Michigan Tier 3 Thermostat Calibration Study Plan

Presentation to Energy Waste Reduction Collaborative

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Agenda

1	Background
2	Objectives
3	Method and Approach
4	Schedule

Background

- Tier 3 thermostats were added to the 2016 Michigan Energy Measures Database (MEMD).

  Measure Description: Tier 3 thermostats are enhanced by data gathering and analytics functionalities, which enables them to use a variety of methods to optimize HVAC settings for efficient and automated energy consumption. Specifically, a Tier 3 thermostat is defined as a thermostat that is compatible with the participant's HVAC system, and has:

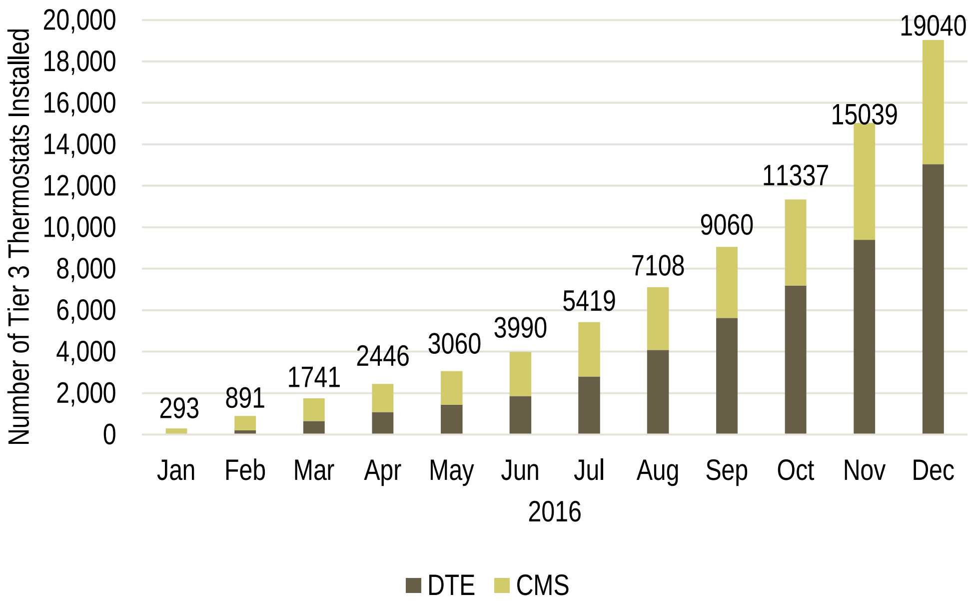
    - *Two-way communication,*
    - *Occupancy detection (through the use of occupancy sensors, geo-fencing, etc.), and*
    - *At least two of the following features: scheduled learning, heat pump auxiliary heat optimization, up-staging/down-staging optimization, humidity control, weather-enabled optimization, and free-cooling/economizer capability.*

- The heating and cooling savings estimates were based on 12 thermostat studies from across the United States, rather than primary data from Michigan.
- The measure was included in the MEMD with the expectation it would be calibrated once sufficient Michigan-specific data were available.

Background

- In 2016, DTE Energy (DTE) installed 13,047 Tier 3 thermostat and Consumers Energy (CMS) installed 5,993 Tier 3 thermostats
- Based on the results of a power analysis, there will be a sufficient number of thermostats installed with at least 12 months of post-installation data by December 2017

Figure 1. Number of Tier 3 Thermostats Installed in DTE and CMS Service Territories in 2016



Objectives

The objective of the Michigan Tier 3 thermostat calibration study is to calibrate the Tier 3 thermostat measure for inclusion in the 2019 MEMD.

1. Conduct primary research to calibrate electric energy savings factor for space cooling and heating, and gas energy savings factor for space heating.

2. Conduct secondary research to determine the efficiency level of baseline equipment in Michigan, incremental cost, and measure life.

