RP1023
FORECASTING & HOME ENERGY ANALYSIS IN RESIDENTIAL ENERGY MANAGEMENT SOLUTIONS

Residential Electricity Load Forecast

Electricity load forecasting at an individual household level has become more prominent with the emergence of smart meters, smart home energy and battery management systems and eventually a smart grid. Accurate forecasts can bring significant economic and environmental benefits when used in:

- **Optimization of distributed generation & electricity consumption**
- **Optimization of battery charging/discharging patterns**
- **Household load scheduling**
- **Network demand response operations/ peak demand reduction**

Figure 1 Load forecast at individual household level is essential for smart energy management systems [1]

[1] WiSE Laboratory, Home Energy Management Systems, http://www.jaist.ac.jp/is/labs/lim-lab/research.php

Methodology

During the first year of the project a thorough literature review has been done and two important methods were identified as relevant to our research.

Load Curve Analysis

Daily household electricity load profiles are analysed in order to infer habitual consumption patterns. For example, relationships between load profiles and temporal variables, and household demographic and anthropologic information can be extracted.

Smart Meter Based Models (SMBM)

Recent uptake of smart meters allows easier access to electricity consumption readings at fine resolutions. State of the art machine learning models can use this data and weather variables such as temperature and humidity to obtain short & very-short term forecasts.

Load curve analysis allows us to gain important insights about household consumption profiles, which in theory can further improve forecast results when combined with SMBM.

We've obtained data-sets from over 10,000 households from Smart Grid Smart City (Australia-NSW) and Commission of Energy Regulation (Ireland) trials. By analysing household stocks from two different climates, valuable information can be gained on the relationship between weather, load profiles and forecasts.

Preliminary Results

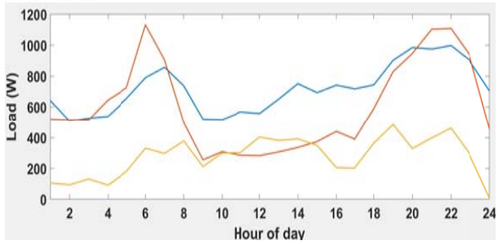
Initial forecast results were obtained by implementing the SMBM approach with Artificial Neural Networks (ANN). Results are shown in Table 1. Even though ANNs are tailored for each household, the obtained results showed big inconsistency, which is mainly caused by different electricity consumption habits of each household. In particular, more volatile profiles with higher standard deviation represent a bigger challenge for the forecast model. A similar problem was observed within the literature; results between different studies varied significantly, due to use of different household data sets exposed to different climates and cultural impacts.

Table 1 SMBM results for day ahead hourly electricity load forecasts on four individual household

	HH 1	HH 2	HH 3	HH 4
MAE (%)	26.61	39.07	67.46	0.59
RMSE (%)	38.54	61.82	92.22	0.83
MBE (%)	2.52	1.23	33.28	-0.25
Accuracy small loads (%)	77.08	91.29	46.88	36.56
Accuracy big loads (%)	28.37	27.55	13.94	8.43
Mean Load (W)	937.23	439.51	625.55	950.32
Standard Deviation (W)	532.98	570.01	795.04	834.76

A load curve analysis was implemented on one household over a year which resulted in three typical daily consumption profiles (Figure 2). The majority of days showed the orange profile (typical working day profile). The yellow profile represents minimal household activity and the blue profile is analogous to active weekends/ holidays.

Figure 2 Typical daily consumption profiles of an example household



Anticipated impacts

The research aims to:

- Gain insights for the relationship between Australian household characteristics and electricity consumption behaviour
- Gain insights on the impact of climate on electricity consumption behaviour
- Assess the impact of forecast horizon and data resolution on forecast performance

These results can benefit smart energy management systems, smart grids, networks and policy advisors.

KEY POINTS

- ***Smart meter data*** *can tell us important information about household electricity consumption habits.*
- ***Smart meter data*** *in SMBM framework can give satisfactory forecast performance and can be preferred over more complex methods with detailed data-sets*

Further information

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