~~Using~~Modelling sample data from smart-type meter electricity usage ~~data to identify unoccupied households~~

Susan Williams [redacted]

Keywords: smart meters, ~~occupancy~~ households, big data, official statistics

1. INTRODUCTION

A smart meter is an electronic device that records and stores consumption information of either electric, gas or water at frequent intervals. These data can be transmitted wirelessly to a central system for monitoring and billing purposes.

The European Commission's Energy Efficiency Directive[2] is a common framework of measures for the promotion of energy efficiency within the EU. It supports the EU's 2020 headline target on 20 per cent energy efficiency, and its provision for the roll-out of smart meters requires member states to ensure that at least 80 per cent of consumers have intelligent electricity metering systems by 2020.

The separate countries of the UK collectively have one of the most ambitious roll-out policies within the EU: to put electricity and gas smart meters in every home by 2020 with rollout starting in 2016~~5~~.

Smart meter electricity energy usage data is attractive to statistical organisations as, subject to data access, it provides detailed information on household energy consumption ~~at the individual level~~ and at high levels of frequency~~timeliness~~.

Preliminary research in the UK's Office for National Statistics has focused on the potential of smart-type meter electricity usage data, made available for research through energy trials, to model ~~identify~~ days where a household may be unoccupied. As a retrospective analysis using actual smart meter data, this information may have a use in the quality assurance of census data. An extension of the research is to investigate whether longe~~r~~ term unoccupied households may be identified, of great use within validating estimates of such properties or to aid with processes such as survey and census fieldwork.

2. METHODS

Data was sourced from consumer behaviour trials of smart-type meters conducted in Ireland and held in the Irish Social Science Data Archive[3]. These data include 30 minute frequency electricity energy usage readings on over four thousand households over 18 months in 2009-2010. These data contain 108 million observations.

The team tested various methods for predicting~~determining~~ whole days when a household may be unoccupied. As there is no information on whether a property is

1 Office for National Statistics

2 http://ec.europa.eu/energy/efficiency/eed/eed_en.htm

3 http://www.ucd.ie/issda/data/commissionforenergyregulationcer/

actually occupied or not, the accuracy of the methods to detect unoccupied households was conducted by examining energy profiles over time by eye. If electricity consumption is fairly flat across 24 hours then the assumption is that the property is unoccupied on that day. Correspondingly, if there is evidence of unsystematic variation in energy usage, particularly associated with either morning and/or evening peaks, then the property is assumed to be occupied. Validation of the methods in this way is therefore subjective; one person may think that the household is occupied based on the consumption data, another person may not.

3. RESULTS

3.1. What electricity consumption pattern does an unoccupied household have?

The graph below shows the mean daily electricity consumption pattern during the trial period, as well as the consumption pattern for what is thought to be an unoccupied day for one sampled household.

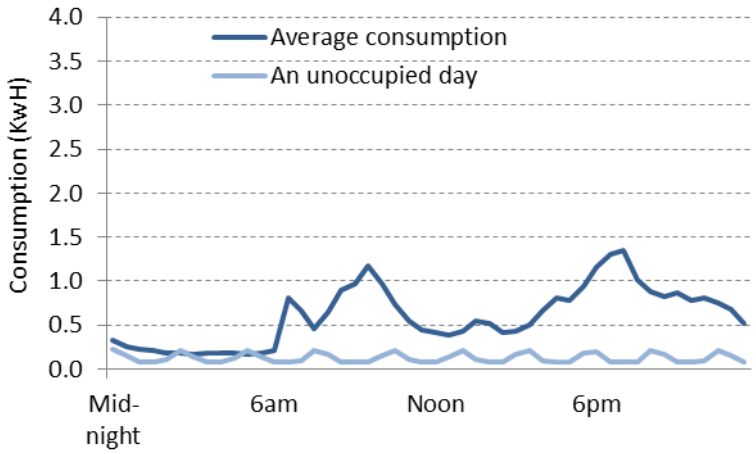

Figure 1: Half hourly consumption for a selected household

The mean daily consumption over the trial period for this household is typical in that both a morning peak and an evening peak can be observed with a dip in the middle when household occupants may be temporarily absent from the home. The unoccupied day has a regular cyclical pattern of electricity consumption, typical of appliances driven by automated controllers such as a fridge or freezer. This is the pattern that has been most often observed in what have been classed as unoccupied households during this research.

3.2. Overview of results

The methods developed used various attributes of energy expenditure on a given day such as the daily average, night time average and variance as well as looking at differences in these values to the 'usual' energy expenditure in a household. Although some of the methods appear to classify unoccupied days reasonably well on their own and with little misclassification, it is conjectured that using methods in combination might further improve classification.

The research is being extended to look at combining methods as well as exploring options to identify longer term vacant households, although the trial data is limited here as it does not contain many such households. With further research to refine the most

promising methods and to identify the most influential variables it is proposed that logistic regression might also be used.

4. CONCLUSIONS

This abstract outlines the research undertaken into the potential of using the data from trials of smart-type electricity meters to ~~identify unoccupied households to~~ help improve official statistics.

The dataset used contains half hourly electricity consumption of over four thousand households over an 18 month period. It was used to develop initial methods to determine the likelihood of whole days when households appear to be unoccupied.

The data on which these methods were tested is large and required processing using big data technologies. Manipulation of similar data representing all households in England will require significant knowledge of a range of big data technologies.