IMPACT EVALUATION PLAN FOR THE SITE-SPECIFIC SAVINGS PORTFOLIO

Prepared for

LAUREN GAGE
Bonneville Power Administration

Prepared by

SBW CONSULTING, INC.

In association with

THE CADMUS GROUP, INC.
NORTHWRITE, INC.

December 23, 2013

sbw

ENERGY + WATER + EFFICIENCY

TABLE OF CONTENTS

1. EXECUTIVE SUMMARY

BPA, with its public power utility partners, acquires savings from a portfolio of energy efficiency programs and offerings that require site-specific savings estimates**.** This portfolio accounts for more than 50 percent of BPA's total energy efficiency achievements. The majority of the savings are from two major areas: custom projects and lighting calculators, although other calculated projects (e.g., small compressed air and HVAC) are included in this portfolio.

This plan defines methods and procedures to be used by the evaluation team (SBW Consulting, Inc., and its subcontractors the Cadmus Group, Inc. and NorthWrite, Inc.) in evaluating impacts of BPA's **Site-Specific Savings** portfolio for Fiscal Years (FY) 2012 and 2013. It also, provides guidance on how evaluations might be conducted for future periods and defines a protocol to be used in contacting end users and utilities.

1.1. FY 2012/2013 Cycle Evaluation Plan

For this cycle, the evaluation will accomplish the following objectives:

1. Estimate first-year kWh savings for the Site-Specific Savings portfolio and for separate portions of the portfolio as needed to understand the savings performance of important program delivery channels.
2. Estimate the lifecycle cost-effectiveness of the Site-Specific Savings portfolio and its constituent program delivery channels.
3. Identify opportunities for improving the M&V implementation, models (e.g., calculators and protocols) and savings estimates for each of the important program delivery channels.
4. Develop recommendations on M&V procedures, including but not limited to documentation and data handling that will improve reliability and reduce cost for future evaluation cycles.

The evaluation team will select a stratified sample of measures that is statistically representative of the portfolio. The study designs and their associated sample size and expected precision are shown in Table 1.

Table 1: Sample Size and Associated Confidence and Precision by Study

Special Study	Option	End Use	Sector	Confidence Level	Precision (±)	Sample Size
	1	Lighting	Industrial	80%	19.6%	8
	1	Lighting	Com/Ag	90%	9.8%	27
	1	NonLighting	Industrial	90%	10.5%	21
	1	NonLighting	Com/Ag	80%	19.3%	14
	2	Lighting	Industrial	80%	19.4%	13
	2	Lighting	Commercial	90%	9.9%	24
	2	NonLighting	Industrial	80%	19.1%	9
	2	NonLighting	Commercial	80%	19.4%	8
Energy Management	Both	All	Industrial	TBD	TBD	13
Total						**137**

Throughout this evaluation, our general approach to data collection will be to fully leverage the data previously collected by project engineers and other BPA and utility staff. We will only collect additional data if needed to achieve reliable estimates of savings for the sampled measures.

Data collection will begin with a review of project documentation for sampled measures. This will be augmented through discussions with engineers associated with the projects from BPA, utility and program implementation contractors as needed to fully understand the measure and the overall context of work performed at the end user site. If necessary, the end user will be contacted and the end user site visited to collected additional information about the baseline and efficient conditions of the measure and the important determinants of measure savings.

We anticipate the need for metering at a number of end user sites. In particular, metering is needed to reliably estimate the operating hours for lighting measures. Light logging will be sufficient when no controls are involved or when the measure involves simple on/off controls and there are not many control points. Power metering will be required when a large portion of savings is associated with dimming controls or there are many points of on/off control. Metering may also be needed for some non-lighting measures to understand important determinants of savings, although we expect that the project files may often provide sufficient data.

The evaluation team will estimate savings and life cycle cost-effectiveness using methods that conform to BPA M&V protocols, RTF Guidelines and evaluation best practices. We will prepare a report documenting study-level and portfolio-level findings for kWh savings and cost-effectiveness. The report will not contain any information that could be used to identify the end users that participate in the evaluation. Further, it will not contain any utility-specific findings or recommendations. However, utilities may choose to build on these studies by oversampling within their own service areas and may use results from the study in estimating impacts of their own portfolios.

1.2. Future Cycles of Evaluation

The Site-Specific Savings portfolio meets the RTF definition of a significant program. Therefore, at a minimum, an impact evaluation should be conducted at least every three years in order to conform to RTF guidelines for Program Impact Evaluation. BPA operates on a two-year rate period and may therefore decide to conduct evaluation of the Site-Specific Savings portfolio for each rate period.

To develop the sampling strategy, the share of savings and major changes in each the delivery channel should be examined for each future evaluation cycle. BPA may also decide to add a variety of special studies in the future, e.g., savings persistence, in-depth investigation of non-energy benefits.

BPA can do two things now that will likely improve the second cycle of evaluation (FY2014/15): (1) require uniform reporting system data about the M&V protocol used for each measure, and (2) assemble complete documentation for each project in a central secure archive managed by BPA.

1.3. End User and Utility Contact Protocol

The major elements of the protocol to be followed by the evaluation team are:

1. Affected Utilities will be notified by a BPA EER that -at least one site in their territory has been selected in the evaluation sample. Webinars will be held with affected Option 1 and Option 2 utilities to review the evaluation process in general and the end user contact protocol.
2. For Option 1 utilities, the evaluation team will request project documentation from BPA. Certain files may be requested from the utilities if they are not found in the BPA or Energy Smart Industrial documentation systems. The evaluation team will request all project files from Option 2 utilities.
3. Following file review, the evaluation team will contact the internal (i.e., BPA/ESI/utility) project engineers to learn more about the project.
4. The evaluation team will contact utilities and describe supplemental data that is needed from the end users, along with an estimate of the time required from the end user's staff to assist in the data collection. Utilities may make the initial end user contact and may be present at the site visit.
5. The evaluation team will call the end-user to brief them on the study and will work with the end user to determine the most efficient methods for acquiring the data. The utility will be notified about the schedule for data collection agreed to with the end user, so that they can participate. If the data collection involves a site visit, the evaluation team will work with the end user to determine what is needed (e.g., safety training, PPE, background checks) to access the relevant portions of the site.

6. Once the evaluation work is complete for a sampled project or measure, the evaluation team will refer any end-user requests for specific findings to the utility..
7. Once the evaluation work is complete for each utility's sampled projects or measures, the findings for that portion of the sample will be provided to the utility upon request.

2. INTRODUCTION

BPA, with its public power utility partners, acquires savings from a portfolio of energy efficiency programs and offerings that require site-specific savings estimates, known for the purposes of this evaluation plan as the BPA **Site-Specific Savings** portfolio**.** The majority of the savings are from two major areas: custom projects and lighting calculators, although other calculated projects (e.g., small compressed air and HVAC) are included in this portfolio.

Under these offerings (defined by BPA's Implementation Manual), Option 1 and 2 utilities develop projects for the industrial, commercial, agricultural and federal sectors. Site-specific savings estimates are developed by the followings means:

- RTF approved standard protocols
- BPA qualified calculators (Lighting, HVAC and Small Compressed Air)
- BPA custom project M&V Protocols
- Option 2 utility lighting calculators
- Option 2 utility custom M&V protocols

The portfolio contains custom projects from two of BPA's regional programs, each of which involves services from third-party contractors (Cascade and PECI): Energy Smart Industrial (all industrial projects regardless of the services provided by Cascade to any individual project) and Energy Smart Grocer custom projects (contractor is PECI). Both Option 1 and Option 2 utilities participate in these two programs.

In the past 10 years, BPA has only conducted one impact evaluation for a portion of the Site-Specific Savings portfolio; an impact evaluation of commercial lighting[1], conducted in 2008. It is important for BPA to conduct impact evaluation for the following reasons:

- The Site-Specific Savings portfolio is more than 50% of BPA's total savings acquisition.
- Evaluation provides an objective basis for assessing performance of key elements of the Site-Specific Savings portfolio.
- Evaluation provides constructive feedback to improve the portfolio.
- It is essential for regional stakeholders that the savings claimed by BPA and its public power utilities are, on the whole, *reliable, available and documented*; impact evaluations can meet this need.
- The RTF Guidelines (Section 5) have specified impact evaluation guidance for impact evaluations. Recent evaluation activities do not conform to these guidelines.

This document describes a plan for evaluating the impact of the Site-Specific Savings portfolio.

[1] http://www.bpa.gov/energy/n/reports/evaluation/commercial/pdf/Evaluation_of_BPA_Commercial_Lighting_Program.pdf

3. KEY CONCEPTS

We rely on the following definitions of key concepts throughout this balance of this plan.

3.1. Project Tracking Data

BPA uses its reporting system to track projects completed by public power utilities under various programs and initiatives. For Option 1 utilities[2], BPA has detailed custom project proposals and completion reports in its system (Option 1 Custom Project Calculator). Option 2 utilities report project data into the BPA system periodically (Option 2 Custom Project Calculator).

We will refer to the data available from the BPA reporting system as the project tracking data.

3.2. Projects

A project is a phase of work at an end user location that improves energy efficiency. An end-user is the customer of a BPA utility. The project tracking data records a date when the project is complete. The data also contains information such as the name of the end user, the location where the work was carried out, and other data critical to this evaluation. End users may authorize the completion of many phases of work, each of which is tracked as a separate project in the BPA reporting system.

3.3. Project Engineers

Project engineers assist in the identification, development, savings estimation, cost-effectiveness analysis, measurement and verification and quality control review of Site-Specific Savings portfolio projects. Project engineers may be BPA staff, utility staff, or staff of BPA or utility project implementation contractors, such as Cascade and PECI. For the purposes of this plan, project engineers are not staff or contractors employed by the end users, even though the end user workforce may have played an important role in the development of a project. This is a critical distinction, as specific protocols (see Section 6) govern contact with end users.

3.4. Measure

For the purposes of this evaluation plan, a measure is the collection of items, within a project, that have the same Technology/Activity/Practice (TAP) description. The BPA reporting system uses a standardized taxonomy (Technology/Activity/Practice) for classifying measures.

[2] Under Option 1, BPA is often involved throughout the project lifecycle by providing technical support, technical implementation, approval of projects and oversight/evaluation. Under Option 2, utilities conduct all aspects of M&V and custom project quality control (e.g., project proposal and completion report review) internally.

The reporting system data describes the measures that comprise each of the projects. As defined in the RTF Roadmap, "A measure is one or more changes in system configuration, equipment specifications or operating practices that reduces electric power consumption as a result of increases in the efficiency of energy use, production, or distribution."

The project engineers assign one of 86 Technology/Activity/Practice (TAP) descriptions to each item of work comprising a project. For example, lighting projects may have many items describing specific lamp and ballast combinations, but all of them would be assigned the TAP code indicating "Lamps/Ballasts."

3.5. Program Delivery Channels

Program delivery channels are key programmatic areas for either BPA or utilities. These channels are defined by the utility option (1 or 2), end use (lighting or non-lighting), and sector (industrial and commercial[3]).

3.6. Guidelines

Over the last three years, BPA and the RTF have developed a series of documents to provide guidance on how to estimate savings. Portions of these documents provide guidance on how to estimate savings from the projects that comprise the Site-Specific Savings portfolio.

- RTF Guidelines - the guidelines the RTF uses to judge the quality and reliability of the savings estimates, costs, benefits, and life for all types of efficiency measures. The sections pertaining to custom measures and program impact evaluation are relevant to the Site-Specific Savings portfolio.
- BPA M&V Guidelines and Protocols – a series of volumes designed to assist the M&V practitioner charged with estimating site-specific gross energy savings for custom projects. All sections of these documents are relevant to the Site-Specific Savings portfolio.
- BPA Implementation Manual – The Manual, together with the customer's Energy Conservation Agreement (ECA) and specifications in BPA's energy efficiency reporting system, provides the implementation requirements for projects reported to BPA. Sections of this document that pertain to projects with site-specific savings estimates are relevant to the Site-Specific Savings portfolio.

Collectively these documents will be referred to as the Guidelines.

3.7. M&V Model

This M&V model (an algorithm or calculation procedure) is the model used by project engineers to estimate savings for the measures that comprise a project. The BPA lighting calculator is an example of such a model. Models for other measures might be building simulation models such

[3] Agricultural projects are grouped with commercial projects for option 1 utilities.

as eQUEST, custom-engineered or standardized spreadsheet calculators, and custom regression models (such as those developed using ECAM).

3.8. M&V Savings

The savings estimated by the project engineers and entered in the BPA reporting system. These savings are based on the M&V model. Please note that the BPA system uses the term "estimated savings" for the savings estimated at the proposal stage and "actual savings" for the savings at the completion report stage. M&V Savings are based on the "actual savings" field in the reporting system[4].

3.9. Evaluation Model

This is the model selected by our evaluation team to re-estimate savings for sampled measures. The same types of models as listed above for the M&V models are possible. Please note that although the evaluation model may differ from the M&V model, this does not necessarily mean that the M&V model was inappropriate for the project. Evaluation models are only needed for a small portion of the delivered measures. Therefore, there may be cases where a more reliable model is used in evaluation of a sampled measure, even though that model would not be cost-effective for M&V on all measures.

