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DTE Insight Smartphone App

Electric Savings Whitepaper – Six Month Analysis Results

DTE Energy®

Know Your Own Power®

June 1, 2015

http://www.navigant.com

Content of Report

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June 1, 2015

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The primary goal of the DTE Insight app is to achieve behavior-based energy savings from the use of the app.

Source: DTE Energy

DTE Insight is a part of DTE Energy's (DTE) diverse portfolio of residential energy efficiency programs. The primary goal of the program is to promote energy efficiency and engage its customers through the DTE Insight smartphone application; henceforth, referred to as an "app."

The app became available for download on Apple devices in July 2014, and on Android devices in August 2014. In December of 2014, the app began showing gas usage data to DTE gas and combo customers.

The app savings value included in this white paper is based on analysis of six month of data from 8,940 participants.

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Currently, the Insight app provides users with access to a variety of information and tools to motivate users to save energy by changing their behavior.

The Insight app seeks to motivate users to save energy by providing access to the following information and tools:

- Hourly (with a one day delay) interval data as well as real-time (60 second) feedback on their home's energy use, which includes allowing users to explore their energy use on a monthly, weekly, and daily basis.
- The ability to set targets for their use to enable better tracking of energy use goals.
- Weather overlays to allow the user to determine if weather changes impacted their home energy use.
- Weekly challenges, which if completed, can earn the user achievement badges and points to improve the appearance of their in-app avatar.
- Tips for completing various home projects that can save the user energy and money on their bill. These projects are labeled to indicate the level of difficulty in completing the project (i.e., do-it-yourself, intermediate, or requires a pro).

Source: DTE Energy

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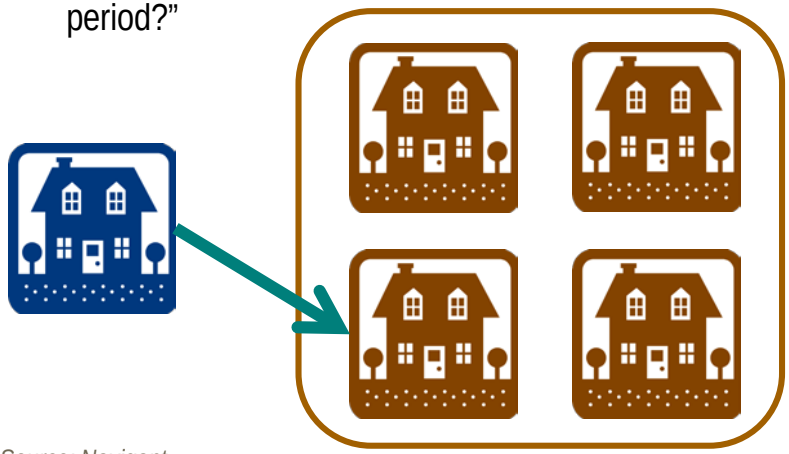
This program was not designed as a randomized control trial (RCT), and so it did not have a control group at the onset. Therefore, a control group was developed through a matching process.

Matching by Electricity Use

Navigant selected the control group matches by identifying the non-participant that had the closest electricity use to the participant in the 12 months before the participant joined the program.

- If two customers (match and participant) have very similar electricity use profiles in the 12 months before a program begins, then the match will provide a good approximation of the participant's counterfactual electricity use during the program period.
- Self-selection bias is assessed by statistically examining the question, "Do participants and their matches show evidence of trending apart during the pre-program period?"



Source: Navigant

Using Surveys to Further Assess the Matches

Matching on past electricity use implies that matches and participants are, on average, observationally equivalent in the way that matters most (electricity use), but they could be different in unobservable ways.

Self-selection bias refers to the result that program savings are over- or under-estimated because participants behave differently than their matches due to unobservable factors that affect both the decision to participate *and* electricity use. Surveys are one means to probe for such unobservable factors.

Self-selection bias survey questions included:

- Have you heard of the DTE Insight app?
  - If yes, why have you not downloaded the app?
  - If no, now that you know about the app, are you interested in downloading it now?

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The matched control group was selected by choosing the best non-participant match from a large potential group for each participant based on minimizing the sum of squared difference in energy usage during the 12 months before a participant downloaded the Insight App.

For each program participant, Navigant compared energy consumption in each month in the period spanning 1-12 months before program enrollment (a twelve month period) to that of all customers in the available pool with billing data over the same 12 months.

For the sake of expositional clarity, denote by t_k=0 the month t in which household k enrolled in the program, with t_k -1 denoting the month before enrollment, t_k +1 denoting the month after enrollment, and so on. Participants with missing bills during the designated matching period [t_k -12, t_k -1] were only selected a match if they had bills in at least 8 of the 12 months.

