2020 HVAC CONTROLS MEASURE CALIBRATION RESEARCH

March 16, 2021

Presented by Brett Close

Consumers Energy Count on Us

DTE

TRC

AGENDA

Project Introduction

Research Objectives & Methodology

Results

- Gas Savings
- Electric Savings

Next Steps

Consumers Energy Count on Us DTE TRC

PROJECT INTRODUCTION

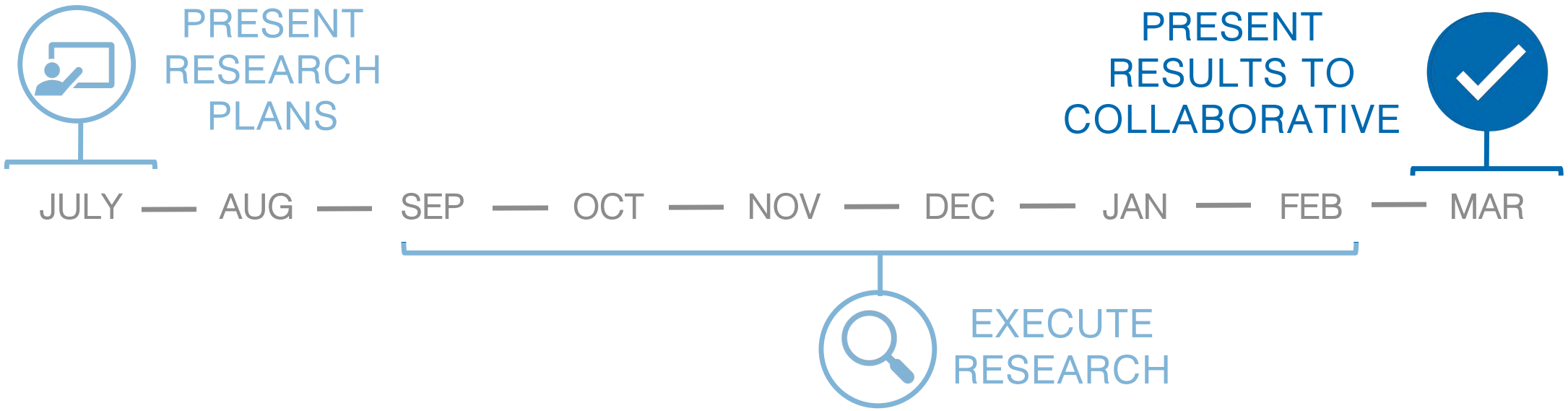
Consumers Energy Count on Us

DTE

TRC

MEASURE CALIBRATION

Measure calibration refers to the process where third-party evaluators conduct Michigan-specific research which analyzes the per-unit savings impacts for current MEMD measures.



Consumers Energy Count on Us DTE TRC

RESEARCH BACKGROUND

HVAC controls contribute substantial savings to Consumers Energy and DTE's current and planned portfolios. Current values in the MEMD lack Michigan-specific information. HVAC measure controls contribute:

- Consumers Energy: 25% of 2020 prescriptive gas plan
- DTE: 20% of 2018 gas savings

Without calibration efforts, uncertainty in these estimated HVAC controls savings is high.

WHAT WE DID:

RESEARCH OBJECTIVES & METHODOLOGY

Consumers Energy Count on Us

DTE

TRC

RESEARCH OBJECTIVES

The objective of this research is to validate energy savings (kWh and MCF/therm) values currently in the MEMD for key HVAC controls measures. Specific research questions for this project include:

- → Are the current deemed kWh and therms savings values for key HVAC control measures reflective of savings in Michigan?
- → If there is sufficient variation and sample size across weather zones: How do the savings vary across Michigan weather zones?
- → If there is sufficient variation and sample size across building types: How do savings vary across building types?

METHODOLOGY

To answer these research questions, the research team used a billing analysis, which compares a customer's energy consumption before and after installing the HVAC controls equipment to identify realized savings for the equipment.

The billing analysis controls for a variety of factors (including weather) to predict savings in a typical year based on local climate data. The next slides provide more details and illustration of this method.

METHODOLOGY

First, our research team gathered appropriate data for this analysis, including:

- Energy consumption data from Consumers Energy and DTE customers who have installed HVAC controls
- Measure installation data from Consumers Energy and DTE customers to calculate total energy savings coming from non-HVAC controls measures
- Local climate data and climate normal (TMY3)

OVERVIEW OF BILLING ANALYSIS METHODOLOGY

Next, our research team analyzed consumption data from January 2017 to October 2020.

We used site-specific regression models, meaning we modeled how energy consumption changed with weather for each individual account.

- This model “backed out” savings for installations of other measures, so that we could isolate the impact of HVAC controls measures.

