



Energy Savings from Programmable Thermostats in the C&I Sector

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Overview



Commercial and Industrial customers of two large Midwestern U.S. utilities (Detroit Edison and Consumers Energy) received programmable thermostats through an opt-in rebate program.

Both utilities started the program in 2009 and it continues today.

More than 10,000 C&I customers (Gas and Electric) have participated in this program.

524,000 non-participant C&I customers were available to be used in matched control groups.

Evaluation Objectives



Energy consumers are often told that programmable thermostats can provide energy savings of 10-30%.

Empirical evidence from a number of studies indicates that savings in the residential sector are usually lower – around 5-10%.

But what are the savings in the commercial and industrial sector?

Objective: Estimate energy savings from programmable thermostats for C&I customers.



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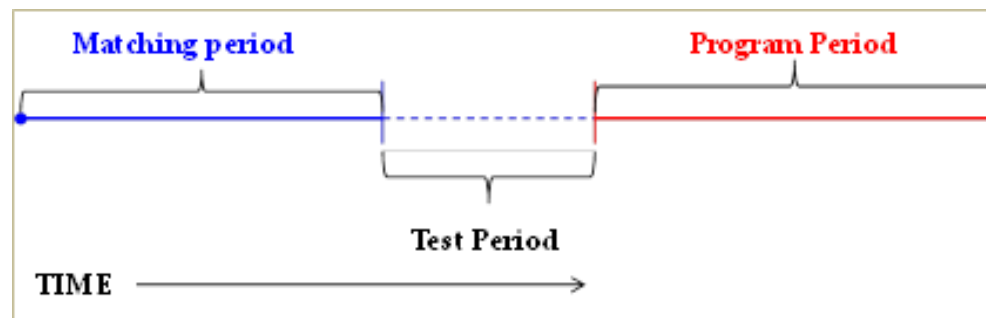
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Statistical Method - Matching



- » Matching a comparison group to the treatment group is a useful “pre-processing” step in a regression analysis
 - › Assure that the distributions of the explanatory variables are the same as those for the comparison group that provides the baseline measure of the output variable.
- » Letting t_k denote the month of program enrollment by customer k , we implemented the test by matching on energy use over the 12-month period $t_k - 16$ to $t_k - 5$, and comparing average energy use for participants and their matches in the four month test window, $t_k - 4$ to $t_k - 1$.



Statistical Method - Matching

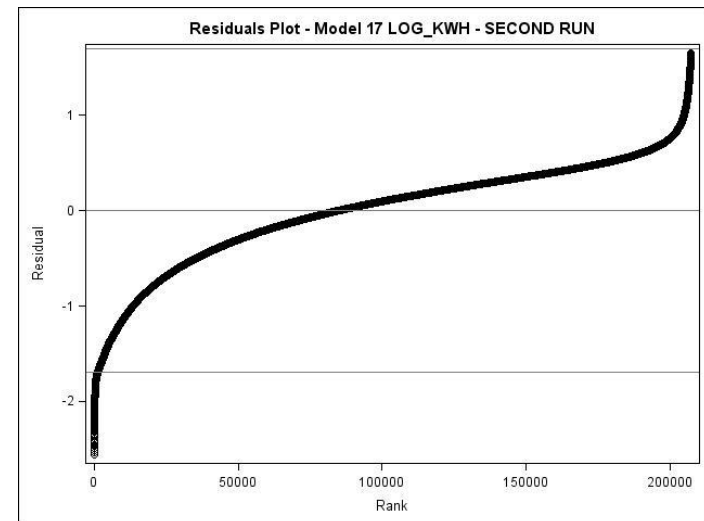
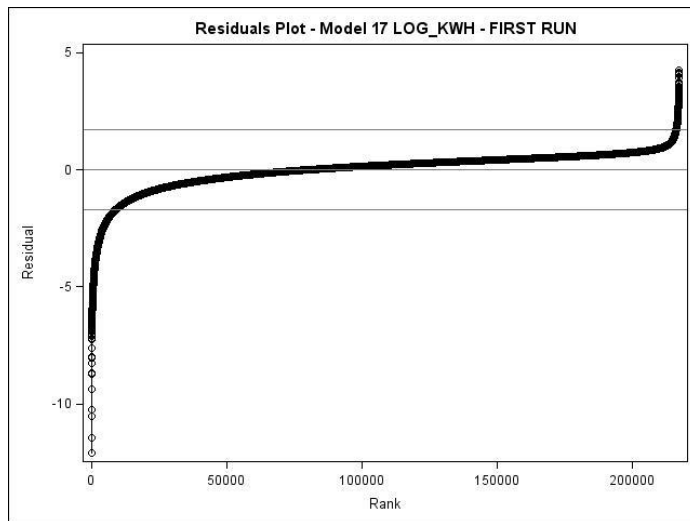