The basis of the comparison for the match is the difference in monthly energy use between a participant and a potential match, D_{PM} (Difference between Participant and potential Match). The quality of a match is denoted by the Euclidean distance to the participant over the 12 values of monthly D_{PM} used for matching; that is, denoting by SSD the sum of squared D_{PM} over the matching period, it is denoted by $SSD^{1/2}$. The non-participant customer with the shortest Euclidean distance to a participant was chosen as the matched comparison for the participant. Matching was done with replacement, such that a non-participant could be the matched control for more than one participant.

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Using the matched comparison group, Navigant conducted two types of statistical approaches to estimate overall electrical savings for this analysis. Model specifications for each of these approaches are included on the next slide.

Statistical Approaches used in Savings Analysis

Approach 1 Regression with Pre-Program Matching (RRPM)	Approach 2 Matching with Bias Correction (MBC)
The first approach follows Ho et al. (2007), who essentially argue that matching a comparison group to the treatment group is a useful "pre-processing" step in a regression analysis to assure that the distributions of the covariates (i.e., the explanatory variables on which the output variable depends) for the treatment group are the same as those for the comparison group that provides the baseline measure of the output variable. This minimizes the possibility of model specification bias. The regression model is applied only to the post-treatment period, and the matching focuses on those variables expected to have the greatest impact on the output variable.*	Matching with bias correction (MBC) introduced by Abadie and Imbens (2011). In this model, the effect of the program in month t is the difference between the energy use of participant k and its estimated counterfactual (baseline) consumption. The estimated counterfactual consumption is the average consumption of its matched household amended to reflect differences between participants and their matches in the covariates X affecting energy use. The amendment of consumption is based on a post-enrollment regression equation involving matched comparison customers only.**

Note: these two approaches use the same set of matched comparison customers

** Ho, Daniel E., Kosuke Imai, Gary King, and Elizabeth Stuart. 2007. "Matching as Nonparametric Preprocessing for Reducing Model Dependence in Parametric Causal Inference." Political Analysis 15(3): 199-236.*

*** Abadie, Alberto, and Guido Imbens. 2011. Bias-corrected matching estimators for average treatment effects. Journal of Business and Economic Statistics 29(1): 1-11.*

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Using the matched comparison group, Navigant conducted two types of statistical approaches to estimate overall electrical savings for this analysis.

Approach 1 - Regression with Pre-Program Matching (RPPM)

$$ADU_{kt} = \alpha_1 Treatment_k + \sum_t \alpha_2 YrMo_t + \sum_t \alpha_{3t} PREkWh_{kt} \cdot YrMo_t + \varepsilon_{kt}$$

Approach 2 - Matching with Bias Correction (MBC)

$$Savings_{kt} = ADU_{kt} - ADU_{kt}^{C}$$

$$ADU_{kt}^{C} = ADU_{kt}^{M} + \hat{\beta}\left(PREkWh_{kt} - PREkWh_{kt}^{M}\right)$$

where:

ADU_{kt} = Average daily energy usage by household k in month t

$Treatment_k$ = A 0/1 indicator variable, taking a value of 1 if household k is an Insight App participant and 0 otherwise

$YrMo_t$ = Month/year indicator variable

$PREkWh_{kt}$ = Average daily usage by household k during the most recent month before household k (or its match) downloaded the Insight App that is the same month as calendar month t.

ε_{kt} = cluster-robust model error term

$Savings_{kt}$ = savings by household k in month t

ADU_{kt}^{C} = estimated counterfactual average daily energy usage by household k in month t

ADU_{kt}^{M} = average daily energy usage by household k's match in month t

$\hat{\beta}$ = the factors used to adjust household k's energy usage to reflect differences between household k and its match in $PREkWh$

$PREkWh_{kt}^{M}$ = Average daily usage by household k's match during the most recent month before household k downloaded the Insight App that is the same month as calendar month t.

