Bonneville Power Administration
UES Portfolio Evaluation Plan
CY2016 Activities

NAVIGANT

Contributors

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1. Introduction

This document includes the Evaluation, Measurement, and Verification (EM&V) plan for evaluating the impact of Bonneville Power Administration's (BPA) portfolio of UES (Unit Energy Savings) measures. Specifically, this evaluation plan defines the approaches and strategy to be used by the evaluation team in calendar year 2016. 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.

For a summary of this document, please see the "Draft 2016 UES Evaluation Plan" presentation or one-pager, available at www.bpa.gov/goto/evaluation.

This plan builds on the guidelines set forth in the Quality System Strategy & Implementation (QSSI) document, Regional Technical Forum (RTF) Guidelines[1] and the BPA Implementation Manual (IM)[2]. This plan also leverages ideas originally captured in the draft evaluation strategy presented in May 2015[3].

The following sections provide a background and context for the evaluation of BPA's UES portfolio.

1.1. Background

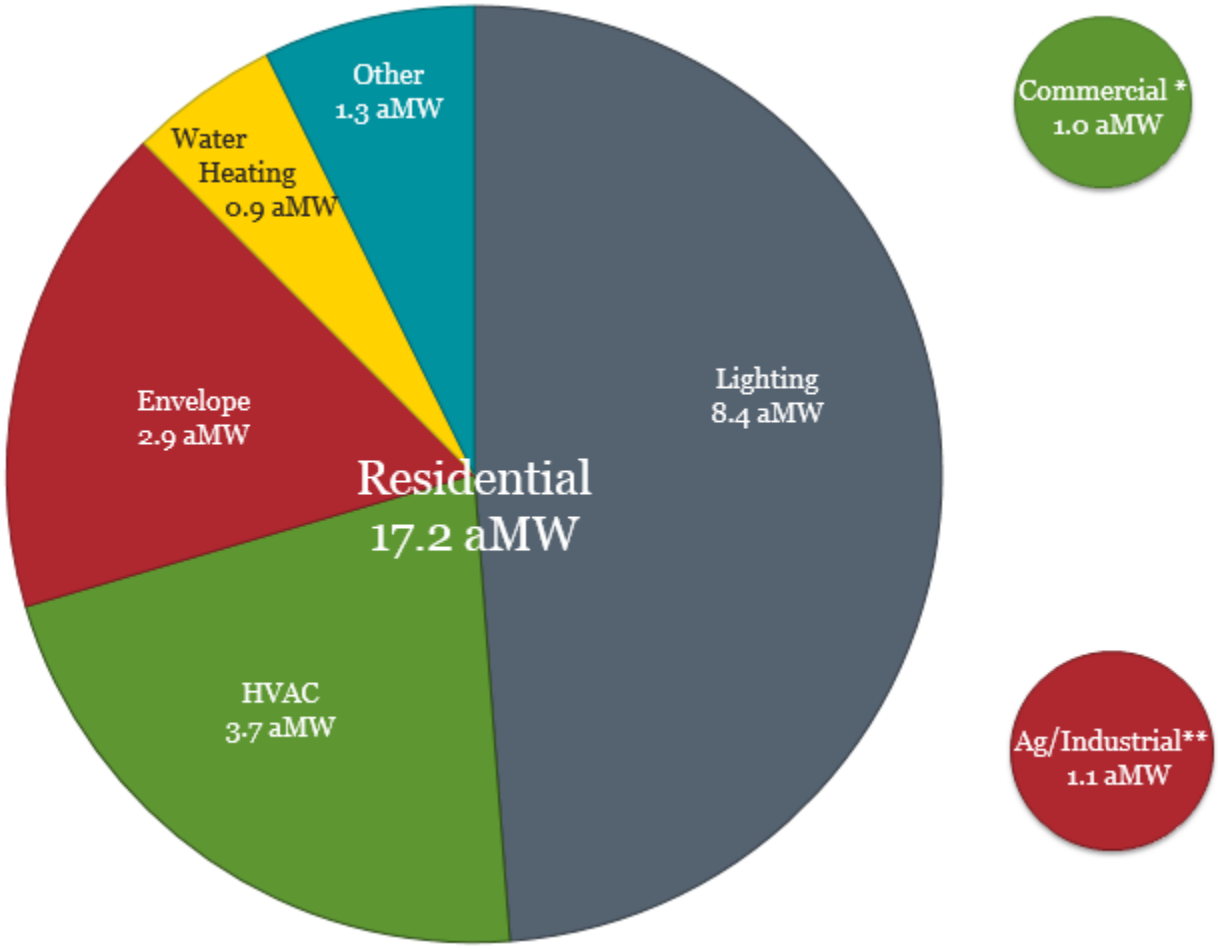
BPA, with its public power utility partners, acquires savings from a portfolio of energy efficiency programs and measures. The portfolio includes:

- Custom measures, requiring site-specific calculation of savings.
- Calculator measures with a standardized savings estimation algorithm and site-specific parameter values.
- UES measures utilizing a constant savings value for each measure application.

The UES portfolio contains measures that span all sectors which together account for roughly 60% of BPA's total reported savings. In addition to inclusion in utility programs, UES measures are also included in BPA's Simple Steps regional program, which involves services from a third-party contractor (CLEAResult). BPA customers with Energy Conservation Agreements report savings for UES measures into BPA's Interim Solution 2.0 (IS2.0) system, following specified policies. Figure 1 provides a summary of FY2015 IS2 data for BPA's UES portfolio.

[1] *Regional Technical Forum, Roadmap for the Assessment of Energy Efficiency Measures, June 17, 2014. http://rtf.nwcouncil.org/subcommittees/Guidelines/RTF%20Guidelines%20(revised%206-17-2014).pdf*
[2] *Bonneville Power Administration, Energy Efficiency Implementation Manual, October 1, 2014. http://www.bpa.gov/EE/Policy/IManual/Documents/FINAL_October_2014_Implementation_Manual.pdf*
[3] *Evaluation Strategy for the Unit Energy Savings Portfolio of Bonneville Power Administration. Prepared for Lauren Gage, BPA. Prepared by Navigant Consulting, Inc. April 30, 2015.*

Figure 1: FY2015 UES Portfolio Summary



Source: Summarized from 3/18/2016 IS2.0 data pull
** Savings from Energy Smart Grocers deemed measures are not included in this summary.*
*** Ag/Industrial value does not include savings achieved through the Scientific Irrigation Scheduling measure.*

1.2. Key Concepts

The evaluation team relies on the following definitions of key concepts throughout this document, which refer to or expand on elements from the RTF Guidelines and QSSI Policies. Their definitions are critical to the correct interpretation of the UES evaluation strategy. Additional definitions are provided in the Glossary section.

Delivery Verification - RTF Guidelines stipulate that Impact Evaluation may be accomplished using delivery verification to estimate savings for Proven measures, i.e., savings equal the verified delivery quantity multiplied by the proven UES savings value. Delivery verification may also be useful in measure development and providing feedback to programs. The RTF Guidelines provide the following additional definition:

> *"Delivery verification involves physical inspection of measures or documentation of measures at the location where the program operator delivers them. For measures delivered to an end use, this involves collecting data from the end user facility to*

confirm that equipment conforms to the measure specifications. For measures delivered upstream of the end use, for example efficient bulbs sold through retailers, this might involve inspection of retailer or end user records of bulb sales or purchases."[4]

Evaluation Domain - Since much of the BPA UES portfolio of measures is delivered by customer utilities outside of BPA "programs," the term "evaluation domain" or "domain" is defined as equivalent to the RTF Guidelines' "program" and includes a group of measures within the same sector, targeting similar end uses. BPA reserves the word "program" for regional, third-party implemented programs funded by BPA.

Evaluation Measure Group - In order to design an efficient evaluation, the evaluation team defined subsets within domains as a group of measures that use similar program delivery method and/or have the same measure status.

Measure Status - In the RTF Guidelines, a measure's category defines the savings estimation that should be used to evaluate savings. The RTF approves three measure categories within the UES portfolio; Proven, Provisional and Other.

1.3. Context

In late 2015, BPA finalized the impact evaluation of its Site-Specific Savings portfolio.[5] BPA has not, to date, evaluated its UES portfolio. Together with BPA, the evaluation team plans to employ a staged, repeatable approach to impact evaluation and impact evaluation planning to evaluate the UES portfolio:

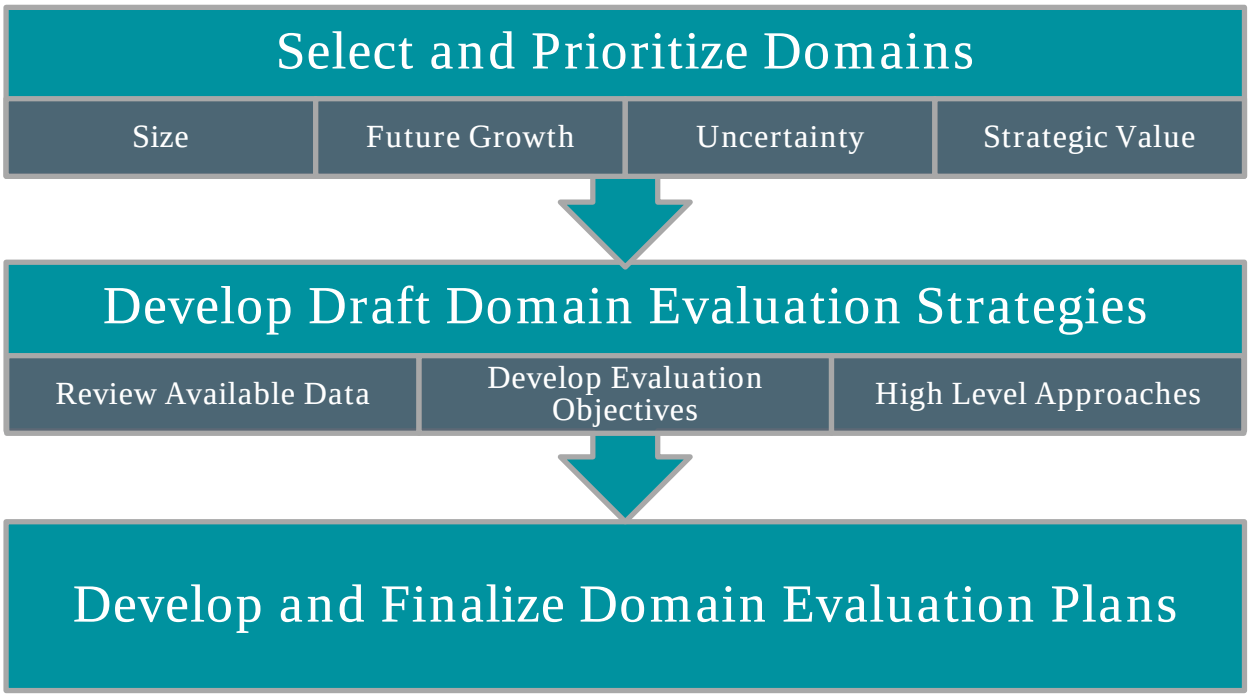
- Impact evaluation and planning will likely be staged over multiple years.
- A subset of measures will receive impact evaluation within a year.
- Evaluators will work with stakeholders to maximize value to programs by prioritizing the measures receiving evaluation each year, and the evaluation objectives for each group of measures.
- Domain or measure group-specific evaluation plans will be developed, as needed, to guide each year's impact evaluation activities.

To select the first year's evaluation domains, objectives, approaches and tasks, the evaluation team followed the planning process summarized in Figure 2.

[4] *Details of the delivery verification strategies included in the 2016 UES evaluation approaches are discussed in detail for each domain in the Appendices.*

[5] *Impact Evaluation of the FY2012-13 Site-Specific Savings Portfolio, November 16, 2015, SBW Consulting & The Cadmus Group.*
https://www.bpa.gov/EE/Utility/research-archive/Documents/Evaluation/Impact_Evaluation_Site-Specific_Portfolio_Final_Report.pdf

Figure 2: UES Portfolio Evaluation Planning Process



Source: Navigant

The evaluation team together with BPA staff determined the high priority domains for the 2016 UES evaluation activities as residential heating ventilation and air conditioning (HVAC), residential envelope, and residential lighting.

1.4. Guidelines

Over the last four 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 UES portfolio.

- RTF Guidelines[6] - 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. In June of 2014, the RTF adopted the updated version of the Guidelines that states that the RTF will provide guidance on delivery verification for UES and Standard Protocols.
- RTF Delivery Verification Requirements – beginning in May of 2015, the RTF identified key data that needs to be collected (or checked) to ensure reliability of RTF savings estimate. These requirements included detailed checklist and updated measure specifications.
- BPA QSSI –presents a framework for establishing BPA's system used to assure high-quality programmatic energy savings, or "quality system." This quality system framework focuses on programmatic energy savings. It includes: Standards, Planning

[6] *Regional Technical Forum, Roadmap for the Assessment of Energy Efficiency Measures, June 17, 2014. http://rtf.nwcouncil.org/subcommittees/Guidelines/RTF%20Guidelines%20(revised%206-17-2014).pdf*

Policies, Oversight Policies, Impact Evaluation Policies and Savings Policies for Custom Projects, Calculators, and Unit Energy Savings.

- BPA Implementation Manual[7] – 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.

1.4.1. Measure Status

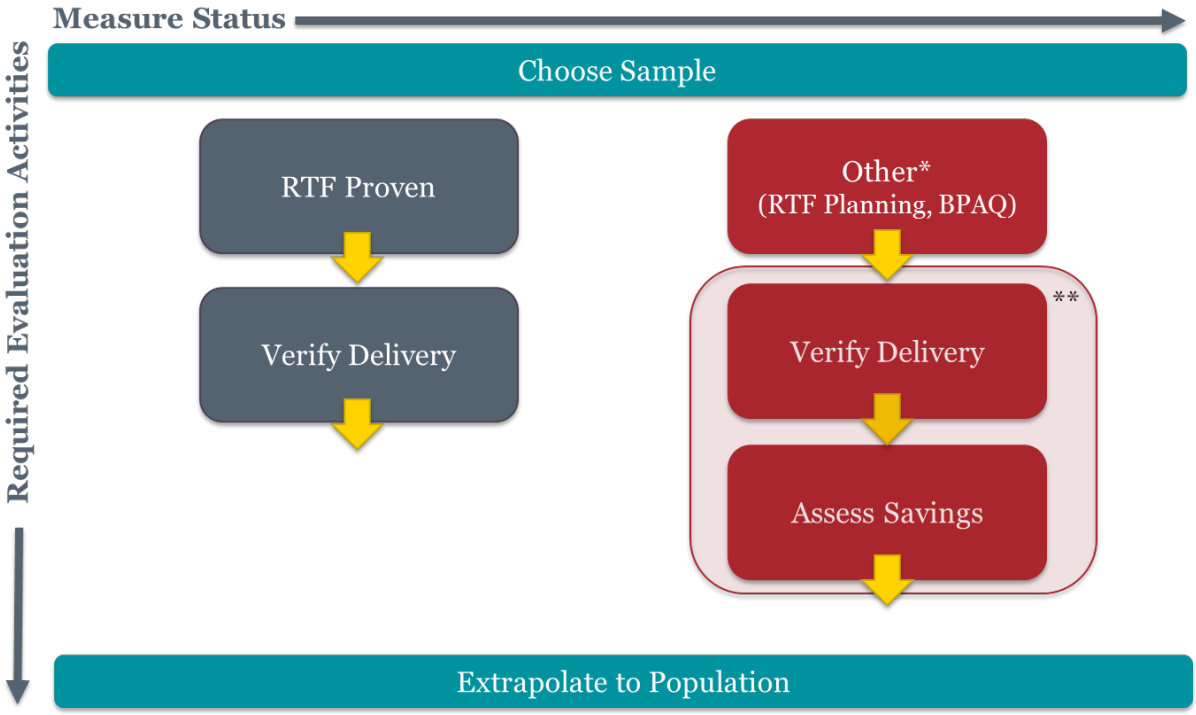
As mentioned in Section 1.2 above, the RTF Guidelines outline three measure categories for impact evaluation of UES measures:

- RTF Proven measures are the measures for which the RTF has determined that savings estimation methods are proven and reliable.
- RTF Provisional are the measures for which the RTF has determined that reliable baseline data is available, but that savings are not yet proven and additional research needs to be conducted.
- Other UES - This includes measures that fall into the RTF-Small Saver and Planning categories, as well as UES measures that have been created by program operators but are not approved by the RTF, such as BPA-qualified measures.

In the RTF Guidelines, a measure's category defines the savings estimation that should be used to evaluate savings as portrayed in Figure 3. For example, the RTF guidelines specify that savings assessment can be completed via delivery verification (DV) for Proven measures using a sample of sites and extrapolated to the population. This is of particular importance, in that DV can be a nimble and cost effective approach, compared to other more rigorous evaluation approaches. For Other UES measures, on the other hand, evaluation must conduct a savings assessment on a sample. Savings assessments generally require higher rigor analyses, such as billing analysis, calibrated simulation modeling, metering or on-site verification to evaluate savings.

[7] *Bonneville Power Administration, Energy Efficiency Implementation Manual, October 1, 2014. http://www.bpa.gov/EE/Policy/IManual/Documents/FINAL_October_2014_Implementation_Manual.pdf*

Figure 3: Required Evaluation Activities based on Measure Status



**RTF Provisional status requires applying approved research*
***These two steps might occur separately or simultaneously, depending on the approach.*
Source: Navigant interpretation of RTF Guidelines

1.4.2. Delivery Verification Requirements

For RTF Proven measures, delivery verification (DV) is used to determine the quantity of units of a measure which are delivered. To be counted, each unit must comply with the defined measure specifications. For all measures except BPA Qualified, these specifications are provided by the RTF and may be updated each time the RTF approves the measure. BPA is responsible for developing and maintaining specifications for BPA Qualified measures.

Each RTF measure specification consists of several elements: Measure Identifiers, Savings Baseline, Implementation & Product (I&P) Standards. The RTF-defined detailed delivery verification requirements for the residential envelope, HVAC and lighting domains within BPA's UES portfolio are provided in Appendix A, B, and C respectively.

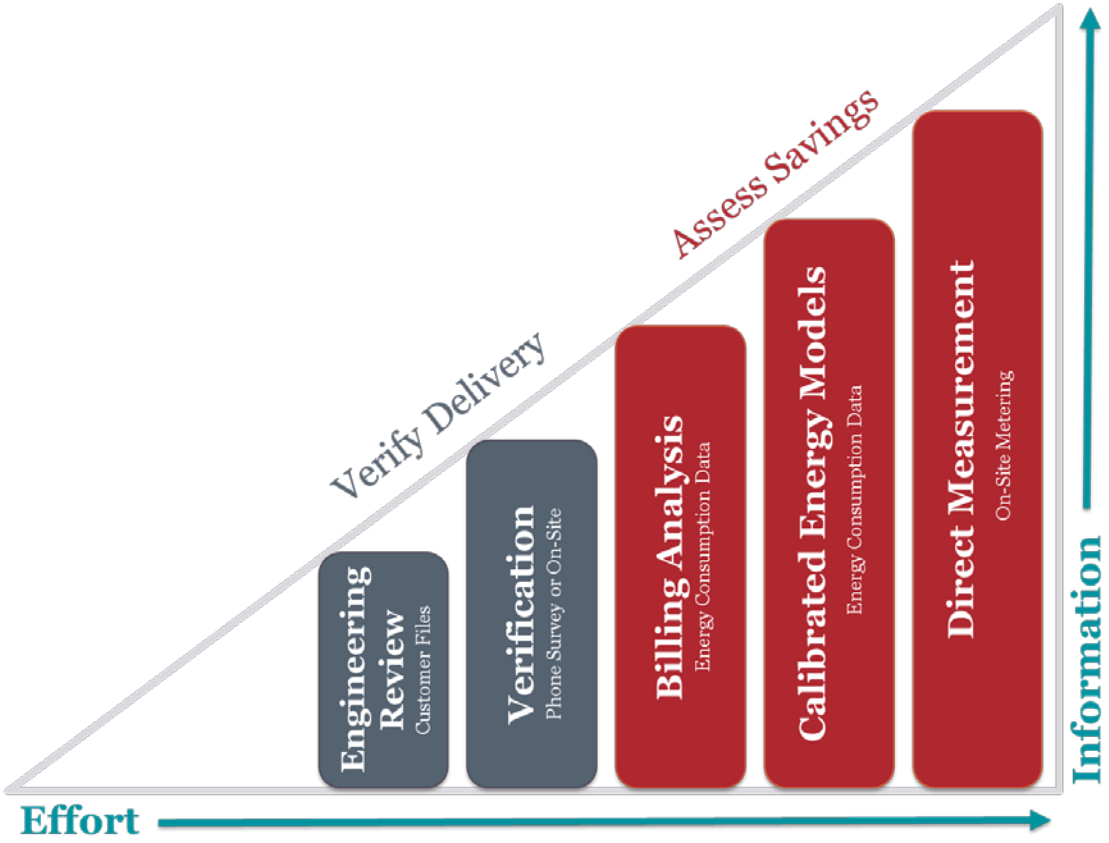
1.5. Overview of Methods

The UES evaluation aims to choose the best method to conduct evaluation while balancing strategic considerations including a measure's status, contribution to savings, uncertainty in claimed savings and programmatic importance. Each different evaluation approach results in a unique combination of effort required and information provided, as illustrated in Figure 4.