Method and Approach

The Michigan Tier 3 calibration study will use regression analysis and secondary research to calibrate energy savings, incremental cost, and measure life. This study includes four tasks:

1. Data Management
2. Savings Analysis
3. Review of Baseline, Incremental Cost and Measure Life
4. Whitepaper Update and Reporting

Data Management

This task involves collecting, combining and cleaning program tracking data, monthly energy consumption data, and weather data.

- 2014-2017 Program Tracking Data from DTE and CMS
- 2014-2017 Residential Monthly Energy Consumption Data (Electric and Gas) from DTE and CMS
- 2014-2017 Michigan Weather Data from National Oceanic and Atmospheric Administration

Savings Analysis

The savings analysis[1] will result in calibrated energy savings values (electric and gas).[2]

Matching

Develop a comparison group based on pre-program energy consumption to serve as the counterfactual

Estimation

Use a regression-based approach to estimate energy savings (electric and gas)

Uplift

Conduct a data-based analysis to quantify and account for potential overlap in savings

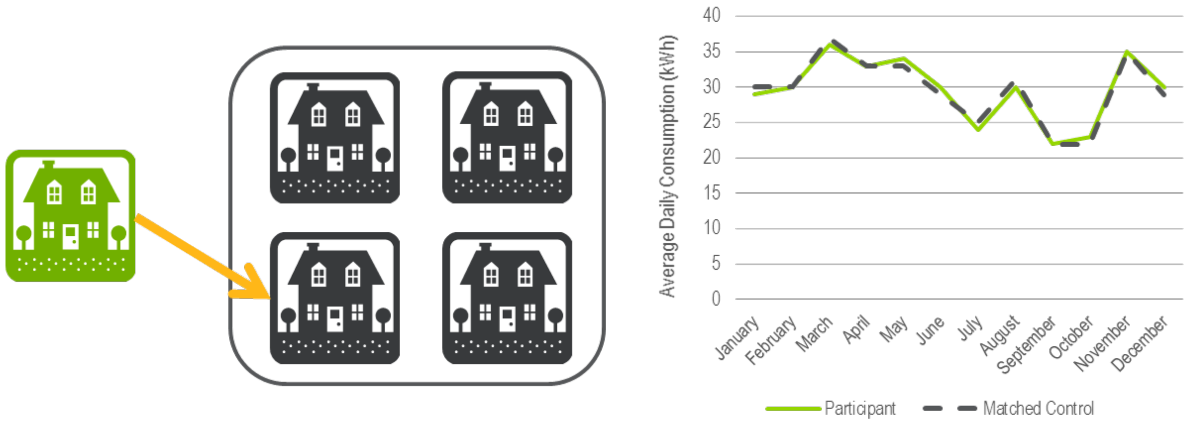
[1] The evaluation team is currently using the proposed method to update the residential advanced thermostat measure in the Illinois Technical Reference Manual Version 7.

[2] Evaluation studies to date have found negligible coincident peak demand savings associated with thermostats. As such, the sample sizes required to estimate coincident peak demand savings with statistical precision using billing analysis is an order of magnitude larger than the current installed base of Tier 3 Thermostats. As a result, coincident peak demand savings is not included in this calibration study and is assumed to be zero.

Matching

Matching develops a comparison group based on pre-program energy consumption to serve as the counterfactual. Matching is considered a useful “pre-processing” step in order to mitigate against model specification bias.[1]

Figure 2. Hypothetical Illustration of Choosing Matched Control Households with Similar Pre-Program Energy Usage