METHODOLOGY: PREPARATION

Specifically, the billing analysis involved four preparation steps:

1. Clean and format data into correct time frames
2. Remove accounts with insufficient pre-installation data
3. Merge on observed and normal (TMY3) weather data
4. Calculate savings from other installed measures (non-HVAC Controls measures)

METHODOLOGY

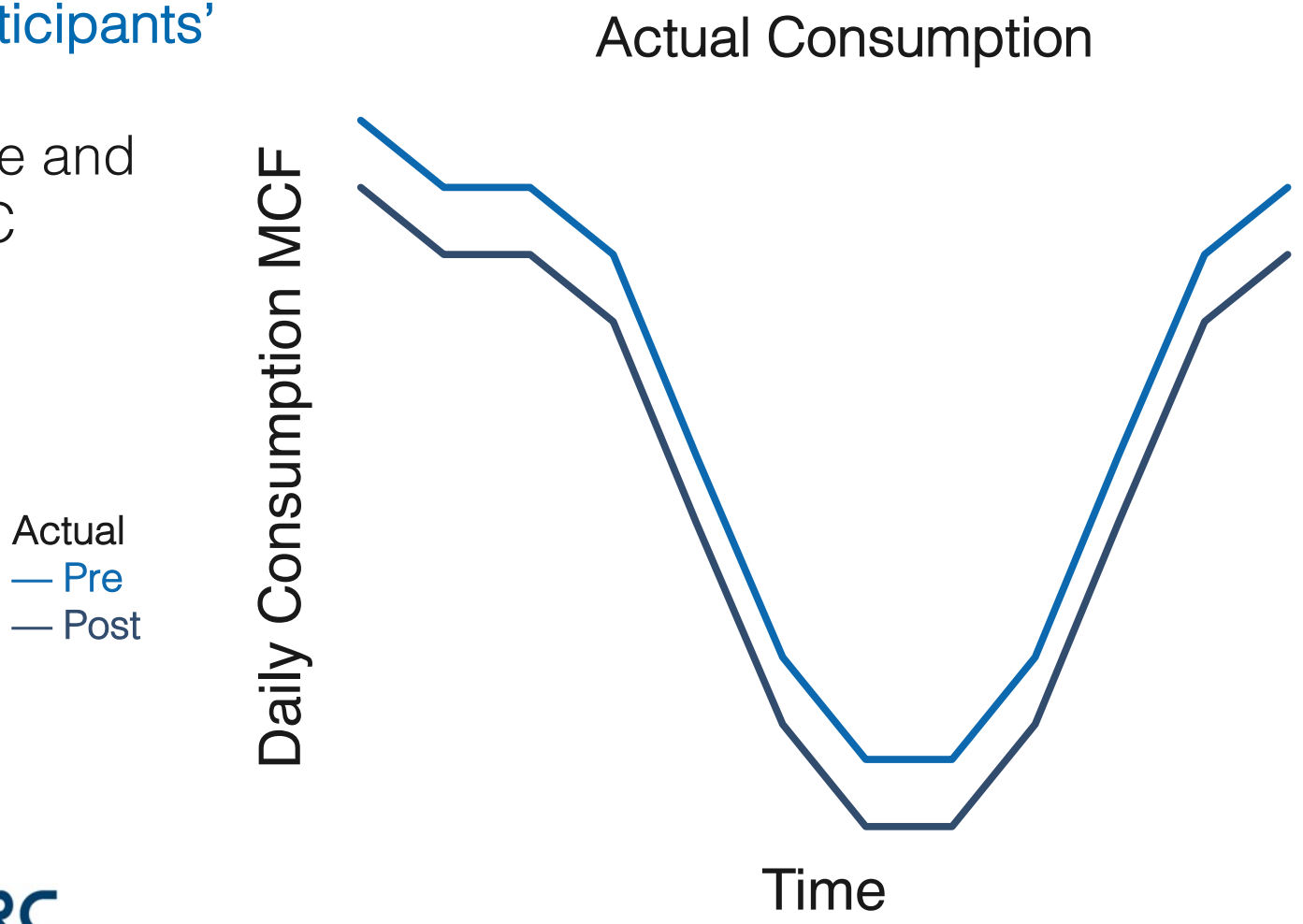
This research used site-specific modeling[1] to calculate the energy savings created by HVAC controls measures. The model is built as follows:

1. Collect a full year of billing data, as available, for the pre- and post-installation years.
2. Model the relationship between pre- and post- period facility energy use and observed weather.
3. Calculate the typical usage for the pre- and post- periods using weather normals.
4. Calculate savings as the difference between weather normalized pre- and post-period predicted annual energy use.

[1] This modeling approach is consistent with UMP chapter 19, section 4.3 and IPMVP option C.

