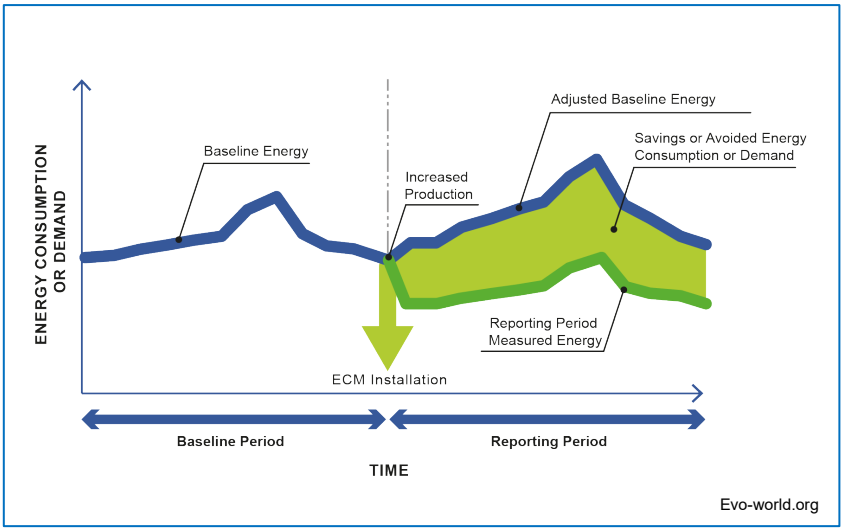
PERFORMANCE CONTRACTING, MEASUREMENT & VERIFICATION

WHITE PAPER #24

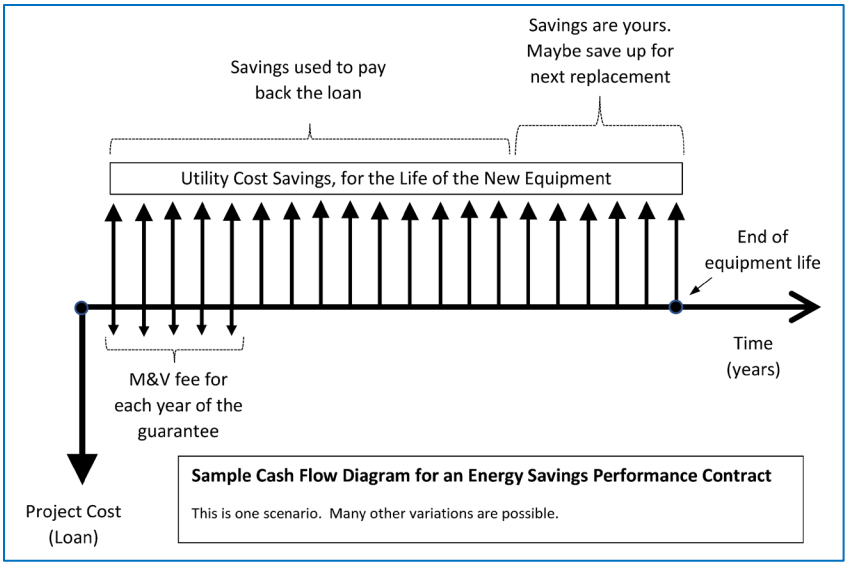
For customers with general questions about how to measure savings, take a look in here.

Measurement strategies are a vital part of any guaranteed savings arrangement.



This paper will provide answers to these questions:

1. What is Measurement and Verification (M&V) and why is it important?
2. What are the basic ways M&V can be performed?
3. What is a Guaranteed Savings Performance Contract?
4. What is an ESCO? What is an ESPC?
5. How do I know if a Performance Contract is right for me?
6. Where do I go to learn more?



1. What is Measurement and Verification and why is it important?

Measurements are useful when they provide accurate feedback of a result. In the case of energy savings improvements where a capital outlay has been made, there is usually an expectation of a return on that investment.

Verification is the goal, and measurement is really just the means to the end. Did the savings come to pass? Better or worse than expected? Are the savings persistent this year like last year? For the business side of energy savings, the need for such verification is obvious.