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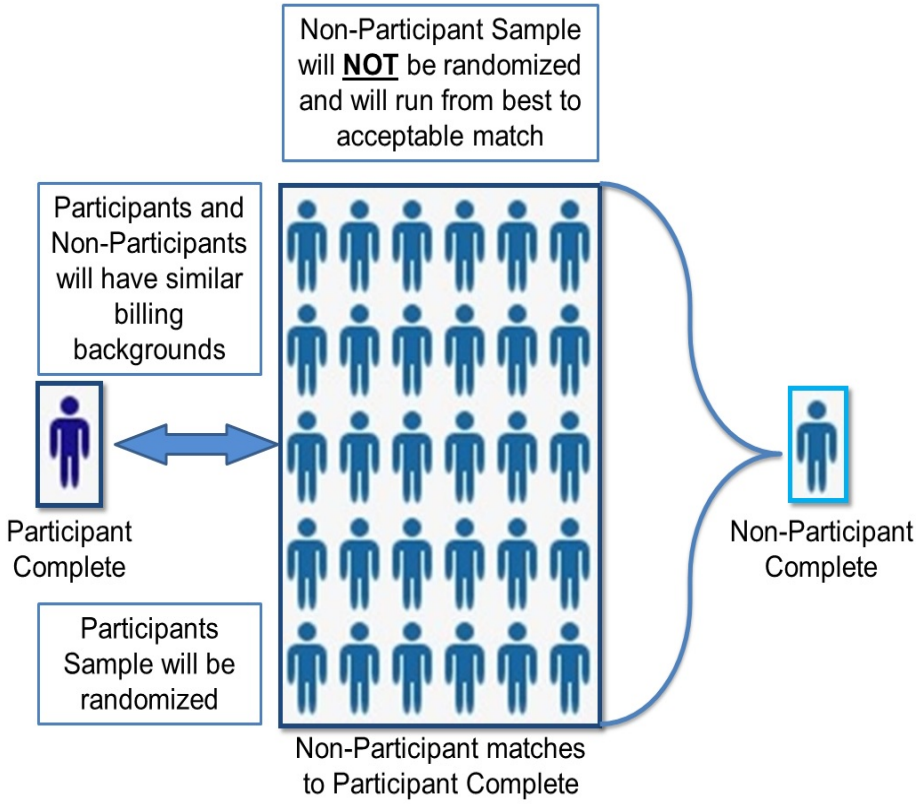
To ensure valid comparisons between participant and non-participant survey responses, Navigant generated a pool of "matched" non-participants for each participant complete.

Participant and Non-Participant Phone Survey Sample

Navigant designed the participant and non-participant survey to identify the types of customers opting into DTE's Insight Pilot program, in addition to establishing baseline data on energy saving behaviors.

Comparisons between participants and non-participants required that participants be "matched" to non-participants based on a study of their billing data. This allows for comparisons to be drawn between "like" individuals. As a result, the sample for this study was nested with non-participant quotas being based on participant completes, creating a one-to-one match.

Using a rolling process, for each randomly drawn participant complete, a pool of "matched" non-participants was generated to establish a non-participant complete. Here, the non-participant sample for each participant will range from the best possible match (1st piece of sample) to the minimum acceptable match (30th piece of sample), where a complete must be established to call the participant to non-participant match final.



Source: Navigant

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Navigant completed a total of 640 customer surveys; 427 participants and 213 non-participant matches.

Participant and Non-Participant Survey Sample

Group	Quota	Number of Surveys Completed
Participants	300	427
Non-Participants	300	213
Total	600	640

Source: Navigant

The response rate for the participant survey was 7% with a cooperation rate of 19%. For the non-participant survey, the response rate was 4% with a cooperation rate of 14%.

Analysis of survey data included use of SPSS, to explore response frequencies and statistically significant differences between participants and non-participants, and NVivo to analyze qualitative survey responses. All survey responses were included in the process analysis; however, for impact-related analysis, only matched participant and non-participant responses were included.

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Even with these evaluation methods in place there are several issues to consider when estimating the energy impacts of the Insight app.

Considerations for Impact Estimates

Consideration	Context	Uncertainties
Sample Sizes	• The current app savings value is based on analysis of data from 8,940 participant and 7,700 matched controls. • The estimate is based on an average of three participant months.	• Error bounds for each savings estimate will tighten as sample sizes increase over time.
Savings Life Cycle	• Savings will likely evolve over time due to app usage patterns and ramping effects.	• How will app usage patterns evolve over time? • How will usage patterns affect savings?
Cohort Effects	• Savings may evolve over time due to differences between "early adopters" and participants who download the app later.	• Are people who sign up early in the program different from those that sign up later? • How will any differences affect savings?
Self-Selection Bias	• Program savings may be over- or under-estimated because participants behave differently than their matches due to unobservable factors that affect both the decision to participate and electricity use.	• Current survey results indicate that estimates of app savings are subject to self-selection bias. Specifically, 21% of non-participant survey respondents had a smartphone and had heard of the app, but chose not to download the app.
Seasonal Effects	• The current app savings value is based on analysis that only includes the months of July through December. This timeframe does not include a full peak electric (cooling) season. • Program savings may be over- or under-estimated because participants use energy differently during different seasons.	• How will savings change through a full peak cooling season?