Delivery verification can generally be completed via two methods: engineering review of customer files or verification of information through end-user contact such as phone surveys or site visits. As such, delivery verification is lower effort, but it also provides less information about claimed saving values.

Assessing savings can be done by conducting billing analysis using energy consumption data, using calibrated energy models or direct measurement. These methods require more effort, but yield greater insight into variation between claimed and estimated savings.

Figure 4: 2016 Evaluation Data Collection Methods



Source: Navigant

When using a delivery verification approach, evaluated savings will follow one three types:

1. Verified Savings: If the evaluation team does not identify any discrepancies in the provided verification documents and the claimed utility savings, full credit will be attributed to that particular sample participant.

2. Revised Savings: If the evaluation team identifies that the appropriate measures are reported, but there are minor discrepancies (e.g., conflicting model numbers, different measure reported), savings will be revised to the appropriate UES value and then included in the analysis.

3. No Savings: If the evaluation team identifies that any required data is missing in the verification documents (customer files and QA/QC documentation) or a parameter is missing, zero credit will be attributed to that particular project.

When using billing analysis, the evaluation team will calculate two realization rates;

- Claimed Savings. Estimated savings compared to the corresponding BPA deemed savings value
- Best-Available Savings. Estimated savings compared to the corresponding current RTF UES value.

This is valuable because in some cases, the RTF's best known savings estimates are different than what was claimed, due to the natural lags in Implementation Manual updates. Therefore, having two realization rates allows BPA to understand the evaluation results relative to both claimed savings and the best-available values. The team will calculate this pair of realization rates at the measure-group and domain-level.

This comparison is complicated by the nature and sequence of the RTF and BPA respectively updating their UES values. A section comparing the current BPA deemed savings value to the current RTF UES value is provided in each of Appendix A, B, and C.

The evaluation team will also review the potential impact of interactive effects across energy-efficiency measures upon the review of draft results based on the proposed evaluation approaches (see Section 1.5.2 details).

1.5.1. Billing Analysis with Staged Approach

For measures being evaluated via a billing analysis, the evaluation team will first conduct billing analysis and then, if necessary, deploy an outlier-analysis staged evaluation approach. This approach will allow BPA and its stakeholders to minimize burden on sampled customer utilities, while still providing the opportunity to gain insight into why estimated savings may vary from claimed savings.

If the billing analysis results are significantly different than the RTF best-available savings estimates, the evaluation team may request customer files to try to better understand draft results. Specific data that might provide value includes baseline heating system and home square footage. Additionally, phone surveys may be required to collect information from the home-owner that is not included in the customer files, such as secondary heat or changes in occupancy.

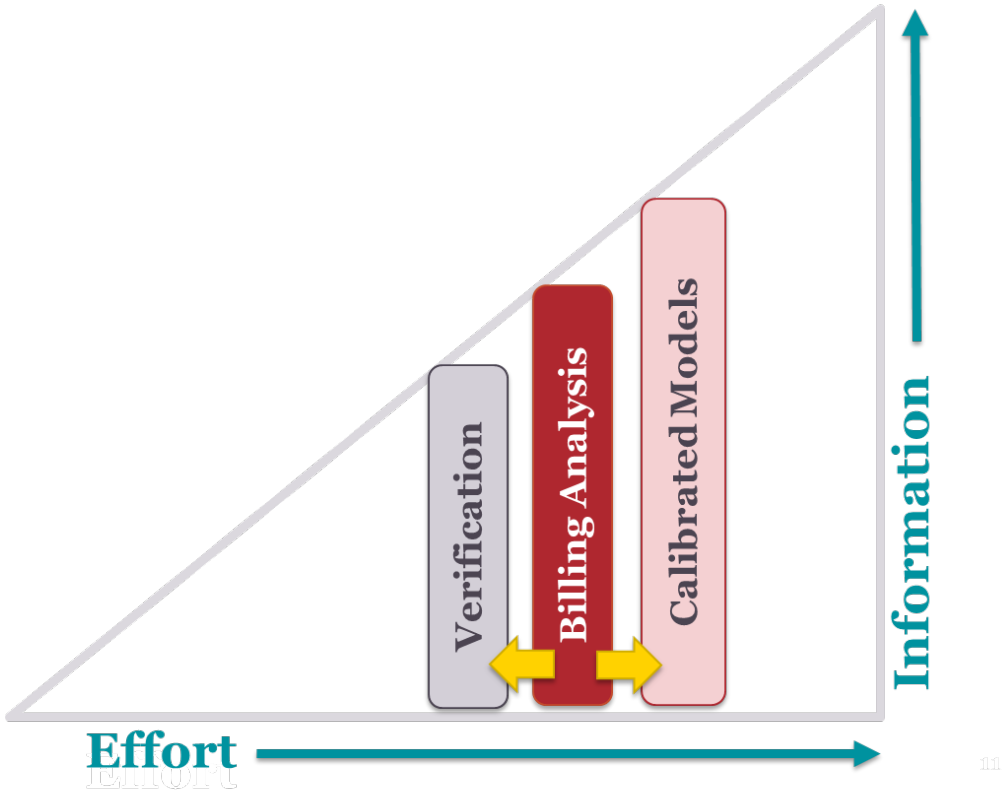
The evaluation team will use participants' energy consumption prior to installing efficiency measures to serve as a comparison group in billing analysis.[8] In order to achieve the best

[8] *One potential bias present in the billing analysis includes bias from self-selection, where participants at some point in time are inherently unique. As a result, comparison sites who did not participate at the time may not serve*

comparison group possible, the analysis team will request energy consumption data for participants in Q3 and Q4 (to the greatest extent possible) of FY2015. Participants with too little energy consumption data after the installation of an efficiency upgrade will be included only as comparison group sites and will not count as evaluated participants.

During the outlier analysis, the team may also work with BPA to determine whether SEEM model calibration could add value to the evaluation. If utilized, the team will use data collected from the programs to calibrate the current RTF SEEM models in order to derive savings estimates using RTF methodology, including how measure interaction is taken into account. SEEM models might also allow the team to estimate measure-level savings.

Figure 5: A Staged Approach to Minimize Customer Burden



Source: Navigant & BPA

as a perfect reflection for the evaluated participants' energy consumption had they not participated in the program. The analysis team attempts to mitigate this bias by using participants from other time periods as the comparison group and using methods to either further refine the selection of comparison sites or to test the validity of sites participating at different times to serve as a comparison group. Two ways to further mitigate this bias for future studies would be to implement a randomized control trial (RCT) or randomized encouragement design (RED).

The evaluation team will work with BPA and its stakeholders to determine both the initiation and timing of the second stage approach[9].

1.5.2. Measure Interaction

When conducting billing analysis, the installation of untracked efficiency measures could cause the evaluation approach to overestimate savings. The evaluation team plans to account for the adoption of untracked efficiency measures by using a comparison group comprised of recent participants, or participants with too little post data to include in the billing analysis.

Similarly, when certain tracked measures are installed together (e.g., HVAC installation with weatherization) the claimed savings should account for any possible measure interaction that affects savings. For tracked measures, Navigant will leverage IS2.0 data to compare realization rates (the verified savings over the UES values) for measures installed in isolation to those installed with other measures for similar cohorts (e.g., single family homes).

2. 2016 UES Evaluation Objectives & Overview

There are two evaluation objectives for the impact evaluation of the UES portfolio in 2016:

- Evaluate the energy savings for consistency with the savings claimed.
- Provide strategic feedback to improve program operation and measures.
    - Where appropriate, assess savings to inform RTF or BPA Qualified estimates.
    - Develop recommendations on data collection, oversight and program procedures, including but not limited to documentation and data handling, to improve reliability and reduce cost for future evaluation years.

For the 2016 UES evaluation, three primary activities will take place: 1) engineering review of select residential lighting measures, 2) billing analysis of select envelope and HVAC measures and 3) evaluation by leveraging PTCS QA/QC processes for select PTCS measures. The approaches for evaluating the impact of BPA's portfolio of UES measures are summarized in Table 1. The evaluation measure groups selected for the 2016 evaluation are described in detail in Section 3 and subsequent respective domain-specific sections.

[9] *As a precursor to those conversations, Navigant analysts will categorize sampled projects based on their error as identified by site level root mean squared error (RMSE). "Outliers" will be defined as the 10% of sites with the greatest error. Navigant may also categorize sites by the magnitude of changes from pre-upgrade energy consumption to post-upgrade energy consumption, where outliers are defined as sites with increases in energy consumption and the 10% of sites with the largest decreases in energy consumption. Additionally, Navigant will graph model predicted energy consumption vs actual energy consumption, separating sites by color for various categorical variables to determine if any clear groupings exist that may warrant further investigation (See Appendix D: Sample Graphs for Outlier Analysis for sample graphs).*

Table 1: 2016 UES Portfolio Evaluation Approach Summary

Domain	Measure Group	Measure Status	Evaluation Approach	Data Sources
LIGHTING	Retail	Proven	Engineering Review	▪ Third Party Data ▪ Customer Files
	By Request	Proven		
ENVELOPE	Insulation	Proven	Billing Analysis	▪ Energy Consumption Data ▪ Customer Files, Phone Surveys*
	Windows	Proven		
HVAC	Prescriptive Duct Sealing	Planning	Billing Analysis	▪ Energy Consumption Data ▪ Customer files, Phone surveys*
	DHP replacing Forced Air Furnaces			
	Performance Duct Sealing	Mix	Engineering Review	▪ QA/QC Data
	HP – All Other	Mix		
	CX, Controls & Sizing	Planning		

** Customer files and/or phone surveys may be used during the 2nd stage (outlier analysis)*
Source: Navigant analysis of BPA IS2.0, summarized from 3/18/2016 IS2.0 data pull
Source: Navigant & BPA

The evaluation team will also analyze the cost-effectiveness of the evaluated savings using ProCost[10]. Specifically, the final analysis and report will include the cost-effectiveness of the UES savings for each evaluated measure, using both the updated 7th Plan inputs as well as the Council's 6th Plan.

3. Sample Design

This section provides a description of the general sampling strategy and the 2016 sample design. Domain-specific details are provided in Sections 5.2, 6.2 and 7.2.

3.1. UES Portfolio Summary

The BPA reporting system uses a standardized taxonomy for classifying measures, Technology/Activity/Practice (TAP). The RTF guidelines, however, provide direction at the program level. They define a program as "a collection of strategies designed to cause delivery of one or more measures to end users in one or more eligible market segments."

In order to apply RTF guidelines to the BPA UES portfolio, BPA has defined a set of 'domains' that are analogous to "programs" as described in the guidelines. Each sector is split into domains. These domains are a combination of sector and end use. From here, the evaluation team defined 'evaluation measure groups' to include a subset of a domain's measures that share

[10] *ProCost is a model developed by the Northwest Power and Conservation Council and is used by the RTF to estimate the cost effectiveness of efficiency measures.*

the same delivery method and/or RTF measure status (e.g. residential retail lighting). Figure 1 provides a summary of the FY2015 UES participation data received as of March, 2016.

3.2. General Sampling Strategy

BPA's QSSI policies have established a target for impact evaluation, striving for domain-level evaluations to attain relative error of 10% at the 90% confidence level, with a minimum acceptable level of 80/20. The evaluation team developed a sampling strategy designed to target a 90/10 domain-level confidence and precision while also attempting to reduce the number of utilities included in the evaluation, in order to minimize the burden on utilities and evaluation cost.

In general, the evaluation of *each* domain will use a two stage sampling design, first sampling utilities, then sampling projects within each utility's participant population. The first stage sample of utilities will be stratified by size, according to a common set of criteria:

- Large contributors, making up greater than 5% of a measure group, will all be sampled (i.e., certainty sample).
- Medium contributors, making up 2 to 5% of a measure group, and small contributors, making up between 0.05 and 2% of a measure group, will be sampled randomly in order to meet confidence and precision objectives.
- Tiny contributors, including the smallest contributors with savings that sum to 5% of the savings or less, will be excluded from the sample.

Two additional steps will be taken at the first-stage sample, in order to ensure representativeness and minimize burden.

1. To the extent possible, any utility not drawn as a large contributor that received FY2014 oversight will be dropped and replaced.[11]
2. After the sample is drawn, representativeness quotas will be checked to ensure that the random sample of utilities faithfully represents the overall population. Currently, the only representativeness quotas being used in the draft design account for participants in[12]:
    a. Heating zones 2 and 3. In the event that an insufficient number of utilities with heating zone 2 and heating zone 3 participants are drawn, the largest heating zone 2 or heating zone 3 participant(s) will be added to the certainty large contributor stratum. The team then may either add utilities or request for voluntary participation by utilities in these under-represented areas.
    b. Medium and small contributors. If a measure group requires 5 or fewer medium and small contributors in total, the two strata will be combined into a medium/small stratum for analysis purposes. Separate quotas for medium and

[11] *FY2014 oversight was conducted on medium-sized utilities. The evaluation team is trying to reduce utility burden where possible, and we do not currently believe this represents a bias to the sample.*
[12] *Additional representativeness quotas at the utility level could be constructed by type of measure installed (e.g. for duct sealing, prescriptive duct sealing or Performance Duct sealing), region, or program implementer (e.g. BPA-run versus utility-run retail lighting measures).*

small contributors will be still be set (e.g., 2 medium and 3 small) for this combined stratum to ensure that representative numbers of each are drawn.

After the utility sample is stratified and drawn, a census of projects will be pulled in cases where billing data is being requested or project-level samples will be randomly drawn in a second stage. The second stage of sampling will be performed differently for the large contributor stratum versus the medium and small contributors, in order to optimize the sample efficiency.[13] For the large contributors, a stratified random sample of projects will be pulled across all of the large contributors combined. For the medium and small contributors, a random sample of 10 project files or a census of billing data will be requested per utility.[14] The project-level samples will be stratified as necessary to effectively capture efficiency and representativeness of the population.

3.2.1 Utility-Specific Oversamples

The draft sample design will most likely not support statistically reliable estimates of savings for utility-specific measure groups. However, additional studies can 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 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.

3.2.2 Sample Selection and Management

Due to aggregate nature of the IS2.0 database, where, depending on the measure, a line item can represent one or many projects, the evaluation team may require additional information to create the final sample. For example, where multiple measures are reported in one line item, the team may request additional household-level data from each of the sampled utilities in order to draw the sample.

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[13] *In general, a two-stage random sample design trades a reduction in the number of clusters drawn (in this case, utilities) for an increase in the number of individual projects drawn, unless the variability in the means of the clusters is higher than the variability in the means of the projects within a cluster. For the 2016 UES evaluation measure groups, we do not expect the differences amongst the clusters (utilities) to be very large, compared to the differences between projects. In order to gain an efficiency from clustering, the realization rates of projects for a given utility would need to be consistently high or consistently low compared to another utility.*

[14] *A cluster (utility) sample size of 10 projects was chosen as a compromise between asking a larger number of utilities for information and asking each utility for more information.*

4. Data Collection

This section describes the general data collection approaches planned for the 2016 impact evaluation of the BPA UES portfolio, as well as considerations for coordination with on-going and future regional efforts. Domain-specific data collection approaches (data sources, collection processes and analysis) are discussed in detail in Sections 5.4, 6.4, and 7.4.

4.1. Data Sources

In order to function cost-effectively and efficiently, the evaluation seeks to leverage any and all data that is already collected from existing BPA and utility staff's data collection efforts. The evaluation team will collect additional data if needed to achieve reliable estimates of savings for the sampled measures. Specifically, the evaluation team will use customer files (the documentation required per the IM), third party data including QA/QC data, billing data and phone surveys to support the 2016 evaluation activities.

4.1.1. Utility Customer Files

Following the contact protocols outlined in Section 9.4, Navigant will work with BPA staff and participating utilities to obtain utility customer documentation and files for each sampled measure, when necessary. This may include data from IS2.0, files uploaded to BPA's EE Docs, data required in the Implementation Manual to be maintained by utilities and any additional information collected by third party implementers or program staff. If files are missing critical information, the evaluation team will work with BPA to determine if the additional information is available through a supplemental request.

4.1.2. Data Collection from Third Party Implementers

In the case of residential lighting projects coming through Simple Steps or residential HVAC projects coming through the PTCS QA/QC registry, Navigant will work directly with the third party implementer (CLEAResult) to obtain data rather than directly contacting utilities in order to reduce the burden on BPA's utility customers. For these cases, Navigant will work with implementers to identify the least intrusive strategy for obtaining data needed by the evaluation team. If necessary data are not available from third parties, the evaluation will request the data from utility customers.

4.1.3. Billing Data

The evaluation team will request billing data to support the evaluation approach for select residential envelope and HVAC measures. Specifically, Navigant will target a census of energy consumption data across the sampled utilities of billing data. The team expects that this large data pull will improve the chances of deriving statistically significant measure-level savings estimates.

In order to reduce the burden on utilities and streamline the billing data request process, the evaluation team will provide a data template at the time of sample notification. To the greatest extent possible, the evaluation team will work with the RBSA analysis team to develop matching data templates to further reduce the burden on utilities. Provided for illustrative

purposes only, Table 22 in Appendix A provides an example of what this data template might look like.

4.1.4. Phone Surveys

Navigant may perform a phone survey of a sample of participants from the billing analysis, as a part of a second stage outlier analysis (described in Section 1.5.1.) Prior to fielding the survey, the evaluation team would develop a survey guide to share with BPA and relevant stakeholders. The team will also follow the pre-defined contact protocols provided in draft in Section 8.4.

4.2. Coordination with BPA Oversight

BPA conducts reviews of UES projects as part of its oversight processes. These reviews verify that customer utilities comply with the IM, each utility's Energy Conservation Agreement and specifications in BPA's reporting system. As such, some of the work involved has similarities to certain aspects of this evaluation, e.g., file reviews for sampled projects. The evaluation team will work with BPA Contracting Officer's Technical Representatives (COTRs) as much as possible to coordinate efforts.

4.3. Coordination with the Region

Many utilities conduct post-inspection activities for envelope and HVAC measures. In future evaluation years, BPA could identify delivery verification requirements in an effort to allow utilities the chance to make additions/alterations to their file review and site visit procedures such that these inspections would capture all required information. These data could be then be documented in the utility files and utilized by BPA. This coordination would benefit BPA utility customers by minimizing the number of contacts with end users required to complete evaluation activities. The evaluation team will explore this opportunity via file reviews and additional stakeholder conversations in 2016.

BPA staff indicate that a potential coordination may also exist with 2016 Residential Building Stock Assessment (RBSA) efforts, specifically regarding billing data requests. Navigant will work with BPA to understand where this could overlap (for example, for use as a control group or to pair requests to limit the frequency at which utilities pull data,) and work to coordinate effectively.

Finally, BPA is considering conducting phone surveys with select residential HVAC & envelope program participants to research hard to quantify non-energy benefits (NEBs) to include in the total resource cost test. If the regional methodology is agreed upon, the sample of envelope measures and the timing of the second stage-outlier analysis may be leveraged. BPA stakeholders will have the opportunity to review the methodology, sampling and contact protocols prior to any survey work.

5. Residential Envelope Domain

5.1. Overview

The residential envelope domain constitutes roughly 17 percent of the total FY2015[15] UES residential portfolio, with 2.9 aMW. The entire domain can be divided into three Technology/Activity/Practices (TAPs): Windows, Insulation and Air Sealing, accounting for 69%, 30% and 1% of domain savings respectively. The vast majority of these savings are in the "RTF Proven" category, as shown in Table 2.

Table 2: FY2015 Residential Envelope Domain Measure Status Summary

Domain	Measure Status	Savings (aMW)	Fraction of Domain	Fraction of UES Residential Portfolio
Residential Envelope	RTF Proven	2.94	100%	17%
	BPA Qualified	0.01	0%	0%

Source: Navigant analysis of BPA IS2.0, summarized from 3/18/2016 IS2.0 data pull

In order to better understand the domain and guide discussions with program staff, Navigant sorted its measures into the following measure groups: TAP, residence type, and low income. Figure 8, Figure 9, and Figure 10 in Appendix A provide the details of those breakdowns.

