Popular science summary

1 Research project objectives

The aim of the project is to develop new methods applicable for short and medium term electricity forecasting (up to one month) and appliance recognition using smart meter data that are both simple and accurate. This would be possible as a result of event recognition algorithms aimed to detect typical behavior of the household. I this project we see three complementary objectives:

1) To develop modeling techniques applicable for short and medium term electricity forecasting based on smart meter data.
2) To propose the appliance recognition approach applicable for electricity forecasting.
3) To propose optimal structure of the dataset that captures variability over appliances and supports accurate forecasting.

2 Research methodology

In the proposed studies we will use existing data sets for load disaggregation and electricity forecasting.

As a modeling tools, we will use both supervised and unsupervised learning algorithm such as artificial neural networks, support vector machines, classification and regression trees, k-nearest neighbors and models aggregation techniques (random forests, boosting). To capture the uncertainty and linguistic variables fuzzy logic will be used. In turn, to determine the similar days we will use following clustering methods: hierarchical clustering, Ward's method, c-means, fuzzy c-means and self-organizing map. In addition, to calibrate the appliance recognition and load forecasting systems, we will use algorithms such as, genetic algorithms, particle swarm optimization and artificial immune systems.

Daily user behavior are highly correlated with the sequence of appliance usages and appliance states in the household, therefore, to find patterns of user activity in a given time and the day of the week will use: grade correspondence analysis and sequential association rules.

3 Research project impact

Taking into account the scope of the project, we expect that the study will lead to a better understanding of the smart metering solutions and show the benefits for the end user. Smart metering systems are expected to play important role in reducing overall energy consumption and increasing energy awareness of the users. Leveraging smart metering to support energy efficiency on the individual user level poses novel research challenges in monitoring the electricity usage. Our research fits into worldwide attempt to reduce electricity consumption in buildings, which basically involves identification of individual sources of energy consumption as a key issue to generate energy awareness and improve efficiency of available energy usage. Households' energy consuming behaviors can be complex and are influenced by several factors such as cultural and societal settings, country-specific regulations and on a more domestic level the type of housing people live in and how they behave in their homes, including the purchase and use of various household appliances.

Therefore, we propose to construct the approach to forecast electricity load on individual household level, what can potentially provide greater intelligence to the smart meters and create value added for individual customers. Without any doubt, the proposed approach fully meets the requirements of innovation and fits into a relatively new stream of ongoing research towards the solutions that will offer the benefits on both, the local and global scale. Just to mention that peak load reduction and distributed generation are two critical functions which are possible by the superior control and communications of an appropriately engineered smart metering grid and willing customers. These functions help to reduce energy consumption, especially at critical times. They also help to effectively integrate various renewable energy sources such as solar panels and windmills.