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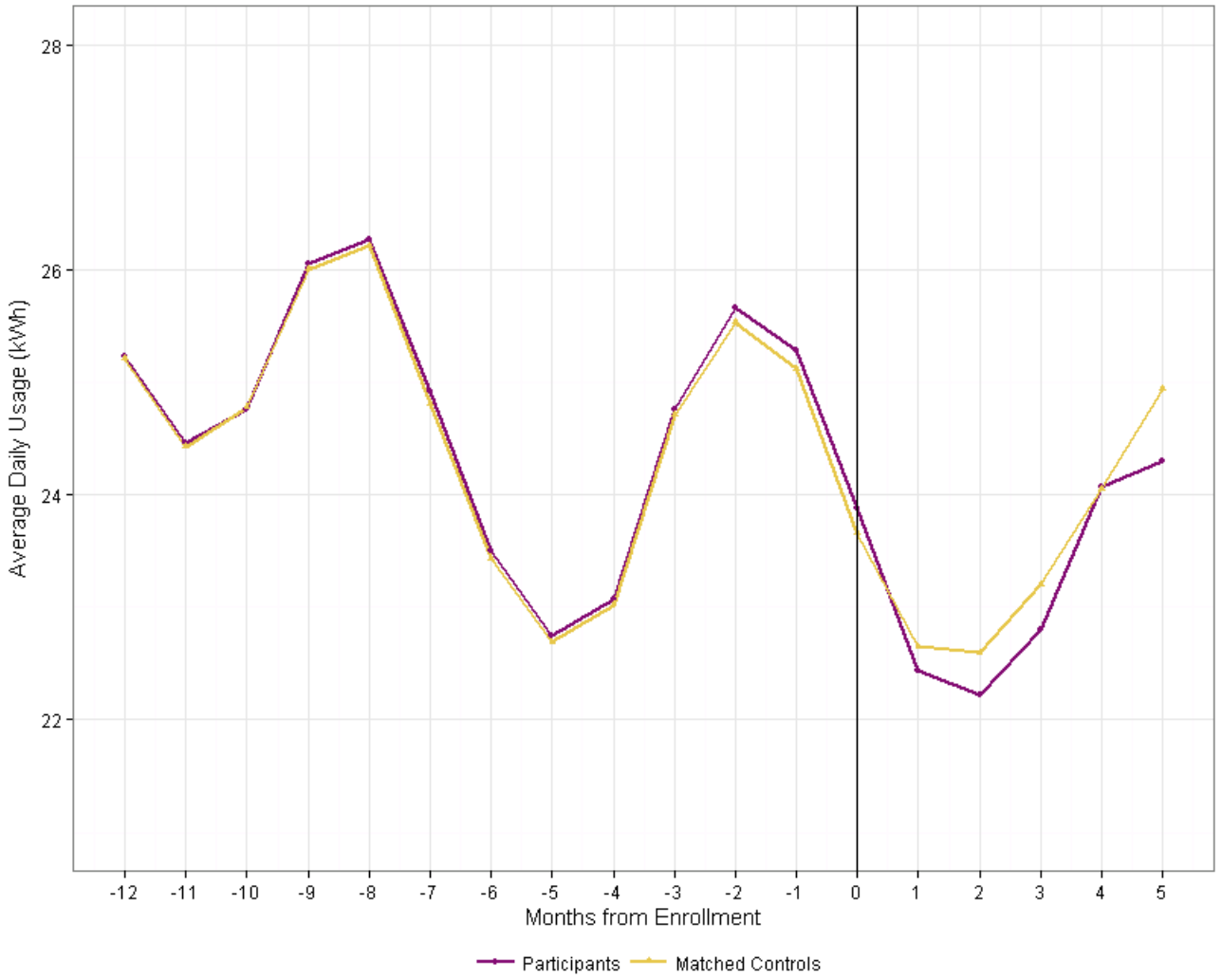
Navigant chose non-participant matches based on usage in the 12 months before each participant enrolled in the program. The divergence of participants and controls in the program period suggests savings from the Insight App.

Comparison of Average Daily Usage for Participants and Matched Controls



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Insight successfully channels participants into other DTE energy efficiency programs. This also indicates joint savings between Insight and the relevant EE programs that should not be counted for both programs.