Data Validations:

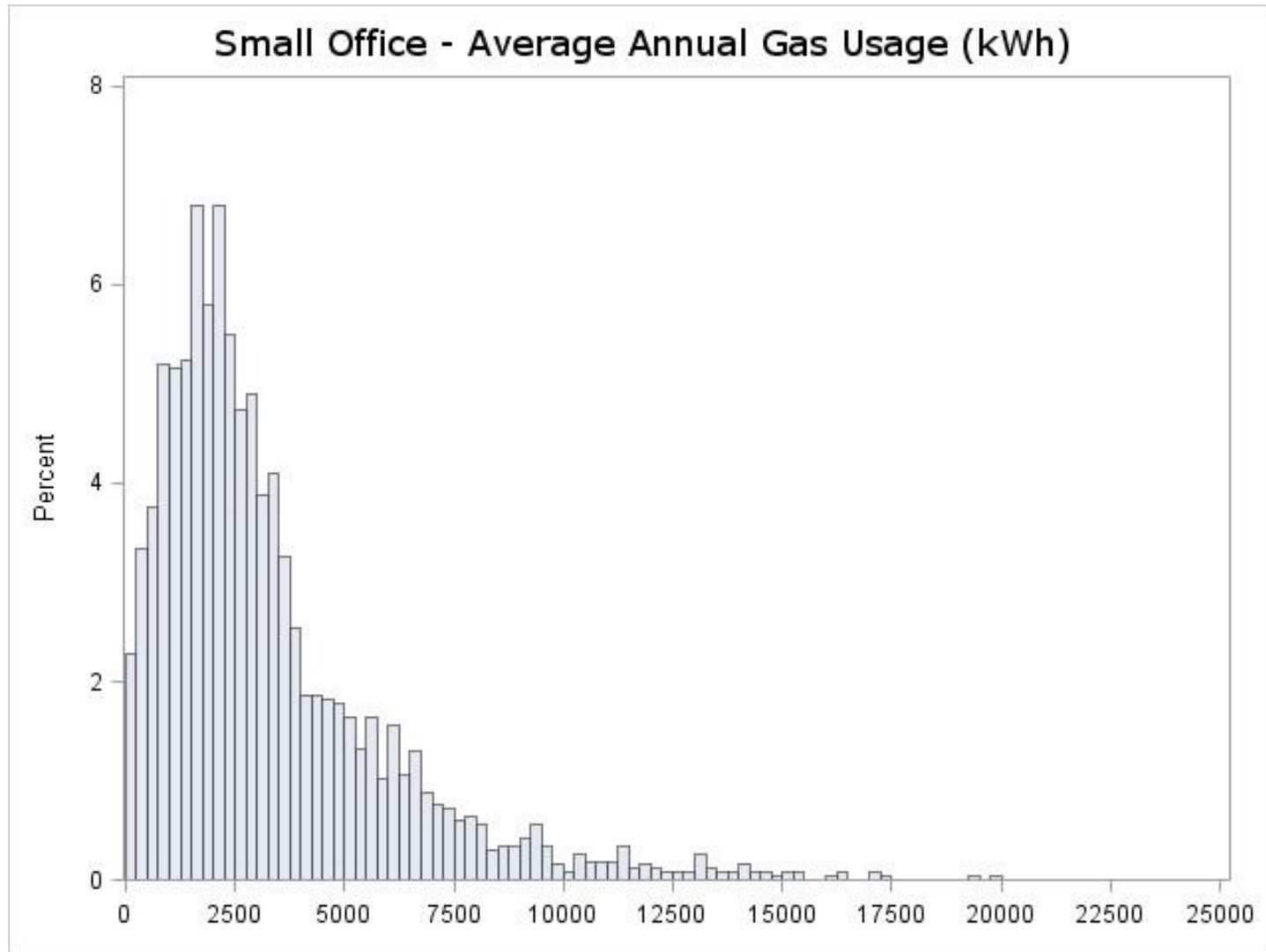
Within a building type, only customers within two standard deviations of the mean pre-program energy use are included in the analysis.

