ComEd Energy Efficiency Program

NMEC TARGETING FOR ENERGY EFFICIENCY PROGRAMS EXECUTIVE SUMMARY

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Prepared By
Power TakeOff

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1.0 EXECUTIVE SUMMARY

In the era of machine learning, advanced algorithms, and Measurement and Verification 2.0, utilities are identifying new techniques to leverage their investment in Advanced Metering Infrastructure (AMI). ComEd has deployed AMI data and commissioned a study to identify what methods could be used to optimize which customers they engage in their energy efficiency program portfolio. AMI data provides unparalleled amounts of inherent information that can be leveraged in ways such as creating far reaching energy usage projections, estimations, and insights into ratepayer behavior. ComEd's energy efficiency programs have additional data that, when paired with AMI data, can be used to identify utility customers who would benefit from targeted engagement and recruitment to participate in energy efficiency programs. This report summarizes key learnings and performance results from using ComEd AMI data and program participation data to identify and predict high savers for lighting projects and variable speed drive installations. The next steps for ComEd to make further use of advanced analytics would be to assess the feasibility and accuracy of models that predict energy savings using population level methodologies, as opposed to the site level methodologies assessed in this study. While the population level analysis from this study is promising, ComEd should further this work by developing more rigorous estimates of savings.

NMEC Targeting Overview

This study analyzed building AMI data for program participants in three measure categories: 1) indoor lighting, 2) outdoor lighting, 3) Variable Speed Drives (VSD). This study used site level normalized metered energy consumption (NMEC) to predict high savers in the portfolio and enable targeted engagement for those specific customers into ComEd energy efficiency programs.[1]

Technical Approach and Methodology

This study consisted of three stages:

1. **Select Measures for NMEC Analysis:** The Power TakeOff team reviewed the ComEd Energy Efficiency Program portfolio to identify which measures and programs were likely candidates for NMEC analysis. The database contained three measure categories with a large enough participant base to attempt to predict savings: Indoor Lighting, Outdoor Lighting, and Variable Speed Drives (VSD).
2. **Targeting High Savers:**
    a. Site level project savings were estimated using linear regression models for a training set, with withheld data making up a testing dataset. Savings were estimated per participant at the facility level.

[1] Site level NMEC is a technique used to measure energy use for individual buildings and can be used to identify drivers of consumption for a building. Population level NMEC is a similar but distinct technique used to measure energy use for a group of buildings in aggregate and can be used to identify differences that exist between groups.

The research team then created prediction models that predicted each participant's NMEC savings using only readily available pre-implementation data. By comparing measured and predicted savings, the research team can assess the potential for this type of analysis to identify customers who save more, which could inform deemed savings adjustments and targeted marketing efforts to achieve higher savings per customer.

   b. Population level: Population level NMEC methods were used to identify subgroups within a population by splitting the population into two groups based on the predicted savings. The models then attempted to predict categories of high savers as distinct from low savers.

3. **Exploratory Analysis:** Due to weak statistical associations between energy savings and participant characteristics, the research team conducted additional analysis intended to identify promising areas of future research. The exploratory analysis provided insights into what changes could be made to the dataset that would enable successful site level analysis in the future.

Summary of Results

Selecting Measures

NMEC modeling is often most successful for energy upgrades that represent relatively high savings per customer (e.g., 10% savings). The application of NMEC for this study design has additional criteria including limiting the study to measures or measure categories that are installed for a large number of customers where only the measures of interest are installed. ComEd's commercial energy efficiency database contained three measure categories with a large enough participant base to attempt to predict savings: Indoor Lighting, Outdoor Lighting, and Variable Speed Drives (VSD).

Savings Predictions

The research team compared measured savings to predicted savings using site level and population approaches. Based on the study design, the team conducted deeper investigation into predicting site level savings than on predicting population level savings.