3.10. Evaluation Savings

The savings estimated by the evaluation team. These savings are based on the evaluation model and rely on best practical data collection and savings estimation practices, as laid out in the Guidelines, and informed by evaluator experience.

The evaluation must estimate the savings achieved during the first year of measure operation. If any of the evaluation data collection occurs more than one year after the measure was complete, it may indicate failures in the measure performance that are relevant to measure lifetime and not to the first-year savings. Savings estimate will reflect the conditions of the measure during the first year of its operation.

Evaluation savings for individual measures will be used in aggregate to estimate savings for the site-specific savings portfolio. .

3.11. Determinant

Factors that influence the amount of savings a measure generates, such as hours of operation or equipment efficiency.

[4] Please note that BPA is in the process of changing the word "actual" to "verified" for reporting purposes.

3.12. Measure Baseline

Measure savings must be determined against clearly defined baseline conditions. The RTF Guidelines define two possible baseline conditions, which are used in this evaluation plan:

- **Current Practice**. A current practice baseline is used if the measure affects systems, equipment or practices that are at the end of their useful life. The baseline is defined by the recent typical choices of the end user in purchasing new equipment and services. Current practice baseline is used for new construction projects.
- **Pre-Conditions**. A pre-conditions baseline is used when the measure-affected equipment or practice still has remaining useful life. The baseline is defined by the existing condition at the end user site just prior to the delivery of the measure.

3.13. ProCost Model

ProCost is a spreadsheet tool, developed by the Northwest Power and Conservation Council, which computes Regional measure lifecycle cost-effectiveness. ProCost uses Regional economic and power system assumptions that are updated with each Council Power Plan.

3.14. Measure Lifetime

Measure lifetime, as defined by the RTF Measure Life Guidelines, is defined as the median number of years during which at least half the deliveries of a measure are in place and operable, i.e., producing savings. For example, consider the installation of 100 VFDs on pumps. If the VFDs were regularly inspected for many years it would be possible to determine when each one became inoperable (failed mechanically or electrically or was removed from service). The lifetime for the measure would be the median number of years to measure failure, i.e., no longer producing savings. An estimate of measure lifetime is a required input to the ProCost Model.

3.15. Incremental Costs and Benefits

When a measure is delivered, costs are incurred and benefits realized, e.g., value of electricity savings and other non-electric benefits such as changes in operations and maintenance expenses. Only incremental costs and benefits are used in estimating a life cycle costs and benefits.

A measure's incremental costs and benefits are those incurred in the efficient case delivery, beyond what is required to establish and maintain the baseline condition. For a pre-condition baseline, the baseline does not involve any change and thus baseline costs and benefits are zero. In this case, incremental costs and benefits are equal to the efficient case costs and benefits. For measures with a current practice baseline, the baseline condition does require a change and therefore has costs and benefits. In this case, the incremental costs are the difference between the efficient case and the baseline case delivery.

4. FY 2012/2013 Cycle Evaluation Plan

The first cycle of impact evaluation under this plan will address the Site-Specific Savings portfolio projects completed during fiscal year (FY) 2012 and 2013 (October 1, 2011 thru September 30, 2013). The evaluation team will select a stratified sample of measures that is statistically representative of that portfolio. Subsequently, we will collect data and perform modeling to estimate savings for each sampled measure. Once we complete analysis of the sample, we will use the results to estimate first-year savings and lifecycle cost-effectiveness of the Site-Specific Savings portfolio. We will also identify opportunities for improving BPA M&V estimates of savings and provide recommendations on how to improve future impact evaluations.

4.1. Evaluation Objectives

There are four evaluation objectives:

1. Estimate first-year kWh savings for the Site-Specific Savings portfolio and for separate portions of the portfolio as needed to understand the savings performance of important program delivery channels.
2. Estimate the lifecycle cost-effectiveness of the Site-Specific Savings portfolio and its constituent program delivery channels.
3. Identify opportunities for improving the M&V implementation, models (e.g., calculators and protocols) and savings estimates for each of the important program delivery channels.
4. Develop recommendations on M&V procedures, including but not limited to documentation and data handling that will improve reliability and reduce cost for future evaluation cycles.

4.2. Portfolio Population

The evaluation will represent the population of measures paid for by BPA in FY 2012 and 2013. The evaluation will estimate first-year savings and will not devote significant resources to estimating measure lifetime for sampled measures. However, reliable estimates of first-year savings cannot be developed for measures completed prior to the start of FY 2012. For measures completed (based on M&V completion date) earlier there is too much risk that savings will not represent conditions that existed in the year following delivery of the measure.

Some of the measures paid for in FY 2012/13 were completed in prior years. Table 2 shows the distribution of savings by fiscal year of completion. About six percent of savings are for projects completed prior to FY 2012. If these are selected for the sample, they will be randomly replaced by other measures.

The table also shows that a small number of measures (representing less than 0.1 percent of savings) appear to have invalid completion dates or dates in the future. Such data errors will be resolved when the report system data for the entirety of FY 2012/13 is assembled, prior to selecting the evaluation sample.

Table 2: Measure Completion by Fiscal Year

Complete in Fiscal Year	Number of Measures	kWh Savings	Percent of Savings
2010	7	1,101,807	0.4%
2011	113	14,708,421	5.8%
2012	3,456	184,796,527	72.3%
2013	1,459	54,920,866	21.5%
2014	15	161,766	0.1%
2102	1	11,502	0.0%
Grand Total	**5,051**	**255,700,889**	**100.0%**

4.3. Sample Design

We have developed a sample design that meets the evaluation objectives. Once we have completed data collection and analysis for this sample, we will be able to estimate savings and lifecycle cost-effectiveness for the important program delivery channels identified by BPA. In addition, we will be able to use the results of the evaluation in formulating recommendations on how to improve the M&V savings estimates within each of these delivery channels.

4.3.1. Definition of Studies

The evaluation objectives require that the sample design support separate and reliable results for each important program delivery channel. Based on input from BPA and utility staff, we identified nine delivery channels important enough to justify a separate study, as shown in Table 3. These channels are defined by the utility option (1 or 2), end use (lighting or non-lighting), and sector (industrial and commercial or the combination of commercial and agricultural for Option 1 utilities). A ninth delivery channel is devoted to the industrial energy management initiative.

Table 3 shows the number of measures and savings associated with each delivery channel. The distribution shown does not account for measures completed after May in FY 2013. Some adjustments to the sample design may be needed once those records are available, but we do not expect any changes to definitions of these studies.

Table 3: Studies Defined for Each Important Program Delivery Channel

				Number of Measures		Savings	
Special Study	**Option**	**End Use**	**Sector**	**#**	**%**	**kWh**	**%**
	1	Lighting	Industrial	201	4%	20,647,251	8%
	1	Lighting	Com/Ag	2,602	52%	56,168,118	22%
	1	NonLighting	Industrial	137	3%	56,959,036	22%
	1	NonLighting	Com/Ag	85	2%	13,138,417	5%
	2	Lighting	Industrial	83	2%	7,556,152	3%
	2	Lighting	Commercial	1,667	33%	62,340,218	24%
	2	NonLighting	Industrial	55	1%	15,776,554	6%
	2	NonLighting	Commercial	208	4%	19,846,488	8%
Energy Management	Both	All	Industrial	13	0%	3,268,655	1%
				5,051	**100%**	**255,700,889**	**100%**

A separate sample will be drawn from the measures that comprise each of these delivery channels making each a separate study within the portfolio evaluation. This allows us to control the statistical precision of the findings for each delivery channel.

4.3.2. Sampling Unit: Measure

The BPA reporting system provides data at both the project and measure levels. A project can comprise more than one measure. It is also possible that more than one project is completed at a single end user location in this evaluation cycle. Sampling could be conducted at the location, project, or measure level. However, the studies defined above require that we separate lighting from non-lighting measures. In order to accomplish this separation, the sample will be selected at the measure level. For example, if an Option 1 end user received both an HVAC upgrade and efficient lighting, that end user would appear in two separate measure lists: one for the Option 1 commercial lighting study and again in the option 1 commercial non-lighting study. Both measures would have a chance of being selected for their respective studies.

Another factor to consider is that savings achieved by one measure can affect the savings of another measure. In the example above, if the change in lighting occurred in spaces served by the HVAC system that is improved there could be significant interactions between the two measures. The approach we will use to handle these measure interactions is discussed in Section 4.5.4.

4.3.3. Target for Confidence and Precision

The target for confidence and precision determines the size of the required sample for any study. BPA has established targets for this evaluation, specifically for the relative precision of the kWh savings estimate. Targets have been established for each study of a delivery channel and for the overall portfolio evaluation. The targets have two components:

- Precision. Indicates how well the savings are estimated, e.g., the true value falls within a range of ± 10% of the sample estimate.

- Confidence. The level of confidence that the true value falls within that range, e.g., we are 95% confident that the true value falls within ± 10% of the sample estimate.

The precision target at the individual study level is ± 10% at the 90% confidence level for studies that account for more than 10% of the portfolio savings. For studies that represent less than 10% of the total portfolio savings the target is ± 20% at the 80% confidence level. The portfolio target is ± 6% at the 95% confidence level.

4.3.4. Selecting an Efficient Sample

The evaluation will use a stratified design in drawing the sample. The measures in each study will be grouped into stratum defined by the size of the M&V savings estimate. This is preferable to a simple random sample given the distribution of savings within each of these study populations. A simple random design would be inefficient and expensive, requiring a sample for more than 1,000 measures.

As an example the stratified study design for Option 1 industrial lighting is shown in Table 4.

Table 4: Example Stratified Design: Option 1 Industrial Lighting (based on partial FY13 data)

	Stratum Boundaries			Savings		
Stratum	Lower (kWh Savings)	Upper (kWh Savings)	Number of Measures	Total (kWh)	%	Sample Size
1	8,024	131,312	104	3,829,850	19%	3
2	141,150	461,617	29	7,724,635	37%	2
3	703,099	2,331,022	4	5,751,408	28%	2
Excluded	59	7,642	63	201,507	1%	0
Certainty	3,139,851	3,139,851	1	3,139,851	15%	1
Study Total			**201**	**20,647,251**	**100%**	**8**

As shown in the table, five strata were created for this study. Stratum 1 contains all measures that have savings between its upper and lower bound of kWh savings (8,024 and 131,312). Strata 2 and 3 contain measures with larger savings. The number of measures declines precipitously moving downward in the table from stratum 1 to 2 to 3. This is a typical pattern observed in non-residential energy efficiency programs. It is caused by the fact that a small portion of the measures account for a large portion of the savings. This is why simple random samples are generally not used in these studies.

There are two additional strata which have special definitions. The first is labeled “excluded.” The study population contains a large number (63 out of 201) measures that so small that when they are all added together they account for only 1% of the savings. These can be excluded from the sampled population without causing any significant decrease in precision. Their removal also increases the efficiency of sampling by reducing the overall variance in savings. The other special stratum is labeled “certainty.” In this case there is a single measure in the certainty stratum. It accounts for 15% of the total study savings. Measures in the certainty stratum are always included in the sample, i.e., they are certain to be selected. It is critical that

data collection and analysis is successful for these measures because they have such a large impact on the precision of the total savings estimate.

4.3.5. Sample Weights: Small Measures are Important

In stratified designs, number of measures in the small savings strata is much larger than in the large savings strata. The probability of selecting a small savings measure is much smaller than the probability of selecting a measure with large savings.

When savings are estimated for the entire study, sample weights (the inverse of the probability of selection) must be applied. The large weights for small savers make them just as important in the estimating savings as are the large savers. For example, as shown in Table 5 sample weights (final column) vary from 1 to 34.7. The three measures selected from stratum 1 represent 19% of total savings. It is important that we get just as reliable an evaluation estimate of savings for these small measures as we do for the much larger savings measures in stratum 3.

Table 5: Sample Weights for Option 1 Industrial Lighting Study

		Savings				
Stratum	Number of Measures	Total (kWh)	%	Savings per Measure	Sample Size	Sample Weight
1	104	3,829,850	19%	36,825	3	34.7
2	29	7,724,635	37%	266,367	2	14.5
3	4	5,751,408	28%	1,437,852	2	2.0
Excluded	63	201,507	1%	3,199	0	NA
Certainty	1	3,139,851	15%	3,139,851	1	1.0
Study Total	**201**	**20,647,251**	**100%**	**102,723**	**8**	

4.3.6. Required Sample

We have developed efficient sample designs for each of the studies that comprise the portfolio evaluation. In total, a sample of 137 is required to represent the portfolio with a precision of ± 6% at a 95% confidence level. These designs are based on the reporting system data through May 2013, but we believe they will not change substantially when the balance of the reporting system data for FY 2013 is added.

The study designs and their associated sample size and expected sampling error are shown in Table 6. The precision of the kWh estimate for the special study of industrial energy management cannot be determined at this time. The sample size shown is a preliminary estimate.