Measurement and Verification is the glue that holds together contracts based on guaranteed savings, because it is the basis of who pays who. In support of the guaranteed savings contract industry, standards of protocol (how to do business) have been developed for M&V. The experience of thousands of projects and input from businesses on both sides of the guarantee pledge has contributed to these standards. The M&V standard most often used today:

- International Performance Measurement and Verification Protocol (IPMVP)
- American Society of Heating Refrigerating and Air Conditioning Engineers (ASHRAE®) Guideline 14. Note: the ASHRAE Standard 14 is intended as the technical document for the IPMVP.

One reality check for the M&V process is the cost of doing it. If, for example, the M&V purpose is to verify that the cost of the project was warranted by the achieved savings, adding cost to the project through M&V makes the economic payback worse even if the savings turn out to be exactly as predicted. This makes M&V a 'necessary evil' that should be used wisely and sparingly.

2. What are the basic ways M&V can be performed?

The M&V concept is simple enough, but the details are sometimes difficult, and solutions vary. In a simplified case, lighting may be the single largest component of electric use in a warehouse – after installing more efficient lighting throughout the warehouse, the savings will be noticeable on next month's electric bill. Verified!! But in a large manufacturing facility with varying production output, a project may be substantial enough to want to know but still only affect a portion of the utility bill - in this case, looking at the electric bill may not be conclusive because of the many other variables at play. So, the one-size-fits-all approach doesn't work with M&V very well.

The specifics of the M&V options occupy as much paper as a Chicago phone book. But they boil down to four basic options, each one with a general category of applicability. The four classic IPMVP options are shown in **Table 1**. Application examples for each option are provided.

Table 1. Measurement and Verification Options

M&V Option	Description
Option A: Retrofit Isolation with Key Parameter Measurement	Savings are determined by partial field measurement of energy use by the system to which an energy conservation measure (ECM) was applied. Partial measurement refers to the fact that some (but not all) key parameters may be stipulated rather than measured, assuming the total impact of possible errors will not significantly affect the resulting savings. The measured and stipulated parameters will be those that that define the energy use of the measure. Measurements may be short-term or continuous.
Option B: Retrofit Isolation with All Parameter Measurement	Savings are determined by comprehensive field measurement of energy use by the system to which an ECM was applied. This option is noted as 'all parameter' because stipulation of a key parameter is not allowed. Measurements may be short-term or continuous and are taken throughout the post-retrofit period.
Option C: Whole Facility Measurement	Savings are determined by taking energy measurements at the whole facility level. Requires a detailed inventory of all equipment included in the meter reading as well as knowledge of equipment use patterns and factors that affect energy use. Regression analysis correlates energy use with independent variables such as weather and occupancy to normalize differences between before/after periods. Measurements may be short-term or continuous and are taken throughout the post-retrofit period.
Option D: Calibrated Simulation	Savings are determined through simulation of the energy use of component systems or the whole facility. Energy use simulation is calibrated with utility billing data and / or end-use metering. After calibration, savings are determined by comparing a simulation of the baseline with either a simulation of the performance period or actual utility data.

Sample applications for M&V Options

Options A and B or 'sub metered' approaches are suited for specific measures and provide good accuracy. For example, if only lighting is replaced, measurements on the lighting circuits before and after will tell exactly what changed. The difference between A and B is whether all or a representative sampling are measured. Option A is well applied to a lighting retrofit where lighting power before/after is measured and applied to a stipulated operating schedule (hours per year) for the lights. Option A could also apply to a replacement air compressor by measuring compressor power before/after at 10% increments of load and apply this to a stipulated typical load profile. An example of option B is a chiller replacement where long term seasonal measurements record power and load. Note the difficulty in applying Option B arising from the need to have long term measurement of the before-condition as well as the new unit.

Option C or 'whole facility' approach uses utility meter readings. It is the simplest but has limitations. If used on smaller projects, buildings with variable occupancy or buildings that undergo additions, etc., different methods may be required. Option C can also be applied to a 'system'; for example metering of all use in a chiller plant that captures ancillary loads will also capture the interactions as a 'bottom line' measurement.

