

# How to Determine and Verify Operating and Maintenance (O&M) Savings in Federal Energy Savings Performance Contracts

November 2007

**Prepared by:**  
Operations and Maintenance Saving Determination  
Working Group

**Approved by:**  
Federal ESPC Steering Committee

Archived File - updated version available.

## Table of Contents

<b>1. INTRODUCTION.....</b>	<b>3</b>
1.1 BACKGROUND.....	4
1.2 EXISTING GUIDANCE.....	4
<b>2. M&amp;V APPROACH.....</b>	<b>5</b>
2.1 CALCULATION METHOD.....	5
<b>3. COST SCHEDULES .....</b>	<b>6</b>
3.1 SCHEDULE DO-3 – PERFORMANCE PERIOD CASH FLOW.....	6
3.2 SCHEDULE DO-4 – FIRST YEAR ENERGY AND COST SAVINGS BY ECM .....	6
<b>4. M&amp;V PLAN.....</b>	<b>7</b>
4.1 DEFINING & DOCUMENTING THE BASELINE.....	7
4.2 MANAGING REPAIR & REPLACEMENT COSTS AND SAVINGS.....	8
4.3 CALCULATING SAVINGS AND ADJUSTING BASELINES.....	9
4.4 DEFINING ONGOING VERIFICATION ACTIVITIES.....	9
<b>5. ANNUAL REPORTS.....</b>	<b>10</b>
5.1 VERIFYING AND REPORTING SAVINGS .....	10
<b>6. EXAMPLE SCENARIOS .....</b>	<b>10</b>
6.1 EXAMPLE 1: O&M SAVINGS IS DUE TO ELIMINATION OF A MAINTENANCE CONTRACT.....	11
6.2 EXAMPLE 2: O&M SAVINGS IS DUE TO REDUCTION IN GOVERNMENT’S O&M STAFF.....	12
6.3 EXAMPLE 3: O&M SAVINGS DUE DECREASED NEED FOR REPLACEMENT EQUIPMENT.....	13
<b>7. LESSONS LEARNED .....</b>	<b>15</b>

*Archived File - updated version available.*

## 1. Introduction

This document was developed by the Operations and Maintenance (O&M) Savings Determination Working Group of the Federal ESPC Steering Committee,<sup>1</sup> and provides guidance on documenting and verifying O&M savings in federal Energy Savings Performance Contracts (ESPCs).

A recent analysis of annual measurement and verification (M&V) reports from 100 ongoing Super ESPC projects showed that 21% of the reported savings were due to reductions in O&M costs. These energy-related cost savings, which can also include savings on repair and replacement (R&R) costs, can constitute a substantial portion of a project's savings, yet O&M and R&R cost savings are often not as diligently verified or reviewed as energy savings.

To support the Super ESPC program's integrity, new projects must strengthen the basis for O&M cost savings. Documenting and verifying O&M or other energy-related savings will help ensure persistence of the savings for the contract term, avoid conflicts, and address oversight agency concerns. Key items identified for enhancement in new projects are baseline documentation, savings calculation methods, and verification of O&M and R&R savings. This document provides guidance in these areas for reoccurring energy-related cost savings, including the following.

- An agency's decision to commit ongoing funds from O&M budgets towards ESPC project payments has long-term impacts and must be documented adequately for future agency staff and oversight agencies.
- The expectations regarding information required in Super ESPC project submittals is clarified, including cost schedules, M&V plans, and annual M&V reports.
- "Savings" due to redirected labor or O&M efforts that do not reduce real expenses cannot be claimed as savings under the Super ESPC program.
- Agencies should maintain O&M cost records that will be needed to document baseline O&M costs for a Super ESPC project.
- Energy services companies (ESCOs) should include detailed information in annual M&V reports to clearly convey the source of O&M savings as well as sufficient data to verify any savings calculations performed.
- Escrow accounts can help alleviate repair and replacement risk for both the ESCO and the agency.
- Variable annual savings and cost streams can be accommodated, and will need to be addressed in the financing arrangement and reflected in the delivery order (DO) schedules.

