Identifying the Fuel Poor from Consumption Behaviour: Towards an Integrated Interpretative Framework of Domestic Energy Consumption in the UK

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Impacts

- Proposes an approach for identifying vulnerable energy customers through the utilisation of smart-meter data.
- Presents spatio-temporal analyses of consumption trends and identifies unique behavioural groups.
- Demonstrates how consumption patterns between groups vary significantly.
- Outcomes can inform strategic and tactical decisions made by public policy makers and energy providers.

Project Background

Recent innovation to energy provision in the UK has been the introduction of smart meter technology. Smart meters, which digitally send energy usage readings to a supplier, aim to provide more accurate tracking of consumption for both the supplier and customer. However, the data produced by these meters can also offer a useful source of behavioural insights for the wider research community. For example, these data provide 'complete' consumer records on a fine temporal scale, which directly correspond with a single household.

Research has suggested that energy consumption corresponds with household activities and movement patterns, and can be influenced by various factors such as weather, household size, life stage or income. Fuel poverty, or vulnerability, refers to the proportion of disposable income that is devoted to energy expenditure in a household. In the UK, a household is defined as fuel poor if spending on energy services exceeds 10% of their income. Understanding fuel poverty is a pressing issue for both consumers and policy makers, as vulnerable individuals may experience acute impacts on welfare.

In collaboration with a major UK domestic energy provider, this research proposes an approach for identifying vulnerable customers through the utilisation of Big Data analytics. It presents spatio-temporal analyses of consumption trends and identifies unique behavioural groups using clustering techniques. This aims to segment and understand the ways in which patterns may vary and fuel poor customers may be identified in the UK. It is hoped that outcomes can inform strategic and

tactical decisions made by public policy makers and energy providers.

Data and Methods

Data were acquired from a large domestic energy supplier in the UK. Samples were obtained from gas smart meters in Scotland and Northern England for 2014, and both the gas and electricity smart meter data for Bristol in 2015. Meters typically recorded half-hourly consumption patterns with both samples covering approximately 2000 smart meters. This case study presents a segmentation of consumption behaviour using the Bristol data.

The methodology involved firstly, examining temporal characteristics of UK energy customers, for example, how patterns of energy use differed according to the time of day and week, as well as seasonal variation. Only gas was chosen for analysis at this stage due to demonstrating higher variability than electricity patterns. Figure 1 demonstrates temporal variations of gas consumption for a weekday in Bristol.
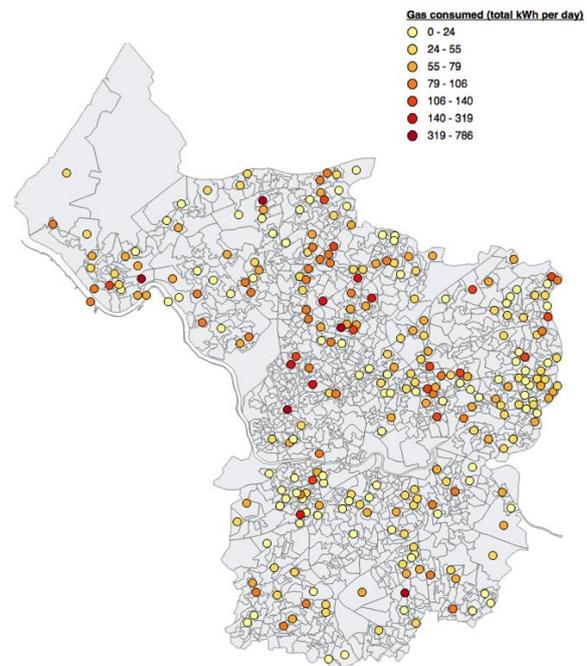

Figure 1. Gas consumption intensity for a weekday of January 2014 in Bristol.

These data were then used to cluster and segment behaviours in order to gauge group variations between customers.

