Opinion Dynamics

Memorandum

To: Jonathon Jackson, AIC; Jennifer Morris, ICC Staff
From: Opinion Dynamics Evaluation Team
Date: July 26, 2018
Re: Evaluation Approach for Tier 2 APS Pilot

This memo outlines our proposed research approach for estimating energy savings for Tier 2 Advanced Power Strips (APS) – Residential Audio Visual to 1) update and inform the current values in the Illinois Statewide Technical Reference Manual (TRM)[1] and 2) better understand whether these classes of technologies merit inclusion within the DSM portfolio.

Technology Overview

This research plan addresses TrickleStar's Tier 2 Wi-Fi PM APS technology, a Tier 2 APS measure. This measure is a multi-plug power strip that removes power from audio visual equipment through intelligent control and monitoring strategies. The TrickleStar technology provides seven outlets for electronics, which offer different features. The first is for television (the control outlet), two outlets for 'always on' technologies such as cable boxes ('always on' outlet), and four outlets that switch technologies on or off such as stereos, DVDs, speakers or game consoles (switch outlets). The switch outlets are turned off or on depending upon infrared or motion sensors embedded within the technology.

This technology logs energy (kW/s) at 30 and 60 second intervals on an hourly basis for the 1) control outlet, 2) aggregated 'always on' outlets, and 3) aggregate switch outlets. Data is captured over Wi-Fi or via a microSD card and can be stored for up to one year. These technologies can be controlled to provide either Tier 1[2] or Tier 2 APS functionality.

Per conversations with the manufacturer, the anticipated range of savings for these devices is 160-240 kWh annually, but could vary depending upon baseline usage, in-service rates, and persistence. Factors driving energy savings also include how the technology is used, such as 1) the countdown timer setting (one or two hours), 2) the number of controlled devices (more devices result in higher savings), and 3) the types of products controlled (e.g., game systems versus stereos).

Research Approach

Our proposed research approach is designed to quantify each input in the existing IL-TRM V6.0 algorithm. The current IL-TRM approach to estimating energy savings for Tier 2 APS is:

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[1] Illinois Statewide Technical Reference Manual – 5.2.2 Tier 2 Advanced Power Strips (APS) – Residential Audio Visual, pp. 56. http://ilsagfiles.org/SAG_files/Technical_Reference_Manual/Version_6/Final/IL-TRM_Effective_010118_v6.0_Vol_3_Res_020817_Final.pdf

[2] Tier 1 APS are multi-plug surge protector power strips with the ability to automatically disconnect specific connected loads depending upon the power draw of a control load, also plugged into the strip

$\Delta kWh = ERP * BaselineEnergy_{AV} * ISR$

Where:

- ERP = Energy Reduction Percentage of qualifying Tier2 AV APS product range
- $BaselineEnergy_{AV}$ = 432 kWh
- ISR = In Service Rate.

Research Design

The current IL-TRM Tier 2 APS measure addresses direct install applications only. As a result, based on the current suite of AIC programs, we believe the HEIQ program is the best place to operationalize the study by leveraging existing program implementation efforts. In particular, using this program delivery channel allows for cost-efficiencies given that program staff can install the Tier 2 APS as part of their normal activities. Further, if this research identifies cost-effective energy savings, the study approach will mimic how the technology will likely be deployed in AIC's portfolio (as part of multi-measure direct install programs, rather than a stand-alone offer to income qualified, multi-family and single-family households).

We will randomly select customers who participate in the HEIQ program in 2018 and 2019, using a randomized control trial design, to install the APS Tier 2 technology. In this approach, we set part of the study population as treatment and the rest as control for the duration of the study period. We understand that Tricklestar has the capability to remotely change the functionality of the device once installed to on (Tier 2) or off (manual) mode. As such, Opinion Dynamics will randomly select participating customers for treatment and convey that selection to Tricklestar at the start of the pilot. Notably, all devices installed require access to Wi-Fi to support remote capture of APS telemetry data, and will be part of the eligibility criteria for participating in this study. Some customers (the control group) will have their device in "off" mode with manual functionality, the others (the treatment group) will be in "on" mode for Tier 2 functionality. We will work with Tricklestar to validate that the correct customers are in each group following pilot rollout.