---

<sup>1</sup> Information on the ESPC Steering committee is available at <http://gaia.lbl.gov/federal-espc/>

## 1.1 Background

O&M and other energy-related cost savings are allowable in federal ESPCs, and are defined as reduction in expenses (other than energy cost savings) related to energy and water consuming equipment:

**10 CFR § 436.31.**<sup>2</sup> Energy cost savings means a reduction in the cost of energy and related operation and maintenance expenses, from a base cost established through a methodology set forth in an energy savings performance contract, utilized in an existing federally owned building or buildings or other federally owned facilities as a result of—  
(1) The lease or purchase of operating equipment, improvements, altered operation and maintenance, or technical services, or...

Energy-related cost savings can result from avoided expenditures for operations, maintenance, equipment repair, or equipment replacement due to the ESPC project. This includes capital funds for projects (e.g., equipment replacement) that, because of the ESPC project, will not be necessary. Sources of energy-related savings include:

- avoided current or planned capital expense,
- transfer of responsibility for O&M and/or R&R to the ESCO, and
- avoided renovation, renewal, or repair costs as a result of replacing old and unreliable equipment.

Methods for estimating O&M savings resulting from changes to equipment have not been developed for the FEMP or IPMVP M&V Guidelines.<sup>3</sup> However, the general rule to follow is that any savings claimed from O&M activities must result in a real decrease in expenditures. O&M budget baselines cannot be based on what the agency *should* be spending for proper O&M; baseline expenditures *must* be based on what the agency *is* spending. The agency's O&M expenditures after implementation need to decrease for savings to be considered real.

## 1.2 Existing Guidance

Preceding the work of this group was the development of the *DOE-FEMP Guidelines Regarding One-Time Savings Payments and One-Time Savings in ESPCs*,<sup>4</sup> dated 10/5/06, which was developed for the Federal ESPC Steering Committee. This document provides guidance regarding allowable one-time payments from agencies to contractors in federal ESPCs.

The guidance allows avoided costs of programmed expenditures that become unnecessary due to implementation of an ESPC project, or savings that exceed contractually guaranteed savings, to be claimed as savings. Such savings must come from real and verifiable budgets, not from the perceived value that the agency receives for the reduction

---

<sup>2</sup> Title 10, Code of Federal regulation part 436 Subpart B – Methods and Procedures for Energy Savings Performance Contracting.

<sup>3</sup> Information on FEMP M&V Guidelines: Measurement and Verification for Federal Energy Projects and International Performance Measurement Protocol is available through

[http://www1.eere.energy.gov/femp/financing/superespcs\\_mvresources.html](http://www1.eere.energy.gov/femp/financing/superespcs_mvresources.html).

<sup>4</sup> [http://www1.eere.energy.gov/femp/financing/superespcs\\_espcbasics.html](http://www1.eere.energy.gov/femp/financing/superespcs_espcbasics.html)

in O&M efforts. “Savings” due to redirected labor or O&M efforts that do not reduce real expenditures cannot be claimed as savings under the Super ESPC program. This guidance applies to recurring O&M savings as well.

This working group (WG) follows a former O&M WG that produced *Planning and Reporting for Operations & Maintenance in Federal Energy Saving Performance Contracts*.<sup>5</sup> That guidance document covers the related topics of:

- Properly allocating O&M and R&R responsibilities, and
- Defining project-specific O&M reporting requirements.

The *FEMP M&V Guidelines v2.2* (Chapter 33) and *Detailed Guide to Option A* (Section 5.10) provide some discussion of issues associated with O&M and R&R savings, whereas the IPMVP does not. The *Practical Guide to Savings and Payments* describes a few related example scenarios. Within the current (2004) Super ESPC indefinite-delivery, indefinite-quantity (IDIQ) contracts, the risk and responsibility matrix provides an overview of key issues. The important relevant concepts from these documents have been incorporated herein.

## 2. M&V Approach

Determining the appropriate level of effort to invest in the M&V of energy-related cost saving is the same as for energy cost savings: The level of M&V rigor will vary according to (a) the value of the project and its expected benefits, and (b) the risk in not achieving the benefits. A graded approach towards measuring and verifying O&M and R&R savings is advised. There is one primary method for calculating O&M savings, which is detailed below.

