to building energy usage behavior can compromise savings numbers.</p>
D	<p>Determines savings using a computer model of the building that is calibrated using measurements.</p>	<p>There are interactive measures that cannot be measured separately using Option A or Option B.</p>	<p>Energy management system that affects lighting & HVAC</p>	<p>Accuracy may vary dramatically. Calculations require experienced modelers, and can be expensive. This option should be used only when no other feasible option is possible.</p>

A Summary of the M&V Guidelines

The NEMVP and most of the later guidelines settled on a framework of four different methodologies of M&V, which is explained very briefly in Table 2.

Every project is different, and different M&V options may be more suitable for some but not other projects. The selection of which M&V option to use is a fuzzy logic type of process in which many criteria come into play. Often the most important criteria are: what is the relative accuracy of the savings number that will be produced with the measure, how much will the M&V option cost to perform, and what risk is there that other non-measure-related activities will affect accuracy of savings values determined.

ESCO Trends: From Option C to Other Options

In the first few decades of performance contracting ESCOs relied on Option C as the predominant M&V approach. Using utility bills allowed the ESCOs to present savings in a manner that made the most sense to their customers. Communication with the customer is easier with bills. Customers want to see savings in reduced utility bills, and that is often the reason they enter into performance contracts in the first place. The major ESCOs in the first few decades of performance contracting were controls manufacturers, and new EMS systems that interfaced with many building systems were often the central part of performance contracts, making these contracts ideal candidates for Option C.

As the years went by, the ESCOs realized that by using Option C, they were becoming liable for any changes in their customers' energy consumption patterns as well. New equipment, new wings, increased occupancy schedules, etc. all brought on increased energy usage in the bills, which reduced the apparent savings as determined by the utility bills. The ESCOs would make baseline modifications to catch those changes in energy usage to recoup their savings, but this led to ever more complicated modifications, which distorted the savings numbers and sometimes led to disputes with their clients which damaged the reputation of performance contracting in the marketplace. On the other hand, as they say, "the bills don't lie", and by tying themselves to utility bill guarantees, ESCOs that produced failing projects were stuck paying shortfall checks for the contract duration.

The risk that the ESCOs encountered was of two kinds: (1) risk that the client's actions would reduce their apparent savings, and (2) risk that the ESCO had guaranteed more savings than could be realized, due to one of the factors in Table 1. In either case, the ESCO might end up paying shortfall checks for years.

In order to reduce their risk, ESCOs began migrating away from Option C guarantees, and switched to Option A for measures whose performance could be isolated, and Option D for interactive measures. Both methods combine field measured parameters with various assumptions to produce savings measurements that are unaffected by factors outside the ESCO's control, such as building occupancy, plug load creep, new construction, etc.

Options A and D M&V use standard engineering calculations to determine savings, and to the extent that the proper measurements are made and the assumptions used are correct, these methods provide a sufficiently accurate assessment of the energy savings resulting from a wide variety of retrofit measures (Option B, in which all parameters are measured, can be even more accurate). A weakness of Options A and D M&V plans, however, is that the field measurements are often taken only once, during equipment commissioning. This means that the project savings are determined once, at the beginning of the performance period, and are assumed to remain the same for the remaining years of the performance period. Annual M&V activities are limited to ensuring that the equipment is still in place and operating, and annual M&V reports merely repeat the calculations contained in the first year's report. As a consequence, customers perceive little value in the process.

The practice of M&V in performance contracting has changed over the past few decades. M&V in performance contracting was supposed to quantify the utility savings being delivered from the performance contract. If the savings targets were not met, M&V was supposed to quantify how much money the ESCO needed to reimburse the customer. Since savings reports are delivered quarterly or annually, proper M&V would ensure that the installed energy conservation measures continue to save over the entire length of the contract. Most importantly, one of the purposes of M&V was to ensure that the ESCO remained actively involved in the success of the performance contract. In the end, the ESCOs, by trying to reduce their risk have instead reduced the quality and appeal of their product, performance contracting.

A NEW APPROACH TO M&V—A COMBINED APPROACH

It is time to bring M&V back to its initial purpose. With this in mind, we are proposing a new approach to M&V in performance contracting. Our approach would:

- Provide confidence that the savings have actually occurred, in a manner understandable to the customer,
- Ensure that the ESCO is actively engaged ensuring that the contracted level of savings is occurring,
- Provide a real determination of whether the savings are occurring throughout the entire contract period

At the same time, many of the concerns of the ESCOs are legitimate and are addressed in our approach as well. Our approach would:

- Minimize the risk of degrading the ESCO's savings due to customer activities that increase energy use,
- Provide a framework for continued positive engagement between the ESCO and the customer, so that the ESCO's site visits and M&V reports are viewed as helpful and effective.

Our proposed method of M&V incorporates the concurrent use of both the Option A (or Option D) and Option C methods. Option C would be used in the first year to demonstrate savings to the customer and to verify that the Option A or Option D method is working, and Option A would be used in succeeding years to reduce the risk or deteriorating savings from increases in the clients' energy usage behavior.

