UNIVERSITY OF CAMBRIDGE | Energy Policy Research Group

Machine Learning and residential electricity consumption: Which households are more responsive to weather?

EPRG Working Paper 2113

Cambridge Working Paper in Economics 2142

Jieyi Kang and David M Reiner

Residential electricity consumption patterns are closely associated with the timing of active occupancy. The traditional method of detecting household occupancy is either through surveys or very high-resolution data, which can be measured hourly or even minute-by-minute. Both methods can be particularly time-consuming and costly. Privacy is another barrier to obtaining what can be highly sensitive data. However, there is the potential that households' demand sensitivity to weather over longer time periods could be a good indicator for detecting occupancy and can therefore be used to infer occupancy status over specific periods. Using this method can be less intrusive and costly for policy makers and utilities to understand residential sector dynamics from a different and/or deeper perspective.

Our analysis employs machine learning methods to fill the gap in the limited studies of the weather effect over different time periods. We use the Irish CER datasets and introduce clustering algorithms to detect household behaviour/daily patterns using weather variables. We separately cluster household responses to three weather attributes – temperature, precipitation, and sun duration. We adopted K-means for the task of weather sensitivity clustering due to its proven capability of handling high-resolution household consumption data. We proposed a novel method of using the

weather sensitivities as proxies to identify daily household patterns. Apart from profiling customers using different weather variables, we analysed the profiles from two additional perspectives: seasonality and workday/weekend differences. In addition, the correlations between weather sensitivity clusters and socio-economic attributes were also examined using statistical tests. One main finding was that living status (i.e., whether living alone or with only adults or with young children), employment status, and the number of adults in the household are the main variables that can help explain differences in consumption patterns.

The major contribution of the novel approach is that it enables electric utilities or other researchers to understand consumption patterns from a new angle by using weather responses, which can be used to reveal different occupancy patterns based on the weather sensitivity clusters. Having a better grasp of the main types of residential customer occupancy pattern could serve as a basis for adopting different demand-side management strategies, from better peak control to electricity price design. Traditionally, occupancy patterns have only been able to be detected either by small-scale trials with higher resolution/electrical appliance level data or larger-scale representative surveys, both of which are costly. Examining clustered weather sensitivity groups offers a quicker way of identifying occupancy and behavioural patterns, and so can deliver insights in a much less time-consuming and much more cost-efficient manner.

Contact jieyi.kang@hotmail.com
Publication May 2021