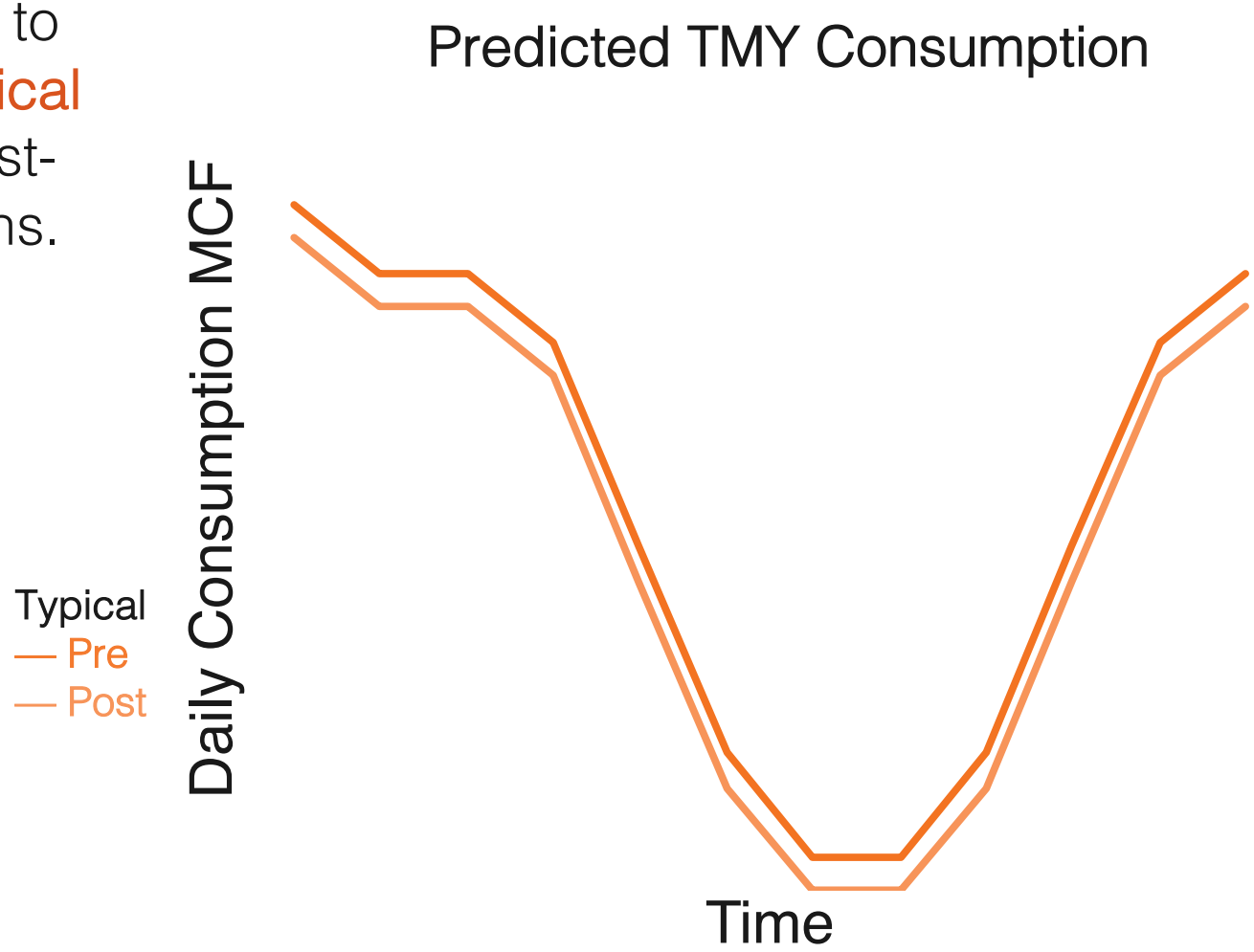
METHODOLOGY: ILLUSTRATION

First, we model **how participants' energy use responds** to observed weather before and after receiving the HVAC controls measures.