Option D is the 'calibrated simulation' approach. This method may be used when measures are easily defined and interaction between measures is minimal. Many engineering software models are in use for this purpose and provide varying degrees of accuracy. In cases where load profiles are steady or strongly weather dependent or when loads are constant, simple calculations or spreadsheets work well. Often it is true of these models that the accuracy is more in the differential between the compared systems than the absolute values they produce. In all cases, actual measurements are more accurate than these estimates. Often it is cost that suggests using this method over others. This method can be very practical when both parties accept the limitations and agree on the assumptions and algorithms used.

Interactions

Interaction between measures is common and, if overlooked, can result in over-stated savings. For example, if high efficiency lighting, de-lamping, and occupancy sensor options are proposed, it is possible that the customer will choose one or two or all three. Calculating each one individually and adding those respective savings up will over-state savings. In this case, the more efficient bulbs only provide savings for the bulbs that exist and if fewer bulbs exist (from de-lamping) there are less savings.

Conversely, interactions can erode savings. Consider again the common lighting replacement. The reduced energy of the lighting means additional heating is needed in winter but less cooling in summer – how that balances for net gain or increase will be climate dependent and, in some cases, envelope dependent. Suffice it to say that interactions are a concern when trying to calculate savings and skip the measurement method.

How interactions are handled for each option.

- Options A and B: Interactions are calculated and incorporated into before/after results.
- Option C: Interactions are conveniently baked into this option since the measurement is overall energy use. This points out that an Option C project that is strictly electric will need to do whole building measurement for heating fuel use as well as electric.
- Option D: Interactions are intended to be incorporated into the computer simulation: professional hourly models do this, spreadsheet calculations may or may not do this depending on the creator of the spreadsheet model.

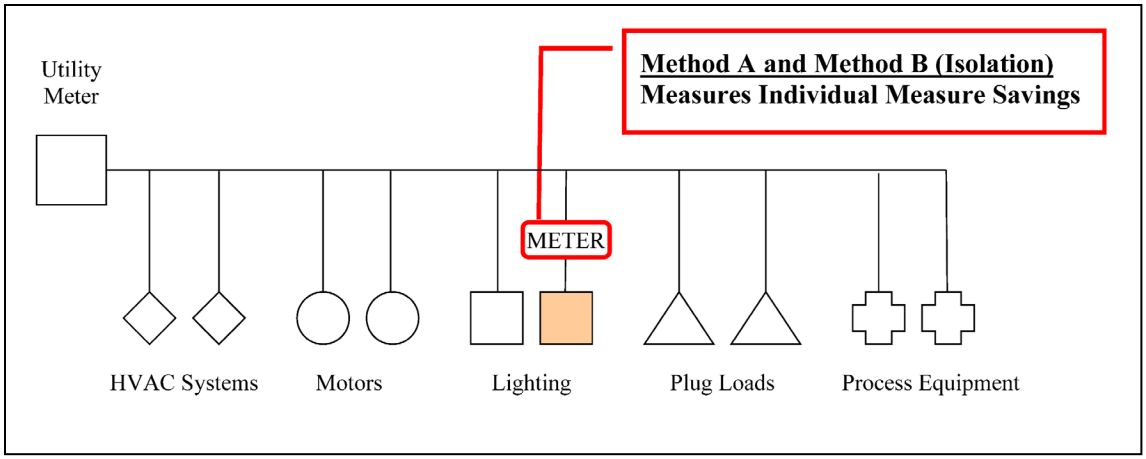
Baseline Adjustments and Normalizing Data