Table 6: Sample Size and Associated Confidence and Precision by Study

Special Study	Option	End Use	Sector	Confidence Level	Precision (±)	Sample Size
	1	Lighting	Industrial	80%	19.6%	8
	1	Lighting	Com/Ag	90%	9.8%	27
	1	NonLighting	Industrial	90%	10.5%	21
	1	NonLighting	Com/Ag	80%	19.3%	14
	2	Lighting	Industrial	80%	19.4%	13
	2	Lighting	Commercial	90%	9.9%	24
	2	NonLighting	Industrial	80%	19.1%	9
	2	NonLighting	Commercial	80%	19.4%	8
Energy Management	Both	All	Industrial	TBD	TBD	13
Total						**137**

It is important to note that the target precision shown in the table will not necessarily be equal to the actual precision shown in the evaluation report. The precision shown here is based on the variation in the M&V savings found in the reporting system. The actual precision will reflect the variation in the evaluation savings for the sample.

4.3.7. Sample Selection and Management

We will select a primary sample by randomly picking measures from each study stratum until we have enough to satisfy the required sample size. We will also select some additional measures from each stratum as potential replacements. Replacements may be needed if it becomes impossible to complete the required data collection for a measure in the primary sample. A measure in the primary sample can only be replaced by a measure from the same stratum.

There are two critical factors to consider in replacing measures:

1. **Impact on other utilities**. Sampled measures within a study stratum will most likely be associated with end users served by more than one utility. A measure dropped from one utility's list will probably require adding a measure to another utility's list.
2. **Certainty selections**. A small number of the measures with the largest savings will be selected with certainty. Because their probability of selection is 1 or certainty, there are no replacements. Failing to complete data collection for any of these certainty selections will substantially decrease the precision of the kWh savings estimate.

4.4. Data Collection

The project engineers and other BPA and utility staff collected data throughout the process of developing the projects found in the Site-Specific Savings portfolio. Our general approach to evaluation data collection will be to fully leverage the data that is available from their efforts and to only collect additional data if needed to achieve reliable estimates of savings for the

sampled measures. This section describes the possible data collection methods. In section 4.5, we describe how we will determine what data are needed for each sampled measures.

4.4.1. File review

We will complete a project file review for all sampled measures. This review will assess whether the M&V model was appropriate, and whether the modeled savings are reliable. The review will also address variances between the M&V model and its supporting data and the relevant Guidelines.

The file review will involve extracting all information relevant to savings estimation and cost-effectiveness for the measure from the supporting documentation and analysis files. This would include, but is not limited to, the following:

- Measure descriptions that detail how the measure saves energy, affected systems and equipment, determinants of savings, and the baseline (Current Practice or Pre-Conditions)
- Data used as baseline or efficient condition inputs to the M&V savings estimation model, including data from visual inspections, operator/occupant interviews, trend metering or secondary sources. Secondary source data would include design documents, manufacturer specifications, equipment databases (e.g., MotorMaster+), and weather data.
- Reported savings values, to be compared against database values to find any transcription or version problems.
- All of the files used by BPA or the Option 1 or 2 utility to estimate savings, including a working final version of the M&V model.
- Invoices, receipts, and other data useful for estimating incremental measure costs.
- Any data that would be useful in identifying non-energy benefits or costs, such as those related to measure impacts on water and wastewater use, or operations and maintenance labor and materials.
- Any data useful for determining whether the measure yielded non-electric energy impacts.
- Any data that informs estimates of measure life.

If the files are missing critical information, such as usable models in Excel format as opposed to Adobe Acrobat files, then we will work with the file provider to determine if the additional information is available through a supplemental request.

4.4.2. Telephone/Email Discussion with Project Engineers

The project engineers are another possible source of data. As needed, we will contact them by telephone or email to obtain information needed for the evaluation that was not found in the project files. In some cases, we will determine that even with the help of the project engineers we still need information that can only be obtained by contacting the end user. For these cases we will have further discussions with the project engineer to:

1. Confirm that the only practical strategy for obtaining the data requires contacting the end user.
2. Obtain a better understanding of the history and circumstances at the end user site, such as other measures and projects that are under way or completed in the same time frame as the sampled measure that might affect our ability to collect the necessary data.
3. Identify the least intrusive strategy for obtaining data needed by the evaluation team, including identifying specific members of the end user staff or vendors that could best assist the data collection.

4.4.3. Telephone/Email Discussion with End Users

In some cases, it may be necessary to obtain information from the end user via telephone or email contacts. Such contacts will be governed by the contact protocols described in section 6.

These contacts may include interviews of operations staff, occupants or vendors associated with a measure. We may conduct these interviews via telephone, supplemented with e-mail as the situation and customer preference dictate. The interviews may be used to clarify baseline or efficient case conditions or features of the measures. When needed, they will also be used to schedule and plan for evaluation work to be performed at the site of a sampled measure.

4.4.4. Site visits

In some cases, it may be necessary to obtain information from the end user via a site visit. Such contacts will be governed by the contact protocols described in section 6.

Based on the file review and discussions with internal engineer, we may determine that more information will be needed from inspection of affected systems and equipment, in-person interviews with operation staff, review of electrical and mechanical plans, inspection of control setting, review of manufacturer's specification, and one-time measurements. Site visits provide data on the efficient-case conditions. They may also shed light on baseline conditions, but in many instances, these will have to be derived from supporting documents and interviews, especially for measures with a Pre-Conditions baseline as defined by the RTF Guidelines.

4.4.5. Affected System Trend Metering

According to the RTF Guidelines, trend metering is needed when the load served by the affected systems varies over time based on the determinants of savings, e.g., outside air temperature or production level; or the operating schedule for the affected system or equipment vary over time based on these same or different determinants. Metering data may be available from the file review. If the metering data is not sufficient, additional metering data

will be collected. Such data might be obtained by installing[5] special metering equipment, interrogating existing customer control systems, or some combination of the two.

4.4.6. Billing / Interval Premise Electric Trend Metering

It may be possible to estimate savings for certain measures by analysis of the data collected by the utility from a customer's billing meters. This might be monthly billing data. It could also be interval (daily or hourly) if the utility meters at the selected sites have this capability.

4.4.7. Weather

Weather conditions are often a significant determinant of energy savings. Weather data used by the M&V model may be available from the file review, and may be applicable for the evaluation model as well. If not, actual and/or TMY weather data will be acquired for the most appropriate NOAA weather station.

4.4.8. Cost-Effectiveness Parameters

Data on measure-specific cost-effectiveness parameters will be obtained from the file review described above and may be supplemented by data collection from project engineers, end users or site visits. These measure-specific parameters include: incremental measure costs**,** non-energy benefits or costs**,** and measure life. The evaluation will use the measure lifetime found in the project file review as the default value and only adjust it if reliable information is gained through the evaluation that would justify substantial changes to the value. For example, if a measure was installed in a very dirty environment where its lifetime would clearly be reduced.

The same data sources will be used to identify measures that have non-electric energy impacts. However, we will only collect data from end users and site visits if such contacts are already required in order to estimate evaluation savings, i.e., we will not make end user contacts just for the purpose of collecting cost effectiveness data.

Some measures may affect the use of non-electric energy. For those measures, the evaluation savings model will be used to estimate those impacts, as will be described in the next section.

Other parameters that are not measure-specific will be required to complete the cost-effectiveness analysis. These include: avoided energy costs (gas and electric), discount rate, and program administrative costs. The values for these parameters will be taken from the most recent default values used by the RTF.

[5] The end user will determine whether their staff or contractors will install the required equipment. If no, members of the evaluation team will perform this work.

4.5. Site-Specific Savings Analysis

This section describes how we will estimate first-year savings for each of the sampled measures. It describes our general approach. In addition, it describes specific approaches for lighting and the special study of industrial energy management. Finally, it describes our approach to handling measure interactions and persistence effects.

4.5.1. General Approach

Our general approach for estimating savings for each sampled measure is to go only as far as needed to achieve reliable evaluated savings estimates, within the limits of practicality. This involves first assessing whether the M&V model can reliably serve as the evaluation model, and then whether the data available for the latter can reliably support critical savings determinants. These initial two steps are accomplished primarily during the file review, which dictates the next steps, namely determining what supplemental data is required, and how the evaluation savings are to be modeled. These steps are portrayed graphically in Figure 1.

Our intent is that these approaches will comply with, or exceed, the Guidelines. In some circumstances, however, this may not be feasible. Baseline trend metering might be needed for certain measures in order to comply with the Guidelines, but it may be that such metering was not performed as part of the project M&V. In such instances, it is not possible to recreate and measure baseline conditions, making it impossible to comply with the Guidelines. For all sampled measures, we will document how the project M&V conforms to the Guidelines, and if not, the reasons why. Similarly, we will document how our evaluation approach conforms, and explain any exceptions.

Selected measures with small savings will represent a large portion of savings in their respective studies, as described in 4.3.5. The program may use less rigorous methods to estimate savings from small measures (for example, Engineering Calculations with Verification for projects under 200,000 kWh/year). However, for this evaluation, all measures, small or large play an important part in estimating savings. Therefore, comparable methods must be used to estimate savings regardless of the amount saved by any selected measure.

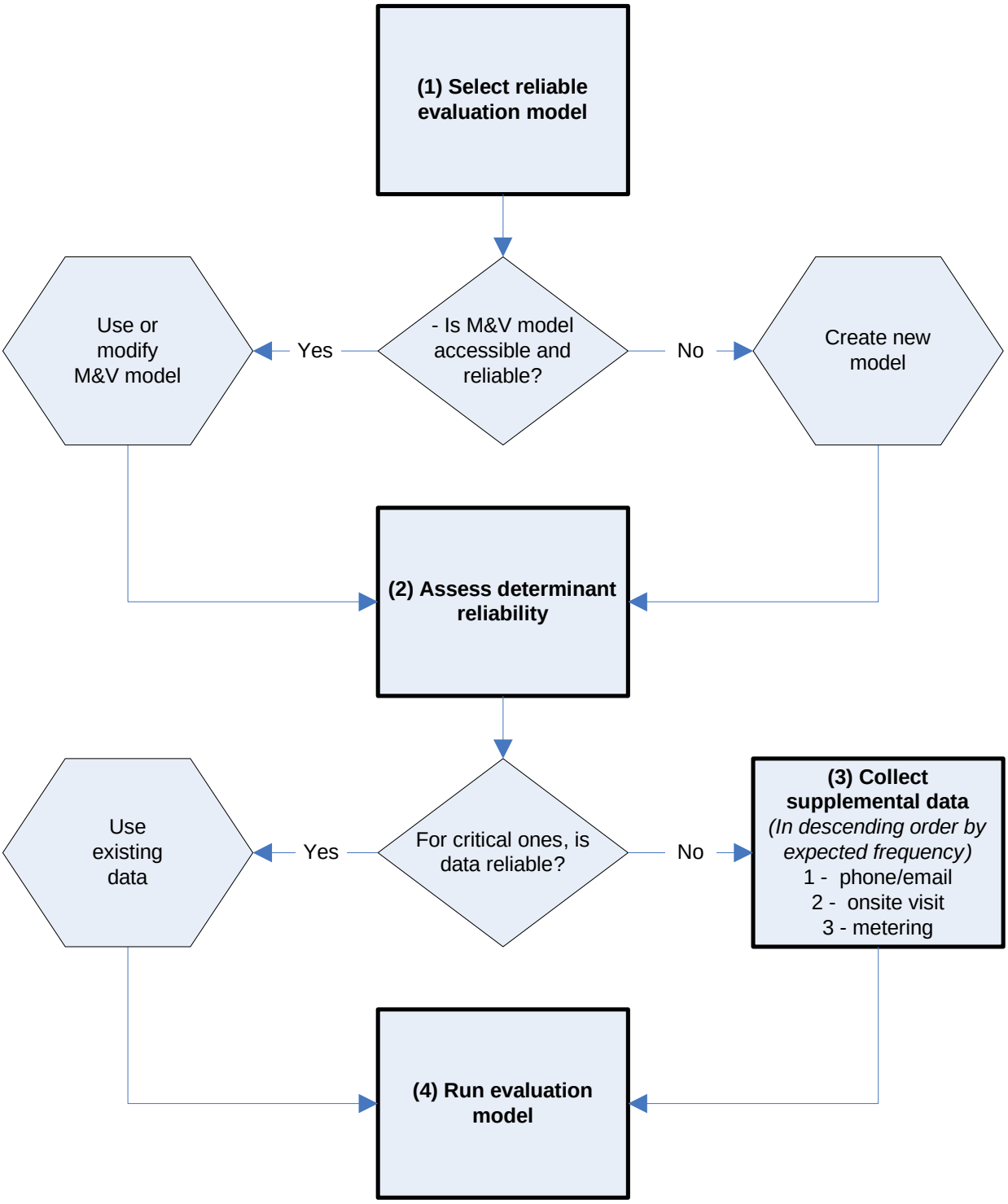


Figure 1: Evaluation Process for Estimating Measure Savings.