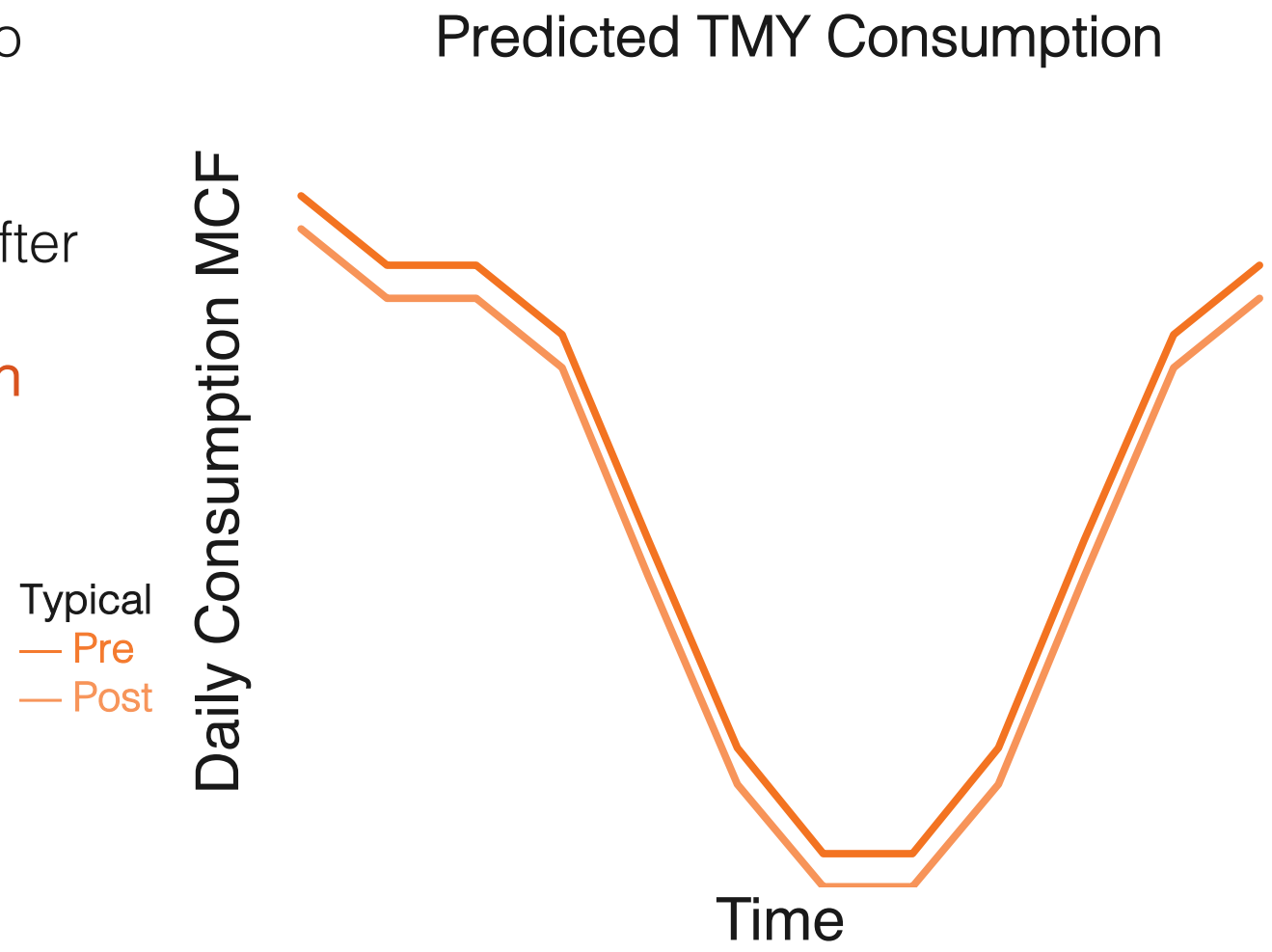
METHODOLOGY: ILLUSTRATION

Next, we use these models to predict energy use in a typical year based on pre- and post-period consumption patterns.



METHODOLOGY: ILLUSTRATION

Energy savings are equal to difference between participant's typical consumption before and after receiving HVAC controls measure – the gap between the two orange lines.



REALIZATION RATES

We are reporting our results as realization rates. A realization rate is the percent of claimed savings actually occurred. If the realization is above 1, customers saved more on average than the claims. If it's below 1, they saved less on average. Here's how we calculated them:

- Sum up all the calculated ("realized") energy savings within a measure group.
- Sum up all the claimed savings within a measure group.
- Divide the calculated savings by the claimed savings.
- We only included projects with a single HVAC Controls measure in the calculation of realization rates.

CONFIDENCE INTERVALS

Each point estimate in this presentation comes with a confidence interval. A few things to know:

- A confidence interval is a range of values, computed from the sample data, for which we have some level of confidence that it contains the population value of interest.
- Because the samples have a lot of variation in them, a confidence interval gives us a way of gauging how precise the estimate is as a way of describing the sample.
- If a point estimate is greater than 1, but the confidence interval includes 1, we do not have great confidence that the true value is actually greater than 1.

RESULTS OVERVIEW

We do not recommend changes to claimed electric savings for any HVAC Controls measures.

We recommend not claiming gas savings for Web Enabled Energy Management System (EMS).

We do not recommend changes to gas savings for any other HVAC Controls measures.

Consumers Energy Count on Us DTE TRC

WHAT WE FOUND:

ELECTRIC SAVINGS RESULTS

Consumers Energy Count on Us

DTE

TRC

ELECTRIC SAVINGS: OVERVIEW

There were three HVAC Controls measures for which we had a sufficient number of projects to run our analysis. These measures were:

- Web Enabled Energy Management System (EMS)
- Guest Room Energy Management, Electric Heating and Cooling
- Evaporative Fan Controls

For these measures, we found realization rates above 1, but with large confidence intervals. For this reason, we recommend no changes.