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Key Findings

Cluster analysis was able to identify six unique groups of consumption. Figure 2 shows the temporal characteristics of gas usage for these groups. Profiles showed large variation in their morning and evening peaks of consumption. Figure 3 shows the spatial distribution of these groups across Bristol. Clusters tended to be quite scattered across the areas with groups 2-5 being the most commonly identified in this sample.
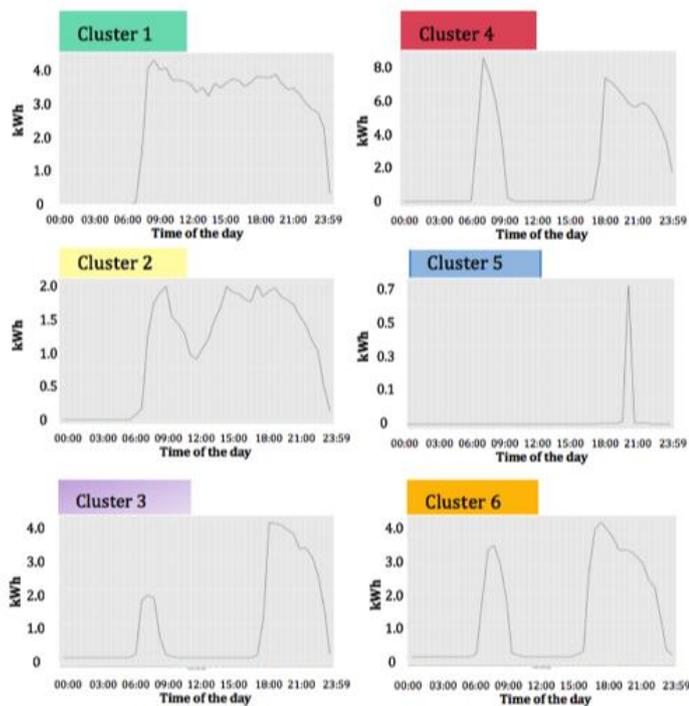

Figure 2. Temporal profiles for Bristol customers.

The researchers also suggest that cluster 5 may be related to the absence of a consumer in the house on the day of the analysis. Previous profiling of vulnerable customers by Ushakova and Mikhaylov (2016) were able to integrate socio-economic characteristics into such a classification. In comparison to these results, clusters 1 and 2 show similarities to the characteristics of those vulnerable customers. These groups demonstrate higher consumption patterns throughout the day, which was attributed to less daily activity patterns outside of the home. However, further analysis linking this sample with household characteristics is needed to confirm the observation for this sample.
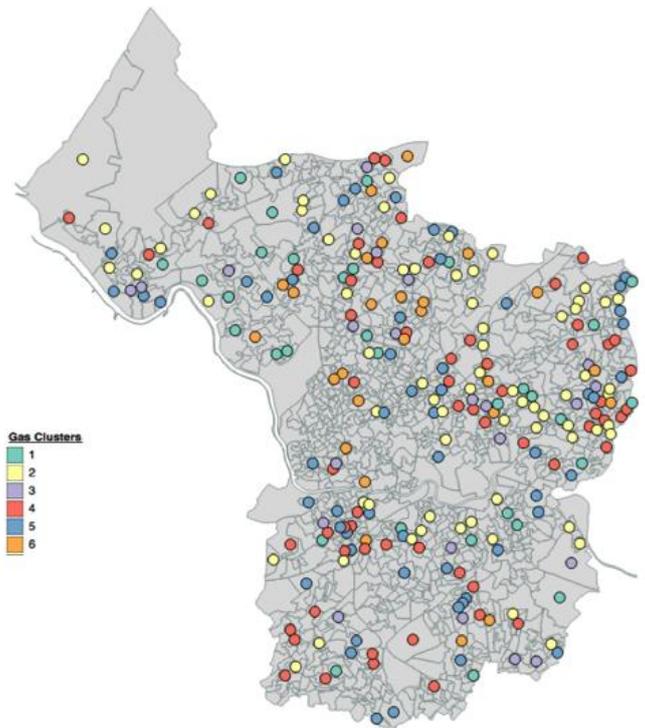

Figure 3. Spatial profiles for Bristol customers.

Future Directions

Future research will aim to link the observed temporal patterns to household characteristics and property attributes to enhance this classification. However, it is evident that consumption patterns between groups vary significantly and further analyses hope to provide beneficial insights to aid policy development and evaluation.

In addition, whilst this analysis is based on only one sample of data, the methodology may be easily transferable to other areas and countries, for example, to predict energy usage in locations where data may be lacking. It can also be utilised to identify households that exhibit fuel poverty and investigate how energy providers may offer a preventive care regime for vulnerable energy customers. Conversely, it may identify those that appear to make excessive use of energy, which may inform energy savings initiatives.