### 2.1 **Calculation Method**

The most common approach to calculating energy-related cost savings involves the same concepts as those used for determining energy savings: Performance-period labor and equipment costs are subtracted from adjusted baseline values, as shown in the equation below.

$$\text{O\&M Cost Savings} = \{ \text{Adjusted Baseline O\&M Costs} \} - \{ \text{Actual O\&M Costs} \}$$

This method is appropriate for most projects, and is especially simple to apply to those that include elimination of a maintenance contract or reduction in government staff. For other projects, costs for replacement parts can often be determined from purchase records and averaged to arrive at an annual baseline value. Labor costs for particular services may be more difficult to quantify since service records may not be representative or may lack sufficient detail. For example, parts costs for replacement light bulbs, ballasts, or steam traps are relatively easy to quantify from purchase records. Labor costs to replace lamps, ballasts, or steam traps are more difficult to quantify because time spent on these specific tasks may not be well documented. Additionally, labor reductions on these

<sup>5</sup> [http://www1.eere.energy.gov/femp/financing/superespcs\\_mvresources.html](http://www1.eere.energy.gov/femp/financing/superespcs_mvresources.html)

specific tasks may not qualify as “real savings” if labor expenditures do not decrease. Although the agency receives value in the sense that labor is freed up to perform other useful tasks, this value may not result in cost savings that can be paid to the ESCO.

Baseline O&M and R&R costs should be based on actual budgets and expenditures to the greatest extent practical. This essentially “measures” the baseline consumption of these parts or services. Estimated expenditures should be avoided if at all possible. In cases where such information is not available and must be estimated, parts and labor costs can be derived from resources such as R.S. Means<sup>6</sup> or other methods. Estimated expenditures should be adjusted to reflect any site-specific factors that would affect costs.

Example applications of this method are demonstrated in Examples 1, 2, and 3 in Section 6.

### 3. Cost Schedules

O&M and R&R savings and costs are found in two places in the financial schedules for a Super ESPC project: performance-period ESCO expenses in schedule DO-3, and first year energy and cost savings by energy conservation measure (ECM) in schedule DO-4.

#### **3.1 Schedule DO-3 — Performance-Period Cash Flow**

Schedule DO-3 presents the cash flow for the Super ESPC project and includes the details of all performance-period expenses incurred by the ESCO over the course of the project.

Performance-period expenses are delineated by contract year in the following line items: Management/Administration; Operation; Maintenance; Repair and Replacement; Measurement and Verification; Permits and Licenses; Insurance; and Property Taxes. Schedule DO-3 shows all performance-period costs incurred by the ESCO, whereas baselines and Agency savings are found in DO-4.

#### **3.2 Schedule DO-4 — First Year Energy and Cost Savings by ECM**

Schedule DO-4 presents a summary of the estimated annual cost savings that will be achieved by each of the ECMs included in a Super ESPC project. This schedule documents the changes in costs to the Agency during the first year. Costs for subsequent contract years can be determined by applying the appropriate escalation rates, if used.

First year savings (or increase in use or costs) due to each ECM are quantified for all energy and commodity sources along with their individual cost impacts. Line items for each ECM include electric energy savings, electric cost savings, demand savings, demand

<sup>6</sup> Means Facilities Maintenance & Repair 2007 Book is available through <http://www.rsmeans.com/bookstore/detail.asp?sku=60307>.

cost savings, other energy-related and O&M cost savings, and others. Savings in this table are positive, while additional costs are recorded as negative values.

#### 4. M&V Plan

The M&V Plan Outline for Super ESPCs contains the following section for documenting O&M and other cost savings for each ECM:

*Excerpt from SuperESPC M&V Plan Outline for each ECM:*

- 3.4 Operations and Maintenance and Other Cost Savings
- 3.4.1 Provide justification for O&M cost savings, if applicable.
- Describe how savings are generated
  - Detail cost savings calculations.
  - Provide performance period O&M cost savings adjustment factors, if different from in Whole Project Data / Global Assumptions section.
- 3.4.2 Provide justification for other cost savings, if applicable.
- Describe how savings are generated.
  - Detail cost savings calculations.
  - Provide performance period adjustment factors, if different from in Whole Project Data / Global Assumptions section.

Already required in the M&V plan is information on how the O&M and other cost savings (including R&R) are generated and calculated. Although not explicitly called out in the M&V plan outline, this information should include baseline documentation, savings calculation methods, and a plan for verification of savings. The M&V plan should clearly indicate how the agency's expenditures will be directly reduced.