Among customers that satisfy this size criterion, we apply the analysis to the top 95% of matches.

Observations with large residuals were removed from the model



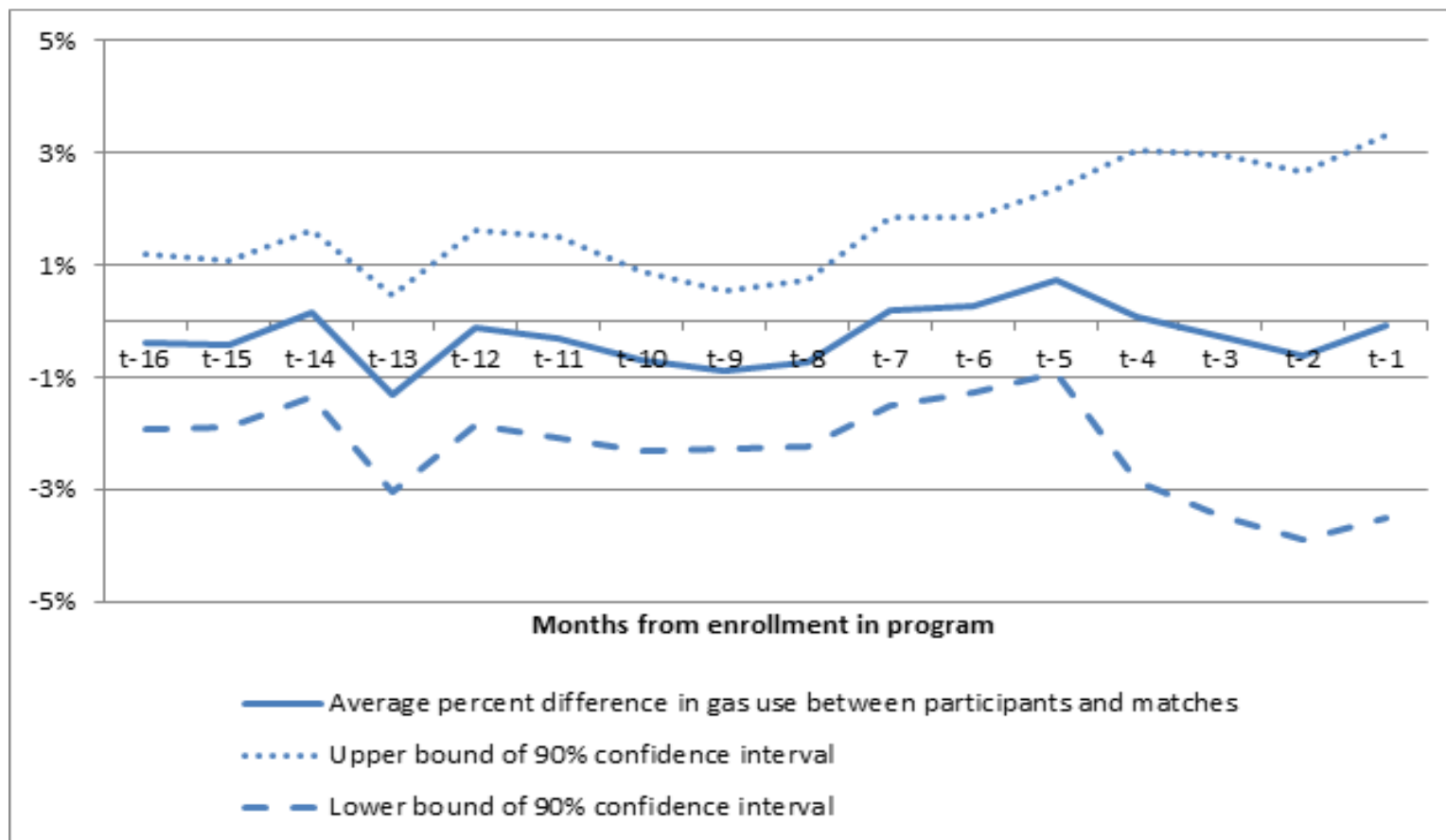
Statistical Method - Matching



Statistical Method - Matching



Gas: The average difference between Treatment and Control is $<1\%$



Statistical Method - Matching



Electric: The average difference between Treatment and Control is $<1\%$

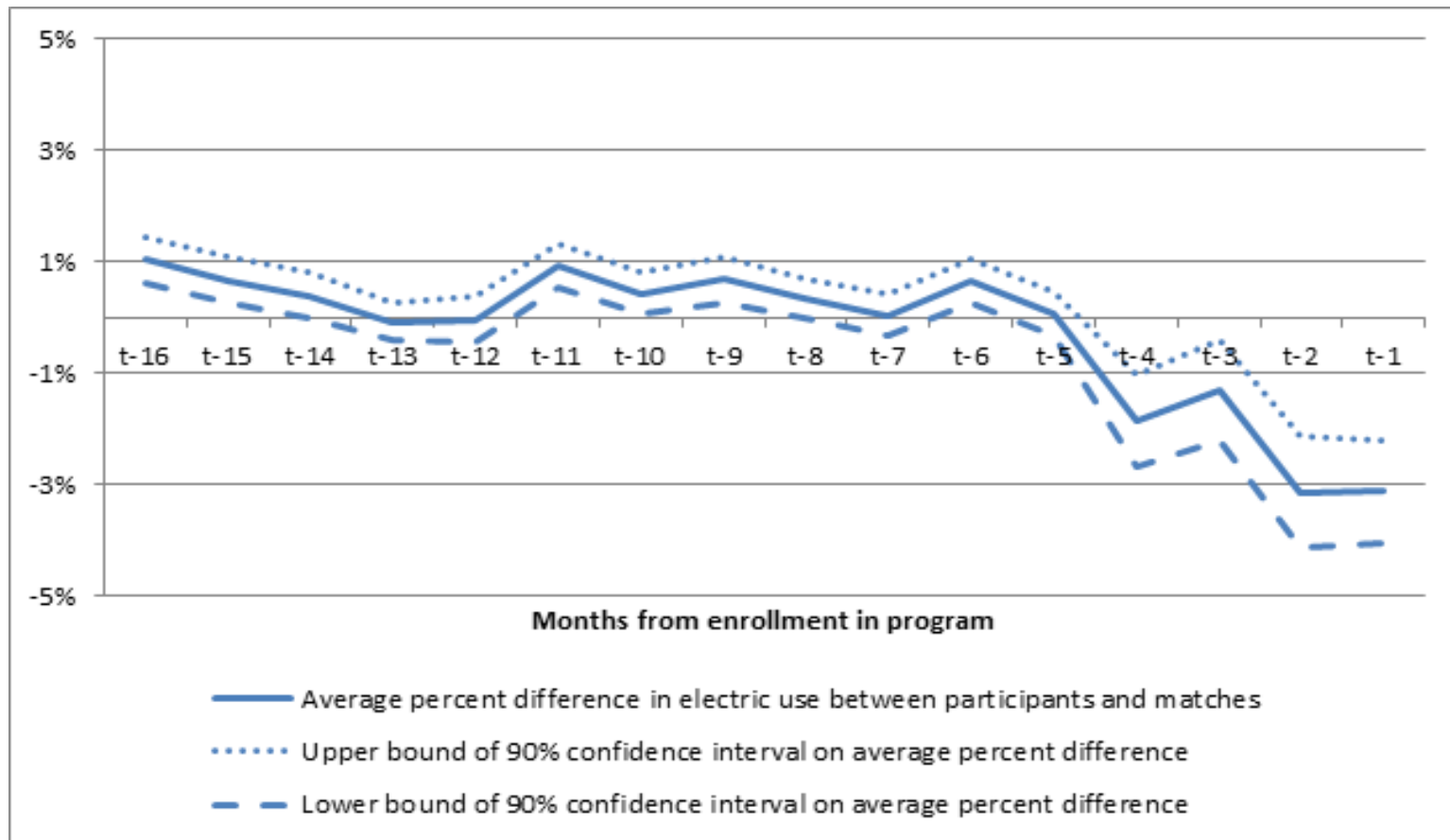




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Regression Analysis



- » 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. Variables affecting energy use not used for matching can be used in the regression analysis.
- » We use a log-linear specification for the regression model, in which coefficient values are interpreted as percentages.
- » This specification expressly accounts for the fact that at the whole building level the savings from the installation of programmable thermostats increases with energy use.
- » The model takes the specific form,

$$\ln NMU_{kt} = \delta_t + \alpha_1 Participant_k + \alpha_2 Match1_k + \alpha_3 DTE_k + \sum_{j=1}^J \beta^j PreEnergy_{kt} \cdot jSector_k + \varepsilon_{kt}$$