5.2. Sample Design

5.2.1. Evaluation Measure Groups, Sampling Unit & Target Precision

The evaluation team selected the following evaluation measure groups for 2016:

- Insulation
- Windows

The team decided to not include air sealing projects in the 2016 evaluation, as they contribute negligible savings to the domain and are difficult to evaluate effectively.

Within the residential envelope domain, the fundamental sampling unit is the participant premise. The overall confidence and precision target for the domain is 90/10. In addition, the windows and insulation measure groups are each being targeted for 90/15 confidence and precision.

Program and evaluation staff agree that results at the measure (e.g. attic versus wall) or residence type (e.g., single family) would be preferable and therefore a large sample size is being requested for this domain. Yet, due to the potential for deriving results with low precision (caused by small sample sizes and/or small, savings relative to total household energy consumption), it is not expected that very granular results will be achieved.

[15] *FY 2015 is from October 1st 2014 to September 30th 2015.*

5.2.2. Required Sample

Reviewing FY2015 data, the evaluation team found a population of roughly 4000 insulation and 5400 windows projects. Based on this population size, the expected variability in billing data (captured in an assumed CV of 0.8) and draft results from BPA's on-going pilot billing analysis, the evaluation team estimated the number of projects required to represent each measure group. The evaluation team calculated a target number of 1700 projects for the insulation measure group and 2500 for the windows measure group.[16] The details of this sample design are provided in Table 10 in Appendix A.

5.3. Analysis Methodology

While delivery verification is an option for the impact evaluation of these Proven measures per the RTF Guidelines, the team did not believe it would be the best approach, as pre- and post-installation conditions can often be hard or impossible to verify (even with site visits) for window and insulation measures. Additionally, the team does not believe on-site visits would provide sufficient value to the program to be worth the level of effort and burden on end-users involved in visiting homes.

Instead, the evaluation team will use a regression analysis of participant energy consumption data, referred to as a billing analysis, with the option of a staged-outlier approach (SEEM model calibration and/or phone surveys, see Section 1.5.1) to evaluate the residential envelope measure groups. Specifically, the team plans to use a fixed-effects conditional savings regression model with paired pre- and post-participation months to estimate domain-level savings.

These models will likely include approximately a year of pre- and post-installation data for each participant site and will focus on FY2014 and FY2015 participants to maximize the sample size. If any utilities are willing to volunteer, the team will use a comparison group of non-participants to account for any non-program related changes in energy consumption (e.g., macroeconomic factors) across the pre- and post-periods.

If the billing analysis results are significantly different than the RTF best-available savings estimates, the evaluation will undertake the second phase - outlier analysis described in Section 1.5.1. The team will collect project files to explain evaluation results, improve the regression models, and help develop any recommendations to the greatest extent possible.

This high-level approach for the evaluation of the residential envelope domain in 2016 is summarized in Table 3.

[16] *In an attempt to acquire usable data for this many sites, the evaluation team has to request billing data for roughly twice as many projects.*

Table 3. Residential Envelope Domain 2016 Evaluation Approach Summary

Fiscal Year	Measure Group	Measure Status	Proposed Evaluation Approach	Optional Additional Evaluation Methods	Data Sources
2014 through Q2 2015	Insulation	Proven	Billing analysis*	▪ SEEM model calibration ▪ Phone surveys	▪ UES Reporting System data ▪ Energy consumption data ▪ Customer files**
2014 through Q2 2015	Windows	Proven			

** Navigant will not include multifamily (MF) homes in the billing analysis approach in 2016 UES Portfolio Evaluation due to the metering issues associated with MF housing and required for the billing analysis.*
*** Initially, the evaluation will accept customer files if it is easy for sampled utilities to provide. During the second stage outlier analysis, a sub-sample may receive a request for customer files.*
Source: Navigant Analysis

5.4. Data Collection

For both evaluation measure groups (insulation and windows), the evaluation team will request a census of participant billing data for each sampled utility. The evaluation team realizes that some utilities may have difficulty pulling the requested number of billing records, i.e. for small utilities with large participation. In these cases, the evaluators will work closely with BPA staff to either assist with billing data extraction, set a lower target than the census, or select a replacement utility as necessary. For large contributors, the team needs to be especially diligent in getting as large a number of participants as possible. Additionally, BPA will request volunteers for utilities outside of the sample in an attempt to increase sample sizes.

The evaluation team may also request a small sample of utility customer files to support the evaluation approach of the residential envelope domain. Although it would be ideal to receive customer files for all projects in the sample, the evaluation team realizes that this could represent a significant burden to utilities. Instead, at the initial sample stage, the evaluation team will accept customer project files from utilities who voluntarily agree to provide this data (e.g. those that have an easy system for pulling this information). If the outlier analysis is undertaken, however, the evaluation team may request a sub-sample of customer files for select outlier projects. The evaluation team will request project files at that time. Additionally, the evaluation team will work individually with utilities to support the easy provision of customer files.

Finally, the evaluation team may conduct phone surveys as a part of second stage outlier analysis. If a phone survey was selected as a second stage approach, the team will use the contact protocols described in detail in Section 8.4.

6. Residential HVAC Domain

6.1. Overview

This domain constitutes roughly 22 percent of the total FY2015[17] UES residential portfolio, with 3.7 aMW and spans eight TAPs. The following is an abbreviated list of the various residential HVAC measures offered by BPA:

- Performance Tested Comfort Systems (PTCS) Measures:
  - Air Source Heat Pumps (ASHP) with Duct Sealing,
  - ASHP without Duct Sealing[18],
  - Commissioning, Controls and Sizing,
  - Performance Duct Sealing,
  - Ground Source Heat Pumps (GSHP) without Duct Sealing, and;
  - Variable Speed Heat Pumps (VSHP) without Duct Sealing.
- Non-PTCS Measures:
  - Prescriptive Duct Sealing,
  - Ductless Heat Pumps, and;
  - Thermostats.

In order to better understand the domain and guide discussions with program staff, Navigant sorted its measures into the following measure groups: TAP, baseline, and measure status. Figure 11, Figure 12, and Table 23 in Appendix B provide the details of those breakdowns.

6.2. Sample Design

6.2.1. Evaluation Measure Groups, Sampling Unit & Target Precision

The evaluation team selected the following evaluation measure groups for 2016:

- Duct sealing (prescriptive and performance)
- DHP replacing forced air furnaces
- Heat Pumps – (ASHP, GSHP and VSHP)
- CC&S

[17] *FY 2015 is from October 1st 2014 to September 30th 2015.*
[18] *Note: Effective April 1st 2015, PTCS heat pump measures with "ducts required" will no longer be available. Thus, Heat Pumps with Duct Sealing measures will not be available starting April 1st 2015. Duct sealing measures will be offered as stand-alone measures.*

Ultimately, BPA staff indicated an interest in these select measure groups (at the TAP and sub-TAP level) depending on a few considerations including uncertainty in current UES values and current and future contribution to savings. The team decided to not include thermostat projects in the 2016 evaluation, as they contribute negligible savings to the domain. To minimize complexity for 2016, the team also decided to hold off on evaluating all other ductless heat pump measures and to look for strategic opportunities to evaluate this measure group in a future year.

For this domain, the evaluation team will use a different sampling approach depending on the evaluation measure group. In general, the fundamental sampling unit is the participant premise. The overall confidence and precision target for the domain is 90/10. In addition, the prescriptive duct sealing and ductless heat pump replacing forced air furnace measure groups are each being targeted for 90/15 confidence and precision.

Prescriptive Duct Sealing & Ductless Heat Pumps replacing Forced Air Furnaces: Navigant will attempt to pull a census of billing data and project files for participants in these two measure groups across the sampled utilities. If Navigant successfully obtains data for less than a majority of these participants (e.g. 75 percent[19]), Navigant will investigate the sampling error and work with BPA to determine a path forward.

Performance Duct Sealing, Heat Pumps & CCS: The team will specify and use an interval sampling approach (e.g. every project which has a project number ending in 1 as the projects come into the BPA site registry) to evaluate a random sample of projects that receive FY2016 QA/QC inspections as projects come in. The evaluation team plans to work with the PTCS team to design the sample and inform the collection of the sites that would receive the QA/QC based on the sample design. Sample replacements may be needed if it becomes impossible to complete the required data collection for a project in the primary sample.

6.2.2. Required Sample

Reviewing FY2015 data, the evaluation team identified measure group populations between 200 and roughly 5400 projects.[20] Based on population size and the expected variability (captured in the following assumed CVs), the evaluation team estimated the number of projects required to represent each measure group as listed below:

- Prescriptive Duct Sealing: 500, CV = 0.8
- Ductless Heat Pumps replacing Forced Air Furnaces: 800, CV = 0.8
- Performance Duct Sealing: 60, CV = 0.7
- Heat Pumps – All Other: 60, CV = 0.7
- Commissioning, Controls & Sizing: 51, CV = 0.3

The details of this sample design are provided in Table 25 in Appendix B.

[19] *The evaluation team will work with BPA to set this threshold.*
[20] *In an attempt to acquire usable data for this many sites, the evaluation team has to request billing data for roughly twice as many projects.*

6.3. Analysis Methodology

While the majority of residential HVAC savings are Proven, an approach beyond delivery verification is required where BPA staff indicated a strategic interest in non-Proven measures. Additionally, the team identified where they believe high uncertainty exists in current deemed savings values and identified non-DV evaluation approaches for these measure groups.

The evaluation team will use the following approaches to evaluate savings for this Residential HVAC Domain.

Prescriptive Duct Sealing and Ductless Heat Pumps replacing Forced Air Furnaces. Delivery verification, by itself, is not an option for the impact evaluation of all projects across these two measure groups, as a portion of these measures are Planning.

The evaluation team plans to use a regression analysis of participant energy consumption data, referred to as a billing analysis. Specifically, the team plans to use a fixed-effects conditional savings regression model with paired pre- and post-participation months to estimate domain-level savings. These models will likely include approximately a year of pre- and post-installation data for each participant site and will focus on FY2014 and FY2015 participants to maximize the sample size, unless significant program changes have occurred over that time period. The team may also use a control group to account for any non-program related changes in energy consumption (e.g., macroeconomic factors) across the pre- and post-periods.

If the billing analysis results are significantly different than the RTF best-available savings estimates, the evaluation team will undertake the second phase - outlier analysis described in Section 1.5.1.

Performance Duct Sealing, Heat Pumps and Commissioning, Controls & Sizing. Not all measures included in this evaluation group are Proven, and therefore, they cannot be evaluated using delivery verification alone. However, the existing measures that are in the Planning category are there due to a lack of baseline research for commissioning, controls and sizing, which BPA is undertaking separately. In an attempt to minimize burden on customer utilities and leverage research being conducted, the evaluation team plans to use delivery verification to preliminarily evaluate the savings from these measure groups.

The team has reviewed the most currently available QA/QC documents and determined that with minor changes the existing documents can collect most, if not all, of the delivery verification requirements. The team is now working with the QA/QC team to update the existing QA/QC documents so that they will satisfy the delivery verification requirements for these evaluation measure groups.

The evaluation team defines BPA measures that are routinely installed in conjunction with other RTF measures as “aggregate” measure. Four of the seven residential HVAC TAPs are, in fact, aggregate RTF measures (please see Table 23 in Appendix B for details). The evaluation team discussed this measure aggregation with BPA staff and learned that all such measures are required to complete all relevant installation documentation as well as be audited by all relevant QA/QC checklists. For example, air-source heat pumps (ASHP) with CCS projects

require both ASHP and CC&S project installation and QA/QC forms[21]. A detailed table outlining the delivery verification requirements for each measure included in the 2016 evaluation measure groups and how they map to QA/QC documentation and installation forms is provided in Table 29 in Appendix B.

This high-level approach for the evaluation of the Residential HVAC Domain in 2016 is summarized in Table 4.

Table 4. Residential HVAC Domain 2016 Evaluation Approach Summary

Fiscal Year	Measure Group	Measure Status	Proposed Evaluation Approach	Data Sources
2014 through Q2 2015	Prescriptive Duct Sealing	Mix	Billing analysis*	▪ UES Reporting System data ▪ Energy consumption data ▪ QA/QC Data ▪ Customer files** ▪ Phone Surveys**
2014 through Q2 2015	Ductless Heat Pumps replacing Forced Air Furnaces	Mix	Billing analysis*	▪ UES Reporting System data ▪ Energy consumption data ▪ Customer files** ▪ Phone surveys**
2016	Performance Duct Sealing	Mix	Delivery verification using QA/QC documentation	▪ UES Reporting System data ▪ QA/QC Data
2016	Heat Pumps – All Other	Mix		
2016	Commissioning, Controls & Sizing	Planning		

** Navigant will not include multifamily (MF) homes in the billing analysis approach in 2016 UES Portfolio Evaluation due to the metering issues associated with MF housing and required for the billing analysis.*
***Initially, the evaluation team will accept customer files if it is easy for sampled utilities to provide. During the second stage outlier analysis, a sub-sample may receive a request for customer files.*

6.4. Data Collection

Depending on the measure group, the evaluation team will request billing data, customer files and/or QA/QC documentation to support the evaluation approach.

Prescriptive Duct Sealing & Ductless Heat Pumps replacing Forced Air Furnaces: Navigant will attempt to pull a census of billing data across the sampled utilities for projects in these two measures groups. The team hopes that this large data pull will improve the precision on the savings estimates of these high priority measure groups.

The evaluation team may also request a small sample of utility customer files to support the evaluation approach of the residential HVAC domain. Although it would be ideal to receive customer files for all projects in the sample, the evaluation team realizes that this could represent a significant burden to utilities. Instead, at the initial sample stage, the evaluation

[21] January 6th, 2016 call with PTCS QA/QC team, call notes.

team will accept customer project files from utilities who voluntarily agree to provide this data (e.g. those that have an easy system for pulling this information). If the outlier analysis is undertaken, however, the evaluation team may request a sub-sample of customer files for select outlier projects. The evaluation team will request project files at that time. Additionally, the evaluation team will work individually with utilities to support the easy provision of customer files.

Performance Duct Sealing, Heat Pumps and Commissioning, Controls & Sizing: Navigant will pull a sample of PTCS QA/QC and site registry data for projects across the sampled utilities.

7. Residential Lighting Domain

7.1. Overview

The residential lighting domain is the largest domain in the residential sector, and it constitutes 49 percent of the total FY2015 UES residential portfolio, with 8.4 aMW. The entire domain can be divided into two TAP: Lamps and Fixtures, representing 95 and 5 percent of the domain's FY2015 savings respectively.

7.2. Sampling

7.2.1. Evaluation Measure Groups, Sampling Unit & Target Precision

BPA staff indicated that while they believe UES values to have low uncertainty for residential lighting measures, the sheer volume of projects suggest they should be included as evaluation measure groups in 2016. In order to better understand the domain and potential evaluation measure groups, Navigant sorted its measures into the following groups: delivery mechanism, lamp type, program and measure status. The distribution and importance of delivery mechanism across the domain is described below. Figure 15, Figure 16, and Figure 17 in Appendix C provide additional details.

The IM[22] defines delivery mechanisms for the measures within the residential lighting domain. Measures reported in FY2015 fall into four categories:[23]

- Retail
- By Request (includes Mail by Request, Over the Counter and Other Distribution Methods)
- Mailed Non-Request (bulbs only)
- Direct Install

Over 80 percent of the domain savings come from measures using the Retail delivery mechanism (see Figure 15 in Appendix C for details). This is of significance because RTF

[22] *http://www.bpa.gov/EE/Policy/IManual/Pages/default.aspx*
[23] *The delivery mechanism for the Fixtures TAP could not be identified as there no delivery verification information such as lamp information or delivery mechanism, available for this TAP.*

delivery verification requirements vary by delivery mechanism. In order to understand the potential for delivery verification, the evaluation team also summarized the FY2015 savings by measures status for the residential lighting domain, as shown in Table 5.

Table 5. FY2015 Residential Lighting Domain Measure Summary

Domain	Measure Status	Savings (aMW)	Fraction of Domain	Fraction of UES Residential Portfolio
Residential Lighting	RTF Proven	8	95%	47%
	BPA Qualified	0.35	5%	2%

Source: Navigant analysis based on 3/18/2016 BPA IS2.0 data pull

Finally, BPA staff showed an interest in gaining insight into the Fixtures TAP. Currently, FY2015 IS2.0 data[24] suggests that this TAP contributes to domain savings, (0.32 aMW,) but no information (such as bulb type or delivery mechanism) is tracked. Given this information gap, the evaluation team plans to conduct a high-level review of fixture projects. The team will also review select Direct Install measures to prepare for future evaluation years.

Ultimately, the evaluation team selected the following evaluation measure groups for 2016:

- Retail
- By-Request
- Fixtures
- Direct Install

For the Retail lighting measure group, the sampling unit is the line item, which for Simple Steps measures, for example, represents a store's total monthly sales for a specific product (SKU). Upon pulling the sample, the evaluation team will provide utilities or the third party implementer with all the information about the sample point that is present in the IS 2.0 data[25] in order make identifying the relevant invoice possible. For the By-Request lighting measure group, the sampling unit is the participating household.

The overall confidence and precision target for the residential lighting domain is 90/10. In addition, the Retail lighting measure group has a target confidence and precision of 90/10 and the By-Request lighting measure group has a target confidence and precision of 90/15.

7.2.2. Required Sample

Reviewing preliminary FY2015 data, the evaluation team identified measure group populations between 300 and roughly 3000 projects. Based on population size and the expected variability across installations (captured in an assumed CV of 0.4), the evaluation team estimated the number of projects required to represent each measure group as listed below:

- Retail - 75

[24] *This is based on the 3/18/2016 data pull of BPA IS2.0*
[25] *Ibid*

- By Request – 65
- Direct Install – 20 (no statistical significance)
- Fixtures - 20 (no statistical significance)

This design will need to be revised once reporting system data for FY2015 is finalized. The details of this sample design are provided in Table 44 in Appendix C.

7.3. Analysis Methodology

For all sampled projects, the evaluation team will attempt to verify the delivery verification requirements outlined in Table 6.

Table 6. Delivery Verification Checklist for Residential Lighting

Delivery Verification Checklist	Documentation Requirements listed in the IM
Delivery mechanism	Invoice
Lamp type	Lamp Type/Size
Appropriate efficient technology, lumen category	Make
	Model
	Unit
Quantity	Quantity
Evaluation range	Order Date
Included on Energy Star qualified list	Proof of being Energy Star qualified

Source: Navigant Analysis

In addition to this verification checklist, Navigant will verify the RSAT[26] Allocation for the Simple Steps lighting program. Navigant will attempt to verify this and all Delivery Verification requirements through the utility customer file review. Specifically, the team will use invoices as the primary data source to verify the items on the verification checklist.

The UES values used for By-Request lamps include removal and storage rate assumptions, making customer verification of delivery unnecessary. That said, the evaluation team would be remiss in not pointing out that current assumptions may not accurately reflect installation practices. Specifically, giveaway lamps typically have much lower in-service rates than upstream lamps have, but the RTF values are the same for CFLs[27]. This could be an area to consider reviewing in future evaluation years.

For the Fixture and Direct Install measures groups, Navigant will review utility customer files to inform future year's evaluation approaches.

The evaluation approach for the measure groups selected for evaluation in 2016 is delivery verification, as summarized in Table 7.

[26] *RSAT is a platform used to allocate a proportion of sales of energy savings measures in each participating retail store to participating utilities.*
[27] *For example, in Maine, a 2012 evaluation found in-service rates of 73% for upstream and 46% for giveaway.*

Table 7. Residential Lighting Domain Evaluation Approach Summary

FY	Measure Group	Measure Status	Proposed Evaluation Approach	Data Sources
2015	Retail	Proven	Delivery verification using customer files	▪ UES Reporting System data ▪ Third Party Data ▪ Customer files
2015	By Request	Proven		

Source: Navigant Analysis

Table 46 in Appendix C provides the detailed mapping of each DV requirement to a data source.

7.4. Data Collection

Depending on the measure group, the evaluation team will request customer files or third party data, including invoices[28]. For the Simple Steps lighting sample, the evaluation team will request the CLEAResult invoice number from the utilities by providing the U*tility Assigned Site ID, Reference Number* and *Completion Data* from the IS2.0 database. The evaluation team will then work directly with CLEAResult to acquire the relevant invoices. The team will also request the RSAT allocation information that will allow the team to verify that the sampled line items reflect the correct proportion of invoices.

For Non-Simple Steps measures, Navigant will request invoices s directly from utilities by providing similar details of the sample from IS2.0. The evaluation team will use these invoices to verify the delivery verification checklist.