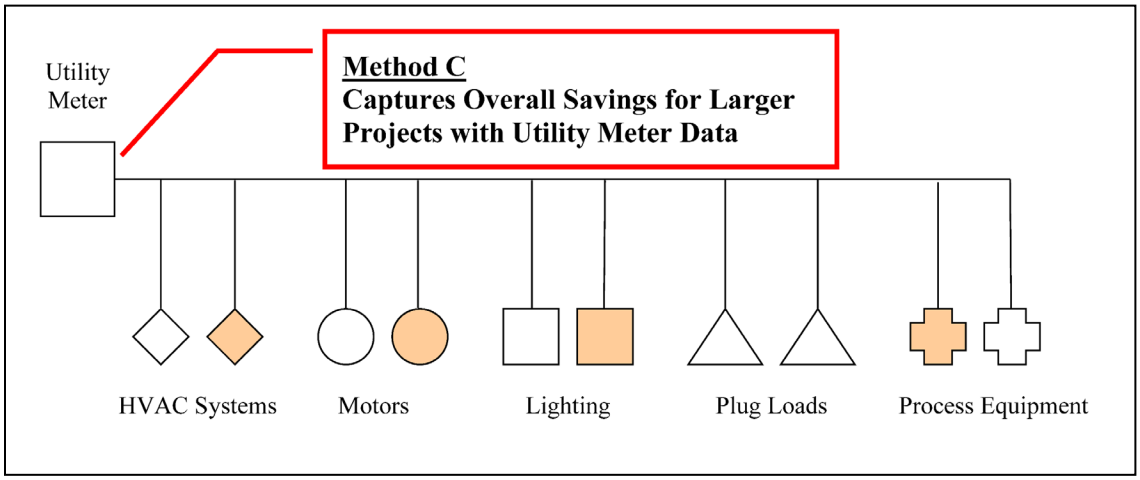
Utopia in the M&V world is a building with no changes at all other than the measures implemented. But in the real world, other things change. When this happens, the baseline is adjusted. The methods vary but have the same goal of establishing an 'apples to apples' comparison to demonstrate whether the measures did or did not achieve the savings. These calculations should be reviewed mutually and, if complex, the owner can stipulate in the contract the option for reviewing them, including ample time to do so. Examples that mess up the math are:

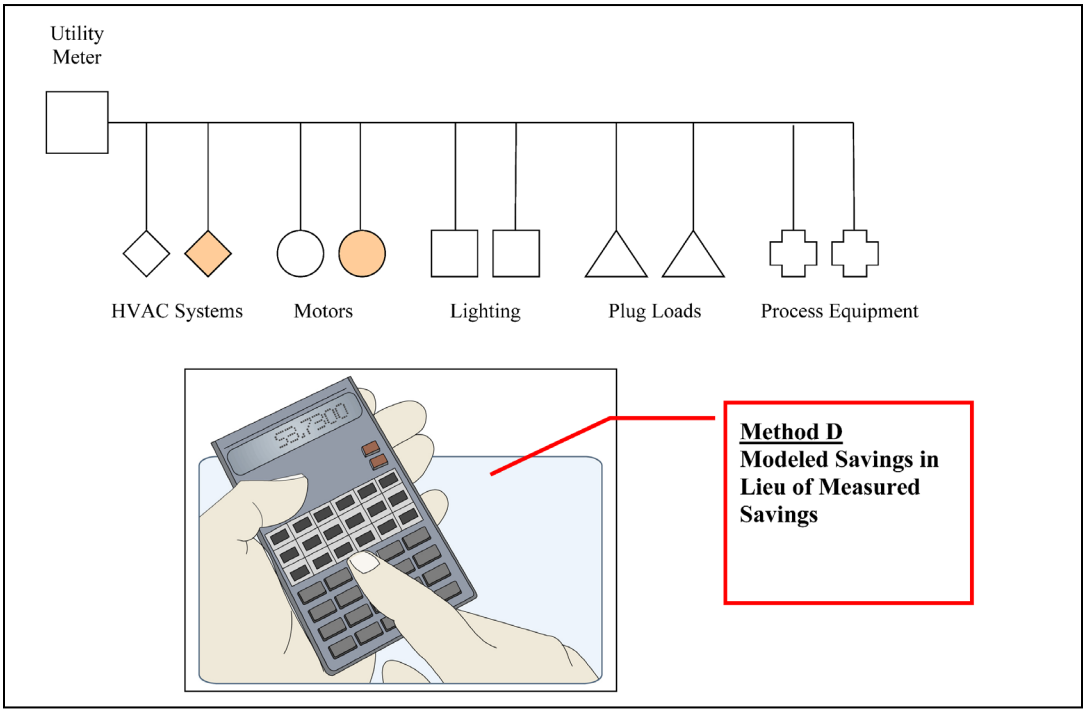
- Adding a new wing to the building
- Increasing or decreasing the number of people
- Different activities inside the building that change energy usage
- Changes in weather year-to-year