Uplift Analysis Results

	Uplift (Participants)
Appliance Recycling	67
Audit and Weatherization	0
Energy Efficiency Assistance	25
Home Energy Consultation	28
Home Energy Survey	235
HVAC	20
Total	375

Uplift – the number of people who participated in another program because of DTE Insight
Source: Navigant analysis of participant tracking data

Joint Savings Analysis Results

	Joint Savings (MWh per 3 months)[1]
Appliance Recycling	21.75
Audit and Weatherization	0
Energy Efficiency Assistance	0
Home Energy Consultation	5.5
Home Energy Survey	16.25
HVAC	4
Total	47.25
Percentage of Insight Savings	13%

Joint savings – the amount of savings subtracted from the annual Insight savings to avoid counting savings twice (in both Insight and the other program).
[1] Savings from other EE programs are based on one year of savings, but for the Insight App, savings are estimated on an average of 3 months of using the app. To make an accurate adjustment for joint savings Navigant adjusted the annual savings from the other EE program data to account for only 3 months of savings.
Source: Navigant analysis of participant tracking data

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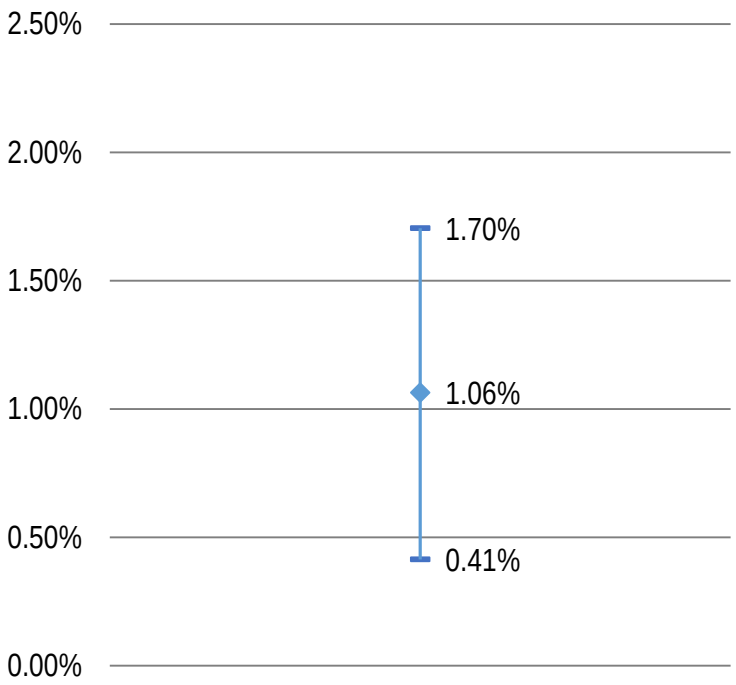
After removing the joint savings with other EE programs from the analysis, estimated electric savings for the DTE Insight program in the first six months are 1.06%.

App Electric Savings Adjusted for Joint Savings
(with 90% Confidence Interval)



# of participants = 8,940
# of matched controls = 7,700
Avg # of months after download = 3
Total Adjusted MWh Savings = 285

Source: Navigant analysis of energy usage data

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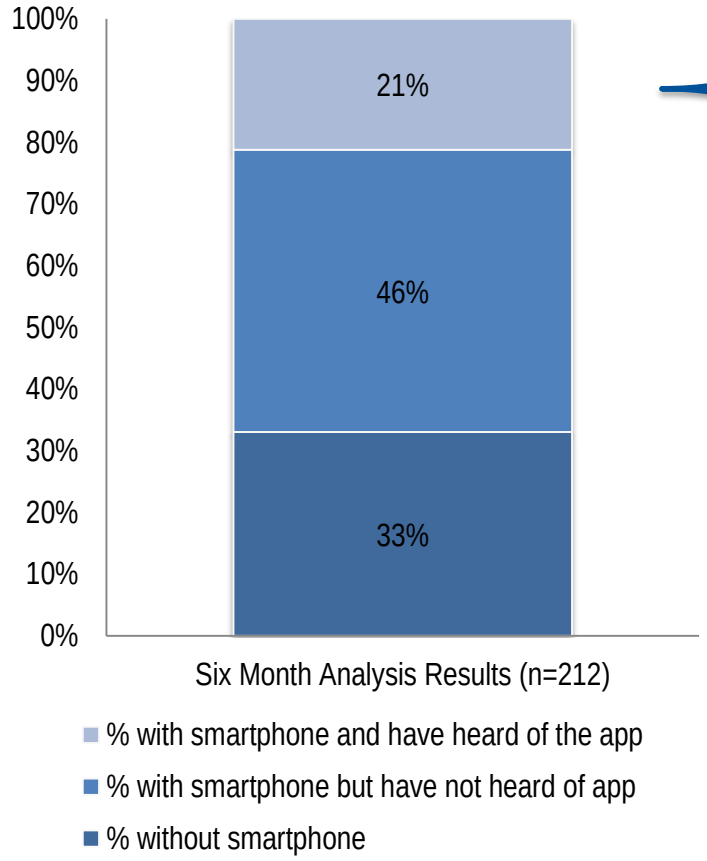
Survey results indicate that these savings estimates are subject to self-selection bias. Specifically, 21% of non-participant respondents had a smartphone and had heard of the app, but chose not to download the app. This indicates that participants are different than non-participants; Navigant's analysis mitigates this difference as best possible in the absence of an RCT design.