8. Project Management

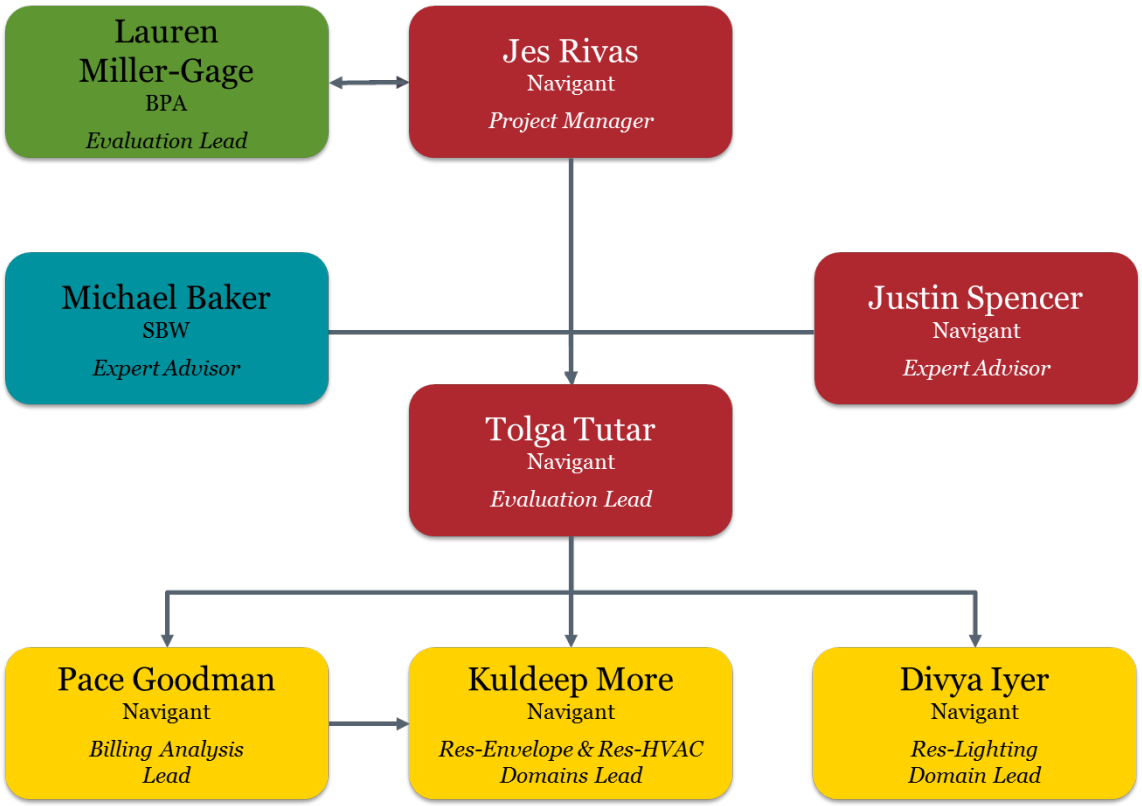
This section provides the general staffing, schedule and reporting plan for managing the CY2016 evaluation activities.

8.1. Staffing

Navigant will be the prime contractor responsible for the evaluation and will be reporting to Lauren Gage, the COTR and project manager for BPA. The organization of the evaluation team is designed to maximize project management and consistency, while maintaining a high level of quality control. Jes Rivas is the project manager and Tolga Tutar is the evaluation lead for this effort. Justin Spencer from Navigant and Michael Baker from SBW Consulting, Inc. will be the expert advisors for the evaluation team and BPA. Both will be responsible for advising the evaluation team on the quality and content of the work products that fully satisfy BPA's requirements. Pace Goodman, Kuldeep More and Divya Iyer are the key experts and leads of this evaluation effort, as shown in Figure 6.

[28] *Utilities submit their invoices to the IS2.0 database. The COTR reviews these invoices and once the invoice is approved, a BPAInvoiceID is generated in IS2.0 and an automated email is sent to the utilities from the database.*

Figure 6: Organization of Evaluation Team

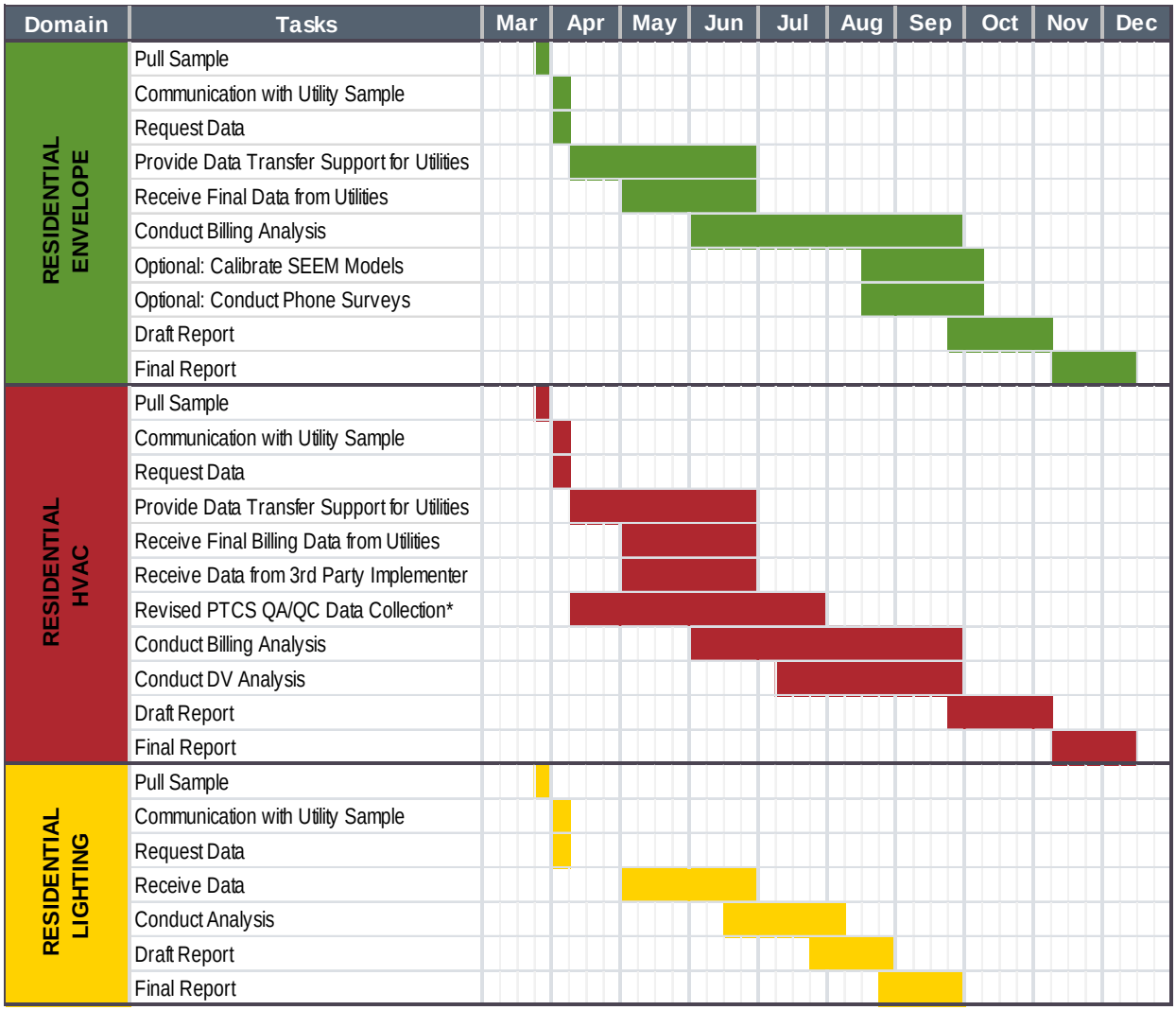


Source: Navigant

8.2. Schedule

The Navigant team expects to complete main CY2016 evaluation tasks as outlined in Table 9.

Table 8. CY2016 Draft Evaluation Schedule



Source: Navigant

8.3. Communication

Together with BPA, the Navigant team has established a consistent communication procedure to ensure the delivery of a quality evaluation that clearly conveys program performance. Key aspects of the communication approach are described below.

8.3.1. Touch Points

Navigant will provide the following throughout the course of the evaluation:

- Weekly written status updates and check-in meetings with BPA evaluation manager. Meetings will review action items, progress, data requests, schedules, and budgets.

- Monthly reports highlighting progress and key aspects of each evaluation task.
- Workshops with BPA staff and program managers, as needed, to identify key issues and concerns for evaluation and to facilitate communications between evaluation and program personnel.
- SharePoint site accessibility for BPA staff and utility representatives to securely post program data and share key program information, project progress, and deliverables.

8.3.2. Reporting

Navigant will prepare report documents, including presentations, which clearly describe the methodology, findings and recommendations of this evaluation. All content will be reviewed by BPA project manager and internal evaluation team.

Upon the conclusion of evaluation activities, Navigant will prepare a final report that documents the methodology, findings and recommendations of this evaluation. The report will document the UES portfolio evaluation findings but will not present any personally identifiable information (PII) that could be used to identify the end users that participate in the evaluation. The report will also not include utility-specific results, although those can be requested is so desired.[29] The final report will provide the results of the cost-effectiveness analysis of the UES savings for each measures within each evaluation domain. We expect that report will have the following structure:

1. Executive Summary
    a. Study Overview
    b. Findings
    c. Conclusions & Recommendations
2. Introduction
3. Objectives
4. Methodology
    a. Data Collection
    b. Sample Design
5. Findings
    a. Evaluation Results
    b. Cost-Effectiveness Results
6. Conclusion & Recommendations
7. Technical Appendices and Data Products

[29] *If requested, BPA can provide utility-specific results: project results for delivery verification and average savings and uncertainty for billing analysis models*

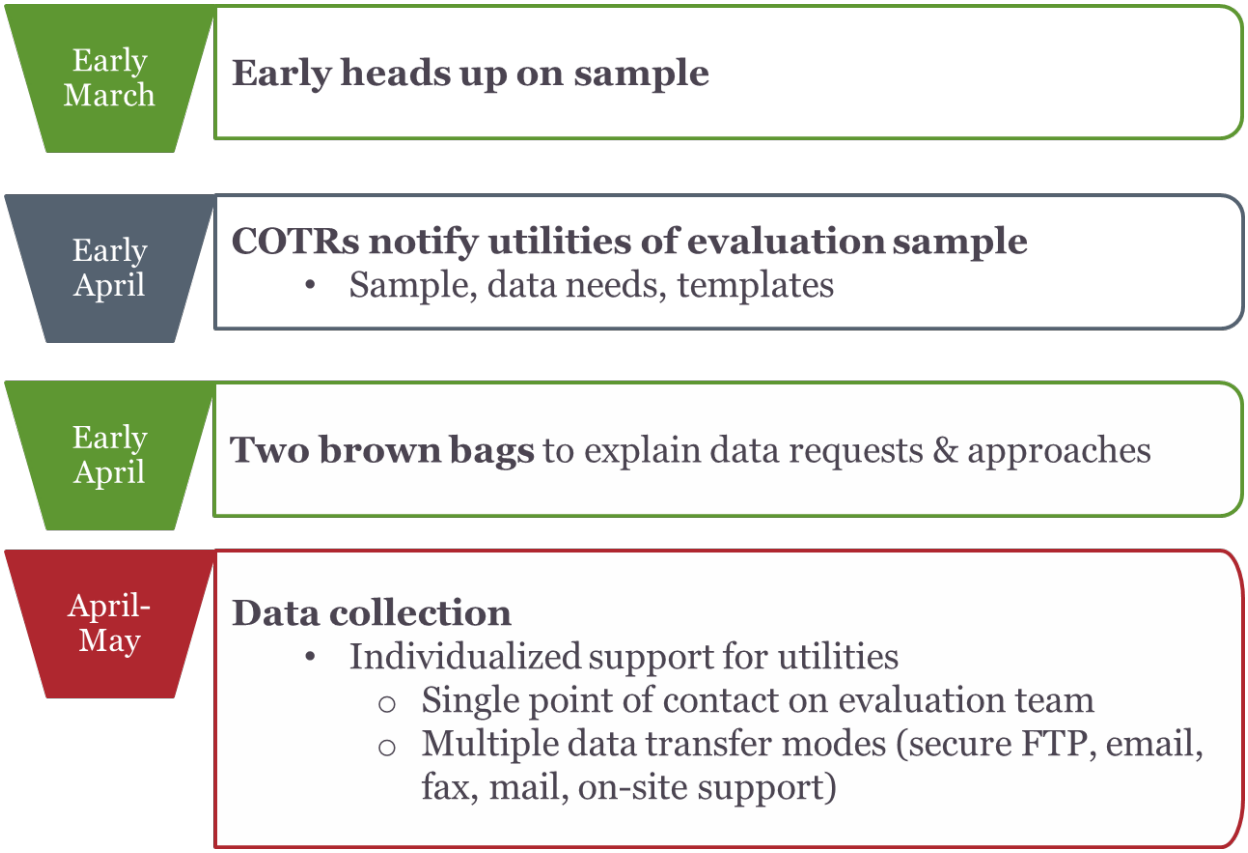
8.4. Utility customer and End User Contact Protocol

This section details the communication and step by step roll-out plan BPA intends to follow between sharing this draft evaluation plan and beginning evaluation work later this year. It also includes the protocol for all utility customer and end-user contact.

8.4.1. Communication / Roll-Out Plan

The evaluation team plans to follow the communication plan outlined in Figure 7.

Figure 7 : 2016 Draft Communication Plan



Source: Revisions to December 18th, 2015 BPA and Navigant planning session

8.4.2. Utility customer Contact Protocols

The Navigant team will adhere to the following end user and utility contact protocol for each evaluation cycle that includes approaches which require the team to contact end users and utility representatives:

1. **Utility Notification of Sample and Utility Project Brownbags**
    a. Evaluation Strategy and Evaluation Plan Review. Prior to the finalization of the 2016 evaluation plan and sample, utilities will be invited to a brownbag to learn about the proposed evaluation strategy. All utilities will be invited to review the

draft plan. Utilities will receive two weeks to review the detailed evaluation plan and provide feedback.

b. Sample Notification. Once the evaluation plan and sample are final, BPA will notify utilities via email that at least one project in their territory has been selected in the evaluation sample. Initial email will provide basic information about sampled sites (such as address, completion date, number of units, invoice number) as an attachment and will request the primary utility contact for the evaluation. BPA will provide detailed information on what information is needed, and any data templates to be filled out.

c. Utilities will provide their primary utility contact for the evaluation.

d. BPA will organize at least one kickoff meeting to provide detailed information about the evaluation, its general process, and the contact protocols. BPA will schedule time with utilities individually, if requested.

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[30]. BPA's contract with the Contractor protects data under the language of BPA's existing contract with the evaluation firm.

2. Customer File Requests

a. Customer files refer to the location and collection of the documentation required in the Implementation Manual. When necessary, the evaluation team will request customer files from BPA. BPA will provide these to the evaluation team through secure FTP.

b. If BPA cannot provide 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. While the focus will be on the required documentation, utilities may provide whatever additional data they collect to the evaluation team.

c. The evaluation team will provide a timeline for file delivery, which will provide a minimum of 30 days. The utility (or BPA if requested by the utility) will upload required files to a secure website. The evaluation team will work with utilities individually to support their data request as much as feasible, including providing support staff to collect (scan and upload) paper files, etc. An extended delivery date may be requested and will be accommodated, if possible.

3. Billing Data Requests

a. Billing data refers to energy consumption data by customer and premise for relevant participants. Depending on the measure being evaluated, the template may also include additional data fields to fill out on an "if available" basis, such as existing primary heating system.

b. This data will be collected using a data template excel workbook. This workbook will include instructions, an example, the data template to fill out, and contact

[30] *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.*

information for any questions that arise. For example Navigant will ask utilities how they define completion data in data request stage.

c. The evaluation team will provide a timeline for file delivery, which will provide a minimum of 30 days. The utility (or BPA if requested by the utility) will upload required files to the secure website The evaluation team will work with utilities individually to support their data request as much as feasible, including providing support staff to collect (scan and upload) paper files, etc. An extended delivery date may be requested and will be accommodated, if possible.

d. Following an initial analysis of the billing data, the evaluation team may request additional data for a select number of sites where the evaluation team finds unexpected results. The evaluation team will work with utilities to facilitate the data transfer with the least burden on the utilities. The evaluation team will be prepared to collect this data through a data template filled out by the utility, enabling the utility to transfer information as it exists using secure FTP, sending evaluation staff to the utility site or other method as preferred by the utility.

4. Phone Surveys of End-Users

a. If phone surveys are utilized in 2016, utilities will be notified at least 2 weeks prior to any end-user contact. They will be provided the survey instrument and materials to support any contact they'd like to make with end-users, including:

i. **Advance letters:** Sending letters to primary site contacts prior to a recruitment call has been found to increase the success of end-user recruitment. The letter notifies the end-user that the site has been selected for evaluation and that the evaluation team will be calling to conduct a phone survey. It provides a brief idea of what impact evaluation means and why the site is being evaluated. The letter will also detail incentives and site activities to be performed by the impact evaluation team, where relevant. Please see Appendix E.

ii. Evaluation team will support utility account representatives and provide a set of potential frequently asked questions to minimize any potential concerns by the end users. Please see Appendix F for sample set of potential frequently asked questions that would be provided to utility account representatives.

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

b. If phone surveys are utilized in 2016, recruiters in the evaluation team will call approved end users to identify their availability and interest in participating in the study. The program evaluation will strive for high rates of end-user participation to ensure unbiased results. The recruitment methods will include the following techniques:

i. Recruitment phone calls: End-users are contacted by telephone, recruited if possible, and asked to schedule a short phone survey at a convenient time, including evenings and weekends as necessary. Recruitment calls will typically be made by a professional recruiter and scheduler soon after

a surveyed individual has indicated a willingness to participate in the phone survey. Navigant will provide key contact information and talking points to the recruiters to avoid any issues. Please see Appendix E for sample talking points that would be provided to recruiters.

9. Glossary

Coefficient of Variation (CV)

A normalized measure of dispersion of a probability distribution and defined as the ratio of the standard deviation, σ, to the mean, μ:

$$c_v = \frac{\sigma}{\mu}$$

Current Practice Baseline

A current practice baseline is characterized by current market practice or the minimum requirements of applicable codes or standards, whichever is more efficient. New construction and major renovations that are covered by codes and standards use this baseline.

Impact Evaluation

Impact evaluation is used to estimate savings from energy efficiency measures. According to the RTF Guidelines, "program impact evaluations estimate savings from a period of program operation. Program impact evaluations involve the analysis of a reliable sample of program participants (and possibly non-participants) to determine the savings." The RTF Guidelines generally refer to evaluation of a portfolio or program, but are flexible in how evaluators define "program."

Other UES

This includes measures that fall into the RTF-Small Saver and Planning categories, as well as UES measures that have been created by program operators but are not recognized by the RTF, such as BPA-qualified measures. Savings estimation methods for these measures require conducting one or more studies that may require site-specific data collection and analyses.

Realization Rate

The term is used in several contexts in the development of reported program savings. The primary applications include the ratio of project tracking system savings data (e.g., initial estimates of project savings) to savings that (1) are adjusted for data errors and (2) incorporate evaluated or verified results of the tracked savings. In the Updated Guidelines, the realization rate does not include program attribution.

Relative Precision

Measures the expected error bound of an estimate on a normalized basis. It must be expressed for a specified confidence level. The relative precision (rp) of an estimate at 90% confidence is:

$$rp = 1.645 \, \frac{cv}{\sqrt{n}} \sqrt{1 - \frac{n}{N}}$$

where n is the sample size, N is the population size, and the coefficient of variance is cv = standard deviation / estimate mean value. The square root expression at the end of the

equation is the finite population correction factor, which becomes inconsequential and unnecessary for large populations.

RTF Proven

These are measures for which the RTF has determined that savings estimation methods are proven and reliable.

RTF Provisional

These are measures for which the RTF has determined that reliable baseline data is available, but that savings are not yet proven and additional research needs to be conducted. Each RTF Provisional measure has an RTF-approved research plan which outlines data collection activities necessary to improve the reliability of the savings estimation method.

Savings Estimation

The RTF Guidelines stipulate a range of recommended methods to quantify estimate savings, depending on the type of measure (UES, Standard Protocol or Custom) and the UES measure category (proven, provisional, small saver, or planning).

Savings Realization Rate (RR)

The ratio of the field of evaluation energy savings to the program's claimed savings. The RR represents the percentage of program-estimated savings that the impact evaluation team estimates as being actually achieved based on the results of the evaluation M&V analysis.

Savings Validation

Savings validation uses impact evaluation to provide a comparison of savings for a measure or group of measures to the deemed UES values. For the purposes of this document, existing measure savings validation is considered a measure development activity, in that it informs savings estimates associated with a measure. If the savings validation shows a significant deviation from the deemed savings estimates, additional measure development may be needed.