ELECTRIC SAVINGS: OVERVIEW

Other electric HVAC Controls measures we reviewed but did not have sufficient sample size to analyze and recommend changes:

- Chilled Water Reset Control
- Critical Zone Supply Reset
- Occupancy Sensor
- Optimal Start Stop on Air Handling Units
- Demand Controlled Ventilation (DCV)

ELECTRIC SAVINGS: OVERVIEW

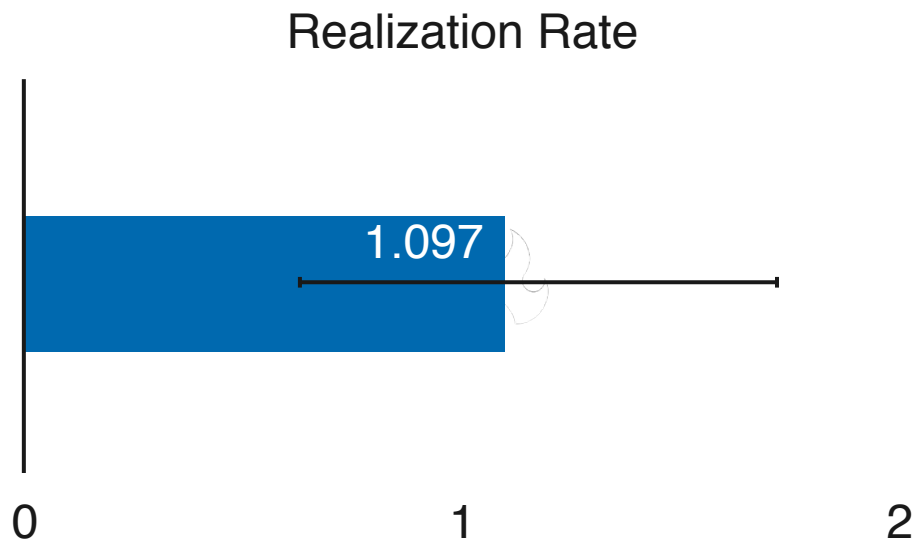
Based on our analysis, we do not recommend changes to claimed electric savings for any HVAC Controls measures.

ELECTRIC SAVINGS: WEB ENABLED EMS

Realization Rate

1.097

On average, customers saved 9.7% more per Web Enabled EMS per year that what is claimed in the MEMD.

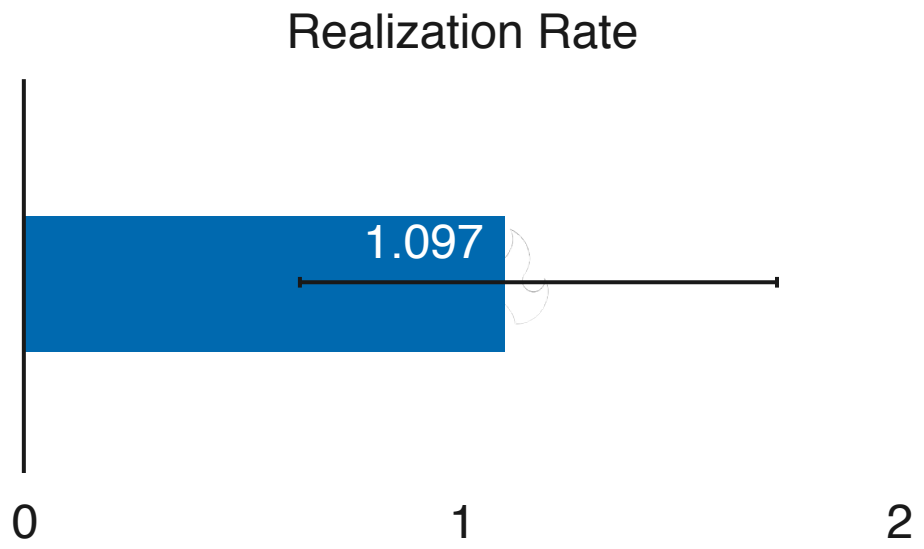


ELECTRIC SAVINGS: WEB ENABLED EMS

Realization Rate

1.097

However, the 90% confidence interval ranges from 0.6 to 1.7, indicating high variability in the sample.