Targeting High-Savers Using a Site Level Approach

Site level NMEC predictions used derived metrics including (but not limited to):

- Hours of operation
- Time-of-day consumption patterns
- Deemed savings
- Average kWh/day in the pre-implementation period

Using only pre-implementation data, the prediction models attempted to predict percent NMEC savings for each site.[2] The predicted percent savings were not closely related to the measured NMEC savings. When the models were trained on random subsets of the data and tested against a validation set, the models explained little to none of the percent savings. The results showed that the model inputs explain only 11% of the variation in the savings for indoor lighting, 9% of the variation in savings for outdoor lighting, and none for VSDs.

The percent savings NMEC models could not predict which ComEd customers would save more energy than others after participating in an energy efficiency program using only AMI data. Assessing percent savings rather than total savings is a conservative approach meant to level the playing field between large and small customers. The approaches tested in this study did not show promise for targeting customers.

The research team repeated the analysis for kWh savings to predict the participants with the highest kWh savings in each measure category. The results of that analysis had lower explanatory power than the percent savings analysis.

Site level NMEC methods were not able to predict which characteristics of individual participants can lead to higher savings. Successful site level NMEC could enable ComEd to target specific individuals for engagement with custom program recommendations. Although those methods did not lead to actionable targeting, population level NMEC could enable ComEd to identify a subset of their population for engagement, leading to higher energy savings if those members of those populations participate in energy efficiency programs.

Targeting High-Savers Using a Population-Level Approach
Population level NMEC methods can be used to identify subgroups within a population. This allows the utility to visualize which subgroups of their population would be undesirable to engage, and which subgroups may be good fits for targeting. Depending on the quality of results, these findings could be used to adjust deemed savings to reflect customer characteristics, and as such, enable ComEd to achieve greater savings per customer by increasing participation among the high saving subgroups. The research team explored population level NMEC methods to provide a starting point for future researchers. The research team separated the study population based on the predicted savings on a randomly selected validation set and then visualized them by separating the dataset into high savers (the top 25%) and low savers (everyone else). Using population methods, the models successfully predicted savings for high savers as distinct from low savers on

[2] The percent savings for a site that consumes 100,000 kWh/year, with savings of 30,000 kWh would be 30%. Measuring percent savings, where all facilities are compared to 100% of their own annual consumption provides an even comparison between large and small facilities.

average. This approach showed promise and presented the research team with statistically significant results.

However, for a population level analysis to adhere to rigor standards, the measurement method should be determined before the data is available. This step was not conducted during this research as the population level analysis was conducted after site level exploration and the completion the projects. In this analysis, each site received a custom model based on review of the available information. In a population level analysis, the data should not be modified after receipt. Further research is needed with the measurement approach determined prior to receipt of data.

Exploratory Analyses

The research team conducted three additional analyses to predict consumption and understand discrepancies between post-installation energy savings and the derived metrics. These analyses included improving the sample, performing a deemed savings analysis, and conducting an engineering review of savings.

Improving the Sample

The techniques used to improve the sample included restricting the dataset to NAICS codes known to model well using NMEC methods, restricting measures to those likely to be impacted by the model inputs such as only weather dependent sites and restricting the data set further to high quality models of medium sized facilities.[3] The additional specificity did not improve the predictive power of the model inputs.

Deemed Savings Analysis

The deemed savings analysis found that deemed savings were not correlated to the NMEC savings. Although this alone does not discount the use of NMEC methods, it is an indication that there are unknown factors impacting facility consumption.

Engineering Review of Savings

Afterward, the research team reviewed a sample of 20-30 facilities to understand the impact of the measures on energy use at each facility. The engineering analysis found no impact of the measures on energy use patterns at the facilities. This suggests that the measures were not a factor in the energy use of these facilities. However, few of the installed measures were expected to save a large amount of energy in a single installation, and even fewer of the measures had been installed in sufficient quantity for either NMEC methods or an engineering analysis to be able to separate the impact of the measure from the noise in the data.

[3] Size was restricted to a minimum annual energy consumption of 35,000 kWh and models needed a CV(RMSE) or at least 0.25, with savings uncertainty <50%.