How data normalizing is handled for each option

- Option A: Usually, normalizing is NA for this option. This is easy to understand in the classic application of option A where lighting kW is measured and hours per year are stipulated. This method and focuses on the component only, and 'freezes' the variable of occupancy.
- Option B: The measurement focus is the component, but weather or occupancy need to be normalized. This is easy to understand in the Option B application of a replacement chiller. Here, the efficiency is well defined for the before/after machine, but between years there can easily be a change in 'load' from weather or occupancy or something else, i.e. without normalizing the load, a very efficient chiller could still show increased energy use if the load in the post-retrofit period is higher. The load becomes a 'proxy' for energy use and is part of the methodology.
- Option C: Changes in load and site conditions can plague Option C projects. The normalization effort via regression is used to negate most of the effects of year-over changes in weather or occupancy. The detailed inventory of equipment and usage patterns is used as a baseline for identifying changes, especially handy if post-project results are less than expected (PC contractors will re-visit the site to look for changes to help explain why).
- Option D: This option inherently is immune to occupancy and weather changes. Standardized weather data and stipulated schedules and hours of use for the equipment loads remain static. This fact favors post-retrofit use values (used to quantify savings) that use the model rather than actual usage. This is a plan discussion item since the actual performance of the machine becomes 'frozen' as well, and so any dysfunction of the machine would go unnoticed using just the model.


Utility Meter
Method A and Method B (Isolation)
Measures Individual Measure Savings
METER
HVAC Systems
Motors
Lighting
Plug Loads
Process Equipment


Utility Meter
Method C
Captures Overall Savings for Larger Projects with Utility Meter Data
HVAC Systems
Motors
Lighting
Plug Loads
Process Equipment


Utility Meter
HVAC Systems
Motors
Lighting
Plug Loads
Process Equipment
Method D
Modeled Savings in Lieu of Measured Savings

3. What is a Guaranteed Savings Performance Contract?

A 'performance contract' is a contractual arrangement that guarantees some outcome that is important to the purchaser. A common use of this contract is for speedy delivery. For example, a conventional design-bid-build project may be able to construct a new building in a year's time and do a fine job of it. But if an owner has a vital business use for the building in six months they may be interested in a "design-build" method of getting the building built, if it can be constructed in six months. In this example, the guaranteed outcome is delivery time. In this example speed of delivery is the focus and so quick decision making, fewer reviews and options, and other minor concessions are appropriate to enable the project goal to be achieved. With good partnering, this arrangement works well for many customers.

Give and take – helping each other succeed

One of the challenges to a customer considering an energy savings performance contract is the differences in project delivery. Some of the reasons for the differences are discussed here.

It is important to note that the owner, in prioritizing the speed of delivery, will need to cooperate with the design-build contractor to assure the outcome – the owner and contractor become partners in this arrangement. For all performance-based contracts, the customer needs to adopt the role of 'enabler' to give the contractor the means to succeed. In many ways this is just common sense and fair, but it will feel different and take some getting used to. In general, the contractor will have a greater degree of control over the project details than traditional design-bid-build methodology. This may be a culture change for larger facilities with in-house review staff accustomed to influencing decisions and deliberating over details and options. In-house construction standards may or may not apply. The contractor may require expediting reviews, limiting options, quick-shipping, etc. There is usually a single point of contact for both parties to encourage quicker decisions than group consensus – the owner will be wise to attach technical experts to the project for guidance. Quality control may be limited to the contractor's own staff. Decisions will be formal but may simply be task orders or other abbreviated form of accounting for expenses and decisions.

Another difference is inherent to the industry. Projects will tend to be large and, except for work within large cities, will usually be remote. Project management remotely introduces new complications from unfamiliar contractors, local codes, etc. Usually there will be an on-site project manager, and this will help.