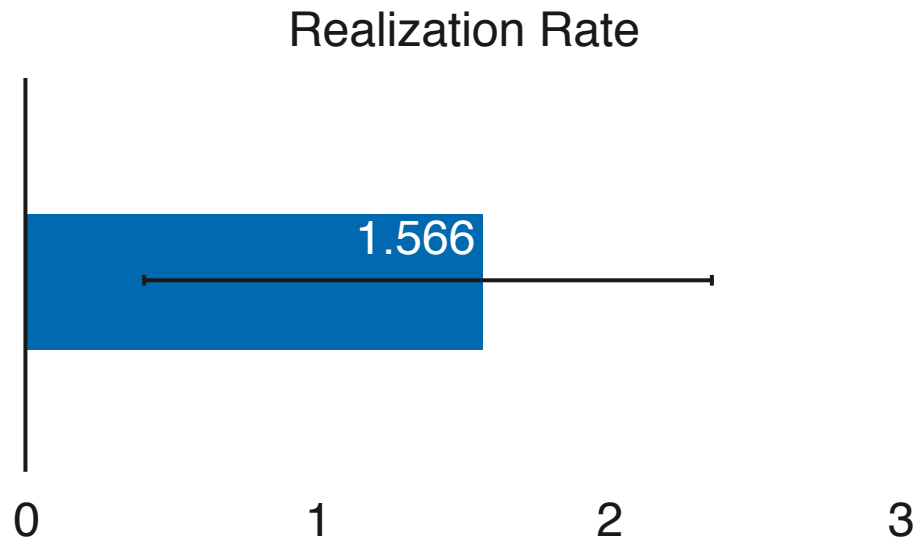


ELECTRIC SAVINGS: GUEST ROOM ENERGY MANAGEMENT, ELECTRIC HEATING AND COOLING

Realization Rate

1.566

On average, customers saved 56.6% more per Guest Room Energy Management, Electric Heating and Cooling per year that what is claimed in the MEMD.

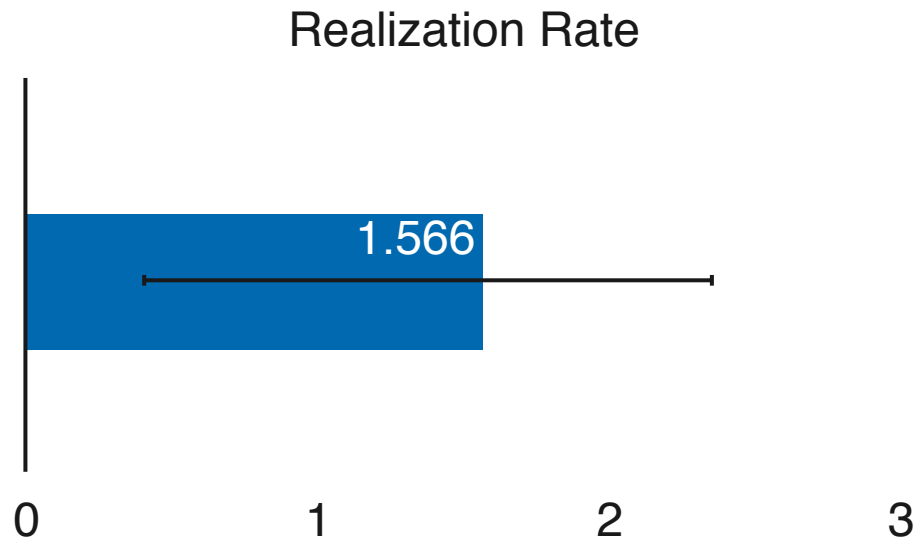


ELECTRIC SAVINGS: GUEST ROOM ENERGY MANAGEMENT, ELECTRIC HEATING AND COOLING

Realization Rate

1.566

However, the 90% confidence interval ranges from 0.4 to 2.4, indicating high variability in the sample.

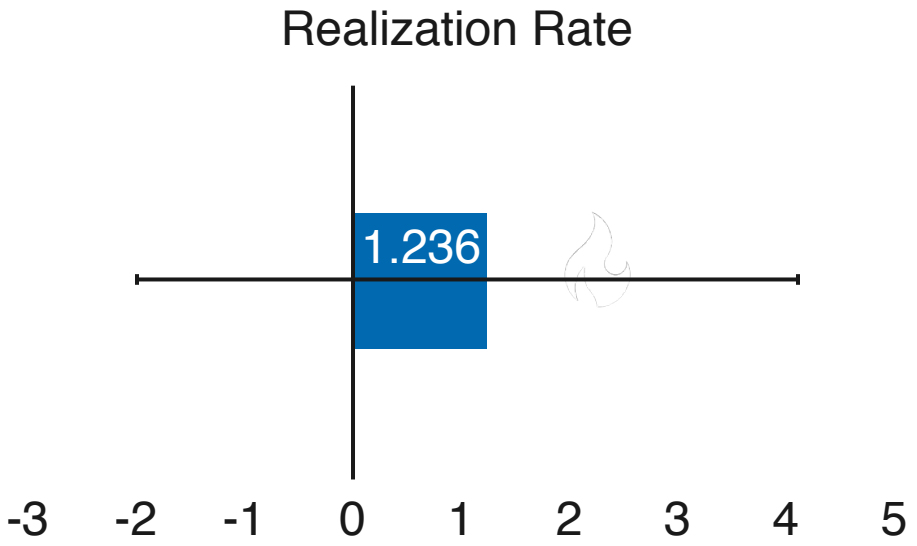


ELECTRIC SAVINGS: EVAPORATIVE FAN CONTROLS

Realization Rate

1.236

On average, customers saved 23.6% more per Evaporative Fan Control per year that what is claimed in the MEMD.

