

# Customer Segmentation through Heating and Cooling Energy Disaggregation

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## Introduction

Electrifying residential heating and cooling systems is a leading approach to not only reducing customer energy costs but reducing thermal sector emissions. Heating electrification continues to require more sophisticated strategies to identify customers well-positioned to transition from unregulated and delivered fuels (such as fuel oil or propane) to efficient electric heating and cooling technologies. Identifying customers reliant on non-electric heating or cooling systems is a challenge because of the lack of consistent data from delivered fuel suppliers, as compared to electric utilities. To achieve the most impact, residential energy efficiency programs require identifying customers who have the highest potential to benefit from electrification and energy saving, and implementing projects at scale for these customer groups.

To address customer identification challenges, analyzing Advanced Metering Infrastructure (AMI) data offers a promising solution. We can leverage AMI data to identify customers using non-electric heating by analyzing energy use patterns relative to outdoor air temperature. By identifying this group, we can design more intentional electrification programs to achieve impactful energy efficiency programs and carbon reduction goals.

## Methods

The research focused on one primary question: which temperatures cause excess energy demands in residential buildings' energy usage? For this, we used AMI and outdoor air temperature data from a sample of 7,500 residential customers. By utilizing the CalTRACK Daily Model from OpenDSM's EEmeter module, we used degree days to disaggregate the energy data of each building in our sample to that of a base load, heating load, and cooling load. Defining buildings according to energy model parameters (such as heating degree day balance points or cooling rate), or model shape, allowed us to group the buildings into unique categories.

Then, by applying a k-means clustering algorithm to the parameters of each building's CalTRACK model, we assigned a category to each building model. We optimized the number of categories to represent with silhouette analysis. These categories were then interpreted for trends and visualized by averaging the model parameters of each category label, creating a high-level representation of the sample group at large.

## Results

The results showed six distinct clusters, each representing unique energy usage profiles. Among them, we identified one group that stands out as the most likely to use non-electric heating, showing minimal electrical heating at cool temperatures. This is an indicator that heating energy is only being applied to the building once outdoor air temperatures reach sub-freezing levels. This implies that a considerable proportion of our sample set is primarily using unregulated fuels to heat their homes, rather than electricity.

## Conclusions

The results of this analysis show a considerable proportion of our sample using little electrical energy at low air temperatures, implying that the main source of heating energy is unregulated fuels rather than more efficient and lower-emissions electrical source. These findings highlight significant opportunities to optimize energy efficiency programs, particularly for homes where electrification could make the most impact. The findings of this work could be paired with additional home characterizations to further enhance the identification of non-electric heating users.