A performance contract related to energy savings is "guaranteed savings". In this case the assured outcome is energy savings. A direct application of this process is a contract that makes capital

improvements to a facility targeting energy savings. Over some period of time, the cost of the work and the performance contractor's fee will balance with the energy savings. In this example the guaranteed savings performance contract would be "revenue neutral" and require no capital outlay or cash flow increase on the part of the owner – the energy savings pays for all of it. A variation of this strategy is used commonly in buildings with aging equipment, deferred maintenance, and no available funding to do the needed capital improvements. In these cases, energy savings from one area (such as lighting) pays for the lights plus helps pay for other needed improvements like replacing old HVAC units, repairing an elevator, or a new roof. For the latter, energy savings along cannot pay for the "normal replacement". By 'bundling' the work and extending the payback from energy savings, more repairs can be done under the contract umbrella. A third variation that is quite common is for the 'bundle' of work to be even larger and the customer add some of their own money to the pot. Common to all methods is leveraging energy savings to pay all or part of the work and minimizing capital outlay and cash flow impacts.

Savings are normally measured in energy use units instead of cost, but then are adjusted for rate changes over time. Agree on assumptions of utility cost and increases, including escalation, during the life of the loan period.

Integral to the savings guarantee is a provision that, if the savings do not come to pass, the contractor will pay the difference. Obviously, this is something the contractor will try to avoid. To reduce the chance of paying these penalties and losing their profit, a performance contractor will usually

- Maintain a specialized staff, skilled in energy projects and calculations
- Use sophisticated modeling to predict results
- Be conservative in the estimates, leaving a 'buffer' by under-stating savings
- Focus on measures with predictable savings

The essential ingredient in a guaranteed energy savings performance contract is M&V. Both parties want the savings to be what has been estimated. Agreeing to the M&V and 'baseline energy use' up front are the two most prevalent contract items to get right. Assuming the M&V protocol is appropriate and agreed upon up front, implementing the M&V is impartial and fair. If M&V is poorly defined or not well understood by both parties, the contract arrangement can become strained. Referencing the picture at the top of this paper, good M&V practice avoids the scenario of both parties pulling on the dollar bill.

Guaranteed savings brings with it the rigor and effort to measure and document energy use – all this takes time and costs money. The guarantee can be for the life of the loan and this intuitively makes sense, but can also be looked at another way: what if the money saved by stopping the M&V activities after a few years are used to do something else? It's a tough question because in return for no M&V the customer gives up the guaranteed savings. Guaranteed savings provisions can be for the life of the loan

but are more typically carried through 3-5 years – the assumption being that if the work has proven itself for that period, a properly trained staff can be expected to sustain those savings without the cost of annual testing.

4. What is an ESCO? What is an ESPC?

ESCO – Energy Service Company
ESPC – Energy Savings Performance Contractor

These two entities are much the same as far as guaranteed savings.

5. How do I know if a Performance Contract is right for me?

This is the million dollar question – literally.

Performance Contracting

- *Is it different?* ***Yes***
- *Can it work for you?* ***Yes***

The funding aspect is a key element in energy savings performance contracting. In essence, a performance contract borrows money from someone else and uses energy savings to pay it back, plus interest, plus the contractor's profit. So, if you have the money, why borrow it? Maybe you'd rather keep it in the bank. Maybe your focus is cash flow, and this serves that nicely for you. Some customers do not have money for needed repairs and this is a viable way to make repairs. An important component for most performance contracts is the duration of the repayment period, commonly 10-25 years. For 'permanent institutions' like schools and government buildings this is not an issue, but many private companies have a shorter business horizon. For this reason, long repayment periods will be a red flag for both the private company and the performance contractor (who wants to be sure you'll be around.).

Truth is there is no one single way of funding improvements that is best for all customers. Whether to borrow, lease, use a performance contract, or sell and move to a new building are all options each customer can weigh and decide.

Bearing in mind that a performance contract is akin to design-build, the relationship is largely based on the concept of partnering. The owner must be prepared to take an active role in the process. The contract provisions will be there but for it to truly work the two parties must work well together – get along. Thus, as you consider different contractors for this, meet with them and get to know them, getting a sense for the comfort level you would have if joined together for five years or more. Communication and personality play a significant role.

More than Funding

There is more to performance contracting than funding. This section shows some ways the ESCO strengths can bring results to customers.

Energy Audit

The energy savings performance contract requires a very good understanding of what the costs and savings will be – without it the guarantee provision is not possible. Thus, the program begins with a detailed audit and study of the facility, aimed at identifying viable projects cable of generating savings. The cost of the audit study is usually incorporated into the overall project cost. Sometimes the audit costs are identified separately and become a fee if the project work does not move past the audit phase.