#### **4.1 Defining and Documenting the Baseline**

In general, the baseline labor and equipment costs can be determined from the following:

- Historical data on cost of equipment parts and consumables
- Records of historical labor hours based on work orders and timesheet systems
- Labor rates including benefits and overhead as well as any part-time or temporary labor services
- Existing service contracts for O&M services

Adequate documentation in the M&V plan will include the following:

- Identification of key variables affecting the realization of savings
- Specification of how the Agency's expenditures will directly be reduced by the implementation of the measure or O&M contract
- Definition of the O&M performance standard (e.g., annual chiller tube cleaning or lamp replacements within 48 hours of burnouts)

An issue in defining the baseline is establishing the time period for analysis. How far back do you go to define the O&M baseline? What if equipment has needed an atypically high level of maintenance during the last years of service? This decision requires engineering judgment, and will depend on the availability of historic data. The fundamental goal is to provide transparency in the decision making process by thoroughly documenting why a specific method was chosen, what data was available and used, and how cost savings were determined.

In general, it is recommended to use as much historical data as possible when defining the baseline conditions. Ideally, maintenance parts and/or labor should be determined for the life of the equipment, and then an average annual cost can be calculated. If the O&M savings vary dramatically from year to year, it may not be appropriate to use an average cost. This is a site-by-site decision since overall savings from the ESPC must cover payments every year. The key is making sure that historic costs would continue if not for the project. Conducting a “reality check” on historic O&M costs using RS Means Facility Maintenance and Cost Data<sup>7</sup> or other data is recommended to ensure that site data are realistic. Actual site data should be used wherever possible.

For sites that do not have detailed O&M records and when the ESCO will be assuming some O&M responsibility, the Agency can allocate a portion of their O&M budget for materials to cover ESCO services. This approach requires a long-term commitment from the Agency, and could be regretted in subsequent years.

Another situation that sometime arises is when baseline O&M procedures are unacceptable or substandard. Projects can increase O&M costs over the baseline conditions by adding new equipment or by requiring certain preventative maintenance activities that were not previously conducted. Since only real budgetary savings can be claimed, O&M “savings” can sometimes be negative if additional costs are incurred. The negative savings should be shown in cost schedule DO-4, just as savings would be.

## **4.2 Managing Repair & Replacement Costs and Savings**

In some cases, a site's O&M budget may include general funding for emergency R&R. Sometimes this is the only R&R budget, and it is not allocated for specific equipment (e.g., boiler X will be replaced in year Y). For Agencies with a sufficient unspecified R&R fund, it may be possible to claim one-time or periodic avoided material costs and/or subcontracted labor fees. Alternatively, if the ESCO is assuming responsibility for some fraction of the infrastructure, a justified portion of the budget attributed to material replacement and contracted labor cost could be allocated as an annual savings. In both cases, the rationale for claiming the cost savings, the source of savings, and the specific year(s) of implementation must be carefully documented.

---

<sup>7</sup>Means Facilities Maintenance & Repair 2007 Book is available through <http://www.rsmeans.com/bookstore/detail.asp?sku=60307>

In some cases an escrow account is established to cover future R&R costs for the new equipment. Use of an escrow account can reduce risks to both the agency and ESCO related to future R&R. An ESCO can allocate a predetermined portion of the payment stream (DO-3 line item) into a dedicated R&R fund. Use of this fund must be related to the equipment installed under the ESPC, and the funds return to the government if they are not used. Draw-downs of funds can be mutually determined by the ESCO and agency as repairs are required. Use of an escrow account limits the financial exposure to the party accepting overall responsibility for R&R of the new equipment.

### **4.3 Calculating Savings and Adjusting Baselines**

Documentation of calculation methods should include how the baseline and actual O&M and R&R budgets will be established and calculated, including costs for labor and materials for equipment replacement, equipment maintenance and repair, and consequential items such as lost energy savings or other effects. Additional details should be included such as hourly labor costs, labor inflation rates, hours required per specific task, and equipment lifetimes.

The M&V plan should also describe how adjustments will be made to savings calculations to account for changes at the facility. Factors such as changes in operating hours, occupancy, loads, and equipment life will affect HVAC system maintenance costs. If baseline cost data will be adjusted, the reasoning and methodology should be included.

It is necessary to define how actual costs will be accounted for during the performance period. Specify what, if any, additional management oversight or logs will be maintained, the nature and frequency of entries, and how the results will be interpreted. Examples include logging of equipment failures and frequencies, equipment down time, and complaints.