4.5.1.1. Select Reliable Evaluation Model

Our starting point in estimating savings will be a review of the M&V model. We will conduct this during the file review. During that review, we will determine, relying on professional

engineering judgment, whether the model, if provided with reliable input data for the savings determinants, will provide sufficiently reliable estimates of savings. The standard we will use is based on the RTF quality standard for standard protocols. An unreliable model would have a high likelihood of greater than 20% uncertainty in the overall savings because of misspecification. For example, if a small VFD measure in an industrial plant relied on whole-facility billing analysis to estimate the savings, we might consider this application inappropriate because of its high unreliability. As part of the evaluation, we would specify an evaluation model—such as post-metering for several weeks applied to manufacturer's pump curves—that would be more likely to provide reliable savings. The outcome of each model applicability review will be a decision on whether to use the M&V model or replace it with another model when we estimate savings for the evaluation. This decision will affect what is done in subsequent steps described in Sections 4.5.1.2 to 4.5.1.4.

As part of our review of the M&V model, we will also compare it to any approved RTF standard protocols for the same measure. An example is the recently approved (although provisional) Irrigation Pump Motor VFD protocol. We will also compare the M&V model to the models recommended in the BPA M&V protocols.

Other areas germane to the model review include whether or not the model addresses significant measure and/or end use interactions, and whether or not it adequately establishes the proper baseline (current practice or pre-condition). We will consider interactions significant if it is likely that the interactive effect exceeds 10% of the measure savings, per the RTF Guidelines for custom measures.

Some of the common M&V models that we encountered during our initial example file review included:

- Calculators
  - Lighting (both the BPA calculator and calculators developed by Option 2 utilities)
  - Compressed air (non-BPA)
  - VFD (BPA)
- Hourly simulations (eQUEST and DOE-2)
- Engineering calculations
  - Simple formulas with several variables (e.g., efficient shrink-wrapping machine)
  - Complex, multi-element spreadsheets (e.g., control changes and VFD installations at various buildings on a college campus)

We did not find any utility-meter-based analyses, such as ECAM or other billing regressions, in our initial review, but we expect to find these in the evaluation sample. One instance would be the Energy Management program, which quantified O&M savings through billing-data-based statistical modeling, with savings from capital measures calculated separately and netted out. Another would be BPA school HVAC projects, which rely extensively on ECAM. We expect to deploy billing analysis using monthly and/or interval data as appropriate, particularly when it can enhance an existing model.

If the M&V model is determined to be reliable, then we will adopt it as the evaluation model, and improve its input-data if necessary (see Step 2 in Figure 1). If the M&V model is found to be unreliable, and thus not suitable to serve as the evaluation model, then we will either enhance or replace it. Enhancement would likely mean adding or replacing certain features, such as measure and end use interactions, while replacement would entail a wholesale change in approach, such as using ECAM instead of a bin model.

The approach above assumes that adequate measure information is available, and that in particular, data and analysis files are transparent and accessible. For example, if an M&V model is only available as a PDF file, then it is generally impossible for the evaluation team to assess the underlying algorithms and formulas for appropriateness and accuracy. In such a situation, it may become necessary to reconstruct the original model or build an alternative one. Consequently, missing or inaccessible M&V models and supporting data can lead to significant costs, not only for evaluation team to develop models from scratch and reproduce data where feasible, but also in terms of additional data collection burdens on customers. When we encounter instances where the M&V model is not functional, we will work closely with BPA and/or the Option 2 utilities to obtain the necessary information, if at all possible.

4.5.1.2. Assess Determinant Reliability

Once the evaluation model—either the M&V model or a more reliable replacement—has been selected, we then must consider each of the model inputs and determine what level of data collection is needed to support a sufficiently reliable savings estimate. In general terms, as laid out in the RTF guidelines, key determinants of savings include, but are not limited to:

1. Hours of operation
2. Equipment efficiency at full and part-load operation
3. Control sequence and settings
4. Outside air temperature, or other weather parameters
5. Production rate and schedule
6. Building occupancy
7. Time of day

During the file review, we will develop a list of critical determinants for that particular project, where critical is defined as having a significant (possibly 10% or more) impact on the calculated savings. We will then find the corresponding values used in the evaluation model, assess the data and/or documentation underlying those values, and determine whether we consider those values reliable. This will involve some engineering judgment. To the extent that sampled measures involve similar systems, equipment and modeling techniques we will ensure that consistent judgments are applied.

For instance, we may determine that hours of operation are a critical determinant for a fan control measure at an industrial facility with a weekly schedule. If the evaluation model incorporated pre and-post metering for two weeks on a random selection of affected fans, then

we may conclude that the determinant value is reliable. However, if the metering only spanned two hours, we may conclude it was unreliable, and therefore, additional onsite metering would be necessary to develop a reliable determinant value. For each measure, we will document our rationale for establishing whether determinants are reliable or not, and how the reliability will be improved if necessary. We will compare across sampled measures to ensure consistency, as well as to identify overarching trends and issues. Preliminary evaluation assessments for measures will be provided to the BPA evaluation team, so they can provide input.

For unreliable critical determinants, we will assess what level of data collection involving the end user would be necessary to obtain reliability for that determinant. In order of cost and complexity, these levels would be (1) telephone/email interview, (2) site visit, and (3) metering. The highest level across all unreliable critical determinants would then determine the level of data collection for the measure.

4.5.1.3. Collect Supplemental Data

Based on the previous step, we will develop a data collection plan for each sampled measure that will establish how data for each unreliable critical determinant is to be obtained, using one or more of the data collection approaches described in in section 4.4. Our general intent will be to use the least costly and intrusive approach to obtain sufficiently reliable values—starting with telephone interviews, proceeding to a site visit if necessary, and then performing metering in the most critical instances.

It is conceivable that certain measures could require multiple metering rounds. Hypothetical examples of these include (a) a fruit processing facility with seasonal production schedules, or (b) a complex HVAC controls project that required separate summer and winter data sets to assess cooling and heating performance, respectively. Such instances would likely be rare, and would be kept to a minimum because of the inconvenience to the end user, as well as the cost to the evaluation.

The data collection plan would outline for the BPA evaluation team the types of data to be collected prior to and during the site visit when needed; utilities will be informed per End User Protocols Section 6. For example, a site visit may involve interviews to find out about production seasons, coupled with collection of nameplate data and short-term metering. It would map out a work sequence to collect data efficiently, with minimum impact on the end user. The plan would also include unit sampling approaches, consistent with the Guidelines, in situations where the measure consists of many pieces of equipment.

Note that in general, we will strive to develop reliable evaluation savings estimates within practical data constraints, and only drop and replace measures from the sample in extreme cases, such as a facility no longer being in business or an end user completely unwilling to participate in the evaluation.

4.5.1.4. Run Evaluation Model

If the M&V model is deemed appropriate to serve as the evaluation model, and the critical determinant values deemed reliable, then this step will essentially be a quality control check. If

the file review uncovered any clerical or procedural errors that led to a mistaken savings value being reported, then those errors will be corrected, and the proper values recorded for this evaluation.

Otherwise, analysis will consist of running the evaluation model with reliable determinant values obtained through evaluation data collection.

4.5.1.5. Estimate Cost Effectiveness

The RTF ProCost model will be used to compute total resource cost-effectiveness for every measure. Measure-specific data such as incremental costs, non-energy costs and benefits and measure lifetime will be obtained from the file review and other sources. If the measure impacts the use of non-electric energy, the evaluation model will be used to estimate these impacts so that they can be accounted for in the cost-effectiveness calculation. Other required inputs for ProCost, e.g., discount rate, avoided energy costs and typical efficiency program administrative costs, will be taken from the most recent default values used by the RTF.

4.5.2. Lighting Measures

A large part of the sample will be lighting measures. In most cases, the M&V model will be some version of the BPA lighting calculator or a similar lighting calculator developed by an Option 2 utility. We will base the evaluation model on the most recent version of the BPA Lighting calculator. As necessary, the model will be modified in order to accurately represent the baseline condition for specific measures. In addition, in most cases we will obtain reliable estimates of operating hours by lighting logger or power metering.

Light logging is sufficient when no controls are involved or when the measure involves simple on/off controls and there are not many control points. Power metering can be more appropriate when a large portion of savings is associated with dimming controls or there are many points of on/off control, such as an office complex with numerous occupancy sensors for individual rooms.

Some measures will not require either logging or metering. This would be the case when reliable metering data is provided with the M&V model or when lighting fixtures are on continuously, such as emergency lighting or plants with around-the-clock operations. In the latter case, we might simply interview an operations manager to confirm the plant schedule and operating hours for the year, so the telephone/email approach would suffice to produce a reliable estimate of the operating-hours determinant.

Even in the cases where we perform lighting logger or power metering, we also plan to estimate lighting hours via the interview technique that is currently under development for the RTF non-residential lighting standard protocols. This will allow us to compare the reliability of this less-expensive interview technique to the metering results. If the interview technique is found to be sufficiently reliable, it could be a major factor in reducing the cost of future evaluation cycles.

4.5.3. Industrial Energy Management

An initial evaluation of the industrial energy management delivery channel was performed by Cadmus (a member of our evaluation team), for measures completed in the Fiscal Year 2010/11. We will conduct a similar study for the FY 2012/13 evaluation cycle. The approaches to be used will build upon the prior work and the recommendations from the first study. In particular, we will use the billing analysis consistent with previous study. We expect to improve reliability by estimating savings from capital projects consistent with approaches described elsewhere. This should lead to a more reliable estimate of the savings associated with operational changes, which is the goal of this delivery channel.

4.5.4. Treatment of Interactive Measures

Savings achieved by one measure can affect the savings of another measure. For example, an HVAC upgrade and improvements to lighting that affect the same spaces within a building. The change in lighting increases the heating load and decreases the cooling load. How much is saved by the HVAC upgrade could be significantly different with and without the lighting change. Thus the order in which savings are estimated can make a difference. If the two improvements occur as part of separate projects that were completed at different times, this should not be an issue for this evaluation. Whichever measure we sample, we will account for the baseline conditions of the affected systems and equipment. If the HVAC is sampled and the lighting occurred first, our evaluation model will capture the lighting characteristic as part of the baseline conditions.

A problem may arise if one or more projects are completed at essentially the same time. Using information from the reporting system, we will determine whether this occurs for any of the measures in our sample. If it does, we will obtain documentation for all the interactive measures at the end user site so that we can determine how the M&V models accounted for the interactions. In particular, we are looking for the measure order that was assumed in estimating each measures savings. We will use the same measure order in estimating the evaluation savings.

4.5.5. Handling Persistence Effects

Supplemental data collection for this evaluation cycle, e.g., end user interviews, site visits or metering, will occur during 2014. Most of the measures in the sample will have been completed more than a year before the supplemental data collection begins. The objective of the evaluation is to estimate savings during the first year of each sampled measure's operation. Various factors that affect savings may change rapidly at the end user site. Some of these changes may involve complete or partial failure of the measure. If this occurs more than a year after the measure is complete, the failure should be treated as a persistence effect. Such a failure is relevant to the assessment of measure lifetime, but should not be allowed to influence the estimate of first-year savings.

In developing the supplemental data collection plan for each measure, we will, in consultation with the end user, confirm that current conditions relevant to the savings estimate, as observed in 2014, substantially correspond with what was in place during the first year after the project was completed (e.g., that the production schedule has remained the same). If we are unable to confirm this, then we will attempt to collect information that would allow us to make a reliable adjustment to estimate first-year conditions (e.g., if the production schedule has changed, we might consider metering, but interviewing the customer to establish the first-year and current schedules, and adjusting the application of metering data accordingly.

A similar approach will be taken when we inspect a measure to determine if it is installed and operable. If we find that it is not operable or only partially operable, we will discuss its condition with the end user to determine when the failure occurred. If it occurred more than a year after the measure completion date, we will model the measure as it was during the first-year of operation, ignoring the more recent failure.

4.6. Study and Portfolio Analysis

Once data collection and analysis is complete for the sample we will analyze the results and estimate electric savings and cost-effectiveness for each study and for the portfolio as a whole. In addition, we will analyze the data to identify opportunities for improving M&V savings estimates and to develop recommendations for how to improve future evaluations.

4.6.1. First-Year kWh Savings

We will estimate first-year savings for each study (i.e., the 9 studies defined in Table 6) using the evaluation model results for the sample, weighted to reflect the probabilities of selection. As described in section 4.3.5, each sampled measure has a weight that is the inverse of the sampling fraction for the stratum from which it was selected. We will adjust that weight to account for any instances where the number of measures evaluated for a stratum changed from the design. This final weight will be used in forming study-level estimates of savings and cost-effectiveness.

Using these final weights, there are two ways to estimate study-level savings. One or the other of these may prove to be superior based on the variability in the evaluation savings estimates across the sample and the degree to which these estimates diverge from the M&V savings estimates. The two methods are as follows.

1. **Weighted Savings**. The total savings for the study is estimated by the total weighted savings, which is the evaluation savings for each sampled measure multiplied by its sample weight and then summed across all sampled measures in the study.
2. **Realization Rate**. The realization rate is the sum of the weighted evaluation savings divided by the sum of the weighted M&V savings of the sampled measures. The total savings for the study is then estimated by multiplying the realization rate by the total M&V savings for all measures in the study.

We will compare the study-level estimates of savings from these two methods. In addition, we will compute the precision associated with each. If there is a low variability in the realization rate, that method may be superior to the weighted savings method. We will report both findings, but we will select the method that works best in the overall for the portfolio

The portfolio savings will be computed by summing the estimates of each study's savings. Portfolio sampling precision will be computed as the savings weighted sum of the squared precision for the individual studies.