Non-Participant Responses to Self-Selection Bias Survey Questions



Source: Navigant analysis of phone survey results

Reasons why Eligible Non-Participants who Heard of App did not Download the App

Non-Participant Responses
27% of these customers did not download the app because they felt it was not useful to them (12 of 49 mentions)
20% said they were not interested in the app (9 of 49 mentions)
16% were unable to provide a reason (7 of 49 mentions)

Source: Navigant analysis of phone survey results

Of the 21% of non-participant survey respondents that said they have a smartphone and knew about the app, 47% expressed that they were not interested in the app (20%) or that they didn't think the app would be useful for them (27%).

To the extent that unobservable variables affecting both post-enrollment energy use and the decision to enroll in the program are correlated with past energy use, then an analysis based on matching on past energy use serves to mitigate self-selection bias as best possible.

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A deemed savings estimate based on the evaluation to-date may over- or under-estimate savings. As a custom measure, savings are evaluated retrospectively and as a result inherently account for seasonal effects, cohort effects, and the savings life cycle.

Considerations for Assigning the Insight App as a Prescriptive or Custom Measure

Considerations		Prescriptive Measure	Custom Measure
Self-Selection Bias	In the absence of a randomized control trial, the evaluation approach uses the best available methods available for addressing self-selection bias. Survey results indicate that estimates of app savings are subject to self-selection bias.	Underestimates or overestimates savings	
Seasonal Effect	The app was available for download in July 2014 and this analysis only covers July 2014 through December 2014. Due to ramp up, the savings estimate does not include electric savings associated with the peak cooling season.	Underestimates savings	Savings will include peak cooling season
Savings Life Cycle	Navigant has observed that customer engagement with web portals decline over time, particularly when the platform is static (e.g., users need to take action to access feedback rather than receiving active notification from the platform). Planned updates to the app are expected to enhance engagement and may increase savings.	Underestimates or overestimates savings	Savings life cycle inherently included in savings estimate
Cohort Effects	If early adopters achieve higher or lower savings than those customers that download the app later, the deemed savings value may be an over- or under-estimate.	Underestimates or overestimates savings	Cohort effects inherently included in savings estimate

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There is a precedent for developing a deemed savings estimate for behavioral measures. Calibration activities can address limitations of current savings estimate (seasonal effects and cohort effects, in particular).

Prescriptive Measure

- There is a precedent in Michigan for deeming savings associated with behavioral measures in which *observed* impacts inform the next year's deemed savings.
- For example, 2016 deemed savings for Home Energy Reports is based on evaluated savings from May 2014 through April 2015. In this case, 2016 deemed savings for the Insight App would be based on evaluated savings from July 2014 through April 2015.
- As noted previously, the current savings estimate may over- or under-estimate true savings due to seasonal effects, cohort effects and savings life cycle.
- To address the savings life cycle, Navigant recommends developing annual savings estimates (i.e., Year 1 savings, Year 2 savings, etc.) similar to Home Energy Reports.
- Incremental savings resulting from increased participation in other programs caused by the Insight App are subtracted from estimated savings to avoid double-counting savings. The deemed savings estimate will be the estimated savings net of double-counted savings.
- Deemed savings are subject to MEMD calibration research. Navigant recommends annual calibration.
- Annual savings would be calculated using the formula below:

  Savings Rate x Number of Active Participants x Average Usage from Matched Controls for the Program Year

  where:
  - the number of active participants is defined as customers with AMI meters who download the app, linked the app to their DTE account, and had an active account with DTE on the last day of the program year
  - matched controls are defined as a group of non-participants selected for the control group using the matching method described on page 7.

Custom Measure

- As a custom measure, program year 2016 savings would be estimated based on evaluated savings for the program year.
- This approach inherently addresses seasonal effects, cohort effects and savings life cycle.