Technology/Activity/Practice (TAP)

TAP is the standardized taxonomy used by BPA reporting system for classifying measures.

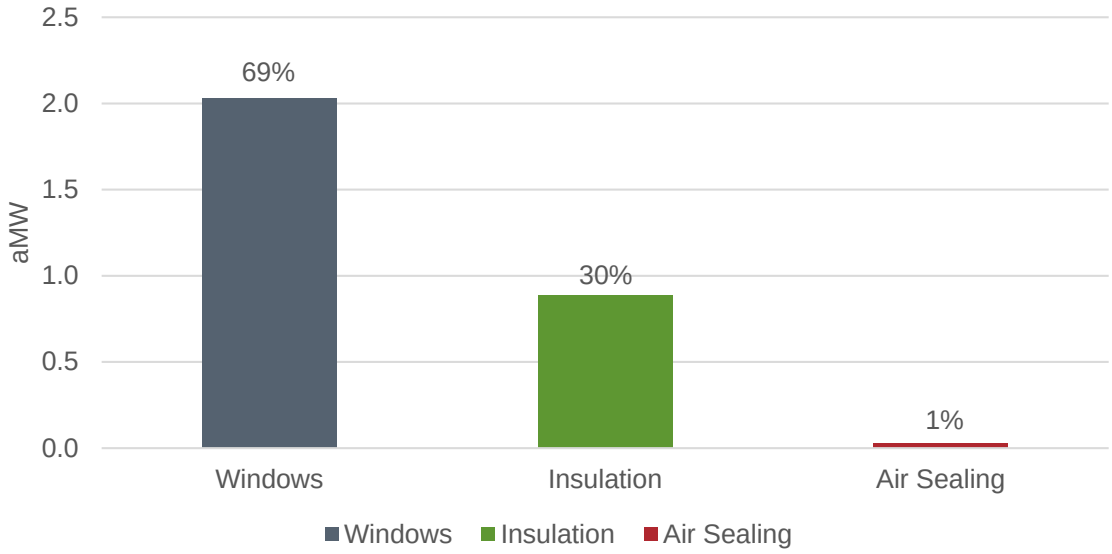
Appendices

Appendix A: Residential Envelope Domain

Residential Envelope Domain – Savings

Figure 8 shows the breakdown of energy savings for Residential Envelope Domain that consists of three Technology/Activity/Practices (TAP).

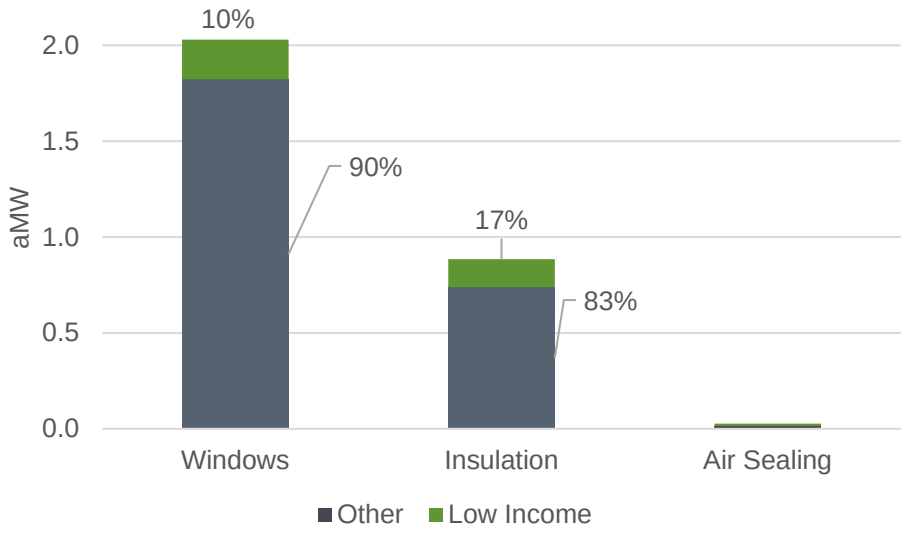
Figure 8: Residential Envelope Domain Savings – Breakdown by TAP (FY2015)



Source: Navigant analysis of measures reported into the BPA IS2.0, summarized from 3/18/2016 IS2.0 data pull

Figure 9 shows the breakdown of TAP level energy savings for Residential Envelope Domain for Low Income measures and other (Non-Low Income) measures.

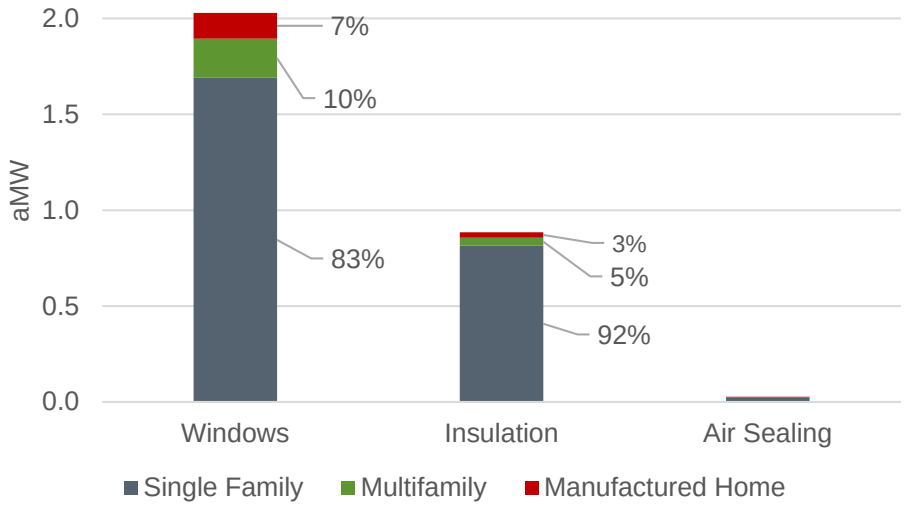
Figure 9: Residential Envelope Domain Savings – Impacts of Low Income for each TAP (FY2015)



Source: Navigant analysis of measures reported into the BPA IS2.0, summarized from 3/18/2016 IS2.0 data pull

Figure 10 shows the breakdown of TAP level energy savings for Residential Envelope Domain for different housing types.

Figure 10: Residential Envelope Domain Savings – Savings by Residence Type for each TAP (FY2015)



Source: Navigant analysis of measures reported into the BPA IS2.0, summarized from 3/18/2016 IS2.0 data pull

Residential Envelope Domain – Sample Size

Table 9. Draft 2016 Sample Size for the Residential Envelope Domain

Measure Group	Strata	Assumed CV	Number of Utilities	Target Number of Projects*
Insulation	Large Contributors	0.8	4	Census of billing data for each utility**
	Medium Contributors	0.8	4	
	Small Contributors	0.8	2	
	Subtotal		**10**	**~1700**
Windows	Large Contributors	0.8	2	Census of billing data for each utility**
	Medium Contributors	0.8	10	
	Small Contributors	0.8	3	
	Subtotal		**15**	**~2500**

** This value represents the target number of projects for which the evaluation team requires usable data. In order to reach this number, the team will need to request billing data for roughly twice as many projects.*
*** Evaluation will target a census of energy consumption data for sampled utilities, a sample may be drawn where this is unfeasible.*
Source: Navigant Analysis

Residential Envelope Domain – Comparison to RTF UES values

In order to determine whether the claimed savings reported for the FY 2015 Residential Envelope measures match with the current RTF deemed values from the RTF measure workbooks[31], Navigant mapped measure-level savings across both data sources. This mapping exercise attempted to tie each UES measure within the residential envelope domain to its RTF workbook. A link was considered correct when the annual savings at the site (kWh per year) and roughly 15 additional parameters were identical between the UES Measure List[32] and the RTF workbook for a given measure. Following table shows high-level findings of this mapping exercise for the envelope domain by residence type.

31 These measure workbooks can be accessed using this link: http://rtf.nwcouncil.org/measures/
[32] Version 3.0 (Valid through Sept. 30, 2015) https://www.bpa.gov/EE/Policy/Solutions/Pages/default.aspx

Table 10. Residential Envelope measure mapping to RTF workbooks

Residence Type	UES measures mapped to the RTF workbooks?	Notes
Single Family	No	BPA savings values for only few windows measures for Class 22 windows match to the RTF workbook version 2.4[33]
Multifamily	No	Likelihood is that the BPA savings values are coming from an earlier version of the RTF workbooks
Manufactured Home	Yes	BPA savings values match to version 3.1[34] of the Weatherization - Manufactured Home workbook

Source: Navigant analysis

Detailed description of the identified discrepancies, grouped by residence type, is provided below.

Single Family: Navigant was not able to map single family envelope measure savings values to RTF UES values, except for a few windows measures.[35] The evaluation team believes that the RTF measure workbooks that correctly map to current BPA deemed values are older than the versions currently included online.[36] Workbooks available online begin with version 2.1, with the oldest decision date reported as August 3, 2010. The BPA effective date from the UES deemed measure list is October 1, 2007, indicating that the BPA savings values may come from a version earlier than version 2.1. The team identified the following additional discrepancies:

- Some of the single family measures have 'Manufactured Homes RTF Workbook Ver 3.1' listed as the 'Workbook Link' in the BPA Deemed UES list. Navigant believes these entries are typos, and did confirm that the savings values for the measures do not match those included in the manufactured homes workbook.
- In the BPA Deemed UES list, a few measures within 'Insulation Single Family - Existing', 'Insulation Single Family - Low Income' and ' Windows Single Family - Existing' have BPA effective dates in 2014 and 2013. Navigant believes these dates are typos.

Multifamily: Similar to the single family measures, multifamily envelope measure savings values do not match with the RTF measure workbooks available online. Workbooks included online begin with version 2.0, with a decision date reported as August 3, 2010. The BPA effective date from the UES deemed measure list is October 1, 2007, indicating, again, the likelihood that the BPA savings values are coming from an earlier version of the RTF workbooks. Additionally, the status for the *Weatherization – Multifamily* workbook is listed as 'Out of Compliance' on RTF website.

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[33] The workbook is available at http://rtf.nwcouncil.org/measures/measure.asp?id=153# . Click on (Show/hide history) link to access the previous versions of the workbook.
[34] The workbook is available at http://rtf.nwcouncil.org/measures/measure.asp?id=151# . Click on (Show/hide history) link to access the previous versions of the workbook.
[35] BPA savings values match with RTF workbook version 2.4 for Class 22 windows.
[36] Weatherization – Single Family http://rtf.nwcouncil.org/measures/measure.asp?id=153

Manufactured Homes: Navigant successfully mapped savings values for manufactured homes measures to version 3.1 of the *Weatherization - Manufactured Home* workbook. The only discrepancies the team identified for this measure group occurred in the BPA Deemed UES list, where all the measures in sub groups 'Windows Manufactured Home Low Income', 'Windows Multifamily Low Income' and 'Windows Single Family Low Income' report the BPA effective dates as '10/1/2014'.

The misalignment between deemed values will be addressed when the evaluated savings are ultimately compared to the savings claimed for this domain. Specifically, the evaluation team plans to report the evaluated savings and realization rates compared to two sets of values: 1) current BPA UES deemed measure values[37] and 2) current RTF values[38]. In addition, the team will attempt to provide an overview of the timing and lags of BPA reporting system values to current RTF values.

Residential Envelope Domain – Delivery Verification Requirements

The RTF Guidelines stipulate that for Proven measures, which make up the majority of this domain, savings assessment can be completed via delivery verification, i.e., savings equals the verified delivery quantity multiplied by the proven UES savings value. In May of 2015, the RTF defined the delivery verification requirements for the Residential Envelope domain. As summarized in Table 12, the requirements vary primarily by TAP and residence type, but the requirements across the three TAPs share similar components. A full detailed set of defined measure-specific delivery verification requirements is provided in below.

Table 11. High-Level Residential Envelope Delivery Verification Requirements

Measure Parameter	Windows	Insulation	Air Sealing
Measure Identifiers	✓ Check for appropriate heating zone ✓ Check for appropriate heating/cooling system type		
Savings Baseline	✓ n/a – OR – Check pre-conditions (as defined in I&P Standards)		
Implementation & Product Standards	✓ Check that delivered measure meets standards*		
Sunset Date	✓ n/a		

**Implementation & Product (I&P) Standards documents are specific to the measure.*
Source: RTF, First Batch May 2015

Residential Envelope Domain – Detailed Delivery Verification Requirements

The following tables provide the detailed delivery verification requirements for the residential Envelope measure groups included in the CY2016 evaluation. [39]

[37] *"UES_Measure_List_3_0_04012015.xlsx" which is UES Deemed Measure List Version 3.0 (One version prior to current version 4.1). This version will be applicable for FY 2015 evaluation as new version (Version 4.1) is applicable from October 1st 2015 which is start of FY 2016.*
[38] *Current RTF measure savings values will be obtained from the applicable RTF measure workbooks available on the RTF website at http://rtf.nwcouncil.org/measures/*
[39] *These tables are sourced from "RESIDENTIAL WEATHERIZATION SPECIFICATIONS" May 12, 2015; Revised July 17, 2015*

Single Family

Table 12: Attic Insulation Upgrade

Component	Specification	Additional Notes	Delivery Verification Checklist
Measure Identifiers	Measure Type Heating Zone Heating System Type	For measure type, see Implementation and Product Standards below	□ Check for appropriate heating zone □ Check for appropriate heating system type
Baseline	Pre-Conditions		□ Check pre-conditions as defined below
Implementation and Product Standards	Pre-conditions and efficient case insulation levels are as follows: • R0 to R38 • R0 to R49 • R11 to R38 • R11 to R49 • R19 to R38 • R19 to R49 • R30 to R38 • R30 to R49 • R38 to R49	R-values listed here are “nominal”, meaning they are the R-values of the insulation within the cavity, not the full assembly effective R-values. The ASHRAE Handbook of Fundamentals is the accepted standard for R-value of materials used by installers. Products that vary from ASHRAE may be acceptable if they comply with all current FTC certifications, testing, and labeling rules and have independent laboratory testing that indicates the products R-value.	□ Check the pre-conditions and installed insulation meet or exceed one of the following (depending on measure type): • pre-conditions was R7 or less and measure resulted in R38 or highest R-value approaching R38 practical • pre-conditions was R7 or less and measure resulted in R49 or highest R-value approaching R49 practical • pre-conditions was R8 to R11 and measure resulted in R38 or highest R-value approaching R38 practical • pre-conditions was R8 to R11 and measure resulted in R49 or highest R-value approaching R49 practical • pre-conditions was R12 to R19 and measure resulted in R38 or highest R-value approaching R38 practical • pre-conditions was R12 to R19 and measure resulted in R49 or highest R-value approaching R49 practical • pre-conditions was R20 to R30 and measure resulted in R38 or highest R-value approaching R38 practical • pre-conditions was R20 to R30 and measure resulted in R38 or highest R-value approaching R38 practical • pre-conditions was R31 to R38 and measure resulted in R49 or highest R-value approaching R49 practical

Component	Specification	Additional Notes	Delivery Verification Checklist
Implementation and Product Standards (cont'd)	Insulation must be installed in areas of the envelope that separate conditioned space and unconditioned space where none exists or the R value is less than described by measure type. Insulation must be installed in contact with the ceiling surface and be installed with a uniform R-value.		□ Check insulation is installed as described

Source: RTF

Table 13: Wall Insulation Upgrade

Component	Specification	Additional Notes	Delivery Verification Checklist
Measure Identifiers	Measure Type Heating Zone Heating System Type	For measure type, see Implementation and Product Standards below	□ Check for appropriate heating zone □ Check for appropriate heating/cooling system type
Baseline	Pre-Conditions		□ Check pre-conditions was no existing wall insulation
Implementation and Product Standards	Wall must be insulated to at least R11	The ASHRAE Handbook of Fundamentals is the accepted standard for R-value of materials used by installers. Products that vary from ASHRAE may be acceptable if they comply with all current FTC certifications, testing, and labeling rules and have independent laboratory testing that indicates the products R-value.	□ Check the installed meets R11 or the highest R-value approaching R-11 practical
	Insulation must be installed in areas of the envelope that separate conditioned space and unconditioned space where no exists or the R value is less than described by measure type. Insulation must be installed in contact with the wall surface and be installed with a uniform R-value.		□ Check insulation is installed as described

Source: RTF

Table 14: Floor Insulation Upgrade

Component	Specification	Additional Notes	Delivery Verification Checklist
Measure Identifiers	Measure Type Heating Zone Heating System Type	For measure type, see Implementation and Product Standards below	□ Check for appropriate heating zone □ Check for appropriate heating/cooling system type
Baseline	Pre-Conditions		□ Check pre-conditions as defined below
Implementation and Product Standards	Pre-conditions and efficient case insulation levels are as follows: • R0 to R19 • R0 to R25 • R0 to R30 • R19 to R30	The ASHRAE Handbook of Fundamentals is the accepted standard for R-value of materials used by installers. Products that vary from ASHRAE may be acceptable if they comply with all current FTC certifications, testing, and labeling rules and have independent laboratory testing that indicates the products R-value.	□ Check the pre-conditions and installed insulation meet one of the following (depending on measure type): • pre-conditions was R11 or less and measure resulted in R19 or highest R-value approaching R19 practical • pre-conditions was R11 or less and measure resulted in R25 or highest R-value approaching R25 practical • pre-conditions was R11 or less and measure resulted in R30 or highest R-value approaching R30 practical • pre-conditions was R19 or less and measure resulted in R30 or highest R-value approaching R30 practical
	Insulation must be installed in areas of the envelope that separate conditioned space and unconditioned space where no exists or the R value is less than described by measure type. Insulation must be installed so that there is no air space between the insulation and the subfloor. Compression of insulation is allowed in order to assure or maintain continuous contact with the bottom of the floor.		□ Check insulation is installed as described

Source: RTF

Table 15: Prime Window Replacement

Component	Specification	Additional Notes	Delivery Verification Checklist
Measure Identifiers	Measure Type Heating Zone Heating System Type	For measure type, see Implementation and Product Standards below	□ Check for appropriate heating zone □ Check for appropriate heating/cooling system type
Baseline	Pre-conditions		□ Check the pre-conditions as defined below
Implementation and Product Standards	Pre-conditions and efficient case windows are as follows: • Single pane to U30 • Single pane to U22 • Double pane to U30 • Double pane to U22	Replacement windows must be certified and labeled for U-factor in accordance with the simulation, testing, and certification procedures of the National Fenestration Rating Council Incorporated (NFRC)	□ Check the pre-conditions and installed insulation meet one of the following (depending on measure type): • pre-conditions was single pane and measure resulted in an NFRC-rated U-factor of 0.30 or lower (or 0.35 for patio door) • pre-conditions was single pane and measure resulted in an NFRC-rated U-factor of 0.22 or lower (or 0.30 for patio door) • pre-conditions was double pane with metal frame and measure resulted in an NFRC-rated U-factor of 0.30 or lower (or 0.35 for patio door) • pre-conditions was double pane with metal frame and measure resulted in an NFRC-rated U-factor of 0.22 or lower (or 0.30 for patio door)

Source: RTF

Table 16: Window Efficiency Upgrade

Component	Specification	Additional Notes	Delivery Verification Checklist
Measure Identifiers	Measure Type Heating Zone Heating System Type	For measure type, see Implementation and Product Standards below	□ Check for appropriate heating zone □ Check for appropriate heating/cooling system type
Baseline	Current Practice		n/a
Implementation and Product Standards	Installation of a U-0.30 or U-0.22 window	Replacement windows must be certified and labeled for U-factor in accordance with the simulation, testing, and certification procedures of the National Fenestration Rating Council Incorporated (NFRC)	□ Check the window has an NFRC-rated U-factor of 0.30 or less □ Check the window has an NFRC-rated U-factor of 0.22 or less

Source: RTF

Manufactured Homes

Table 17: Attic Insulation Upgrade

Component	Specification	Additional Notes	Delivery Verification Checklist
Measure Identifiers	Measure Type Heating Zone Heating System Type	For measure type, see Implementation and Product Standards below	□ Check for appropriate heating zone □ Check for appropriate heating/cooling system type
Baseline	Pre-Conditions		□ Check pre-conditions as defined below
Implementation and Product Standards	For homes with adequate roof pitch (built on or after 1976), pre-conditions and efficient case insulation levels are as follows: • R0 to R30 • R11 to R30	R-values listed here are "nominal", meaning they are the R-values of the insulation within the cavity, not the full assembly effective R-values. The ASHRAE Handbook of Fundamentals is the accepted standard for R-value of materials used by installers. Products that vary from ASHRAE may be acceptable if they comply with all current FTC certifications, testing, and labeling rules and have independent laboratory testing that indicates the products R-value.	□ Check the pre-conditions and installed insulation ***meet one of the following*** (depending on measure type): • pre-conditions was R11 to R17 and measure resulted in R30 or highest R-value approaching R30 practical • pre-conditions was R7 or less and measure resulted in R30 or highest R-value approaching R30 practical
	For pre-HUD certified homes only (those built on or before 1975): • R0 to R22		□ Check that ***both apply*** (for pre-HUD certified homes only): • pre-conditions was R7 or less and measure resulted in R22 or highest R-value approaching R30 practical • Home is pre-HUD certified
	Insulation must be installed in areas of the envelope that separate conditioned space and unconditioned space where none exists or the R value is less than described by measure type. Loose-fill insulation must be installed in contact with surface with a uniform R-value.		□ Check insulation is installed as described