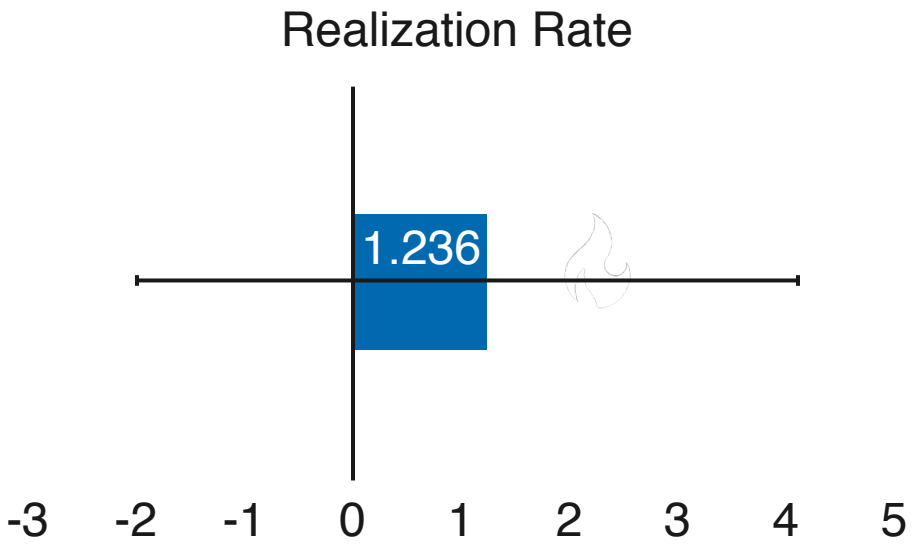


ELECTRIC SAVINGS: EVAPORATIVE FAN CONTROLS

Realization Rate

1.236

However, the 90% confidence interval ranges from -2 to 4.1, indicating high variability in the sample.



ELECTRIC SAVINGS: OVERVIEW

For the HVAC Controls measures with insufficient sample size, the primary challenge was there were limited sites with sufficient pre-period AMI data.

Due to insufficient sample sizes, the evaluation team recommends no changes to the electric savings for these measures.

Additionally, the evaluation team encountered a secondary challenge with sites installing multiple types of HVAC Controls measures, which made disentangling savings between those types of measures difficult.

WHAT WE FOUND:

GAS SAVINGS RESULTS

Consumers Energy Count on Us

DTE

TRC

GAS SAVINGS: OVERVIEW

There was only one HVAC Controls measures for which we had a sufficient number of projects to run our analysis: Web Enabled Energy Management System (EMS).

GAS SAVINGS: OVERVIEW

Other Gas HVAC Controls measures we reviewed but did not have sufficient sample size to analyze and recommend changes:

- Building Automation System (BAS)
- Occupancy Sensor
- Demand Control Ventilation (DCV)

GAS SAVINGS: OVERVIEW

Based on our analysis, we recommend reviewing the gas offering for Web Enabled EMS. This review would try to determine if there are elements of the offering or measure definition that would be expected to lead to increases in gas consumption, and if they can be changed.

GAS SAVINGS: OVERVIEW

Based on our analysis, we recommend reviewing the gas offering for Web Enabled EMS. This review would try to determine if there are elements of the offering or measure definition that would be expected to lead to increases in gas consumption, and if they can be changed.

As an interim step, we recommend not claiming gas savings for Web Enabled EMS.

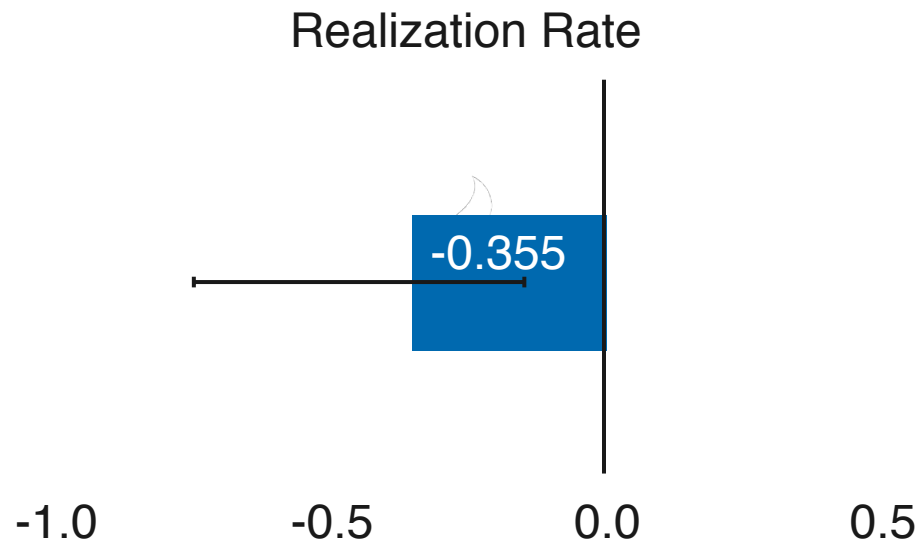
We do not recommend changes to gas savings for any other HVAC Controls measures.

GAS SAVINGS: WEB ENABLED EMS

Realization Rate

-0.355

On average, customers started consuming more gas after installing Web Enabled EMS.