- » In this model α_1 indicates average monthly percent savings by program participants. For gas the model was estimated for the heating season, October-April. A companion model for gas savings during the cooling season revealed no statistically significant savings. For electricity the estimated model is an annual model.



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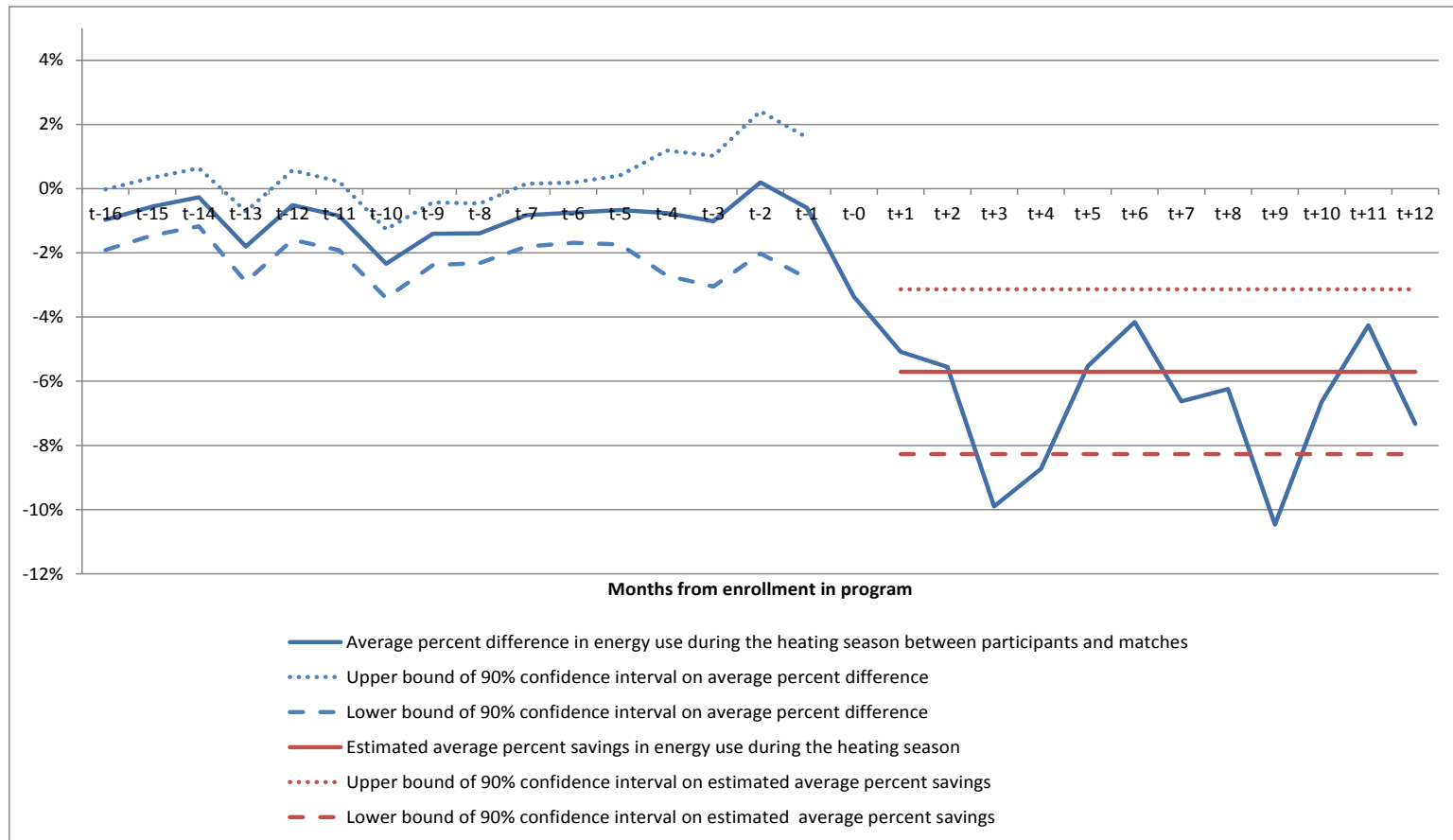
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Results and Conclusions