The following individuals from Navigant contributed to this report:

Jenny Hampton
303.728.2473
Jennifer.Hampton@navigant.com

Bill Provencher
608.497.2327
Bill.Provencher@navigant.com

Carly McClure
608.497.2344
Carly.McClure@navigant.com

Latisha Younger-Canon
608.497.2346
Latisha.Younger.Canon@navigant.com

Sonrisa Cooper
360.828.4019
Sonrisa.Cooper@navigant.com

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Thelma Dobson

Jason Kupser

Vicki Campell

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DTE Insight
Mobile App for Customers

Ten Month Analysis Results Presentation to
Energy Optimization Collaborative
June 16, 2015

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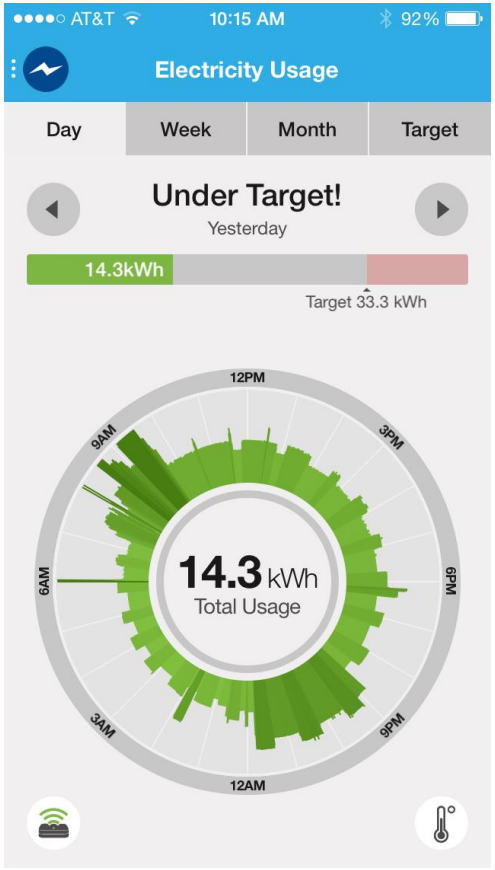
The DTE Insight app aims to achieve behavior-based energy savings from the use of the app, and to cause lasting changes in the energy efficiency market and increase adoption of energy efficient products, services or practices. Currently, the Insight app provides users with access to a variety of information and tools.

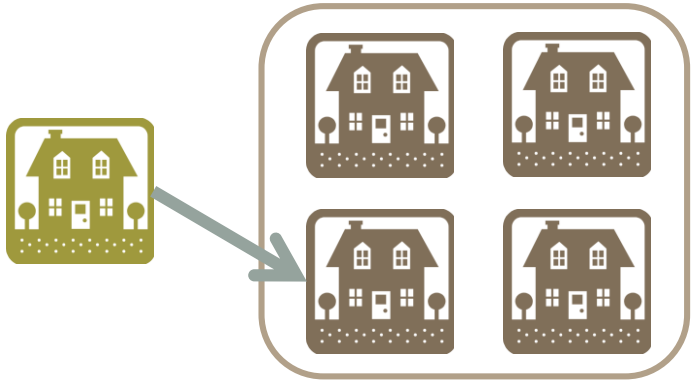


Source: DTE Energy

- DTE Insight is a part of DTE Energy's (DTE) diverse portfolio of residential energy efficiency programs to encourage market transformation.
- The Insight app is designed to cause lasting changes in the energy efficiency market and increase adoption of energy efficient products, services or practices.
- The app seeks to motivate users to save energy by providing access to a variety of information and tools including hourly (with a one day delay) interval data, target setting, weekly challenges and tips for completing various home projects that can save the user energy and money on their bill.
- The app became available for download on Apple devices in July 2014, and on Android devices in August 2014. In December of 2014, the app began showing gas usage data to DTE gas and combo customers.
- The app savings value included in this presentation is based on analysis of ten month of data from 11,617 participants.

Navigant selected the control group matches by identifying the non-participant that had the closest electricity use to the participant in the 12 months before the participant joined the program.

- If two customers (match and participant) have very similar electricity use profiles in the 12 months before a program begins, then the match will provide a good approximation of the participant's counterfactual electricity use during the program period.