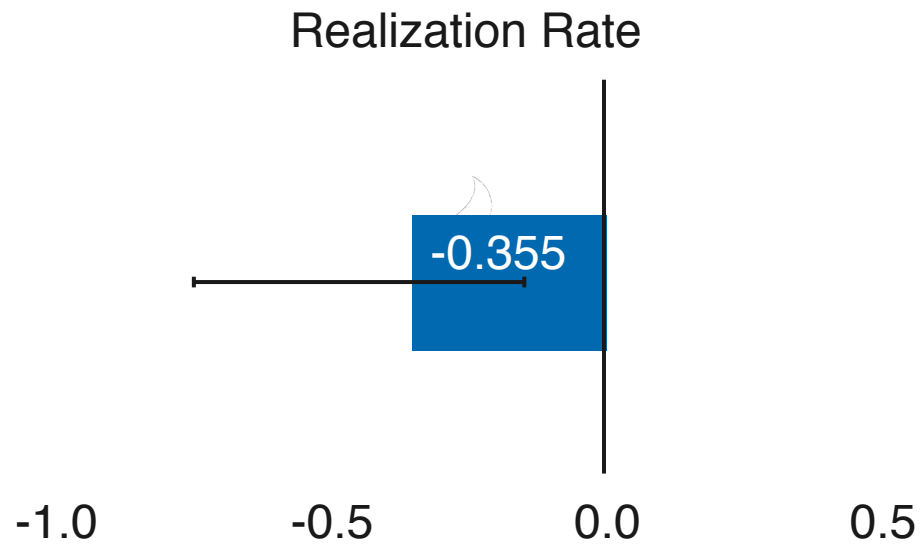
GAS SAVINGS: WEB ENABLED EMS

Realization Rate

-0.355

The 90% confidence interval ranges from -0.75 to -0.15.

- Of our sample with no other HVAC controls measures, 13 of 15 sites consumed more gas after installing Web Enabled EMS.



GAS SAVINGS: WEB ENABLED EMS

Realization Rate

-0.355

We investigated these measures further to try to understand the mechanism:

- These projects were spread across 7 different building types.
  - Not likely to be driven by building type.
- 6 of these projects did not involve any other gas measures.
- The other 9 did include other gas measures, but those other measures accounted for only 17% of the claimed savings.
  - Not likely an anomaly of our adjustment for other savings.
- Among the projects in our sample, a majority (9 of 15) claimed more gas energy savings than their pre-period gas consumption.
  - May indicate a flaw in the underlying assumptions.

Consumers Energy Count on Us DTE TRC

thank you

Brett Close

bclose@trccompanies.com

METHODOLOGY: PREPARATION

Details on selected steps are summarized below.

1 Clean and format data into correct time frames

- Because meter readings happen at different times, we aligned consumption data to be able to compare across accounts.

METHODOLOGY: PREPARATION

Details on selected steps are summarized below.

2 Remove accounts with insufficient pre-installation data

- In order to observe sufficient temperature variation, we limited the analysis to customers who had at least nine month of pre-period AMI or GCM data or at least 6 months and sufficient weather coverage.

METHODOLOGY: PREPARATION

Details on selected steps are summarized below.

3 Merge on observed and normal (TMY3) weather data

- In order to capture local meteorological conditions, we mapped customers to weather stations based on geographic proximity.

METHODOLOGY: PREPARATION

Details on selected steps are summarized below.

4 Calculate savings from other installed measures (non-HVAC Controls measures)

- To control for this over time, we used EPRI load profiles for Michigan and surrounding states to develop savings profiles by end-use throughout the year.
- We added these claimed savings into actual energy consumption to calculate counterfactual usage.

METHODOLOGY: CONTROLLING FOR OBSERVABLES

We applied site-specific model to model energy consumption using observed weather conditions.

We predicted counterfactual usage by applying weather normals on model coefficients

General Form Regression Model Used

$$C_t = \alpha_c + \beta_1 HDD65_t + \beta_2 CDD65_t + \beta_3 HDD75_t + \beta_4 CDD75_t + u_{ic}$$

KEY

- C_t = energy consumption for customer at time t
- $HDD65_t$ = HDD at base temperature 65
- $CDD65_t$ = CDD at base temperature 65
- $HDD75_t$ = HDD at base temperature 65
- $CDD75_t$ = CDD at base temperature 75
- u_c = an idiosyncratic error term

Consumers Energy Count on Us DTE TRC

BOOTSTRAP CONFIDENCE INTERVAL

We use bootstrap confidence intervals in this presentation. A few things to know:

- Bootstrapping is a statistical resampling technique that estimates a confidence interval using the variability of the sample to tell us about the variability in the population, requiring very few assumptions.
- In a traditional confidence interval, we usually either rely on an assumption about the distribution of data or make an argument about its properties due to sample size (asymptotic properties) and calculate the confidence interval based on the observed variance.
- Bootstrapping does not rely on such assumptions or arguments, and can even provide improved statistical properties.