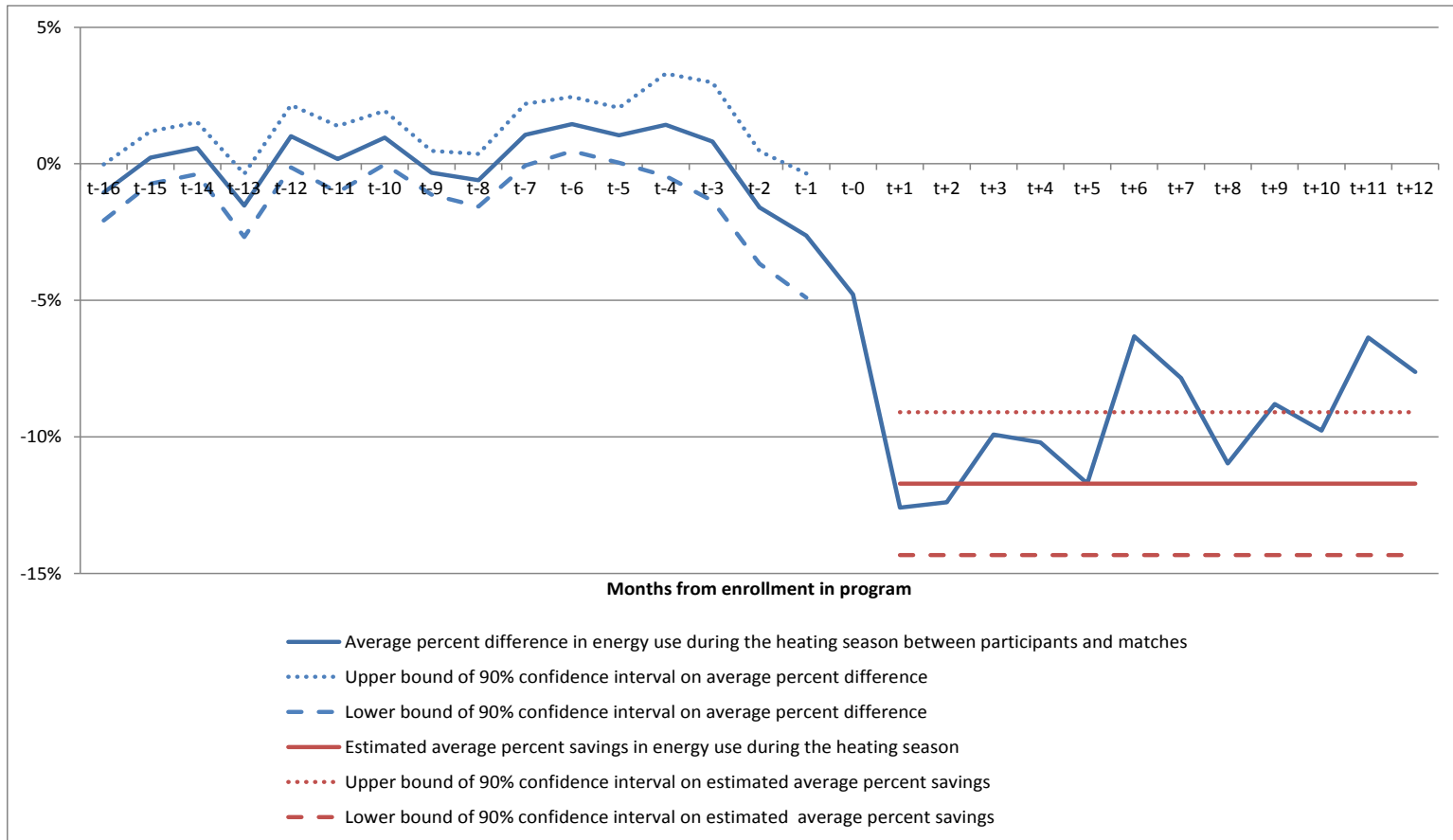
Small Retail – Gas – 5.0% Savings



Results and Conclusions



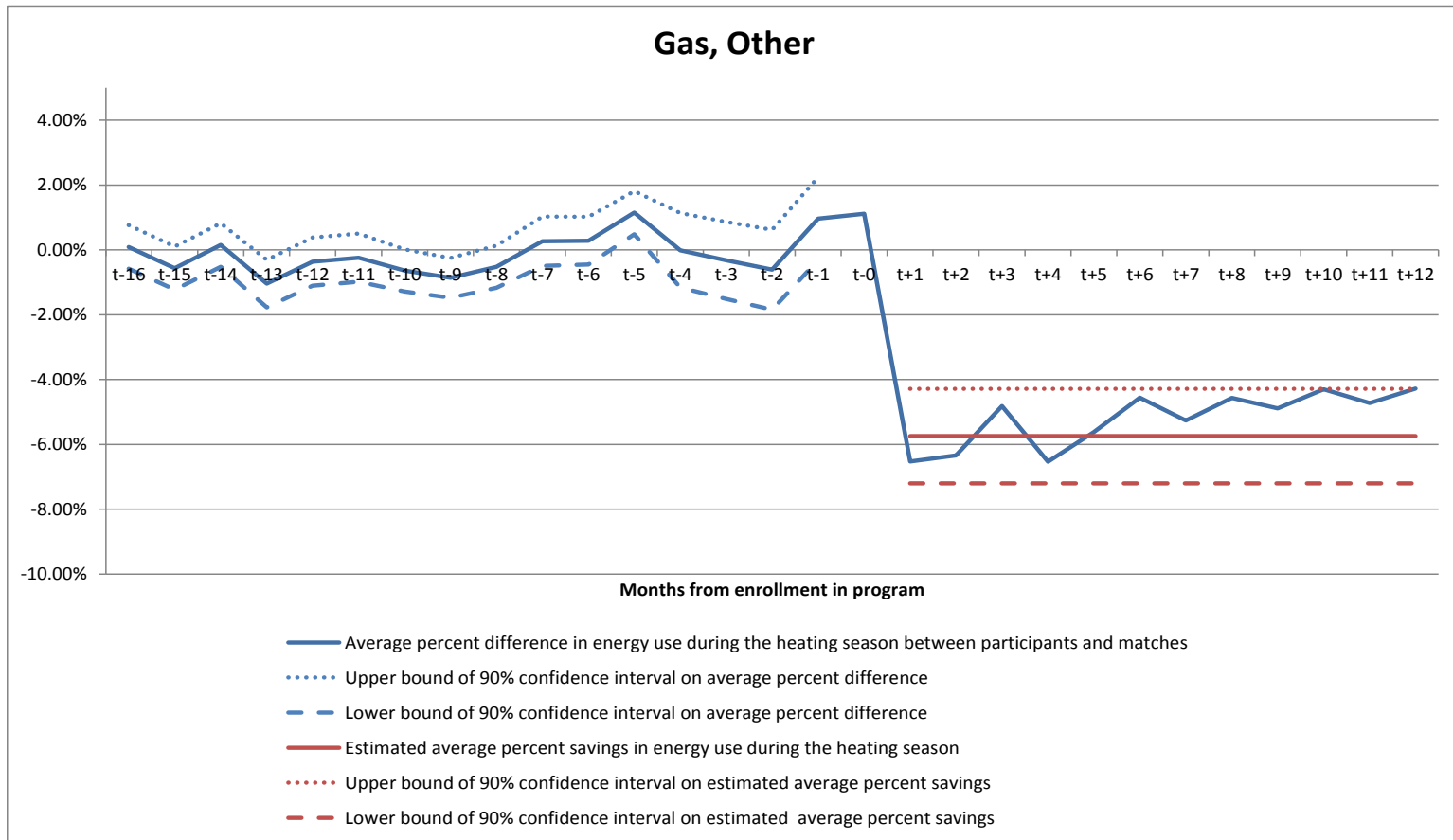
Small Office – Gas – 10.2% Savings



Results and Conclusions



» Other – Gas – 5.0% Savings



Results and Conclusions