Numbers

Consider things you or your staff have identified that can save energy. This is the 'inspiration' part. The 'perspiration' part is identifying how much savings, how much cost, payback period, ranking the measures, etc. The true business case for energy savings depends entirely on numbers like these.

Expertise

Many businesses do not have the luxury of in-house energy savings expertise. ESCOs and ESPCs are specialists in the field of energy savings, practical solutions, and the ability to quantify answers and evaluate options for customers. Some measures are easy to identify, but others are not. Even the most basic retrofit, lighting, has several paths to take for best outcome. Consider:

- Lighting source efficiency
- Lighting fixture efficiency
- Lighting control options
- Indirect energy effect on the building heating and cooling energy consumption
- Light levels – sometimes there is more light or less light than is needed
- Expected life of fixtures – sometimes new is very close to the cost of a retrofit
- *Lighting problems that can be corrected during the project*

The last item is of special value to a customer, and it applies to lighting and all other systems. Where there are existing problems, hasty choices in efficiency programs can leave root problems intact – or, worse, upgrade and sustain them so they stick around for another 20 years. Thorough evaluation and customer interviewing up front can identify building 'sore spots' and

provide options to correct them during the project. Utilizing an ESCO / ESPC brings that level of expertise into the facility.

More than Energy

Very often the energy savings performance contracting process is utilized for more than energy savings. Most building owners considering such a contract are not new. Not only has normal wear and tear gone on, but things have changed. The ability to expand the scope of services and build up a series of improvements related to energy savings is a popular aspect of the guaranteed savings approach. Adding to the appeal is the one-stop shopping approach where the customer may find it easier to get things done this way, as opposed to a more formal approach using an architect or engineer and bid documents. Since project management is incorporated into the deliverable, relatively large projects can be accomplished with this approach.

Transparent

Few businesses can claim that energy savings and building improvement projects are their core business. Utilizing an ESCO can allow the energy savings work and its benefits to occur with minimal distraction to the core business. In entering this type of agreement, the customer gains the expertise for this niche market for the duration of the work, while they continue to focus on what their company does.

Sooner than Later

Because of the focused expertise and experience, ESCOs and ESPCs can deliver projects quickly. This can be an important differentiator since the sooner the project is done the sooner the savings benefits are realized.

Energy savings performance contracts bring energy system expertise, provide a detailed energy audit, quantify costs and savings for you, make funding available, and deliver projects that save energy - all in exchange for a fee. The project scope can include more than just the energy saving items if desired. Energy savings pays for or subsidizes the work and fees over a period of time. If there is interest in this type of program, contact a few ESPCs and get to know them better.

Business decisions involve money. The table below provides some cross-check concepts for evaluating your proposed ESPC contract.

Table 1. Top 10 Unique Considerations of Performance Contracting for Implementing a Project

The following are some quality check items for the business / money aspect of an energy savings performance contract. Some are watch-outs. It never hurts to double check.

Some of these are from the viewpoint of the customer and others are from the viewpoint of the contractor. They all point to the unique nature of the project delivery method, and the need for the customer to be able to adapt to some changes. Like anything new, the more you know, the better decision you'll make.

	Concept	Discussion
1	Loan payback period should not exceed the life of the equipment or systems loaned on.	This would be analogous to a 20-year loan on an automobile purchase– you do not want to end up still paying for it when it is gone. Look for statements of expected equipment life, and verify they are realistic.
2	If the guaranteed savings term is much shorter than the contract total term length (e.g. 3 years guaranteed vs. 15 years total), there is a risk to the owner.	If savings degrade, the cash flow will look different and unanticipated costs may arise. If the contract is designed to be 'revenue-neutral', then any years when the savings do not come to pass will constitute a new bill, for which there needs to a be method to pay. To guard against this, encourage the ESCO to provide conservative savings estimates so that the actual savings are better than the contract stipulations, or build-in a degradation factor on the savings that increases over time. Some of the degradation could come from lack of maintenance, and so identify maintenance expectations and commit to these.
3	If design defects are identified during the guarantee period, this can cost the owner money over the life of the loan after the guarantee time is up.	Unless the guaranteed savings extends for the full loan term, this is a risk to the owner. A contract stipulation can guard against this by providing for long term annual payment equivalent to the missed savings. With a verified defect, ongoing M&V and associated fees would not be needed.
4	The ownership of new equipment is unique when being financed.	Until the loan is paid off, the equipment is the property of the lender. This will limit future modifications to the equipment during the life of the loan. Specific maintenance and records will probably be required by the lender and ESPC. Because of the 'gray area', ask a lot of questions…. Like what would happen if the equipment failed after 10 years under a 20-year note.
5	Energy savings will be the prime objective in all activities.	Other considerations, while not ignored, may be taken less seriously than the owner is used to…such as adherence to facility guidelines and preferences, reliability and redundancy, aesthetics, detailed design and documentation, and attention to related systems. Maintaining reasonable balance will require some effort by the customer. The narrow view is understandable – since the contractor is guaranteeing energy savings, it is their natural focus.