Source: RTF

Table 18: Floor Insulation Upgrade

Component	Specification	Additional Notes	Delivery Verification Checklist
Measure Identifiers	Measure Type Heating Zone Heating System Type	For measure type, see Implementation and Product Standards below	□ Check for appropriate heating zone □ Check for appropriate heating/cooling system type
Baseline	Pre-Conditions		□ Check pre-conditions as defined below
Implementation and Product Standards	Pre-conditions and efficient case insulation levels are as follows: • R0 to R22 • R11 to R22	The ASHRAE Handbook of Fundamentals is the accepted standard for R-value of materials used by installers. Products that vary from ASHRAE may be acceptable if they comply with all current FTC certifications, testing, and labeling rules and have independent laboratory testing that indicates the products R-value.	□ Check the pre-conditions and installed insulation ***meet one of the following*** (depending on measure type): • pre-conditions was less than R7 and measure resulted in R22 or highest R-value approaching R22 practical • pre-conditions was R7 to R11 and measure resulted in R22 or highest R-value approaching R22 practical
	Insulation must be installed in areas of the envelope that separate conditioned space and unconditioned space where no exists or the R value is less than described by measure type. Insulation must be installed so that there is no air space between the insulation and the subfloor. Compression of insulation is allowed in order to assure or maintain continuous contact with the bottom of the floor.		□ Check insulation is installed as described

Source: RTF

Table 19: Prime Window Replacement

Component	Specification	Additional Notes	Delivery Verification Checklist
Measure Identifiers	Measure Type Heating Zone Heating System Type	For measure type, see Implementation and Product Standards below	□ Check for appropriate heating zone □ Check for appropriate heating/cooling system type
Baseline	Pre-conditions		□ Check the pre-conditions as defined below
Implementation and Product Standards	Pre-conditions and efficient case windows are as follows: • Single pane to U30 • Single pane to U22 • Double pane metal frame to U30 • Double pane metal frame to U22	Replacement windows must be certified and labeled for U-factor in accordance with the simulation, testing, and certification procedures of the National Fenestration Rating Council Incorporated (NFRC)	□ Check the pre-conditions and installed insulation meet one of the following (depending on measure type): • pre-conditions was single pane and measure resulted in an NFRC-rated U-factor of 0.30 or lower • pre-conditions was single pane and measure resulted in an NFRC-rated U-factor of 0.22 or lower • pre-conditions was double pane with metal frame and measure resulted in an NFRC-rated U-factor of 0.30 or lower • pre-conditions was double pane with metal frame and measure resulted in an NFRC-rated U-factor of 0.22 or lower

Source: RTF

Table 20: Window Efficiency Upgrade

Component	Specification	Additional Notes	Delivery Verification Checklist
Measure Identifiers	Measure Type Heating Zone Heating System Type	For measure type, see Implementation and Product Standards below	□ Check for appropriate heating zone □ Check for appropriate heating/cooling system type
Baseline	Current Practice		n/a
Implementation and Product Standards	Installation of a U-0.30 or U-0.22 window	Replacement windows must be certified and labeled for U-factor in accordance with the simulation, testing, and certification procedures of the National Fenestration Rating Council Incorporated (NFRC)	□ Check the window has an NFRC-rated U-factor of 0.30 or less □ Check the window has an NFRC-rated U-factor of 0.22 or less

Source: RTF

Multi-Family

The evaluation team could not find the DV requirements specification for multi-family measures in the "RESIDENTIAL WEATHERIZATION SPECIFICATIONS" (May 12, 2015; Revised July 17, 2015) document from where the above tables were sourced. The evaluation team will work with BPA staff to identify the DV requirements for Multi-Family measures.

Residential Envelope Domain – Draft Billing Data Collection Template

The following table provides an illustrative example of how the data collection template may be structured. As mentioned in the Section 4.2, the evaluation team will work together with BPA and regional stakeholders to ensure data requests are as similarly and streamlined as possible to reduce customer utility burden and improve evaluation efficiency in the region.

Table 21 : Draft data Collection Template for Billing Data

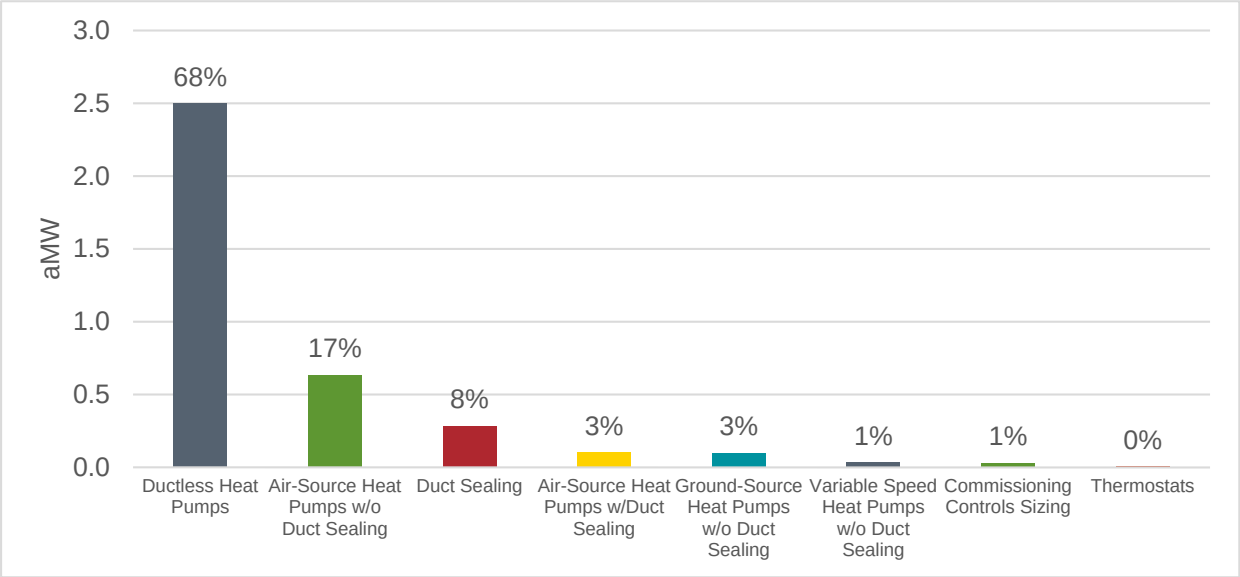
Billing Data							Measure Data								Site Data				
Premise ID	Account ID	Proxy for Meter #	Meter Read Date	Read Code (Actual, Estimated or Correction)	Days in Read Cycle	kWh Usage	Measure 1 Installation Date	Measure 1 Quantity of Units	Measure 1 Units (e.g., sq ft, DHP System)	Measure 1 UES Measure Name	Measure 2 Installation Date	Measure 2 Quantity of Units	Measure 2 Units (e.g., sq ft, DHP System)	Measure 2 UES Measure Name	Heating Zone	Utility	Zip Code	Conditioned Square feet	Building Type (e.g., SF, MF, or MH)
Character	Character	Character	Date	Categorical	Numeric	Numeric	Date	Numeric	Character	Character	Date	Numeric	Character	Character	Integer	Character	Character	Numeric	Categorical

Source: Navigant

Appendix B: Residential HVAC Domain

Figure 11 shows the breakdown of energy savings for Residential HVAC Domain that consists of eight Technology/Activity/Practices (TAP).

Figure 11: Percent of Domain-Savings by TAP (FY2015[40])



Source: Navigant analysis of measures reported into the BPA IS2.0, summarized from 3/18/2016 IS2.0 data pull

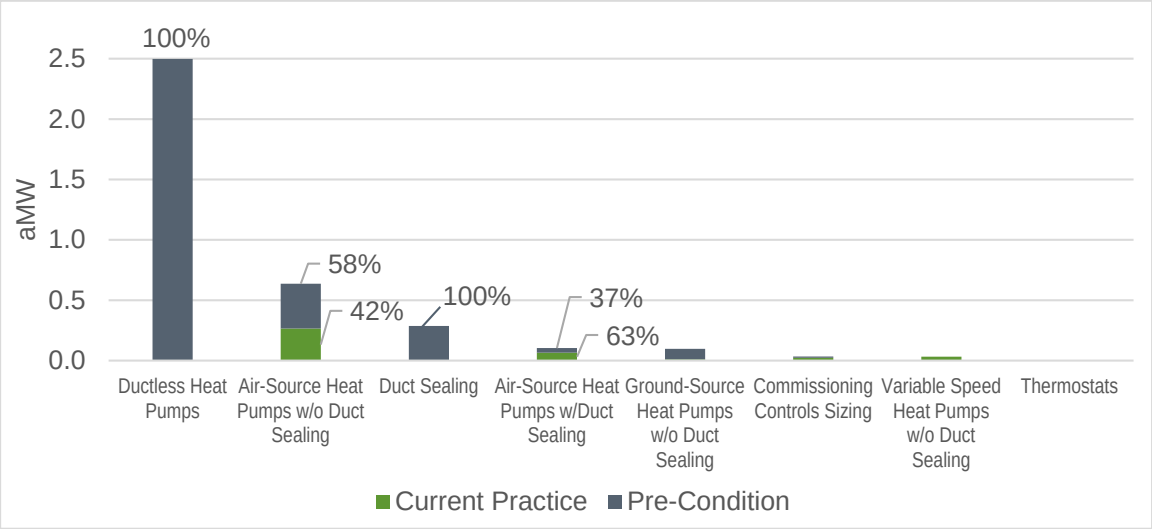
[40] *FY 2015 is from October 1st 2014 to September 30th 2015.*

Figure 12 show the breakdown of TAP level energy savings for Residential HVAC Domain for Current Practice baseline and Pre-Condition baseline.

A current practice baseline is characterized by current market practice or the minimum requirements of applicable codes or standards, whichever is more efficient. New construction and major renovations that are covered by codes and standards use this baseline.[41]

A pre-conditions baseline is used when the "measure-affected equipment or practice still has remaining useful life." According to the RTF Guidelines, "the use of the terms upgrade, replacement and conversion in describing a measure all indicate that savings for the measure are estimated using a pre-conditions baseline."[42]

Figure 12: Percent of TAP-Savings by Baseline (FY2015)



Source: Navigant analysis of measures reported into the BPA IS2.0, summarized from 3/18/2016 IS2.0 data pull

[41] *More information on the Current Practice baseline can be found here: https://www.bpa.gov/EE/Policy/IManual/Documents/July%20documents/9_BPA_MV_Absent_Baseline_Applicaton_Guide_May2012_FINAL.pdf*

[42] *Ibid.*

The following figures show the breakdown of TAP level energy savings for Residential HVAC Domain for different measure statuses.

Table 22. Savings by TAP & Measure Status (FY2015)

Domain	TAP	Measure Status	Savings (aMW)	Fraction of Domain
Residential HVAC	Ductless Heat Pumps	RTF Proven	1.94	53%
		BPA Qualified	0.55	15%
	Air-Source Heat Pumps w/o Duct Sealing	RTF Proven	0.64	17%
	Duct Sealing	RTF Proven	0.20	5%
		RTF Planning	0.09	2%
	Air-Source Heat Pumps w/ Duct Sealing	RTF Proven	0.10	3%
	Ground-Source Heat Pumps w/o Duct Sealing	RTF Proven	0.09	2%
		BPA Qualified	0.01	0%
	Variable Speed Heat Pumps w/o Duct Sealing	BPA Qualified	0.03	1%
	Commissioning, Controls & Sizing	RTF Planning	0.03	1%
	Thermostats	RTF Proven	0.00	0%

Source: Navigant analysis of BPA IS2.0, summarized from 3/18/2016 IS2.0 data pull

The evaluation team defines BPA measures that are routinely installed in conjunction with other RTF measures as "aggregate" measure. Four of the seven residential HVAC TAPs are aggregate RTF measures as shown in the following table:

Table 23. Res-HVAC TAP – Measure Types

TAP	Included Measures (If Aggregate)
Ductless Heat Pumps	-
Duct Sealing	-
Air-Source Heat Pumps w/o Duct Sealing	Air-Source Heat Pumps + Commissioning, Controls & Sizing
Air-Source Heat Pumps w/ Duct Sealing	Air-Source Heat Pumps + Commissioning, Controls & Sizing + Duct Sealing
Ground-Source Heat Pumps w/o Duct Sealing	Ground-Source Heat Pumps + Commissioning, Controls & Sizing
Commissioning, Controls & Sizing	-
Variable Speed Heat Pumps w/o Duct Sealing	Variable Speed Heat Pumps + Commissioning, Controls & Sizing

Source: Navigant analysis

It is important to identify the aggregate and non-aggregate measures as all aggregate measures are required to complete all relevant installation documentation as well as be audited by all relevant QA/QC checklists. This informs the evaluation team about which documents are available for each of these TAPs.

Residential HVAC Domain – Sample Size

Table 24. Draft 2016 Sample Size for the Residential HVAC Domain

Measure Group	Strata	Assumed CV	Number of Utilities	Target Number of Projects*
Prescriptive Duct Sealing	Large Contributors	0.8	5	Census of participant billing data**
	Medium Contributors	0.8	3	Census of participant billing data**
	Small Contributors	0.8	2	Census of participant billing data**
	Subtotal		**10**	**~500**
Ductless Heat Pumps replacing Forced Air Furnaces[43]	Large Contributors	0.8	6	Census of participant billing data**
	Medium Contributors	0.8	6	Census of participant billing data**
	Medium and Small Contributors	0.8	2	Census of participant billing data**
	Subtotal		**14**	**~800**
Performance Duct Sealing	***Subtotal***	**0.7**	**n/a**	**60**
Heat Pumps – All Other***	***Subtotal***	**0.7**	**n/a**	**60**
Commissioning, Controls & Sizing	***Subtotal***	**0.3**	**n/a**	**51**

** This value represents the target number of projects for which the evaluation team requires usable data. In order to reach this number, the team will need to request billing data for roughly twice as many projects.*
***Navigant does not estimate sampling error or a sample size for these measure groups, because the evaluation team plans to collect data on the census of these projects within the sampled utilities.*
****The evaluation team will sample heat pump and CCS projects directly, due to the third party data available for both as described in Table 29 below.*
Source: Navigant Analysis

[43] *This measure group includes Ductless Heat Pumps replacing Electric Forced Air Furnaces only.*

Residential HVAC Domain – Comparison to RTF UES values

In order to determine whether the claimed savings reported for the FY 2015 Residential HVAC measures match with the current RTF deemed values from the RTF measure workbooks[44], Navigant developed a mapping protocol.

This mapping protocols attempts to tie each UES measure within the Residential HVAC Domain to its RTF workbook. A link was considered correct when the annual savings at the site (kWh per year) and roughly 15 additional parameters were identical between the UES Measure List[45] and the RTF workbook for a given measure. Following this procedure, the team identified the following matches, grouped by TAP.

Duct Sealing

- Single Family, Existing and New Homes - ResSFDuctSealing_v2_3.xlsm, version 2.3.
- Single Family, Prescriptive - ResHeatingCoolingPrescriptiveDuctSeal_v1_0.xlsm, version 1
- Single Family, Low Income - Res_SFDuctSealingFY10v2_1.xls, version 2.1
- Manufactured Home, Existing Homes - ResHeatingCoolingDuctSealingMH_v2_3.xls, version 2.3
- Manufactured Home, New or Existing Homes - ResHeatingCoolingDuctSealingMH_v2_4.xlsm, version 2.4

Ductless Heat Pumps

- Single Family, Existing, Zonal Heat - DHP_Provisional_Existing_FY10v1_1.xls, version 1.1

Ground-Source Heat Pumps

- All - ResGSHP_v2_2.xlsm, version 2.2

Commissioning, Controls & Sizing

- Manufactured home - ResMHPTCSCommissioningControlsSizing_v2_5.xls, version 2.5
- Single Family - Res_SFHeatPumpsFY10v2_4.xls, version 2.4

Air-Source Heat Pump with Duct Sealing

- Manufactured home, existing – The BPA measure savings is the combination of the following three measures
    - Air Source Heat Pump-Conversion from the baseline system – Matches with Res_MHHeatPumpsFY10v2_1.xls, version 2.1

44 These measure workbooks can be accessed using this link: http://rtf.nwcouncil.org/measures/
45 Version 3.0 (Valid through Sept. 30, 2015) https://www.bpa.gov/EE/Policy/Solutions/Pages/default.aspx

    - Air Source Heat Pump-Commissioning, Controls and Sizing – Matches with Res_MHHeatPumpsFY10v2_1.xls, version 2.1
    - Air Source Heat Pump-Duct Sealing - ResHeatingCoolingDuctSealingMH_v2_3.xls, version 2.3

- Single Family, Conversion/Upgrade – The BPA measure savings is the combination of the following three measures
    - Air Source Heat Pump-Conversion/Upgrade from the baseline system – Matches with Res_SFHeatPumpsFY10v2_3.xls, version 2.3
    - Air Source Heat Pump-Commissioning, Controls and Sizing – Matches with Res_SFHeatPumpsFY10v2_3.xls, version 2.3
    - Air Source Heat Pump-Duct Sealing - ResHeatingCoolingDuctSealingMH_v2_3.xls, version 2.3

Air-Source Heat Pump without Duct Sealing

- Manufactured home, existing – The BPA measure savings is the combination of the following two measures
    - Air Source Heat Pump-Conversion from the baseline system – Matches with Res_MHHeatPumpsFY10v2_1.xls, version 2.1
    - Air Source Heat Pump-Commissioning, Controls and Sizing – Matches with Res_MHHeatPumpsFY10v2_1.xls, version 2.1

- Single Family, Conversion/Upgrade – The BPA measure savings is the combination of the following two measures
    - Air Source Heat Pump-Conversion/Upgrade from the baseline system – Matches with Res_SFHeatPumpsFY10v2_3.xls, version 2.3
    - Air Source Heat Pump-Commissioning, Controls and Sizing – Matches with Res_SFHeatPumpsFY10v2_3.xls, version 2.3

The team also identified the following discrepancies

Duct Sealing

- Manufactured Home, Prescriptive - Name of measure is "prescriptive," but savings match the "performance" RTF workbook, ResHeatingCoolingDuctSealingMH_v2_4.xlsm, version 2.4. The current prescriptive measure workbook is version 1.0[46]

[46] *On 10/20/2015, RTF has deactivated Performance based duct sealing measures for Manufactured Home and combined them with the Prescriptive duct sealing measures. More information is available at http://rtf.nwcouncil.org/measures/measure.asp?id=137# .*

Ductless Heat Pumps replacing Forced Air Furnaces [47]

- Manufactured home, conversion – Savings do not match. The current RTF workbook version is 1.3, with an approval date of 11/10/2015.
- Single Family Ductless Heat Pumps – Savings do not match. The current RTF workbook version is 1.3, with an approval date of 11/10/2015.

Air-Source Heat Pump with and without Duct Sealing

- Manufactured home, upgrade - Current RTF workbook offers measures which correspond except for the duct sealing options. For these measures, savings in the current RTF workbook are significantly lower than the BPA measures. Additionally, BPA does not offer all climate zone options like the RTF does.[48]

Ductless Heat Pumps

- Manufactured Homes, Existing, Zonal Heat – Savings do not match. The current RTF workbook version is 1.2, with an approval date of 9/22/2015.[49]

Variable-Speed Heat Pump[50]

- Single family, upgrade - The evaluation team cannot determine which RTF workbook is the one the BPA measures are based on, since they all differ in measure definitions.
- Single family, conversion - Current RTF workbook does not include conversion to VSHP measures. The evaluation team cannot determine which RTF workbook is the one the BPA measures are based on, since they all differ in measure definitions.