4.6.2. Cost-Effectiveness

For each sampled measure, we will use ProCost to estimate the lifetime sum of costs and benefits. The analysis must be performed for each measure, as each study comprises many different measures, which may have different measure lifetimes. The final sample weights, discussed in the previous section, will be used to calculate an appropriately weighted sum of costs and benefits for each study and for the portfolio. The Total Resource Cost test (ratio between costs and benefits) will also be calculated for each study and for the portfolio. The RTF assumption of 20% of incremental measure cost as administrative cost will be used for this evaluation.

4.6.3. Opportunities to Improve M&V Practices

As we analyze each sampled measure, we will track differences between the M&V and evaluation determinant inputs and savings models. If the same model is used, the differences may be due to changes in the input values for one or more determinants. If we use a different model, differences may result from the changes in model algorithms or changes in the input values for determinants. We will assess these differences for each measure and across the measures in each study. Based on this assessment we will identify opportunities for the BPA or the Option 2 utilities to improve their M&V implementation, models (e.g., calculators and protocols) and savings estimates. These opportunities may involve improvements in the M&V models. They may also involve improvements in the data collection methods used to determine key inputs for those models. These recommendations will specifically address any needed changes in BPA M&V protocols and guidelines.

4.6.4. Recommendations to Improve Future Evaluations

As we complete data collection (from file review through metering), and the analyses (modeling of sampled measures through estimation of portfolio-savings), we will track factors that lead to costs that could be avoided in future evaluation cycles. Some of these costs may arise from the need in the first evaluation cycle to develop various databases, computational tools and data collection procedures. Others may relate to the practices of BPA, its program implementation contractors and Option 2 utilities, including documentation quality. These could include the systems for tracking and retention of project data and documentation.

In addition, based on the assessment of M&V savings described in the preceding section, we will determine how the M&V protocols might be modified to improve future evaluations. In particular, we will look for cost-effective strategies for improving baseline data collection. Baseline data is difficult to collect unless done by the project engineers during the time the project is being developed.

We will develop recommendations on how to reduce the costs of future evaluation cycles. Based on the assessment of M&V protocols we will also make recommendations that would improve the reliability of the evaluation savings estimates. We will also suggest ways the evaluations can run more smoothly, such as improving communications or better procedures for collecting data from utilities and end users.

4.7. Reporting

We will prepare a report that documents the methodology, findings and recommendations of this evaluation. The report will document both study-level and portfolio-level findings for kWh savings and cost-effectiveness. The report will not contain any information that could be used to identify the end users that participate in the evaluation. Further, it will not contain any utility-specific findings or recommendations. See section 4.8.1 for a discussion of how utility-specific impact evaluation can be coordinated with this evaluation.

The report will be consistent with the content, transparency and comparability guidance found in the RTF's Program Impact Evaluation guidelines. We expect that report will have the following structure:

1. Executive Summary
    a. Findings
    b. Recommendations
2. Introduction
3. Background
4. Objectives
5. Methodology
    a. Data Collection
    b. Site-Specific Savings Estimation
    c. Study and Portfolio Savings Estimation
    d. Life-Cycle Cost-Effectiveness Analysis
6. Findings
    a. First-Year kWh Savings
    b. Life-Cycle Cost-Effectiveness
    c. Adherence to BPA M&V protocols and guidelines

7. Recommendations
   a. Opportunities to Improve M&V Savings Estimates
   b. Strategies for Improving Future Evaluations
8. Technical Appendices and Data Products

4.8. Coordination with Other Studies

There are three opportunities to coordinate this evaluation with other studies as described in this section.

4.8.1. Utility-Specific Oversamples

The sample design shown in section 4.3 will not support statistically reliable estimates of savings for utility-specific portions of the Site-Specific Savings portfolio. However, additional studies could be added to the sample design that would support estimates for specific utilities.

If utilities are interested in conducting an oversample in their territory to gain statistical significance, the utility can contact the evaluation contractor. The evaluation contractor will work with the utility to determine the sampling strategy for their study (e.g., overall or by end-use) and the required confidence/precision. The participating utilities would have to separately contract with the evaluation team for the oversample.

BPA will fund the fixed costs associated with the impact evaluation (e.g., database development, sampling, evaluation protocols, training) and the utility requesting an oversample will fund the marginal costs of additional site-specific analysis costs (e.g., data collection and savings estimation). The utilities will also be responsible for any expenses associated with preparation of utility-specific evaluation reports and presentations.

There are two options for oversampling.

4.8.1.1. Integrated Studies

This option is available for utilities that can make a commitment to oversampling by January 30, 2014. Additional utility-specific studies will be added to the sample design shown in Table 6 as requested by these utilities. These studies must be for one or more of the measure delivery channels (defined by end use and sector) shown in that table, for example “Lighting / Commercial.”

For each of these studies, BPA will fund the number of measures that would have been selected without the utility oversample. These measures may be used by the utility in estimating savings for the utility-specific study. The utility will determine whether the measures it funds as part of the oversample will be available to BPA for use in estimating savings for the BPA portfolio.

Only measures reported to BPA can be included in the oversample under the integrated studies option.

4.8.1.2. Separate Studies

This option is available to utilities at any time.

In this option, the utility may provide data for additional measures not reported to BPA. It may also provide other program tracking data to be used in defining groups of measures to be studied. The utility may define its oversample studies in any fashion supported by the data available from BPA or from its own tracking systems.

The utility may use evaluation results for measures from the BPA study in estimating savings from the oversample studies. It may also be possible, if the utility choses, to use results from the utility oversample in the BPA estimate of portfolio savings. However, this will depend on the timing of the oversample study.

4.8.2. BPA Oversight

BPA conducts reviews and analysis of Site-Specific Savings portfolio projects as part of its oversight processes. These reviews and analyses address compliance of the projects with the BPA Implementation Manual, each utility's Energy Conservation Agreement and specifications in BPA's reporting system. The work involved is very similar to certain aspects of the approach for this evaluation, e.g., file reviews for sampled projects.

Additions could be made to the file review and site visit procedures for this evaluation that would capture the information required for oversight. The evaluation team could be charged with the responsibility of gathering these data for the evaluation sample. These data would then be delivered to BPA staff responsible for oversight that would then complete any required analyses.

This coordination would benefit those responsible for oversight by eliminating the need for them to draw samples and collect data. It would benefit BPA utility customer's by consolidating requests for project files and minimizing the number of contacts with end users required to complete BPA's oversight and evaluation activities.

4.8.3. RTF Standard Protocols

The RTF is currently developing standard protocols for estimating savings for non-residential lighting measures. Once proven, the standard protocol would provide a less expensive method for determining the operating hours (based on a structured interview) of the lamps and fixtures that comprise a measure. In order to prove this method, the RTF requires both metered data and interview data for lighting measures. The approach described for lighting in Section 4.5.2 requires the collection of both types of data for each sampled measure. These data, appropriately masked to protect end user identity, could be provided to the RTF to support this development process.

BPA could benefit from this collaboration in future evaluation cycles. Once proven, this method would eliminate the need for metering lighting projects in future evaluation cycles, thus substantially reducing the costs of those evaluations.

4.9. Project Management

The evaluation team will work closely with BPA staff in managing all aspects of this evaluation. Our plan for project management is described below.

4.9.1. Staffing Plan

SBW will be the prime contractor responsible this evaluation. Figure 2 shows the structure of the evaluation team.

Michael Baker will be the principal investigator and the primary contact between evaluation team and BPA. He will be responsible for ensuring delivery of high quality and timely work products that fully satisfy BPA's requirements and will be responsible for regular status reporting to BPA. Dr. M. Sami Khawaja of Cadmus will provide him with expert advice on statistical methods.

Bing Tso, will directly support Mr. Baker in the technical management of the work and in preparing the evaluation report. He will direct our team of engineers and technicians who will deploy approaches described in previous section of this plan in estimating savings and cost-effectiveness for the sample of measures.

Three senior engineers will assist Mr. Tso in daily supervision of the engineering and technical staff and quality control review of all technical work products. Jeffrey Romberger, from SBW, will perform this function for all commercial sector measures. Lynn Qualmann, from SBW, will be the industrial lead. Jeff Cropp of Cadmus will be responsible for supervising the Cadmus engineering staff and coordinating with the SBW supervisors. In addition, Bill Koran of NorthWrite, will assist with applications of ECAM+ to the sample.

A lead engineer will be assigned to each sampled measure. Lead engineers will be responsible for all aspects of the site-specific work for their assigned measures. Our supervisory staff will assign lead engineers whose level of skill and experience match the requirements of each measure. All technical work products of these lead engineers will be subject to quality control review by one of the supervising engineers.

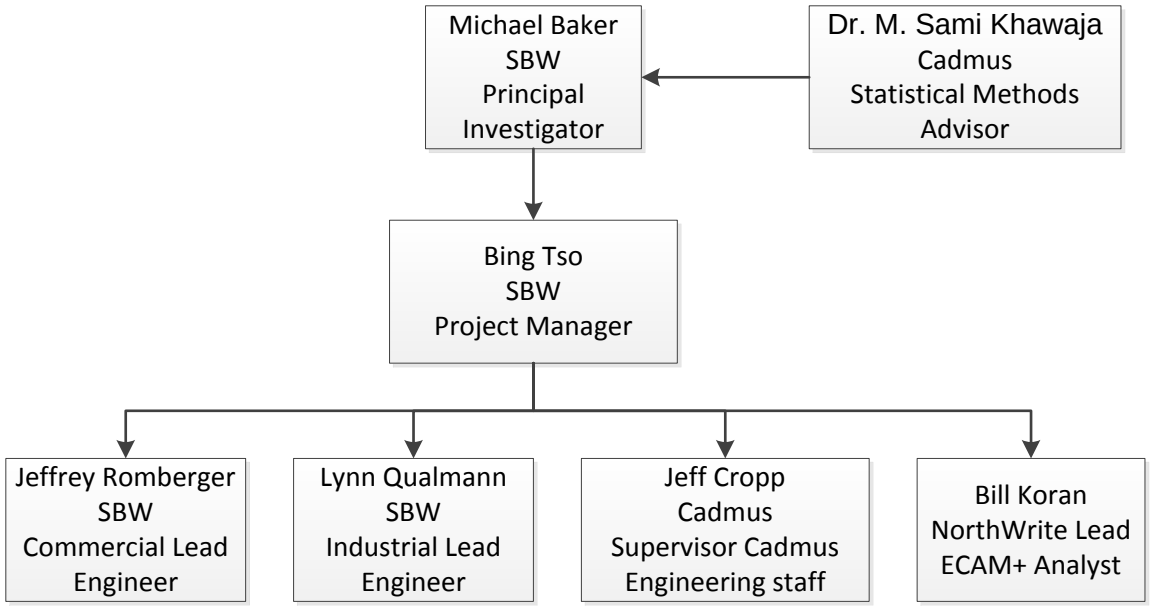


Figure 2: Organization of Evaluation Team

4.9.2. Task Plan

We will complete this evaluation by conducting the work described in the following task plan.

4.9.2.1. Study Preparation

The following tasks must be completed prior to selecting the sample of measures:

1. **Develop evaluation database**. In this task, we will obtain the complete records for Fiscal Year 2013 from the BPA reporting system. We will work with BPA to resolve any data issues and standardize the measure-level data so that it is ready for use in selecting the evaluation sample. In addition, we will enhance the structure of the database so that it is ready to receive data from and provide necessary support for all stages of the evaluation work, including sample recruitment, site-specific data collection and analysis and reporting.
2. **Develop site workbook template**. A Microsoft Excel™ workbook template will be developed that will be used to document the data collection and analysis results for each sampled measure. The workbook will manage summary data from recruitment, file review, project engineer interviews, end user interviews, site visits, and metering. The workbook will also record the summary results of the savings analysis and record information comparing the M&V and evaluation savings estimates. The documentation for each sampled measure will include a completed site workbook, along with other files that document the detailed calculations of savings and the supporting primary data. The site workbook structure will be standardized so that its contents can be automatically imported by the evaluation database.
3. **Enhance sampling tool**. A sampling tool has been developed and used in preparing the sample design for this plan. We will add features to this tool so that we can use it in selecting the sample, managing lists of sampled measures required by the End User and

Utility Contact Protocol (section 6), generate a site workbook for each sampled measure and manage sample disposition.

4. **Develop procedures manual**. We will develop a manual for use by our engineering and technical staff. It will give them specific guidance on how to apply the approaches described in this plan to each of the sampled measures. It will include procedures for file review, interviews, site visits and metering as they apply to lighting and non-lighting measures. It will also provide them with instruction on how to use the site workbook. These procedures and the site workbooks will be based on similar ones developed by the evaluation team for many other evaluations of site-specific savings measures in the Pacific Northwest and throughout the country.
5. **Training**. We will conduct classroom and in-field training as needed to ensure that all members of our evaluation team fully understand the procedures of this evaluation, including those for file review, end user contact, interviews, site visits and savings estimation.
6. **Special study procedures**. We will develop additional sections of the procedures manual to be followed in conducting the special study of the industrial energy management delivery channel. These sections will cover collection of data needed for statistical modeling of end user billing data, the estimation of savings from capital measures, and the estimation of savings for operational measures.