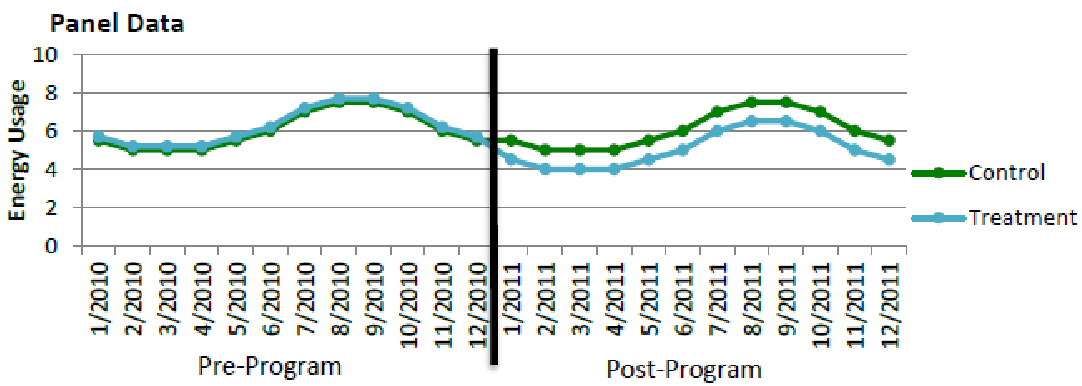
For this study, we will match on 2014 pre-program usage, by zip code

[1] A report authored at Lawrence Berkeley National Laboratory cites the regression with pre-program matching (sometimes referred to as “matched control group” or MCG method) method as a reasonable alternative to establishing baseline conditions when the “gold standard” of program evaluations, a randomized control trial (RCT), is not an option.

Estimation

This study will use a regression model with pre/post program data in a panel data set to estimate savings. Because participants and matched control groups are equivalent in energy usage except for the installation of Tier 3 thermostats (by design), thermostats must drive any differences in usage in the post program period.

Figure 3. Panel Data Illustration



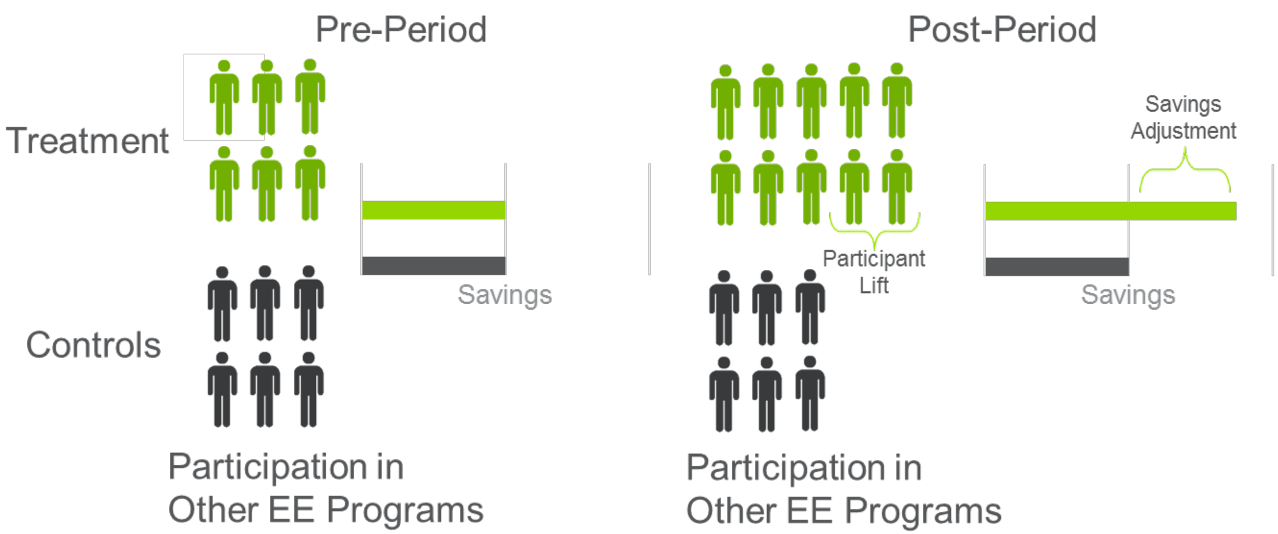
Source: SEE Action Report[1]

[1] State and Local Energy Efficiency (SEE) Action Network. 2012. *Evaluation, Measurement, and Verification (EM&V) of Residential Behavior-Based Energy Efficiency Programs: Issues and Recommendations*. Prepared by A. Todd, E. Stuart, S. Schiller, and C. Goldman, Lawrence Berkeley National Laboratory. http://behavioranalytics.lbl.gov.
Refer to Appendix A for model specification.