» Overall – Electric – No Savings

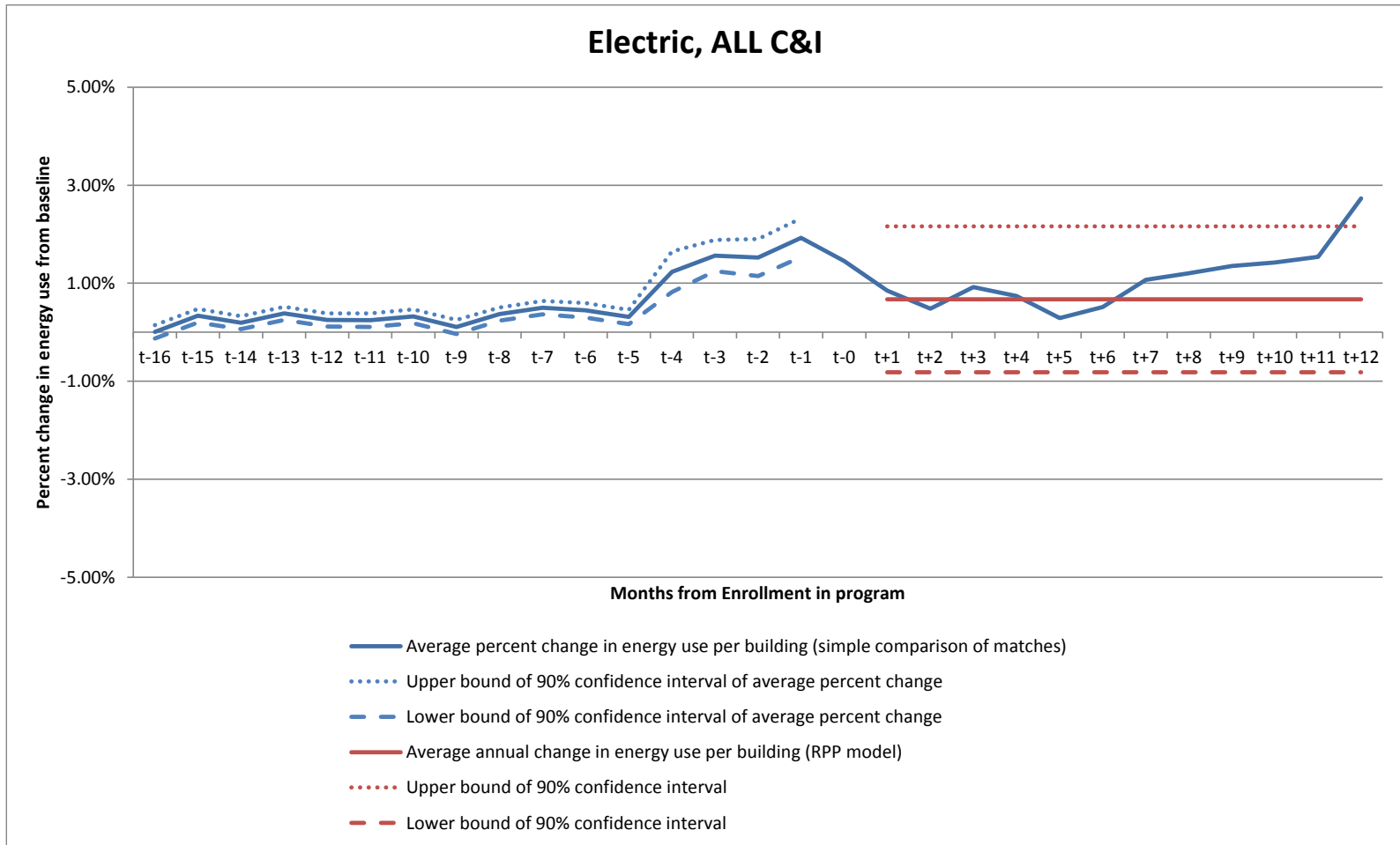




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Careful consideration should be given to the matching method used in impact evaluation.

- Ex: Nearest Neighbor, Caliper, Mahalanobis, Kernel-weighted, etc.

Test your matches with a hold-out period to determine if the match is consistent

Test your regression model with multiple specifications

- Matching should reduce the likelihood of model specification bias

The key to this analysis is patience and an acute attention for detail.