The First Year: M&V Option A and Option C

Rather than providing an Option A or Option D guarantee, we are proposing that the ESCOs use both Option A or D and Option C for the first year of the contract.

Although there are drawbacks to using utility bill analysis as a formal M&V technique, we believe there is value to demonstrating that the energy use in treated buildings has been reduced by the amount the ESCO predicted. Where data are available, we recommend that ESCOs use utility bill or whole-building data—at least in the first year of the performance period—to determine the reduction in energy use as a result of the project. Some analysis will be required to normalize for weather and/or occupancy, but the likelihood for large baseline adjustments should be minimal during the early years of the contract.

At the same time, the ESCO would determine energy savings using the Option A method which will be used for the remainder of the contract period. The ESCO would then have two savings numbers, which, of course would not be the same, but which should be close. Either of the Option A (or Option D) or Option

C results would be used as the final savings number, whichever is defined in the contract.

Performed as an adjunct to the M&V techniques the ESCO would use for the life of the contract, utility bill analysis in the first year would give the customer confidence that the assumptions inherent in the Option A or B and methods were correct, and that the ESCO's approach to M&V is estimating energy savings with an acceptable level of accuracy.

Succeeding Years: Re-measurement of Parameters and Recalculation of Savings

Demonstrating that utility bill analysis leads to the same estimate of energy savings as the simpler techniques used by the ESCO is necessary to increase confidence in the M&V procedure. However, as currently structured, M&V plans involving Options A and D essentially stipulate that the equipment performance will remain constant for the life of the contract. This is the result when performance measurements are made only once during the commissioning process, and this set of one-time measurements is used to determine the level of savings for the life of the contract.

Once the Option A or D methods have been validated using utility bills in the first year, these Option A or D methods can be used for the second and following years, with one change. Except for simple ECMs such as lighting replacements, we recommend that the ESCO repeat the measurements required for Options A and D on an annual basis during the M&V process, and insert these measurements into the Option A and D calculations. By calculating savings annually with current data, the ESCOs will be able to provide M&V that reflects current conditions and will demonstrate that equipment performance has not deteriorated. Proper M&V must be able to demonstrate when good projects succeed, and when poorly executed projects fail—and this method will.

Annual re-measurement and recalculation will tie each year's M&V back to the first year's utility bill analysis. This re-measurement and recalculation will determine whether the installed equipment has continued to operate with the same efficiency as in the first year of the performance period, when measured data was used to calculate a level of savings that was verified using utility bill analysis.

Succeeding Years: Equipment Re-commissioning

Finally, if the M&V process includes annual measurement and annual recalculation of energy savings and allows the possibility that the project may fail, the ESCO will be more active in ensuring that the

equipment will continue to function as originally intended. As the ESCO has more of a stake in ensuring that the guaranteed savings occurs, the ESCO will likely re-commission the equipment that the ESCO has installed. ASHRAE Guideline 0 defines commissioning as “a quality-oriented process for achieving, verifying, and documenting that the performance of facilities, systems, and assemblies meets defined objectives and criteria.” This definition fits well with the original intention of M&V. Re-measurement of operational parameters, combined with maintenance, adjustment and repair to restore the equipment to its original performance will help ESCOs ensure that their projects meet their performance guarantees. In many performance contracts, the ESCO is already carrying out these activities as part of their performance period services.

Maintenance and repair are an important part of the M&V process. When combined with re-measurement of operational parameters to ensure that the equipment is operating as intended, the annual M&V process will become more of an annual re-commissioning process designed to maintain (or restore) equipment operation to its original state.

CONCLUSIONS

Measurement and verification in performance contracting has moved from relying primarily on utility bill analysis to methods that depend on measuring equipment operational parameters. In many cases measurements of equipment performance are only done once and are assumed to remain accurate for the life of the guarantee period. These techniques reduce ESCO risk, but have made the M&V process less transparent, less accurate and less understandable to the customer. Consequently, some customers perceive little value in M&V. The authors propose some modest changes to the M&V process that will restore the value of M&V, and ensure that the savings reported by ESCOs corresponds to real reductions in energy use and energy costs in their customers' facilities. These changes include:

- Using utility bill analysis in addition to other M&V methods during the first year of the performance period, to demonstrate that the simpler methods result in the same level of savings as shown in utility bills.
- Performing calculation of energy savings with re-measured operational parameters on an annual basis, to ensure that equipment is operating with the same efficiency as in the first year of the performance period.
- Combining these annual measurements with maintenance and adjustment as part of an annual

re-commissioning process to ensure that the equipment continues to operate with the same performance throughout the life of the contract.

It is our contention that should the M&V process incorporate these changes, the perceived value of performance contracting will increase in the customer's mind, as:

- M&V will be tied to the one metric the customer understands, a reduction in utility bills,
- the quarterly and/or annual M&V reports will be based on recent measurements, and
- the ESCO will continue to provide value continually re-commissioning the equipment to ensure it continues to save as originally intended.

By enhancing current M&V practice, the industry should be able to take steps to secure a successful future for performance contracting.

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