No RTF Measure Found

- Duct Sealing Low Income Existing Manufactured Home Air-Source Heat Pump Not Super Good Cents/Energy Star[51]

The misalignment between deemed values will be addressed when the evaluated savings are ultimately compared to the savings claimed for this domain. Specifically, the evaluation team plans to report the evaluated savings and realization rates compared to two sets of values: 1)

[47] BPA staff indicated that BPA will be adopting the RTF measure savings in October 2016. For the UES Deemed Measure List Version 3.0, DHP replacing FAF measures were BPA Qualified. RTF has combined SF and MH homes measures.
[48] BPA staff indicated that BPA will be adopting the RTF measure savings in October 2016.
[49] BPA staff indicated that BPA will be adopting the RTF measure savings in October 2016. Currently these measures are BPA Qualified.
[50] BPA staff indicated that BPA will be adopting the RTF measure savings in October 2016. Currently these measures are BPA Qualified.
[51] BPA staff indicated that BPA will be adopting the RTF measure savings in October 2016.

current BPA UES deemed measure values[52] and 2) current RTF values[53]. In addition, the team will attempt to provide an overview of the timing and lags of BPA reporting system values to current RTF values.

Residential HVAC Domain – Delivery Verification Requirements

The RTF Guidelines stipulate a set of recommended methods to estimate savings from UES measures, depending on the measure status. Table 27 summarizes the FY2014 savings by measures status for the Residential HVAC Domain.

Table 25. FY2015 Residential HVAC Domain Measure Summary

Domain	Measure Status	Savings (aMW)	Fraction of Domain
Residential HVAC	RTF Proven	2.85	81%
	RTF Planning	0.11	3%
	BPA Qualified	0.58	16%

Source: Navigant Analysis of BPA UES Reporting System

For the Proven measures, which make up the majority of this domain, savings assessment can be completed via delivery verification. In May, September and November of 2015, the RTF defined the delivery verification requirements for the Residential HVAC Domain. As summarized in

Table 28, the requirements vary primarily by measure, but the requirements across all eight TAPs share similar components. A full detailed set of the defined measure-specific delivery verification requirements is provided in the Appendix.

Table 26. High-Level Residential HVAC Domain Delivery Verification Requirements

Measure Parameter	HVAC Measures
Measure Identifiers	✓ Check measure type (including upgrade vs conversion, replacing forced air furnace, with CAC or without CAC, etc.) ✓ Check climate zone (Heating zone 2 or 3, any cooling zone) ✓ Check house size (<4000 sq.ft or ≥ 4000 sq.ft.) ✓ Check house vintage (new construction or retrofit) ✓ Check housing type (single family, manufactured home) ✓ Check for appropriate heating/cooling system type ✓ Check insulation levels
Savings Baseline	✓ n/a – OR – Check pre-conditions (as defined in I&P Standards)
Implementation & Product Standards	✓ Check that delivered measure meets standards*

[52] *"UES_Measure_List_3_0_04012015.xlsx" which is UES Deemed Measure List Version 3.0 (One version prior to current version 4.1). This version will be applicable for FY 2015 evaluation as new version (Version 4.1) is applicable from October 1st 2015 which is start of FY 2016.*

[53] *Current RTF measure savings values will be obtained from the applicable RTF measure workbooks available on the RTF website at http://rtf.nwcouncil.org/measures/*

Measure Parameter	HVAC Measures
Sunset Date	✓ n/a

**Implementation & Product (I&P) Standards documents are specific to the measure.*
Source: RTF delivery verification workbooks, batch 1, 2 and 3.

Residential HVAC Domain – Detailed Delivery Verification Requirements

To better inform the proposed evaluation approaches mentioned above, Navigant mapped current delivery requirements for each TAP against available QA/QC documentation and utility customer files for the same TAP. The following table shows whether current QA/QC documentation and utility customer files satisfy current delivery verification requirement for each TAP.

Table 27. DV requirements vs QA/QC & Customer Files

TAP	DV Requirements satisfied by QA/QC documentation	DV Requirements satisfied by utility customer files
Ductless Heat Pumps	No	Yes
Duct Sealing	No	No
Air-Source Heat Pumps w/o Duct Sealing	Yes	No
Air-Source Heat Pumps w/ Duct Sealing	No[ii]	No
Ground-Source Heat Pumps w/o Duct Sealing	No	Yes[iii]
Commissioning, Controls & Sizing	Yes	No[iv]
Variable Speed Heat Pumps w/o Duct Sealing	No	Yes[v]

i - Measure identifiers such as heating/cooling zones are not directly collected in the QA/QC and Project files but it can be derived using the physical address being collected on those documents.
ii - QA/QC form for ASHP satisfies the DV requirement for ASHP & CCS. But since this is an aggregate measure which involves ASHP, CCS and Duct Sealing, it does not satisfies the DV requirements for the whole TAP as QA/QC document for duct sealing does not satisfy DV requirements for duct sealing.
iii – Project files collect DV requirements for all GSHP measures except when 'electric water heater with desuperheat pre-heating is installed' for water-to-water GSHP. This requirement is optional.
iv – There is no separate QA/QC form for CCS TAP but QA/QC form for Air-Source Heat Pump has a checkbox which suggests that that QA/QC form may be used for stand-alone CCS measures. The evaluation team will work with BPA staff to confirm this and then finalize.
v – Navigant believes that project files for this TAP include "PTCS Air Source or Ground Source Heat Pump Form" from IM Document Library which satisfies the DV requirements. The evaluation team will work with BPA staff to confirm this and then finalize.
Source: Navigant

The following tables provide the detailed delivery verification requirements for the residential HVAC measure groups included in the CY2016 evaluation.

Table 28 : Ductless Heat Pump replacing Forced Air Furnace

DV Component	Specification	DV Requirement Checklist
Measure Identifiers	Climate Zone (Heating)	Check heating zone
	Housing Type	Check housing type (manufactured home or single family)
Savings Baseline	Pre-conditions	Check that existing space heating system is an electric forced air furnace
Implementation and Product Standards	HSPF Rating	Check DHP rated 9.5 HSPF with nominal tonnage of 3/4 ton or greater is installed
	Installation Location	Check installation location is the main living area of the home

Source: RTF

Table 29 : Ductless Heat Pump replacing Zonal Electric Heat

DV Component	Specification	DV Requirement Checklist
Measure Identifiers	Heating Zone	Check for heating zone
	Cooling Zone	Check cooling zone
Savings Baseline	Pre-Conditions	Check pre-conditions were electric resistance zonal system
	Pre-Conditions	Check that house does not have a heat pump, ductless heat pump, or a whole house forced air heating system
Implementation and Product Standards	HSPF Rating	Check inverter drive DHP with nominal 0.75 tons or more and HSPF rating of 9.0 or higher is installed
	Installation Location	Check DHP is installed in main living area

Source: RTF

Table 30 : Duct Sealing – Performance and Prescriptive

DV Component	Specification	DV Requirement Checklist
Measure Identifiers	Heating Zone	Check for heating zone
	Heating System Type	Check heating system type
Savings Baseline	Pre-Conditions	Check that 30% of ducts are located in unconditioned space OR
		- that there were supply leaks to unconditioned space within 15 feet of the air handler
	Pre-Conditions	Check the house has not previously had its ducts sealed through a utility duct sealing program.
Implementation and Product Standards	Installation Specification	Check that accessible non-flex duct joints and connections located in unconditioned space are sealed with UL-181 listed mastic
	Installation Specification	Check that accessible flexible duct connections located in unconditioned space have interior and exterior liners secured and are air-sealed and tightened appropriately.

Source: RTF

Table 31 : Air-Source Heat Pumps

DV Component	Specification	DV Requirement Checklist
Measure Identifiers	Heating Zone	Check Heating zone
Implementation and Product Standards	HSPF Rating	Check system meets 9.0 HSPF or greater

Source: RTF

DV requirements for Air-Source Heat Pumps w/o Duct Sealing TAP are the combination of DV requirement for the following two TAPs:

1. Air-Source Heat Pumps w/o Duct Sealing, and;
2. Commissioning, Controls and Sizing.

DV requirements for Air-Source Heat Pumps with Duct Sealing TAP are the combination of DV requirement for the following three TAPs:

1. Air-Source Heat Pumps w/o Duct Sealing,
2. Commissioning, Controls and Sizing, and;
3. Duct Sealing

Table 32 : Ground-Source Heat Pumps

DV Component	Specification	DV Requirement Checklist
Measure Identifiers	Measure Type	Check measure type (including upgrade vs conversion, with desuperheater or without, with CAC or without CAC)

DV Component	Specification	DV Requirement Checklist
	Climate Zone	Check climate zone (Heating zone 2 or 3, any cooling zone)
	House Size	Check house size (<4000 sq.ft or ≥ 4000 sq.ft.)
	House Vintage	Check house vintage (new construction or retrofit)
Savings Baseline	Pre-Conditions	Check previous heating system was either ASHP or electric FAF
		If applicable, check existing water heater was an electric tank without desuperheat
Implementation and Product Standards	Installation Specification	Check if GSHP is installed
		If applicable, check that electric water heater with desuperheat pre-heating is installed

Source: RTF

DV requirements for Ground-Source Heat Pumps w/o Duct Sealing TAP are the combination of DV requirement for the following two TAPs:

1. Ground-Source Heat Pumps w/o Duct Sealing, and;
2. Commissioning, Controls and Sizing.

Table 33 : Commissioning, Controls and Sizing

DV Component	Specification	DV Requirement Checklist
Measure Identifiers	Heating Zone	Check Heating zone
Implementation and Product Standards	Product Specification	Check heat pump is new and rated by AHRI
	Balance Temperature	Check heat pump balance point is at 30°F or lower
	Auxiliary Heat	Check auxiliary heat is controlled to one of the following: - Single stage OR multi stage without air temperature sensor control: auxiliary heat is controlled so that it does not engage when the outdoor temperature is above 35°F, except when supplemental heating is required during a defrost cycle or when emergency heating is required during a refrigeration cycle failure. - Multi stage with air temperature sensor control: auxiliary heat is controlled so that it does not engage when the supply air temperature is above 85°F.
	Thermostat Controls	Check thermostat has manual changeover feature or heating/cooling lockout (if applicable)
	Temperature change across indoor coil	Check temperature change across indoor coil is at or above temperature in Table below:
	Compressor cutout	Check that compressor is not cutout at temperatures above 5°F (if applicable)
Implementation and Product Standards (Continued)	Airflow across indoor coil	Check airflow across indoor coil is either: - As specified in manufacturer's literature. - ≥ 325 CFM per ton of nominal heating capacity
	External static pressure	Check that external static pressure does not exceed 0.8 in of water (200 Pa)

Source: RTF

Figure 13: Temperature change across indoor coil table

Minimum Temperature Split (ºF)				
Outdoor Temperature (ºF)	CFM per Ton			
	300	350	400	450
5	13	11	10	9
10	15	13	11	10
15	17	15	13	11
20	19	17	15	13
25	20	18	16	14
30	21	19	17	15
35	23	21	18	16
40	25	23	20	18
45	28	25	22	20
50	31	27	24	22
55	34	29	26	23
60	36	31	28	25
65	38	33	29	26

Source: RTF - Air Source Heat Pump Commissioning, Controls, and Sizing Specification" Adopted: May 12, 2015; Revised July 21

Table 34 : Variable Speed Heat Pumps

DV Component	Specification	DV Requirement Checklist
Measure Identifiers	Heating Zone	Check for heating zone
	Cooling Zone	Check cooling zone
Implementation and Product Standards	Installation Specification	Check system is variable speed with inverter driven compressor
	HSPF Rating	Check system meets 9.0 HSPF or greater

Source: RTF

DV requirements for Variable Speed Heat Pumps w/o Duct Sealing TAP are the combination of DV requirement for the following two TAPs:

1. Variable Speed Heat Pumps w/o Duct Sealing, and;
2. Commissioning, Controls and Sizing.

Residential HVAC Domain – Possible Evaluation Data Sources

Following tables show detailed delivery verification (DV) requirements for Res-HVAC TAPs and it's availability in the possible evaluation data sources.

Ductless Heat Pumps

Table 35 : Ductless Heat Pump replacing Forced Air Furnace

DV Component	Specification	DV Requirement Checklist	Available in QA/QC form?	Available in Utility Customer Files?
Measure Identifiers	Climate Zone (Heating)	Check heating zone	Can be derived	Can be derived[54]
	Housing Type	Check housing type (manufactured home or single family)	No	Yes
Savings Baseline	Pre-conditions	Check that existing space heating system is an electric forced air furnace	No	Yes
Implementation and Product Standards	HSPF Rating	Check DHP rated 9.5 HSPF with nominal tonnage of 3/4 ton or greater is installed	No	Yes
	Installation Location	Check installation location is the main living area of the home	No	Yes

Source: Navigant review

[54] *Climate zone can be derived from the serving utility and site's physical address.*

Table 36 : Ductless Heat Pump replacing Zonal Electric Heat

DV Component	Specification	DV Requirement Checklist	Available in QA/QC form?	Available in Utility Customer Files?
Measure Identifiers	Heating Zone	Check for heating zone	Can be derived	Can be derived
	Cooling Zone	Check cooling zone	Can be derived	Can be derived
Savings Baseline	Pre-Conditions	Check pre-conditions were electric resistance zonal system	No	Yes
	Pre-Conditions	Check that house does not have a heat pump, ductless heat pump, or a whole house forced air heating system	No	No
Implementation and Product Standards	HSPF Rating	Check inverter drive DHP with nominal 0.75 tons or more and HSPF rating of 9.0 or higher is installed	No	Yes
	Installation Location	Check DHP is installed in main living area	No	Yes

Source: Navigant review

Duct Sealing

Table 37 : Duct Sealing – Performance and Prescriptive

DV Component	Specification	DV Requirement Checklist	Available in QA/QC form?	Available in Utility Customer Files?
Measure Identifiers	Heating Zone	Check for heating zone	Can be derived	Can be derived
	Heating System Type	Check heating system type	No	No
Savings Baseline	Pre-Conditions	Check that 30% of ducts are located in unconditioned space OR	No	Yes
		- that there were supply leaks to unconditioned space within 15 feet of the air handler	No	No
	Pre-Conditions	Check the house has not previously had its ducts sealed through a utility duct sealing program.	No	Can be derived from PTCS site registry[55]
Implementation and Product Standards	Installation Specification	Check that accessible non-flex duct joints and connections located in unconditioned space are sealed with UL-181 listed mastic	Yes	No

[55] *PTCS Site registry records past reported activity*

DV Component	Specification	DV Requirement Checklist	Available in QA/QC form?	Available in Utility Customer Files?
	Installation Specification	Check that accessible flexible duct connections located in unconditioned space have interior and exterior liners secured and are air-sealed and tightened appropriately.	Yes	No

Source: Navigant review

Air-Source Heat Pumps w/o Duct Sealing

Table 38 : Air-Source Heat Pumps

DV Component	Specification	DV Requirement Checklist	Available in QA/QC form?	Available in Utility Customer Files?
Measure Identifiers	Heating Zone	Check Heating zone	Can be derived	Can be derived
	House Insulation	Check whether house insulation level is poor, fair, or good	No	No
	Cooling Zone	For ASHP conversion with central air systems, check for appropriate cooling zone	Can be derived	Can be derived
Implementation and Product Standards	HSPF Rating	Check system meets 9.0 HSPF or greater	Yes	Yes

Source: Navigant review

Variable Speed Heat Pumps

Table 39 : Variable Speed Heat Pumps[56]

DV Component	Specification	DV Requirement Checklist	Available in QA/QC form?	Available in Utility Customer Files?
Measure Identifiers	Heating Zone	Check for heating zone	Can be derived	Can be derived
	Cooling Zone	Check cooling zone	Can be derived	Can be derived
Implementation and Product Standards	Installation Specification	Check system is variable speed with inverter driven compressor	No	Yes
	HSPF Rating	Check system meets 9.0 HSPF or greater	Yes	Yes

Source: Navigant review

Ground-Source Heat Pumps w/o Duct Sealing

Table 40 : Ground-Source Heat Pumps

DV Component	Specification	DV Requirement Checklist	Available in QA/QC form?	Available in Utility Customer Files?
Measure Identifiers	Measure Type	Check measure type (including upgrade vs conversion, with desuperheater or without, with CAC or without CAC)	No	No
	Climate Zone	Check climate zone (Heating zone 2 or 3, any cooling zone)	Can be derived	Can be derived
	House Size	Check house size (<4000 sq.ft or ≥ 4000 sq.ft.)	No	No
	House Vintage	Check house vintage (new construction or retrofit)	No	Yes
Savings Baseline	Pre-Conditions	Check previous heating system was either ASHP or electric FAF	No	Yes
		If applicable, check existing water heater was an electric tank without desuperheat	No	No
Implementation and Product Standards	Installation Specification	Check if GSHP is installed	Yes	Yes
		If applicable, check that electric water heater with	Yes	No

[56] *Navigant believes that project files for this TAP include "PTCS Air Source or Ground Source Heat Pump Form" from IM Document Library which satisfies the DV requirements. The evaluation team will work with BPA staff to confirm this and then finalize.*

DV Component	Specification	DV Requirement Checklist	Available in QA/QC form?	Available in Utility Customer Files?
		desuperheat pre-heating is installed		

Source: Navigant review

Commissioning, Controls and Sizing

Table 41 : Commissioning, Controls and Sizing[57]

DV Component	Specification	DV Requirement Checklist	Available in QA/QC form?	Available in Utility Customer Files?
Measure Identifiers	Heating Zone	Check Heating zone	Can be derived	NA
Implementation and Product Standards	Product Specification	Check heat pump is new and rated by AHRI	Yes	NA
	Balance Temperature	Check heat pump balance point is at 30°F or lower	Yes	NA
	Auxiliary Heat	Check auxiliary heat is controlled to one of the following: - Single stage OR multi stage without air temperature sensor control: auxiliary heat is controlled so that it does not engage when the outdoor temperature is above 35°F, except when supplemental heating is required during a defrost cycle or when emergency heating is required during a refrigeration cycle failure. - Multi stage with air temperature sensor control: auxiliary heat is controlled so that it does not engage when the supply air temperature is above 85°F.	Yes	NA
	Thermostat Controls	Check thermostat has manual changeover feature or heating/cooling lockout (if applicable)	Yes	NA
	Temperature change across indoor coil	Check temperature change across indoor coil is at or above temperature in Figure 13 below	Yes	NA
	Compressor cutout	Check that compressor is not cutout at temperatures above 5°F (if applicable)	Yes	NA

[57] *There is no separate QA/QC form for CCS TAP but QA/QC form for Air-Source Heat Pump has a checkbox which suggests that that QA/QC form may be used for stand-alone CCS measures.*

DV Component	Specification	DV Requirement Checklist	Available in QA/QC form?	Available in Utility Customer Files?
Implementation and Product Standards (Continued)	Airflow across indoor coil	Check airflow across indoor coil is either: - As specified in manufacturer's literature. - ≥ 325 CFM per ton of nominal heating capacity	Yes	NA
	External static pressure	Check that external static pressure does not exceed 0.8 in of water (200 Pa)	Yes	NA

Source: Navigant review

Figure 14: Temperature Change across Indoor Coil Table

Minimum Temperature Split (ºF)				
Outdoor Temperature (ºF)	CFM per Ton			
	300	350	400	450
5	13	11	10	9
10	15	13	11	10
15	17	15	13	11
20	19	17	15	13
25	20	18	16	14
30	21	19	17	15
35	23	21	18	16
40	25	23	20	18
45	28	25	22	20
50	31	27	24	22
55	34	29	26	23
60	36	31	28	25
65	38	33	29	26

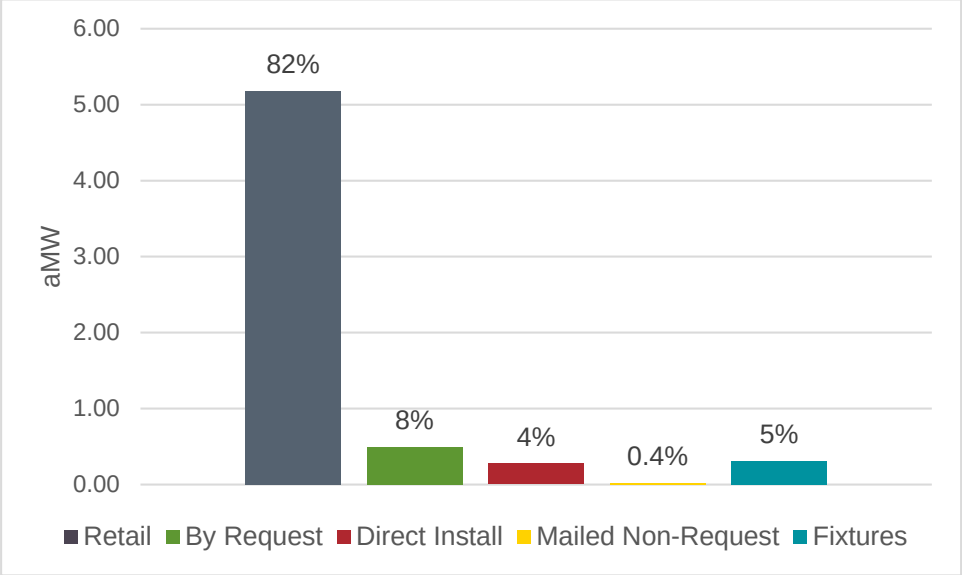
Source: RTF - Air Source Heat Pump Commissioning, Controls, and Sizing Specification"
Adopted: May 12, 2015; Revised July 21

Appendix C: Residential Lighting Domain

Residential Lighting Domain – Savings

The following figures show the breakdown of energy savings for Residential Lighting Domain by measure group Figure 15 shows the savings breakdown by delivery mechanism and Figure 16 shows the savings breakdown by lamp type and delivery mechanism. Figure 17 shows the breakdown of the savings by Simple Steps and Non-Simple Steps program savings for Retail and By-Request delivery mechanism.