4.9.2.2. Data collection and analysis

The following tasks will be completed once all procedures, tools and training is complete and we are ready to select the sample. We will complete these tasks in a manner that is consistent with the End User Protocols (Section 6).

1. **Sample selection**. Using the sampling tool, we will analyze the complete population of measures for FY 2012 and 2013 and create the final sample designs for each study. We will then use the sample tool to select the samples (primary selections and replacements) and prepare lists for each utility that will be used to manage the End User and Utility Contact Protocol.
2. **Utility coordination**. Once we know which utilities are involved in the sample we will work with BPA staff to establish coordination contacts and initiate the contact protocol with each of them.
3. **Obtain project files**. Following the contact protocols, we will work with BPA staff and participating utilities to obtain complete project documentation and files for each sampled measure.
4. **Site-specific data collection and analysis**. Following the contact protocols, we will complete file review, project engineer interviews, end user interviews, site visits, metering and other data collection needed to support the evaluation. We will also apply the procedures described in this plan to estimate the savings for each measure.

5. **Equipment and logistical support**. We will provide logistical support for our engineers and technical staff related to scheduling data collection activities, travel and the provision of the appropriate metering equipment in a timely fashion to end user sites where it is required.
6. **Study and portfolio estimation**. We will process all measure-level results to obtain study- or portfolio-level results for savings and cost-effectiveness. We will also assembe the reasons for differences between M&V and evaluation estimates and data that support recommendations for improving M&V savings estimates and future evaluations.
7. **Develop recommendations**. We will analyze the data for each study's sample and develop recommendations for improving M&V savings estimates and improving future evaluations

4.9.2.3. Reporting

1. **Draft report**. We will prepare a report that documents this evaluation as described in section 4.7. This report will be distributed for review and comment to parties selected by BPA.
2. **Final report**. Working with BPA staff, we will obtain all review comments and make revisions to the report deemed appropriate by BPA. A final version of the report will prepared and submitted to BPA.
3. **Presentation**. We will conduct two presentations of the report. The first will be to BPA staff. The second presentation will be to other parties as determined by BPA.

4.9.2.4. Project Management

Our principal investigator and other senior staff will manage relationships with BPA, participating utilities and the work of our evaluation team as described in section 4.9.1. This will include management activities needed to coordinate with other studies, if BPA decides to proceed with such coordination.

4.9.3. Schedule

Figure 3 graphically depicts, as a Gantt chart, the schedule for completing the task plan. The chart shows the expected start and finish dates for each task and the critical path dependencies among the tasks.

ID	Task Name	Duration	Start
1	BPA assembles final FY 2012/13 tracking data	23 days	Mon 12/16/13
2	**Study preparation**	**98 days?**	**Mon 12/16/13**
3	Develop evaluation database	20 days	Thu 1/16/14
4	Develop site workbook template	40 days	Mon 12/16/13
5	Enhance sampling tool	30 days	Mon 12/16/13
6	Develop procedures manual	40 days	Mon 12/30/13
7	Training	20 days	Thu 4/3/14
8	Special study procedures	1 day?	Mon 2/17/14
9	**Data collection and analysis**	**210 days**	**Thu 2/13/14**
10	Sample selection	5 days	Thu 2/13/14
11	Utility coordination	10 days	Thu 2/20/14
12	**Project file review**	**27 days**	**Thu 3/6/14**
13	Obtain project files	20 days	Thu 3/6/14
14	Review files including contacts with internal engineers	20 days	Thu 3/13/14
15	Deliver file review results to COTR	2 days	Thu 4/10/14
16	Site-specific data collection and analysis reduce time for 137 site	150 days	Thu 3/27/14
17	Equipment and logistical support	150 days	Thu 3/13/14
18	Study and portfolio estimation	20 days	Thu 10/23/14
19	Deliver site workbooks to utilities for review	5 days	Thu 11/20/14
20	Develop recommendations	20 days	Thu 11/6/14
21	**Reporting**	**60 days**	**Thu 12/4/14**
22	Draft report	30 days	Thu 12/4/14
23	Final report	20 days	Thu 1/15/15
24	Presentation	10 days	Thu 2/12/15
25	Project management	325 days	Mon 12/16/13

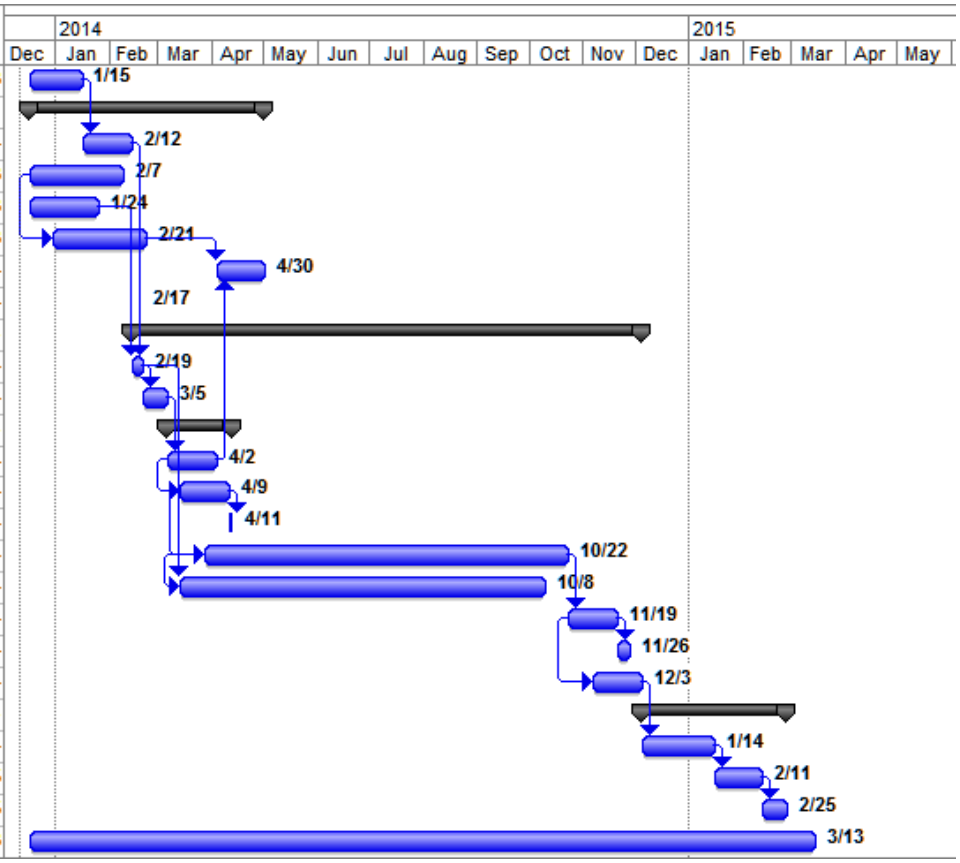


Figure 3: Evaluation Schedule

5. Future Cycles of Evaluation

In this section, we describe the frequency and possible scope of future evaluation cycles. In addition, we provide recommendations that may improve these future evaluations.

5.1. Frequency

The RTF guidelines for Program Impact Evaluation call for evaluation of significant programs once every three years. The Site-Specific Savings portfolio meets the RTF definition of a significant program. Therefore, at a minimum, the evaluation should be conducted every three years.

Yet, BPA operates on a two-year rate period. BPA may therefore decide to conduct evaluation of the Site-Specific Savings portfolio for each rate period. This would somewhat exceed the RTF guidelines. However, it would allow for coordination with the BPA oversight process and would be justified, as the Site-Specific Savings portfolio is approximately 50 percent of the total BPA efficiency portfolio.

Special studies may be needed on a more frequent basis. If new delivery channels are developed and deployed, then it may be appropriate to evaluate them soon after their deployment to provide early feedback to operations staff.

5.2. Study Definitions

The share of savings for each delivery channel should be examined for each rate period. In addition, the importance of new delivery channels should be considered. If the importance and savings of delivery channels in the Site-Specific Savings portfolio is similar to that the FY 2012/13, then the nine- study design should be maintained, to estimate savings and cost-effectiveness and provide feedback on ways to improve M&V savings estimates.

A variety of special studies may be needed in addition to those that estimate savings and cost effectiveness for major delivery channels and the Site-Specific Savings portfolio as a whole. The special studies may include by are not limited to the following:

- Savings persistence for various types of measures
- In-depth investigation of non-energy benefits
- Estimation of free-ridership

5.3. Recommendation for Improving Future Evaluations

One of the products of the first evaluation cycle will be recommendations for improving future evaluations. However, those recommendations will not be available until that evaluation cycle is complete. BPA can do two things now that will likely improve the second cycle of evaluation (FY2014/15).

1. **Uniform Data on M&V Protocol**. Uniform data about the M&V protocol used for each measure should be required by the reporting system. This should apply to projects from all utilities. At a minimum, the data should contain the name of the BPA protocol followed in estimating savings or an indication that none was followed. In addition, the data should indicate whether metering data was collected before or after the delivery of the measure. These additional data on all projects and their measures will considerably improve BPA's ability to predict the cost of future evaluations.
2. **Central Archive of Project Files**. Complete documentation for each project file should be copied to a central secure archive managed by BPA. A project identifier that is known to both BPA and utility staff should organize the archive. The project identifier must be uniquely matched to project tracking records maintained in the reporting system. This archive will benefit all parties by eliminating the onerous process of assembling such documentation for sampled measures. All parties could also use this archive as the primary repository for such documentation, helping to organize the work of utilities and program operators. In addition, quality control standards could be agreed to by all parties that would ensure comparable documentation was available for all projects.

6. END USER AND UTILITY CONTACT PROTOCOL

The evaluation team will adhere to the following protocol for any evaluation cycle that includes studies that require the team to contact end users. Please see Section Appendix A for the process flow for this contact protocol.

1. **Utility Notification of Sample and Utility Project Webinar**

   a. Utilities will be notified by the BPA EER by email that at least one site in their territory has been selected in the evaluation sample. Initial email will contain an attachment with basic information about sampled sites (utility assigned and BPA project identifier, project name, facility name, location, end user contact information, calculator file name, description of sampled measure, primary engineering contact) and will request the following from utilities: primary utility contact for the evaluation and Doodle poll request for initial Webinar (approximately 2 weeks after initial email).

   b. Utilities respond with designation of the primary utility contact for the evaluation and primary engineering contact for each measure, if Option 2. Additionally, if a third-party contractor is involved in the project, the utility will determine whether engineers from that firm may be contacted by the evaluation (see Step #3 below).

   c. BPA will hold Webinars for all primary utility contacts to review evaluation process in general and this end user contact protocol. Option 1 and Option 2 meetings will be separate due to differences in data provision processes.

   d. BPA will notify the BPA and ESI project engineers of measures that have been sampled for which they are noted as the primary engineering contact.

   e. Any utility submitting data directly to the evaluation team may negotiate and execute with the evaluation team a non-disclosure agreement that meets the utility's requirements for protecting end user information[6]. Alternatively, utilities may send requested data to their EER or BPA project manager for transmittal to the evaluation team and have confidence that data will be be protected under the language of BPA's existing contract with the evaluation firm.

2. **Data Request: Project file requests**

   a. Option 1 utilities

   - Evaluation team will request completion report files from BPA for all Option 1 files and types of files needed. BPA will provide these to the evaluation team through secure FTP. For Option 1 Industrial sites, BPA will work with Energy Smart Industrial to collect additional data or calculation files.

[6] Please note that BPA has a contract with the evaluation firm that requires data protection of the data. Therefore, this NDA may be most useful to utilities that provide data directly to the evaluation team (e.g., Option 2 utilities).

- If BPA or Energy Smart Industrial files do not include all of the project documentation for some sites, the utility will be contacted by the evaluation team and the needed files will be noted on the sample list (e.g., calculation file or metered data file). We expect this to be done on a small portion of Option 1 projects and therefore will be conducted on an ad hoc basis as the need.
- Within one week of the request from the evaluation team, the utility (or BPA if requested by the utility) will upload required files to the secure website, placing them in the folder created for each end user. A later date may be requested and will be accommodated if possible.

b. Option 2 utilities

- Evaluation team will request all project files for the Option 2 sampled sites and will include direction on the types of files needed, including but not limited to program applications, field notes, drawings, photographs, functional M&V models, metering data, product specification sheets. This request will be conducted as a single "batch" for each Option 2 utility.
- Within three weeks of the Option 2 Webinar, utilities will upload required files to the secure website, placing them in the folder created for each end user. A later date may be requested and will be accommodated if possible.

3. Contact of Internal Project Engineers

a. Following file review, the evaluation team will contact the internal (i.e., BPA/ESI/utility) project engineers to learn more about the project, on an ad hoc basis as needed by the evaluation team. The discussion with the internal project engineer will:

- Answer questions regarding the project or files.
- Obtain information needed for the evaluation that was not found in the project files.
- If end user contact will still be required, discussion will inform evaluation team on the history of the project and circumstances at the site and to identify the least intrusive approach for obtaining data needed by the evaluation.