The benefit of this RTC approach is that it provides an estimate of energy savings associated with the isolated effect of replacing a standard power strip (always on) with a Tier 2 device. This effort also precludes the need to establish a pre-period prior to the installation of the equipment because it develops a baseline of energy consumption by randomly placing customers into on or off mode. This is done by switching the devices into different functional modes in a random way such that we can identify the effect of device operation. It is important to note that this approach will not estimate differences in energy savings for customers due to changes in their behavior that may be caused by installing the device (e.g., if there are any behavioral changes in the home due to the mere presence of the device).

This study will be conducted over a minimum six to eight-month period. We chose this study duration for two reasons: 1) to develop a robust estimate of in-service rates and persistence of the installed technology, and 2) to mitigate any bias associated with changes in energy consumption due to seasonality. The duration of the study advances the industry knowledge related to persistence of these devices within homes and mitigates concerns related to differences in energy consumption over time.

Sample Design

The optimal sample size for this study is 400 HEIQ participants. We conducted a power analysis[3] to determine the required number of sample points sufficient to detect energy savings, if effects are present. The power analyses assume we will use daily device telemetry data within the impact analysis. We considered multiple scenarios based on (a) the effect size (percent savings) and (b) variation in energy usage (reflected in the coefficient of variation (CV) of daily usage).[4] We designed the power analysis to detect the specified effect size with 80% statistical power at a 90% statistical confidence level. We assume a coefficient of variation (CV) of 1.0. We employed a conservative effect size of 10% to 15% savings per device and Table 1 provides the results of the power analyses. This sample of 400 will be large enough to mitigate customer attrition, changes in outlet use, or removal of the device.

Table 1. Power Analysis: Sample Sizes Needed Study

Group	10% Effect Size	15% Effect Size
Treatment	200	90
Control	200	90
Total Sample Points	**400**	**180**

Analysis Plan

We will use a regression modeling approach to measure energy savings and baseline consumption. More specifically, we will use a Difference-in-Difference approach, using APS telemetry data, to estimate the energy baseline, as well as the change in energy that results from the device. In addition, we will use telemetry data to identify an in-service rate.

Study Advantages and Limitations

We selected this research design because it will provide the most actionable information to update the IL-TRM and support decisions related to inclusion of this measure in AIC's portfolio.

- This study is designed to ensure that the energy savings are detectable, if savings are present. An alternative approach to estimating impacts is to use AMI data. While this approach has some advantages, namely pre-installation energy consumption, it is unlikely to yield detectable and isolatable impacts for the technology without substantial participation. This is because the effect size for the measure is small relative to overall household consumption, and because these measures will be installed with other measures as part of the HEIQ direct install program design.
- This study offers the most cost-effective approach to estimate the effects of Tier 2 APS operations, rather than installation. We understand that simply installing the device in a household may change customer energy behavior on the circuit. However, we hypothesize that this effect may be marginal

[3] A power analysis informs the number of sample points that must be included in an impact assessment to have a reasonable expectation of the impact assessment seeing changes, if the changes are present. Power analysis is largely a function of the number of sample points and the variation of energy use across the sample points. We used *Measurement and Verification Principles for Behavior-Based Efficiency Programs*. The Brattle Group. May 31, 2011 as the source for our calculation methodology.

[4] The coefficient of variation is a standard measure of variance in the data that is standardized by the associated mean of the measure of interest, calculated as the ratio of the sample standard deviation to the sample mean. A higher CV reflects more variation.

compared to the operational savings impact. An alternative approach to estimating installation and operational impacts would be to install a Power Meter prior to the installation of the device to capture a pre-installation baseline (4 months), followed by installation of HEIQ measures with the Tier 2 APS technology (4 months), and remote operation of Tier 2 functionality (4 months). The cost of Power Meters coupled with the cost of two additional in-home visits, with marginal anticipated benefits, makes this approach less optimal.

Despite these benefits, we acknowledge that there are limitations associated with the study design:

- The study does not estimate behavioral savings associated with installing the device. As noted above, we believe that the proposed study approach is the most cost-effective way of estimating the majority of energy savings from these devices. If there is interest in estimating this behavioral impact, we would recommend installing a Power Meter to capture sufficient pre-period data (see bullet above).
- This study focuses exclusively on HEIQ participants, and these customers may have different plug-load usage than other customers. Specifically, there may be variations across populations in terms of the type and age of plug-load meaning that energy savings determined through this study may not be generalizable to other AIC residential customers. In addition, we understand that AIC's income qualified customers have lower access to Wi-Fi than other AIC customers (69% of low income as compared to 89% for non-low income), which means that results may also not be generalizable to customers without Wi-Fi.