Tier 2 Residential Advanced Power Strip (APS)

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Presentation Overview

Objective: Seeking TF position on field trial methodologies

- Clarify the differences between CalPlug's field trial methodology with Pre/Post Monitoring using HOBOs
- Cover the 9 sample Pre/Post Monitoring from ET Study
- Seek TF feedback on the two approaches and how it impacts future data collection studies

Advantages/Disadvantages of Both Approaches

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The relevant differences between the CalPlug and pre-post monitoring approaches that motivated the use of both methods are as follows.

CalPlug method advantage
Eliminates variability in usage patterns between pre and post timespans

CalPlug method disadvantage
May not fully account for user interaction with APS when system is turned off (since simulated)

Pre-post monitoring advantage
Includes all user interaction effects and feedback with APS controls when A/V devices are turned off.

Pre-post monitoring disadvantage
Cannot control variability in usage patterns between pre and post timespans without prohibitive, long-term monitoring.

NOTE: The instrumentation uses a flashing LED light to alert the host site users as the actual APS device would, in order to illicit a remote control response. However, if the test subject did not respond to the M&V instrumentation's LED light but would have turned the TV back on in an actual APS application, results will be skewed. – **It should be noted that all trial participants were specifically advised and shown how to respond to the LED light flashing during the field trial. – They were requested to push the button on their remote until the LED stopped flashing . – This was the only variable in the trial CalPlug field trial.**

Pre/Post HOBO Monitoring

- Traditionally pre/post metering trials have been used to determine the energy saving performance of different technologies. However even slight variability in device usage patterns within the same household presents a large challenge in determining the actual energy saving performance of Tier 2 APS devices.

- This **variability** in usage patterns from one period to the next **necessitates both larger sample sizes and longer trial periods** to deliver a level of confidence in the energy saving performance of the device being tested when pre/post metering is used for field trial purposes.

- However, a pre/post field test large enough for statistical significance would be quite expensive and creates a barrier to the feasibility of the field test.

- To date there has not been a pre/post field trial conducted that has removed or tracked the uncontrolled variables which will lead to incorrect conclusions on energy savings.

SDG&E ET Field Trial Study Additional M&V on 9 homes Using HOBOs

- 9 sites were selected for additional post-installation monitoring to supplement the primary M&V approach and to provide further data for evaluation.
- These sites were post-monitored with HOBO plug load data loggers after the actual APS had been installed upon removal of the CalPlug method instrumentation and monitored for 21 days.
- HOBO plug load loggers were installed in series with the actual A/V APS device upon removal of the custom instrumentation units.
- The timer was set to 1 hour as in the simulation. Although no remote control data or other was collected during this post-installation period except for total energy used. It was previously determined that annual usage estimates reach a steady state fairly quickly, but this does not account for variability in how the equipment is used which will alter energy savings.

SDG&E ET Field Trial Study Additional M&V on 9 homes Using HOBOs

- Results suggests 32% energy savings from the baseline using HOBO logging instead of 50% in the CALPLUG SVS field trial approach

Method	# of Sites	Baseline Annual Usage [kWh]	Std Dev [kWh]	Annual Savings [kWh]	Standard Deviation [kWh]	% Savings	Standard Deviation
CalPlug	42	463	317	234	183	50%	14%
Pre-post	9	461	160	134	57	32%	14%
Total set derated by pre-post findings	42	463	317	149	117	32%	9%

- The HOBO pre/post approach approximates to 64% of the simulated savings from the CALPLUG SVS field trial approach
- It should be kept in mind that both the CalPlug and pre-post approaches have advantages and deficiencies, as discussed in the M&V approach section which led to the selection of the CalPlug methodology over pre/post metering.
- The difference in findings should be only considered in light of the differences between the two approaches and how the deficiencies were addressed or not addressed in each approach.

Summary

- Both methods have limitations due to their treatment of various uncontrollable, independent test variables relating to user behavior and usage patterns.
- The CalPlug methodology was selected due to it consisting of only one variable (which was addressed via the field trial methodology).
- A summary of the data collected, the “uncontrollable” variables in each approach and how they were addressed for each trial is provided on slide 8.
- As such, results from both methods should be viewed for the statistical significance and ability to monitor and address trial environment independent behavioral variables

Field Trial Approach Summary Table

	Field Trial Approach	
	CalPlug Method	**Pre/Post Hobo**
Household Samples	61 Samples	9 Samples
Data Frequency	Second by Second	Minute by Minute
Data Points Monitored	10 parameters including Voltage, Current, True RMS Power, IR, Instantanious Energy Used/Saved, Total Cumulative Energy Used/ Saved, Power Down Timer, Time/Date	Total Cumulative Energy Used
Data Points Acquired	737,856,000 - 14 GB	272,000
Variables Removed via Field Trial Approach	Simulation mode removes the variables associated with changes in, the duration individual devices are used, variability of devices being used, weather condition effects, number of household occupants, duration of household occupation and changes in TV schedules.	Hobo Logging captures householder reaction to T2 APS control process
Variables Unremoved / Managed via Field Trial Approach	Simulation mode addresses householder reaction to T2 APS control process by continuously flashing a bright LED light via the IR sensor during an energy saving event.	Nil - variables can only be managed through a very large sample set over an extended period of time.

TF Feedback on Both Approaches

- Given the detailed data collected via the CalPlug field trial method, will hobo pre/post logging of the same sample size be statistically significant?
- Do we need to select one field trial approach or specify sample sizes based on the field trial approach being suggested at the time and the data being collected?
- Should the level of data parameters monitored in a field trial approach determine the number of sample sites required for a field trial to reach statistical significance?
- Given all the information available, what additional information (if any) should be added to the work paper?

Appendix Slides

CALPLUG SVS Field Trial Methodology

Given these challenges, below is an outline of the key field trial execution requirements assessing Tier 2 APS devices:

- The field trial should occur in actual targeted environments (i.e. households and/or offices)
- The field trial approach should require minimal or no change in householder's interaction with their devices
- It should provide a detailed understanding of equipment usage patterns in the field trial environments
- Data shall be acquired each second for each in situ field trial environment to allow for detailed analysis of household energy and device usage and Tier 2 APS device functionality
- The Tier 2 APS device should be set to "log mode" and equipment connected to the energy saving device is monitored but not controlled by the Tier 2 APS device
- The APS device should record (every second) its decision points to track when the energy saving mode was enacted (i.e., the power to the connected equipment was switched "off"), Note - The APS device must be configured to not turn off the equipment but to monitor when it would have isolated power to the connected devices.
- All data threads should be date and time stamped (synchronised) as this will facilitate a high level of data interrogation of the power consumption data acquired.

This approach will enable real time monitoring of power consumption and energy savings while the energy saving device simulates its actual operation.

Furthermore, this logging approach allows for the monitoring of the actual power usage trends and the potential impact of the Tier 2 APS device, without distorting the equipment usage characteristics of the household by the Tier 2 APS device itself. This significantly reduces the variability in pre/post device installation metering and is the recommended approach to best determine the energy efficiency impact of Tier 2 APS devices.