4. Inform to Utilities: Supplemental Data Needed from End-Users

a. The evaluation team will contact utilities with sampled sites that need additional data requirements at least two weeks prior to the earliest date of initial end user contact. An initial data request will include all measures in the primary sample. The evaluation team may subsequently request replacement sites (i.e., those needed to replace sites in the primary sample that refuse to participate). These requests will be one site at a time.. The data needs will be appended to the initial sample list and will include the following information:

- Description of the data needed from the end user and proposed method for obtaining that data

- Estimate of the time required from the end user's staff to complete the data collection, including all phases of the data collection, e.g., telephone interview, participation in inspection or metering.
- Two week time frame within which the evaluation team will make initial contact with the end user

b. Each utility will add the following information to the sample list and return it to the evaluation team within one week, or a later date may be requested and will be accommodated if possible:

- Whether and when utility will make initial contact with the end user. Evaluation team will provide a script and a 1 to 2 page written summary with BPA's logo. The summary will describe the background and purpose of the evaluation, introduce SBW, state that results will be only used in to improve future practices, and state that individual end user data will be protected. These can be used to introduce the study to end users in email or telephone contacts.
- If site visit is required, whether the utility wants to be present during the visit
- Adjustment or addition of recommended name and contact information for the end-user initial point of contact. For Option 1 projects, the information in the BPA reporting system will be included on the sample list; utilities may recommend a change to the initial contact point. Option 2 projects will need to include the information as this is not in the BPA system.
- Any additional comments, questions, concerns by the utility

5. End-user Contact and Supplemental Data Collection

a. Evaluation team will call (this may be preceded with an introductory email) the end-user initial point of contact to brief them on the study, the specific projects or measures that have been sampled, and the additional data that is required to complete the evaluation.

b. Evaluation team will work with the end user to determine the most efficient methods for acquiring the data, and will determine who on the end user staff will be involved and when the telephone or site visit activities can be conducted.

c. In all cases, evaluation team will notify the utility about the schedule for data collection agreed to with the end user, so that they can participate.

d. If the data collection involves a site visit, the evaluation team will work with the contact to determine what is needed to access the relevant portions of the site. This may include special clothing, safety training, other training, or background checks and security authorization. Evaluation team will work with the end user to meet all site access requirements.

e. As needed, non-disclosure agreements will be executed between the evaluation team and the end user.

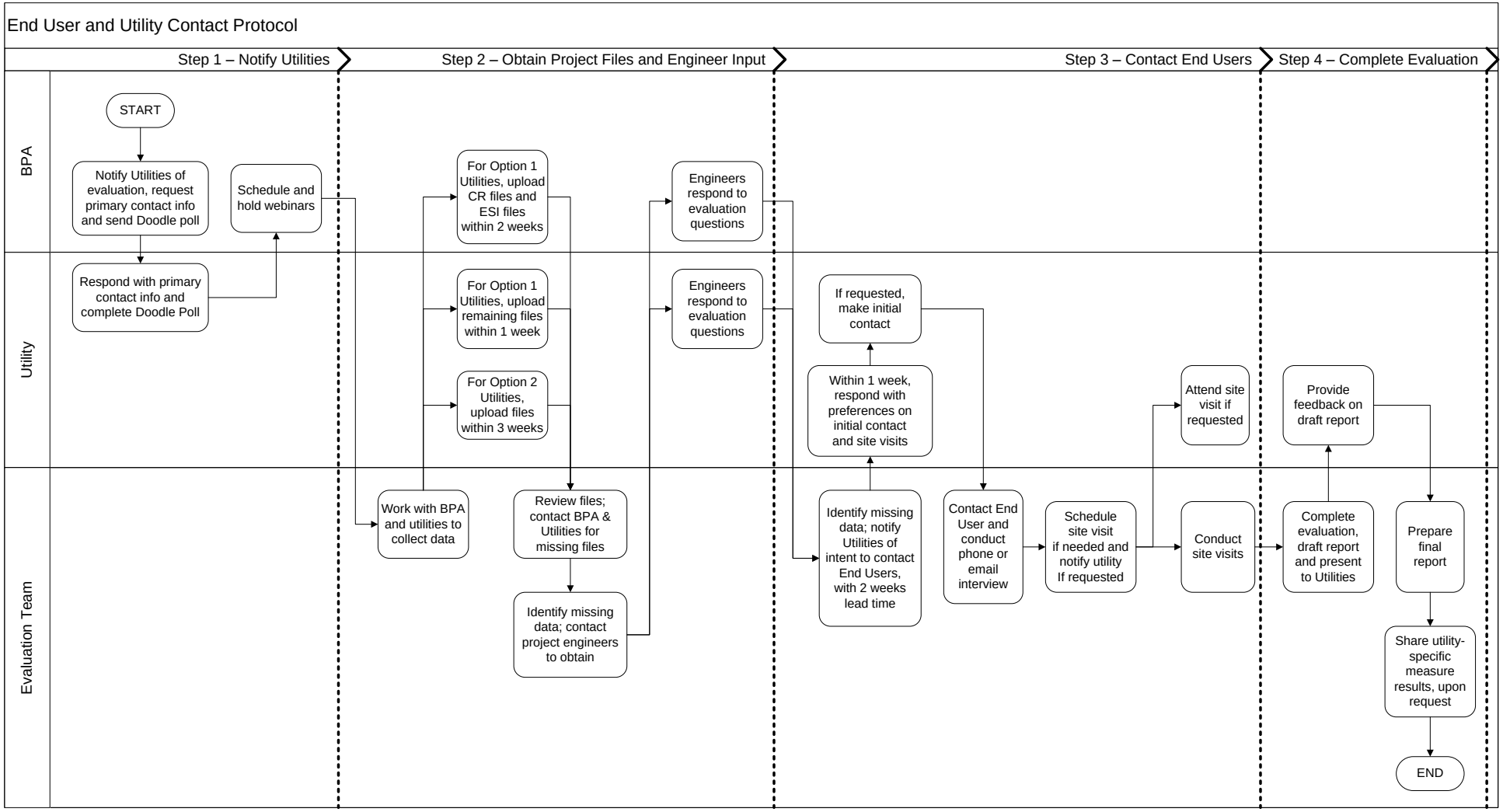
f. Once all end user requirements have been satisfied, the site visit will proceed.

g. A few days prior to any site visit, evaluation team will contact the end user to confirm arrangements for the site visit. If any arrangements are changed, evaluation team will notify the utility.

6. If the evaluation team receives a request from an end user for the site-specific study results, the evaluation team will respond by saying "Please contact your utility for detailed evaluation information". The evaluation team will notify the utility of this request and the utility may provide the site-specific results at their discretion.

7. Once the evaluation work is complete for each utility's sampled projects or measures, and the evaluation team is ready to begin work on the draft report the findings, the evaluation will notify the utilities that the site-specific results are ready for their review. A secure download link to site workbooks will be emailed to utilities if they request to see the results. The findings will be contained in an Excel workbook for each measure studied. Utilities may provide comments on the any aspect of the findings to the evaluation team.

A. End User Contact Protocol Process Flow



B. SITE-SPECIFIC SAVINGS PORTFOLIO ASSESSMENT

We completed an assessment of the Site-Specific Savings portfolio to understand how savings are distributed among important program delivery channels. The assessment clarified what data are available for all projects and the additional data that could be assembled for sampled projects prior to any contact with end users.

B.1. Standardized Measure Data

BPA uses the reporting system to track projects and measures completed under various programs and initiatives.

BPA provided a snapshot of data from the reporting system including all projects completed in FY 2012 and FY 2013 projects completed through May 2013. Separate data tables were provided for lighting and custom projects. The lighting projects tables included all lighting projects completed by Option 1 utilities using the BPA lighting calculator. The custom project data included all Option 1 projects other than lighting (with the exception of a few large custom lighting projects) and projects of all types reported by Option 2 utilities.

We extracted two levels of information from the reporting system: project and measure. The project-level data identified the end user location where the work was done, completion date and other summary information about the project. The measure-level data described the efficiency measures delivered to the end user that comprised the project, including measure classification and savings.

A third more detailed level of data was also provided for the Option 1 lighting projects. This data was obtained from a scan of the individual lines found in the BPA lighting calculator. Each line represented the lighting changes made to particular types of fixtures within specific spaces. This data is useful when summarized in completing the measure-level description of Option 1 lighting. However, it is not available for Option 2 lighting projects. In order to obtain this level of detail for Option 2 lighting projects, it would be necessary to collect all the lighting calculator files from these utilities and develop software capable of extracting each line from these workbooks.

The reporting system uses different data structures for lighting and custom project information. Fields of comparable information have different names and different values are used for coded entries. These structures were examined and a scheme developed for combining all records into a standardized data structure at the measure-level. Data for the following standardized measure-level fields were assembled for 5,051 measures.

- **Option**. Indicates whether measures originate from either an Option 1 or Option 2 utility.
- **ReportingMeasureType**. Indicates whether the measure originates from the BPA lighting calculators (coded as lighting) or from custom project reporting (coded as custom). All Option 2 lighting is coded as custom.
- **Utility**. The name of each utility.

- **State**. The state in which the end user is located.
- **Zip**. The ZIP code in which the end user is located.
- **ResourceOpportunityType**. Indicates whether the measure is a lost opportunity (new construction or major remodel) or retrofit project.
- **Sector**. Possible sectors are Agricultural, Commercial or Industrial.
- **BuildingType**. This field describes the type of building (43 possible types) where the measure was delivered.
- **EndUse**. Indicates the end use, e.g., HVAC, hot water, compressed air, directly affected by the measure.
- **MeasureCategory**. This is the first part of BPA hierarchical scheme for classifying measures. Twenty-nine categories are found in the data, such as HVAC controls, transformers and heat recovery.
- **TechnologyActivityPractice**. This is the second and more detailed portion of the BPA measure classification scheme. 86 distinct classes of measures are found in the data, such as reciprocating chiller improvements and plate milk pre-cooler.
- **Protocol**. This field is supposed to distinguish the BPA M&V protocol used to estimate savings. In particular, it separates measures estimated using ECwV from other protocols. This information is not available for any of the Option 2 measures. In addition, it does not appear to be reliably coded for Option 1 measures.
- **CompletionDate**. This is the date that measure delivery was completed.
- **MeasureSavingskWh**. This is the estimated site-level savings from the measure. It is not bus bar savings, and is not adjusted for savings in distribution loses.

B.2. Example Project File Review

In addition to the reporting system, BPA and the Option 2 utilities maintain electronic and hard copy records that document each delivered measure. The following types of records may be retained:

- Field notes documenting the features of the baseline conditions.
- Audit report and recommendations.
- Savings estimation spreadsheets or other models, e.g., EQuest or ECAM used in estimating savings before or after project completion.
- Incentive/grant application and approval forms.
- M&V plans.
- Invoices.
- Field notes documenting features of the delivered measures.

- Trend metering.
- Manufacturer cut sheets.

We collected available records for 44 projects covering a range of different types of projects from BPA and each of the Option 2 utilities. The example projects were selected to represent the range of different approaches used in estimating savings. Some, such as lighting, involved the use of a standardized spreadsheet calculator. Others involved trend metering and the specification of a customized model for estimating savings.

Of particular concern in our review was whether the files provided enough information for us to understand the models used in estimating savings and the data collected to specify those models. We were looking for a functional copy of the model used to estimate savings. This could be a spreadsheet that implemented a standard calculation, such as generally used for lighting measures or a spreadsheet containing customized engineering calculations. However, the file would have to be the actually spreadsheet and not a print image (PDF) of the model inputs or outputs. Only the actual spreadsheet file would allow us to examine the equations used in the calculations. It might also be the inputs for a simulation model such as EQuest, but again the file would have to be the actual input file that could be used to run the model.

We conducted an initial review of the files provided for each example project. We identified projects that lacked functional models and asked either BPA staff or Option 2 utility staff to search further for available records. In many cases, additional files were found and provided. Table 7 shows the results to date with the projects organized by option and project type. In total we have been able to obtain functioning models for 33 out of 44 projects (13 out of 19 for Option 1 and 20 out of 25 for Option 2). In recent discussions, BPA has indicated that additional models can be recovered for Option 1 projects by further searching in records maintained by program operations contractors. In some cases for Option 2 projects the utility staff report that the models are considered proprietary by the vendors and cannot be provided. In other cases, models may be recoverable through additional efforts by utility or contractor staff.

The finding concerning the availability of functional models is a critical cost factor for the impact evaluation. Without such a model, the evaluation team would have to develop a new model for the measure instead of adjusting or revising an existing model, a much more expensive approach. In addition, without access to the model used it may be very difficult to determine whether the data gathered as part of M&V are sufficiently reliable. This will make the task of determining what data are required for the evaluation more difficult.

Another major factor in conducting the evaluation will be the complexity of the projects and the data needed to reliably estimate savings. We looked for indications of measure complexity that would allow us to estimate the level effort that would be needed to estimate savings for the impact evaluation. One indicator was whether the M&V model required metering data, such as power measurements for affected equipment or systems. As shown in Table 7, savings estimate for 17 out of 44 projects involved metering data. The use of trend metering may make the estimation more or less complex, but in all cases the presence of metering data helps us to better understand the level of effort that will be required for the impact evaluation.