Uplift

The installation of a Tier 3 thermostat may increase participation in other energy efficiency programs (i.e., program uplift). To avoid double-counting, the savings associated with program uplift will be subtracted from the Tier 3 thermostat (and attributed to the lifted program).

Figure 4. Illustration of Uplift Analysis



Refer to Appendix B for Difference-in-Differences calculation.

Baseline, Incremental Cost and Measure Life Review

This task will rely on secondary research to update baseline, incremental cost and measure life.

Table 1. Proposed Approach for Review of Baseline, Incremental Cost and Measure Life

Category	2016 MEMD	Calibration Plan
Baseline	Manual Thermostat	DTE and CMS studies will be used to inform baseline
Incremental Cost	$221, if actual costs are not available	Secondary research (e.g., amazon.com, homedepot.com) of costs of prominent software integrated Tier 3 thermostats
Measure Life	9 years	Secondary research, including review of other state Technical Resource Manuals

Whitepaper Update and Reporting

This task includes developing a work paper for submission to the EWR Collaborative for inclusion in the 2019 MEMD, as well as a supporting presentation.

Schedule

Most of the analysis will take place in Q1 and Q2 of 2018.

Figure 5. Proposed Schedule

		Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun
Task 1	Data Management									
Task 2	Savings Analysis									
Task 3	Baseline, Incremental Cost and Measure Life									
Task 4	Whitepaper Update and Reporting								A	B

A - Presentation to the Energy Waste Reduction Collaborative

B - Whitepaper Update delivered to MPSC on June 1, 2018

Equation 1. Linear Fixed Effects Regression Model

$$ADU_{k,t}$$

$$= \alpha_k + \beta_1 HDD_{65,k,t} + \beta_2 CDD_{65,k,t} + \beta_3 post_t + \beta_4 post_t * HDD_{65,k,t} + \beta_5 post_t * CDD_{65,k,t} +$$

$$\beta_6 treat_k * HDD_{65,k,t} + \beta_7 treat_k * CDD_{65,k,t} +$$

$$\beta_8 post_t * treat_k + \beta_9 post_t * treat_k * HDD_{65,k,t} + \beta_{10} post_t * treat_k * CDD_{65,k,t} + \varepsilon_{k,t}$$

Where

- $ADU_{k,t}$= average daily usage for customer k during time (i.e., bill) t
- α_k = Site fixed effects, which are binary variables (one for each site) that take on the value of 1 for a given site and 0 otherwise. This variable accounts for site specific conditions, such as the number of occupants.
- $HDD_{65,k,t}$ = Heating degree days for customer k during time (i.e., bill) t at a 65°F balance temperature.
- $CDD_{65,k,t}$ = Cooling degree days for customer k during time (i.e., bill) t at a 65°F balance temperature.
- $post_t$ = A binary variable indicating whether time period t is after the installation (taking a value of 1) or before (taking a value of 0). This variable will take values of 1 and 0 for both customers who receive a new thermostat and comparison group sites.
- $treat_k$ = A binary variable indicating whether customer k is in the treated participant group (taking a value of 1) or in the comparison group (taking a value of 0). This variable will not change over time for any customers.
- $\varepsilon_{k,t}$ = The cluster-robust error term for customer k during date t. Cluster-robust errors account for heteroscedasticity and autocorrelation at the customer level.

In this model, β_9 is the estimate of average daily energy savings for space heating associated with Tier 3 thermostats, and β_{10} is the estimate of average daily energy savings for space cooling associated with Tier 3 thermostats.

Equation 2. DID Calculation

$$DID\ Statistic = \left(Program\ year\ treatment\ group\ participation - pre\ year\ treatment\ group\ participation\right)$$
$$-\left(program\ year\ control\ group\ participation - pre\ year\ control\ group\ participation\right)$$