	Concept	Discussion
6	The customer must be around longer than the life of the loan period.	Permanent institutions such as government buildings, schools, etc. are very good candidates. Businesses that change ownership often would probably be poor candidates for performance contracting. Historically, this has limited long term guaranteed savings projects to certain businesses listed. But private industry is very resourceful. For example, eliminating the guarantee and adding third party calculation reviews and normal/customary design/construction guarantees could still connect your project need with these specialized teams for the same funding sources and results. Of course, this adds risk to the customer especially when utility budget dollars are removed based on projected savings. Let's hear it for conservative savings estimates!
7	Energy Savings Performance Contracts are long term contracts and are a risk to the ESPC.	The risk taken on by the ESPC is one of the reasons for the fees charged.
8	M/V and baselines are the crux of the savings contract and need to be clearly defined.	Baseline definitions must include provisions for adjusting up or down with external influences, like colder or warmer than usual seasonal weather, building additions, occupancy, production rates, etc. It may be good business to hire a third party consultant to review these and other key pieces of the contract, to assure project success and avoid it becoming adversarial. Do not be hurried at this stage.
9	How equipment is operated and maintained has an effect on energy use.	It is essential to establish the 'rules' for O/M such as indoor temperatures, hours of operation, and frequency of servicing and then provide the necessary monitoring to assure the promises are kept. Thus, the owner will have contract obligations on how the building is operated and maintained during the life of the loan. For example, if operating schedules or temperatures are changed by the customer, or if equipment is not maintained, the contractor may adjust the annual savings, effectively charging the customer back for the changes.

	Concept	Discussion
10	The guaranteed savings contract provision has the potential to create an adversarial relationship with the customer.	Establishing clear cut rules, with owner buy-in, on how it is determined who owes who what, are essential. Project management interpersonal skills and a conservative estimate with a little wiggle room are other tools, but they do not replace clear contract language that is, from the onset, fair to both parties. There are cases where the lack of guarantee would 'break' the operation, in which case a rigid and full-term M&V contract may be appropriate. This amounts to less net savings (since M&V has a fee each year it is applied and might take away 5-10% of the savings depending on project size), but then the remaining savings are guaranteed. Consider provisions that are partnering to help the contract succeed – these are usually in the form of risk-sharing or flexibility. Some possibilities: • If one year doesn't make the savings, but the next year exceeds the savings, the over-performing year can subsidize the other • If savings continually exceed estimates, the windfall is shared between parties • If savings are habitually less than the guarantee, give the contractor the option of installing additional measures that create equal savings in lieu of a long term penalty payment

6. Where do I go to learn more?

Contact some of your business peers that have utilized Performance Contracting and learn from their experience. Ask them what worked and what didn't.

International Performance Measurement and Verification Protocol (IPMVP), Volume 1

Latest version location is Efficiency Valuation Organization (EVO), requires purchase

Searching keywords can locate an older version to download, free, such as nrel.gov, eeporformanc.org

M&V Guidelines: Measurement and Verification for Performance-Based Contracts, U.S. Department of Energy, Federal Energy Management Program

Search using keywords and download latest edition, free

Measurement and Verification of Energy Savings, Haberl, J. and Culp, C., Chapter 27, Energy Management Handbook, 8th ed., Fairmont Press.

This is a book that would require purchase