Best practice is to use standard accounting procedures that allow for direct comparison of baseline to performance period costs (apples to apples). Another option may be to use a “control group” facility which is similar to the project site to determine what the O&M costs would have been in the absence of the ECM.

### **4.4 Defining Ongoing Verification Activities**

The M&V plan defines all ongoing verification activities and should include the following:

- How savings persistence will be ensured
- How compliance with performance standards for the facility will be verified
- What will occur if performance standards are not met
- How savings will be counted if site behavior changes, and what will occur if actual O&M costs increase
- How long O&M savings will last. (Often, cost savings should only be scheduled for part of the contract period.)

## 5. Annual Reports

O&M and R&R savings must be adequately verified and reported during the performance period. The Annual Report outline for Super ESPC projects contains the following section for documenting the O&M savings for each ECM:

*Excerpt from SuperESPC Annual Report Outline for each ECM:*

- 2.4 Details of O&M and Other Savings (if applicable)
  - 2.4.1 Describe source of savings, if applicable.
    - Describe verification activities.
    - Provide performance period O&M savings adjustment factors, if applicable.
  - 2.4.2 Describe source of other savings, if applicable.
    - Describe verification activities.
    - Provide performance period adjustment factors, if applicable.

### **5.1 Verifying and Reporting Savings**

Although not explicitly called-out in the Annual Report outline, adequate documentation should include the following:

- Dates and times of on-site verification activities (including government witnessing if appropriate)
- Review of key variables affecting the realization of savings
- Verification that standards of performance have been met

Baseline budgets and service contract fees may be escalated to account for inflation during the contract term. Escalation rates need to be documented and should come from sources such as the National Institute of Standards and Technology, which estimates such factors for life-cycle costing. Guidance on performance period adjustment factors, which are intended to account for inflation, are provided through FEMP.<sup>8</sup>

## 6. Example Scenarios

Three example scenarios are provided to illustrate some of the common sources of O&M savings in ESPC projects:

1. Elimination of a maintenance contract
2. Reduction in government's staff
3. Decreased need for replacement equipment

---

<sup>8</sup> NIST includes the rates in two tools it produces for FEMP annually every April, the Building Life-Cycle Cost (BLCC) tool and the Energy Escalation Rate Calculator (EERC). Both BLCC and the EERC can be downloaded from the FEMP website, listed under software tools ([http://www1.eere.energy.gov/femp/information/download\\_blcc.html](http://www1.eere.energy.gov/femp/information/download_blcc.html)).

## 6.1 Example 1: O&M savings from elimination of a maintenance contract

Prior to the implementation of the ESPC, space conditioning at the facility was provided by aging boilers and chillers that were maintained by a third party under a maintenance contract. The ESPC replaces the aging equipment with newer, more efficient equipment, which the ESCO maintains for the life of the contract.

This is probably the easiest type of O&M savings to verify, and the least controversial. Since a maintenance contract will be eliminated, O&M cost savings can be claimed. The annual O&M savings will be the cost of the maintenance contract during the baseline year, inflated by a constant amount each year to account for price inflation, as outlined in the eliminated service contract. There can be little disagreement that these cost savings are achieved, since the former equipment is no longer in service and no longer requires maintenance. O&M savings are calculated using the following equation:

$$\text{O\&M Cost Savings} = \{ \text{Adjusted Baseline O\&M Costs} \} - \{ \text{Actual O\&M Costs} \}$$

The O&M savings is then the difference between the annual cost of the old contract, adjusted for inflation, and the actual maintenance costs, which will be zero. The first step is to determine the site's current costs for the service contract that will be eliminated. A review of the service contract showed costs of \$22,250 in the baseline year, with an annual increase in fees of 1.5%.

During the performance period, the adjusted baseline costs will be the current costs inflated by a constant amount each year (1.5%). The actual O&M costs for these staff in the performance period are expected to be zero. The savings stream from these savings for a ten-year period is shown in Table 1.

Table 1: O&M Maintenance Savings from Eliminated Service Contract

Annual System Maintenance Cost			
Year	Existing Cost	Post-Install Cost	Net Savings
0	\$22,250		
1	\$22,806	\$0	\$ 22,806
2	\$23,376	\$0	\$ 23,376
3	\$23,961	\$0	\$ 23,961
4	\$24,560	\$0	\$ 24,560
5	\$25,174	\$0	\$ 25,174
6	\$25,803	\$0	\$ 25,803
7	\$26,448	\$0	\$ 26,448
8	\$27,109	\$0	\$ 27,109
9	\$27,787	\$0	\$ 27,787
10	\$28,482	\$0	\$ 28,482
			<b>\$255,507</b>

Verification of these savings includes confirmation that the equipment and related O&M contract was eliminated in the post-installation or year 1 report. All following performance reports will thoroughly document the source of savings.