Table 7: Project File Review Findings

Option and Project Type	Number of Projects	Number with Functioning M&V Model	Number with Metering
1	**19**	**13**	**1**
Industrial	**8**	**8**	**1**
Lighting	3	3	0
NonLighting	5	5	1
NonIndustrial	**11**	**5**	**0**
Lighting	5	5	0
NonLighting	6	0	0
2	**25**	**20**	**6**
Commercial	**15**	**13**	**1**
Lighting	10	9	0
NonLighting	5	4	1
Industrial	**10**	**7**	**5**
Lighting	1	1	0
NonLighting	9	6	5
Grand Total	**44**	**33**	**7**

B.3. Portfolio Assessment

In the last part of this assessment, we analyzed the standardized measure data to understand the distribution of savings and the portfolio of measures with respect to a number of factors that we might consider in the sample design for this evaluation. We analyzed the following ten factors:

- Utility Option
- Completion Date
- Location
- Utility
- Sector
- Resource Opportunity Type
- Building Type
- End Use
- Measure Category
- Size of Savings

This analysis also helps us understand the quality of the available data for various data fields, such as end user ZIP code, that will be critical in conducting the evaluation and estimating the level of effort required.

Utility Option

Table 8 shows the savings and percent of savings for Option 1 and Option 2 utilities and for each the portion associated with lighting and non-lighting measures. Lighting dominates the savings, accounting for more than 57 percent of the total savings. For both lighting and non-lighting measures the majority of savings come from Option 1 utilities. However, BPA reports that Option 2 utilities tend to report their measures toward the end of the fiscal year, so this relationship may change once all of Fiscal 2013 has been reported. Non-lighting measures have substantially larger savings per measure, for Option 1 by more than a factor of 10. However, there are more than 10 times as many lighting measures, thus the total savings for the two types are nearly the same.

Table 8: Measures and Savings by Option and Measure Type

Option and Measure Type	Number of Measures	kWh Savings	Percent of Savings	Average Savings / Measure
1	**3,034**	**149,778,072**	**59%**	49,367
Lighting	2,803	76,815,369	30%	27,405
Non-Lighting	231	72,962,703	29%	315,856
2	**2,017**	**105,922,817**	**41%**	52,515
Lighting	1,750	69,896,370	27%	39,941
Non-Lighting	267	36,026,447	14%	134,931
Grand Total	**5,051**	**255,700,889**	**100%**	**50,624**

Location

Information on the location of measure deliveries will be critical to the administration of the evaluation. Data on the street address, ZIP code and state is available for all measures. If site visits are required for the evaluation, we will be able to use these data in planning the required travel. Table 9 shows the distribution of savings across the states served by BPA's utilities. The State of Washington accounts for more than three-quarters of the savings.

Table 9: Measures and Savings by State

State	Number of Measures	kWh Savings	Percent of Savings
Washington	3,632	197,497,016	77.2%
Oregon	704	37,358,118	14.6%
Idaho	283	8,556,740	3.3%
Montana	392	7,106,451	2.8%
Wyoming	35	5,099,324	2.0%
Nevada	4	78,545	0.0%
Utah	1	4,695	0.0%
Grand Total	**5,051**	**255,700,889**	**100.0%**

We have also used the ZIP code for each measure to determine whether overnight trips will be required to conduct site work. The distance to each ZIP code from the staff offices (Seattle and Portland) of the evaluation team have been determined and each ZIP code has been assigned to local or overnight travel. Table 10 shows three quarters of the measure savings are located within local travel distance. The sample will be stratified by size of measure savings, so the distribution of sampled measures will be similar to the distribution of measure savings.

Table 10: Measures and Savings by Travel Requirement

Travel Requirement	Number of Measures	kWh Savings	Percent of Savings
Local	3,276	194,120,609	75.9%
Overnight	1,775	61,580,280	24.1%
Grand Total	**5,051**	**255,700,889**	**100.0%**

Utility

The utilities served by BPA vary widely in size and the size of the savings that they report to BPA. We have placed each of the utilities in one of six categories as shown Table 11 in terms of their reported savings. The table shows the distribution of savings across the Option 1 utilities, with savings distributed approximately equally among the top three savings groups.

Table 11: Option 1 Utilities - Savings by Utility Savings Group

Utility Savings Groups (kWh)	Number of Utilities	kWh Savings	Percent of Savings
A: > 10,000,000	2	49,686,286	33.2%
B: 5,000,000 to 10,000,000	6	37,442,505	25.0%
C: 1,000,000 to 5,000,000	22	42,102,990	28.1%
D: 500,000 to 1,000,000	14	10,609,966	7.1%
E: 100,000 to 500,000	27	8,784,392	5.9%
F: < 100,000	25	1,151,933	0.8%
Grand Total	**96**	**149,778,072**	**100.0%**

As shown in Table 12, the distribution of savings is dramatically different for Option 2 utilities. For them, 96 percent of savings are reported by 3 utilities.

Table 12: Option 2 Utilities - Savings by Utility Savings Group

Utility Savings Groups (kWh)	Number of Utilities	kWh Savings	Percent of Savings
A: > 10,000,000	3	101,683,478	96.0%
C: 1,000,000 to 5,000,000	1	3,945,004	3.7%
E: 100,000 to 500,000	1	294,335	0.3%
Grand Total	**5**	**105,922,817**	**100.0%**

Sector

Table 13 shows how measures and savings are distributed by sector, with nearly 60 percent of savings associated with measures delivered to commercial sector end users. However, as shown in Table 14 and Table 15, the distribution looks different when you isolate Option 1 and 2 utilities. For Option 1 utilities, the largest sector is industrial instead of commercial. For Option 2, commercial sector accounts for more than three quarters of the savings and there are no agricultural measures.

Table 13: Option 1 and 2 Combined - Measures and Savings by Sector

Sector	Number of Measures	kWh Savings	Percent of savings	Average Savings / Measure
Commercial	4,462	150,872,344	59.00%	33,813
Industrial	478	102,074,824	39.92%	213,546
Agricultural	111	2,753,721	1.08%	24,808
Grand Total	**5,051**	**255,700,889**	**100.00%**	**50,624**

Table 14: Option 1 Utilities - Measures and Savings by Sector

Sector	Number of Measures	kWh Savings	Percent of savings	Average Savings / Measure
Industrial	339	78,702,683	52.55%	213,546
Commercial	2,584	68,321,668	45.62%	33,813
Agricultural	111	2,753,721	1.84%	24,808
Grand Total	**3,034**	**149,778,072**	**100.00%**	**49,367**

Table 15: Option 2 Utilities - Measures and Savings by Sector

Sector	Number of Measures	kWh Savings	Percent of savings	Average Savings / Measure
Commercial	1,878	82,550,676	77.93%	33,813
Industrial	139	23,372,141	22.07%	213,546
Grand Total	**2,017**	**105,922,817**	**100.00%**	**52,515**

Resource Opportunity Type

The available data can also be used to classify measures and savings by resource opportunity type as shown in Table 16. Nearly 90 percent of the savings are associated with retrofit measures. The balance is accounted for by lost opportunity measures, which are either features of new construction projects or major renovations. Although lost opportunities are a relatively small share of the portfolio, some of them will be selected as part of the evaluation. We will have to correctly account for local energy codes and national standards in force at the time and location where the measure was approved in developing appropriate baseline conditions for these measures.

Table 16: Measures and Savings By Resource Opportunity Type

Resource Opportunity Type	Number of Measures	kWh Savings	Percent of Savings	Average Savings / Measure
Retrofit	4,827	227,611,622	89.0%	47,154
Lost Opportunity	224	28,089,267	11.0%	125,399
Grand Total	**5,051**	**255,700,889**	**100.0%**	**50,624**

Building Type

The measures are classified into 43 distinct building types. We have re-classified these into larger categories in order to understand the important types present in the portfolio. Important determinants of measure savings such as operating hours, lighting requirements, HVAC system type, and end use profile vary substantially across these building types. As shown in Table 17, the largest share of savings is found in industrial facilities, many of which will impact process loads and are determined by process schedule and production output. The next largest share of savings is associated with "other" building types (most of which is coded as "other" even in the more detailed building typing). For these, we will need to use the more detailed breakdown by building type available in the data to understand the energy use characteristics of the building where the measure was delivered. No single building type dominates the portfolio, so we will have to deal with a wide variety of types in conducting the evaluation.

Also shown in the table are the average savings per measure. On average, measures in industrial facilities are more than twice as large as any others, over 200,000 kWh saved. All but one of the other building types are in a narrow range of savings per measure; from 20,000 to 60,000 kWh saved. Health measures are somewhat larger at 75,630 kWh saved.

Table 17: Measures and Savings by Building Type

Building Type	Number of Measures	kWh Savings	Perrcent of Savings	Average Savings / Measure
Industrial Facility	447	93,491,133	36.6%	209,152
Other	1,576	55,366,943	21.7%	35,131
Office	681	25,212,079	9.9%	37,022
Retail	487	16,300,602	6.4%	33,471
School	313	13,902,257	5.4%	44,416
Warehouse	522	13,883,163	5.4%	26,596
Non-Food Retail	467	10,842,439	4.2%	23,217
Health	138	8,509,179	3.3%	61,661
Food Retail	267	8,018,581	3.1%	30,032
Education	60	5,369,759	2.1%	89,496
Lodging	93	4,804,755	1.9%	51,664
Grand Total	**5,051**	**255,700,889**	**100.0%**	**50,624**

End Use

The database classifies each measure according to the primary end use it affects. The distribution of savings by end use is shown in Table 18. Nearly 60 percent of all savings are associated with Lighting. The top six end uses account for more than 98 percent of savings. Savings per measure varies dramatically across end use. The top two end uses vary by more than a factor of 10 in terms of savings per measure. Measures associated with end uses found in industrial facilities have the highest savings per measure.

Table 18: Measures and Savings by End Use

End Use	Number of Measures	kWh Savings	Percent of Savings	Average Savings / Measure
Lighting	4,553	146,711,739	57.4%	32,223
Motors/Drives	92	31,586,456	12.4%	343,331
HVAC	224	29,802,214	11.7%	133,046
Process Loads	59	16,953,155	6.6%	287,342
Refrigeration	35	14,686,475	5.7%	419,614
Compressed Air	56	13,067,935	5.1%	233,356
Whole Bldg/Meter Level	6	1,300,959	0.5%	216,827
Irrigation	7	816,180	0.3%	116,597
Facility Distribution System	5	639,636	0.3%	127,927
Food Preparation	10	86,736	0.0%	8,674
Water Heating	4	49,404	0.0%	12,351
Grand Total	**5,051**	**255,700,889**	**100.0%**	**50,624**

Measure Category

BPA has developed a two-tiered system for classifying measures. The most detailed tier is called PAT (practice, activity and technology). 86 categories are defined by the PAT tied. The less detailed tier groups PATs into 29 broader types. Which are called measure categories. The savings for some of these are very small, so we have further grouped them into a smaller number of categories as shown in Table 19. We will need to deploy different approaches in order to reliably estimate savings across these categories of savings. For example, HVAC controls measure may modify the hours of operation for HVAC equipment, while other HVAC measures might change the performance characteristics of the heating or cooling equipment. As was found for end uses, measures involving lighting equipment account for the largest share of savings. Only a small portion of lighting involves controls. However, control measures of all types account for more than 20 percent of savings. As was seen in the end use table, measures that affect equipment types found in industrial facilities have the highest savings per measure.

Table 19: Measures and Savings by Measure Category

Measure Categories	Number of Measures	kWh Savings	Percent of Savings	Average Savings / Measure
Lighting	4,393	142,752,981	55.8%	32,496
Process	124	31,958,173	12.5%	257,727
HVAC Controls	87	18,652,346	7.3%	214,395
Process Controls	37	16,693,170	6.5%	451,167
Motors/Drives Controls	45	14,337,674	5.6%	318,615
Pumps and Fans	55	13,167,039	5.1%	239,401
HVAC	113	7,821,486	3.1%	69,217
Other	54	6,604,731	2.6%	122,310
Lighting Controls	143	3,713,289	1.5%	25,967
Grand Total	**5,051**	**255,700,889**	**100.0%**	**50,624**

Size of Savings

The distribution of savings by size is highly skewed, with less than 1 percent of measures accounting for twenty-five percent of savings as shown in Table 20.

Table 20: Measure and Savings by Size of Savings

Savings Category (kWh)	Number of Measures	Percent of Measures	kWh Savings	Percent of Savings
A: > 1,000,000	34	0.67%	67,066,247	26.23%
B: 200,000 to 1,000,000	195	3.86%	77,017,092	30.12%
C: 50,000 to 200,000	611	12.10%	59,468,053	23.26%
D: 5,000 to 50,000	2,715	53.75%	48,559,682	18.99%
E: < 5,000	1,496	29.62%	3,589,816	1.40%
Grand Total	**5,051**	**100.00%**	**255,700,889**	**100.00%**