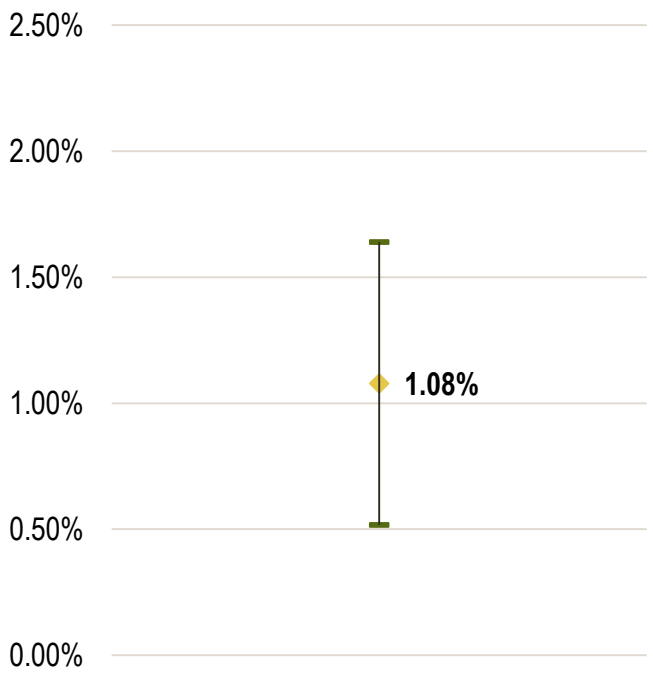


In the first ten months of the program, Insight successfully channeled participants into other DTE energy efficiency programs. This also indicates joint energy savings between Insight and the relevant EE programs that should not be counted for both programs.

- Analysis of DTE's program tracking data reveals that the Insight app channeled a total of 186 participant customers into other DTE energy efficiency programs.
- Joint savings – the amount of savings subtracted from the annual Insight savings to avoid counting savings twice (in both Insight and the other program) – equaled 17 MWh, or 2% of the total Insight app savings, during the study period.
    - Savings from other EE programs are based on one year of savings, but for the Insight App, savings are estimated on an average of 6 months of using the app.
    - To make an accurate adjustment for joint savings Navigant adjusted the annual savings from the other EE program data to account for only 6 months of savings.
- These incremental savings resulting from increased participation in other programs caused by the Insight App are subtracted from estimated savings to avoid double-counting savings, therefore the savings estimate will be net of double-counted savings.

After adjusting for joint savings with other EE programs from the analysis, estimated electric savings for the DTE Insight app in the first ten months are 1.08%.

App Electric Savings Adjusted for Joint Savings
(with 90% Confidence Interval)



# of participants = 11,617
# of matched controls = 9,727
Avg # of months after download = 6
Total Adjusted MWh Savings = 874

Source: Navigant analysis of energy usage data

A deemed savings estimate based on the evaluation to-date may over- or under-estimate savings due to self-selection bias, seasonal effects, the savings life cycle and cohort effects.

Considerations	
Self-Selection Bias	In the absence of a randomized control trial, the evaluation approach uses the best available methods for addressing self-selection bias. Survey results indicate that estimates of app savings are subject to self-selection bias.
Seasonal Effects	The app was available for download in July 2014 and this analysis only covers July 2014 through April 2015. Due to ramp up, the savings estimate does not include electric savings associated with the peak cooling season.
Savings Life Cycle	Navigant has observed that customer engagement with web portals decline over time, particularly when the platform is static (e.g., users need to take action to access feedback rather than receiving active notification from the platform). Planned updates to the app are expected to enhance engagement and may increase savings.
Cohort Effects	If early adopters achieve higher or lower savings than those customers that download the app later, the deemed savings value may be an over- or under-estimate.

There is a precedent for developing a deemed savings estimate for behavioral measures. Calibration activities can address limitations of current savings estimate (seasonal effects and cohort effects, in particular).

Prescriptive Measure

- There is a precedent in Michigan for deeming savings associated with behavioral measures in which *observed* impacts inform the next year's deemed savings.
- For example, 2016 deemed savings for Home Energy Reports is based on evaluated savings from May 2014 through April 2015. In this case, 2016 deemed savings for the Insight App would be based on evaluated savings from July 2014 through April 2015.
- As noted previously, the current savings estimate may over- or under-estimate true savings due to seasonal effects, cohort effects and savings life cycle.
- To address the savings life cycle, Navigant recommends developing annual savings estimates (i.e., Year 1 savings, Year 2 savings, etc.) similar to Home Energy Reports.
- Incremental savings resulting from increased participation in other programs caused by the Insight App are subtracted from estimated savings to avoid double-counting savings. The deemed savings estimate will be the estimated savings net of double-counted savings.
- Deemed savings are subject to MEMD calibration research. Navigant recommends regular calibration.
- Annual savings would be calculated using the formula below:

  Savings Rate x Number of Active Participants x Average Usage from Matched Controls for the Prior Program Year

  where:

  - the number of active participants is defined as customers with AMI meters who download the app, linked the app to their DTE account, and had an active account with DTE on the last day of the program year
  - matched controls are defined as a group of non-participants selected for the control group using the matching method described on page 7 of the white paper submitted on June 1, 2015.

Questions?