## 6.2 Example 2: O&M savings from reduction in government's O&M staff

Prior to the implementation of the ESPC, space conditioning at the facility was provided by aging boilers and chillers that were maintained by government employees. The ESPC replaces the aging equipment with newer, more efficient equipment, which the ESCO will maintain. As a result of this retrofit, three of the Agency's maintenance staff members will no longer be required. Two staff members will be taking retirement, while one other will be transferred to another division within the Agency.

Since there will be a reduction in the government's maintenance staff, O&M savings can be claimed. O&M savings are calculated using the following equation:

$$\text{O\&M Cost Savings} = \{ \text{Adjusted Baseline O\&M Costs} \} - \{ \text{Actual O\&M Costs} \}$$

The first step is to determine the site's current costs for the staff members that will be eliminated. A review of the site's accounting records indicates that the salaries and benefits of the three eliminated employees cost the agency \$200,500 the last year. This is the baseline costs for year 0. During the performance period, the adjusted baseline costs will be the sum of the annual salaries and benefits of the staff members who will be eliminated inflated by a constant amount each year (2% in this case). The actual O&M costs for these staff in the performance period are expected to be zero.

The savings stream from these savings for a ten-year period is shown in Table 2, which assumes that a 2% annual salary increase would have occurred.

Table 2 : Labor Cost Savings for 10 Year Contract

Year	Annual System Labor Costs		
	Existing Cost	Post-Install Cost	Net Savings
0	\$200,500		
1	\$204,510	\$0	\$204,510
2	\$208,600	\$0	\$208,600
3	\$217,028	\$0	\$217,028
4	\$221,368	\$0	\$221,368
5	\$225,796	\$0	\$225,796
6	\$230,311	\$0	\$230,311
7	\$234,918	\$0	\$234,918
8	\$239,616	\$0	\$239,616
9	\$244,408	\$0	\$244,408
10	\$249,297	\$0	\$249,297
			<b>\$2,275,852</b>

The first-year or post-installation verification of the O&M savings will confirm maintenance staff reductions and that the ESCO has assumed prescribed O&M activities. All following performance reports will thoroughly document the source of savings and confirm that the ESCO is continuing to perform the O&M activities.

A problem could arise if the maintenance staff is not reduced. Then it would be necessary to determine what new O&M responsibilities the facility has taken on, or savings should not be claimed. For example, it could be that a new building was constructed. During the performance period, it is important to establish that any increased maintenance was not due to the equipment installed under the ESPC. In some cases this may require examination of service call records from before and after the implementation of the ESPC.

### 6.3 Example 3: O&M savings from decreased need for replacement equipment

Material-related savings frequently result from lighting and lighting controls projects. In this example, the agency is responsible for maintenance both before and after the equipment installation. Although there is no reduction in staff for which to claim labor savings, there will be cost savings on replacement materials.

For this project, lighting maintenance savings will result from the following:

1. Reduced material requirements (e.g., lamps, ballasts)
  - Reduced operating time — Control measures increase equipment life by reducing the burn time of lamps and ballasts.
2. Warranty-related savings — Newly installed lamps, ballasts, and fixtures come with a manufacturer warranty of 3 years.

The reduction in equipment costs is determined by calculating the difference between what replacement parts for the baseline would cost and what parts for the new lighting system cost.

$$\text{O\&M Cost Savings} = \{ \text{Adjusted Baseline O\&M Costs} \} - \{ \text{Actual O\&M Costs} \}$$

For this project, the following assumptions apply:

1. Lamp and ballast costs and expected lifetimes are defined in Table 3.

**Table 3: Costs and Lifetimes for Lighting Equipment**

Equipment	Rated Life (hours)	Cost per unit
4' T12 lamp (existing)	20,000	\$ 1.98
2 lamp EE magnetic ballast (existing)	100,000	\$ 15.63
2 lamp RO electronic ballast (new)	75,000	\$ 12.30
4' T8 lamp (new)	24,000	\$ 2.19

2. Increased cycling of the lights resulting from the occupancy sensors has a negligible effect on lamp/ballast life.
3. The entire project (including all other measures) has a performance period of 10 years.
4. Escalation of materials costs will be 2.5% per year.