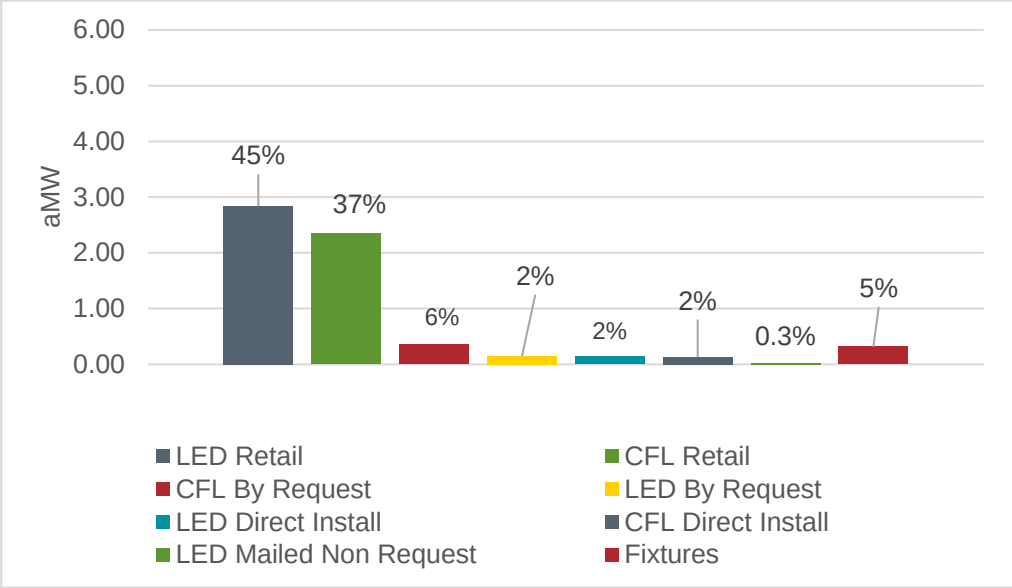
Figure 15: Residential Lighting Domain Savings – Breakdown by Delivery Mechanism (FY2015[58])



Source: Navigant analysis measures reported into the of BPA Is2.0 based on the 3/18/2016 data pull

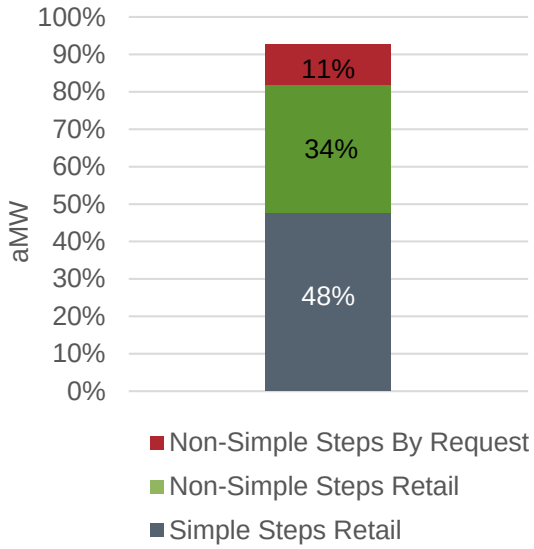
[58] *FY 2015 is from October 1st 2014 to September 30th 2015.*

Figure 16: Residential Lighting Domain Savings –Breakdown by Lamp Type & Delivery Mechanism (FY2015[59])



Source: Navigant analysis measures reported into the of BPA Is2.0 based on the 3/18/2016 data pull

Figure 17: Residential Lighting Domain Savings –Breakdown by Program Type & Delivery Mechanism (FY2014*)



**Please note that this breakdown is for FY2014. At the time of this writing, the evaluation team did not have this data for FY2015, so this figure is intended to provide only a sense of the split of savings across the Simple Steps and non-Simple Step programs.*

Source: Navigant analysis of measures reported into the BPA IS2.0

[59] *FY 2015 is from October 1st 2014 to September 30th 2015.*

Residential Lighting Domain – Sample Size

Table 42. Draft 2016 Sample Size for the Residential Lighting Domain

Measure Group	Strata	Assumed CV	Number of Utilities	Target Number of Projects
Retail	Large Contributors	0.4	4	45
	Medium and Small Contributors	0.4	3	30
	Subtotal		**7**	**75**
By Request	Large Contributors	0.4	4	45
	Medium and Small Contributors	0.4	2	20
	Subtotal		**6**	**65**
Total			**9**	**140**

Source: Navigant Analysis

Residential Lighting Domain – Comparison to RTF UES values

Navigant developed mapping protocols to tie each UES measure within the Residential Lighting domain to its RTF workbook. A link was considered correct when the annual savings at the site (kWh per year) and roughly 15 additional parameters were identical between the UES Measure List[60] and the RTF workbook for a given measure. Following this procedure, Navigant was able to map every measure in the Lamps TAP to one of four RTF workbooks.[61]

- ResSpecialtyLigthing_v1.2
- ResLightingLED_v3_0
- ResLightingLED_v2
- ResLightingCFLandLEDLamps_v3_3_LED2

In a few cases, the delivery mechanism referenced for a deemed value within the UES Measure List did not align with the delivery mechanism for the same savings value listed in the RTF workbook.[62] Table 45 provides a summary of these discrepancies by lamp type. The misalignment between deemed values will be addressed when the evaluated savings are ultimately compared to the savings claimed for this domain. Specifically, the evaluation team plans to report the evaluated savings and realization rates compared to two sets of values: 1) current BPA UES deemed measure values and 2) current RTF values[63]. In addition, the team will attempt to provide an overview of the timing and lags of BPA reporting system values to current RTF values.

[60] Version 3.0 (Valid through Sept. 30, 2015) https://www.bpa.gov/EE/Policy/Solutions/Pages/default.aspx
[61] Navigant could not map measures within the Fixtures TAP to a RTF workbook due to lack of lamp information.
[62] RTF UES values reference different removal and storage rates for the different delivery mechanisms, resulting in different savings value.
[63] http://rtf.nwcouncil.org//measures/

Table 43. Summary of Identified Discrepancies within the Residential Lighting Domain

Measure Group	BPA Delivery Mechanism	RTF Delivery Mechanism	RTF workbook version
LEDs	By Request (Over-the-counter)	Documented requested in-person give-away. Unit must comply with Energy Star specifications.	ResLightingLED_v3_0
CFLs	By Request (Over-the-counter)	Give-away/Mail by Request	ResCFLLighting_v2_2
Specialty CFLs	By Request (Other distribution method)	Retail	ResSpecialtyLigthing_v1.2

Source: Navigant Analysis

Residential Lighting Domain – Delivery Verification Requirements

The RTF Guidelines stipulate that for Proven measures, which make up the majority of this domain, savings assessment can be completed via delivery verification, i.e., savings equals the verified delivery quantity multiplied by the proven UES savings value. In May of 2015, the RTF defined the delivery verification requirements for the Residential Lighting domain. As summarized in Table 46, the requirements vary by delivery mechanism and not lamp or program type.

Table 44. Delivery Verification Requirements

Measure Parameter	Delivery Mechanism Retail	Delivery Mechanism Direct Install & NEEA Socket Count	Delivery Mechanism Mail by Request, Unsolicited Mailing, Give Away
Measure Identifiers	✓Check savings are from retail ✓Check savings match appropriate efficient technology ✓Check savings match appropriate lamp type ✓Check savings match appropriate lumen category	✓Check savings are from direct install or NEEA socket count ✓Check savings match appropriate efficient technology ✓Check savings match appropriate lamp type ✓Check savings match appropriate lumen category ✓Check savings match appropriate room type	✓Check savings are from mail by request, unsolicited mailing or give away ✓Check savings match appropriate efficient technology ✓Check savings match appropriate lamp type ✓Check savings match appropriate lumen category
Savings Baseline	n/a		
Implementation & Product Standards	✓ Check that CFL or LED is on the Energy Star Qualified list		
Sunset Date	n/a		

Source: RTF, First Batch May 2015

Residential Lighting Domain – Documentation Requirements

The following table provides the detailed documentation requirements for the residential lighting measure groups included in the CY2016 evaluation.

Table 45: Documentation Requirements by Delivery Mechanism

Distribution Type	Requirements and Specifications	Documentation Description (Retain in Customer File)
Direct Install	Customers must (1) physically install measures, (2) witness installation or (3) visually inspect a representative sample after installation by another party.	Completed Measure Distribution Documentation form (available in the Document Library) or equivalent form with required information.
Retail Markdown	• Customers may use in-store markdown or end-user coupons. • For in-store markdown, customers must submit a store sales report for each participating store with date, manufacturer, model number. Measure type and any other identifying elements of each sale generated by the promotion. Reports must document the allocation methodology when a store serves multiple utility customers.	Store sales reports or, for coupons, other documentation that product meets BPA's requirements.
Direct Mail/Mail by Request	The requirements and payment levels in place on the date the product enters the mail stream apply (i.e., for drop shipments, the "round stamp" date on United States Postal Service (USPS) form 8125 and for straight mailings, the "statement certification date" of USPS form 3607R).	Completed Measure Distribution Documentation form (available in the Document Library) or equivalent form with required information.
Over-the-Counter (e.g., distribution at customer events or customer's office or left a customer's house upon request)	Customer representatives must distribute measure to verified end users.	Completed Measure Distribution Documentation form (available in the Document Library) or equivalent form with required information.
Other	See your COTR for requirements and specifications.	See your COTS for requirements. At a minimum, required documentation includes date of distribution, distribution recipients and quantity.

Source: BPA Implementation Manual, Oct 2014

Residential Lighting Domain – Changes to Measure Distribution in 2015

Effective April 1, 2015, the following changes were made to measures included within the existing residential lighting delivery mechanisms.

Table 46: Updated Delivery Mechanism Definitions

Effective April 1, 2015 the following Measure Distribution Processes will take effect.

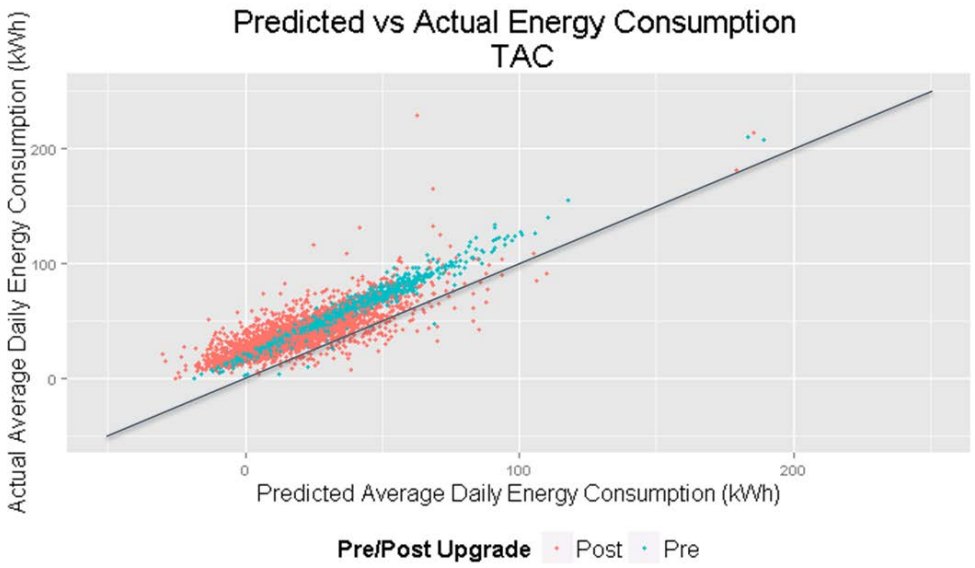
Distribution Type	Requirements and Specifications	Documentation Description (Retain in Customer File)
Retail	• Customers may use in-store markdown or end user coupons. • For in-store markdown, customers must submit a store sales report for each participating store with the date, manufacturer, model number, measure type and any other identifying elements of each sale generated by the promotion. Reports must document the allocation methodology when a store serves multiple utility customers. • Coupons must contain the (utility) customer name and end-user address and require the customer to (1) document that the product meets BPA's requirements or (2) create store sales reports.	Store sales reports or, for coupons, other documentation that product meets BPA's requirements.
Mailed, Non-Request (CFL and LED bulbs only)	The requirements and payment levels in place on the date the product enters the mail stream apply (i.e., for drop shipments, the "round stamp" date on United States Postal Service (USPS form 8125 and 3607R).	Completed Measure Distribution Documentation form (available in the Document Library) or equivalent form with required information.
By Request	Mail by Request-see requirements for Mailed, Non-Request above	
	Other delivery mechanisms that include distributing produces "over the counter", at events, or otherwise directly to the customer upon their request.	
Direct Install	Customers must (1) physically install measures, (2) witness installation or (3) visually inspect a representative sample after installation by another party.	

Source: BPA Implementation Manual, Oct 2014

Appendix D: Sample Graph for Outlier Analysis

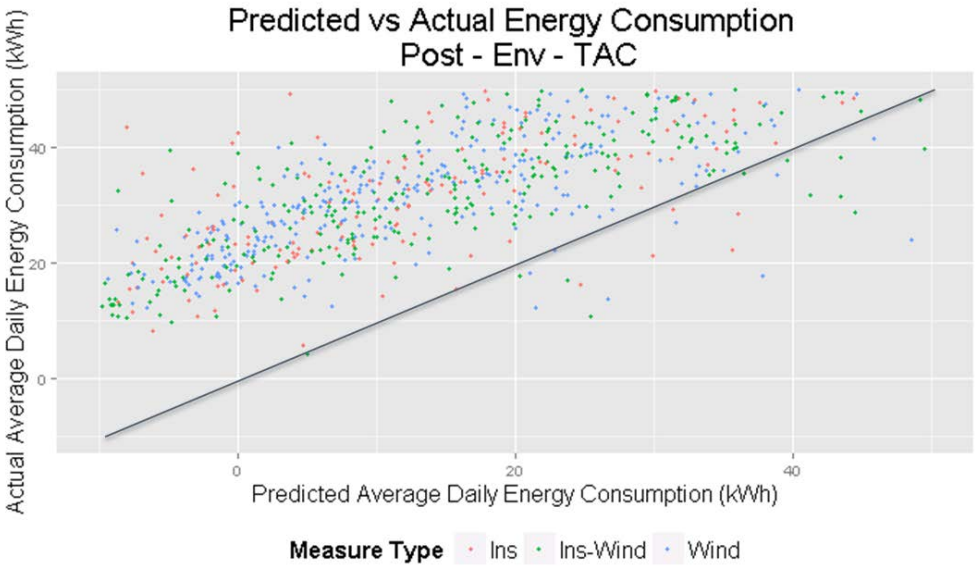
As discussed in Section 1.5.1, Navigant will graph model predicted energy consumption versus actual energy consumption as shown in the following figures, (which are meant only to provide examples).

Figure 18: Outlier Analysis – Sample Graph



Source: Navigant analysis

Figure 19: Outlier Analysis – Sample Graph



Source: Navigant analysis

Appendix E: Utility customer Contact Protocol Supporting Documents

Sample Letter for Primary Site Contacts

INSERT Example Utility Logo

2016

Dear [Utility Name] Customer:

Our records show that you have participated in the [Utility Program Name] Program in [Year of Participation]. Thank you for your participation.

The purpose of this letter is to inform you that you have been selected at random to participate in a research study of the effectiveness of [Utility Name & Utility Program Name] Program, and you may be contacted soon by telephone with a request for your participation in a short phone survey to gather information about your program equipment. [Utility Name] has contracted Navigant Consulting to conduct this study.

We appreciate your support of [Utility Name]'s energy efficiency efforts and we are grateful for your participation in this research. The information you provide will help determine the effectiveness of existing efficiency programs and assist in the design of future programs. Your participation in this study will not affect your bill through [Utility Name].

All data collected during this research will remain confidential. If you have any questions, please contact [Utility Name].

Sincerely,

[Utility Representatives' Names, Signatures and Contact Information]

Sample Call Center Talking Points

[Utility Name] is currently employing Navigant Consulting (NCI) to conduct an evaluation of its energy efficiency programs. This fall, the evaluation team is conducting phone surveys for [Utility Name] customers for its [Utility Program Name] Programs.

Between [Start date of site visits] and [End date of site visits], the evaluation team is fielding a phone survey to [Utility Program Name] participants. Table 49 provides key contact information by role.

Table 47. Evaluation Team Contact Information

Who	Role	Contact	What	When
Navigant [Evaluation Team Member's Name]	[Utility Program Name] [Role]	TBD	Site visits	TBD

Table 50 summarizes the evaluation efforts, including duration and target number of completed surveys.

Table 48. Evaluation Information

Evaluation Effort	Estimated Number of Completes	Estimated Duration
Site visits [Utility Program Name]	TBD	TBD

If the customer has any further questions, please direct them to [Utility Representative Name and Contact Information].

Appendix F: Sample List of FAQs for Sampled End Users

Q: What is the purpose of the study?

This study is being conducted to determine energy savings associated with [Utility Program Name]. In order for utilities to offer reliable and cost-effective [Utility Program Name] program, we need data to prove [Utility Program Name] practices save energy. Studies like this one allow Northwest utilities to continue to provide energy-saving programs.

Q: Who is sponsoring this study?

A: This study is sponsored by Bonneville Power Administration in partnership with your local utility.
Bonneville Power Administration conducts studies like this every few years to evaluate energy efficiency program opportunities. Past studies are available on the Bonneville Power Administration website located at http://www.bpa.gov/ .

Q. Is there a cost to participate?

A: No. Participants will not be responsible for any costs associated with participating in this study. Any equipment used on site will be provided by Bonneville Power Administration or participating study partners.

Q: How are participants selected for this study?

A: All participants were selected randomly.

Q: How will my information be kept secure?

A: During the course of this study, all personal information, energy use, and other provided information will be protected on a secured website. All research data will be presented in aggregate, and no reports published internally or externally will contain any personally identifiable information.

Q: Who is the primary contact for this study?

A: The primary contact throughout the study period will be your utility account representative.

Q: What are the benefits of participating?

A: Participants will be assisting in a very important study that will ensure that energy efficiency strategies are effective and delivering value to customers. At the end of the study period, a report will be published identifying the results for the [Utility Program Name]. This report may provide guidance for future participants of the [Utility Program Name].

Q: Can I volunteer to participate if I was not selected for the study?

A: Unfortunately, no. Since this is a randomized study, only participants of the [Utility Program Name] who was randomly selected will be invited to participate.

Appendix G: Sources of Error & Mitigation Strategies

The Navigant team's evaluation approach will include a reliability assessment to reduce threats, bias, and uncertainty in the evaluation activities. Potential sources of errors and mitigation approaches for these evaluations might include the following:

1. **Non-Response Bias:** Non-response bias is always an issue when conducting surveys of voluntary participants. If phone surveys are utilized in 2016, the evaluation team will employ industry standard techniques for mitigating the impact of non-response. These include stratifying the sample, making phone survey calls at varying times of day and evening, and calling sampled participants at least seven times before removing them from consideration. The evaluation team will enlist BPA staff to make initial utility contacts and follow up to ensure participation of sampled utilities.
2. **Sample Bias:** The sample will be drawn with representativeness targets as described above. Quotas for representativeness reduce the likelihood that a random sample will misrepresent the population, by ensuring that the sample population represents the participant population with respect to whichever parameters, if any, exist that correlate to savings.
3. **Self-report bias:** When end-users are asked questions as part of a survey, the accuracy of their responses are subject to biases and errors in their memories or in their interpretation of past events. While meaning to provide truthful answers, end-users may give responses that contain information that is different than would have been collected on-site, leading to biased data. Navigant will mitigate this bias by asking specific questions that may help the respondent to recall their experiences with the program. The Navigant team will utilize its best practices developed from its previous experiences with end-user surveys to ensure the correct questions are asked in the proper method.
4. **Methodological Error:** The evaluation work conducted will include careful analysis and quality control to ensure that results have real meaning and do not overstate the conclusions that can be derived from the available data. In some cases, the evaluation team will conduct method review sessions with outside experts, including utility and RTF staff.