The first step is to determine the site's costs for replacement lighting equipment. A review of the site's records indicated that replacement lighting equipment for the fluorescent T12s totaled \$5100 and \$5450 the last two years, with an average of \$5275. A reality check based on the expected useful service life of the equipment and known operating hours was then conducted to confirm that this value is reasonable, as shown in Table 4.

**Table 4 : Predicted Baseline Material Costs**

<b>Baseline</b>	<b>Qty</b>	<b>Cost</b>
Lighting equipment (2-Lamp T-12 fixtures w/ EE magnetic ballast):	5,000	
Run Hours:	3,000	
Lamp replacements per year:	1,500	\$ 2,970
Ballast replacements per year:	150	\$ 2,345
<b>Annual Cost:</b>		<b>\$ 5,315</b>

The third step is to estimate the expected replacement equipment costs for the post-installation scenario. These calculations are shown in Table 5.

**Table 5: Predicted Post-Installation Material Costs**

<b>Post-Install</b>	<b>Qty</b>	<b>Cost</b>
Lighting equipment (2-Lamp T-8 fixtures w/ Electronic ballast):	5,000	
Run Hours (with occupancy controls):	2,250	
Lamp replacements per year:	938	\$ 2,051
Ballast replacements per year:	150	\$ 1,845
<b>Annual Cost:</b>		<b>\$ 3,896</b>

Next, the cash-flow from the material savings are determined, accounting for the lamp and ballast warranty that comes with the new lighting system. Under this warranty, all replacement lamps and ballasts will be provided by the equipment manufacturer at no cost for the first three years. Using the inflation rate of 2.5% for material costs, the material maintenance cost savings for the 10-year project term would vary year to year, as shown in Table 6.

**Table 6: Annual Cost Savings on Replacement Parts**

Annual System Equipment Cost				
Note	Year	Existing Cost	Post-Install Cost	Net Savings
	0	\$5,275		
Warranty Period	1	\$5,407	\$0	\$5,407
Warranty Period	2	\$5,542	\$0	\$5,542
Warranty Period	3	\$5,681	\$0	\$5,681
Yr 0 costs (\$3,896) escalated to Year 4	4	\$5,823	\$4,300	\$1,522
	5	\$5,968	\$4,408	\$1,560
	6	\$6,117	\$4,518	\$1,599
	7	\$6,270	\$4,631	\$1,639
	8	\$6,427	\$4,747	\$1,680
	9	\$6,588	\$4,865	\$1,722
	10	\$6,752	\$4,983	\$1,766
				<b>\$ 28,120</b>

Annual verification of the O&M savings will include the Agency reporting the actual number and cost of replacement lighting equipment to the ESCO, who will compare the data to what would have been required in the baseline case.

## 7. Lessons Learned

Some lessons learned from other projects provide some key points to keep in mind:

- An agency's decision to commit ongoing funds from O&M budgets towards ESPC project payments has a long-term impact and must be documented adequately for future agency staff in both the M&V plan and the annual reports. Information should include why a specific method was chosen, what data was available and used, and how cost savings were determined.
- Operations & maintenance budget baselines cannot be based on what the agency *should* be spending for proper O&M; baseline expenditures *must* be based on what the agency *is* spending. The agency's O&M expenditures after implementation need to decrease for savings to be considered real.
- A graded approach towards measuring and verifying O&M and R&R savings is advised according to (a) the value of the project and its expected benefits, and (b) the risk in not achieving the benefits.
- Agencies should maintain O&M cost records that will be needed to document baseline O&M costs. These records should be included in the Super ESPC proposal.
- ESCOs should include detailed information in annual reports to clearly convey the source of O&M savings as well as sufficient data to verify any savings calculations performed.
- Escrow accounts can help alleviate R&R risk for both the ESCO and agency.

- Variable annual savings and cost streams can be accommodated and will need to be reflected in the DO schedules.
- Using an Option B or continuous measurement approach to tracking ongoing O&M savings can be cumbersome to the agency because of the required record keeping and accounting for ongoing changes at the site.

Archived File - updated version available.