Using technology in smart grids to influence user behaviour

TOSHIBA

Supporting Toshiba Research Europe Ltd. to simulate the smart grid and understand how their technology could be used to positively influence user behaviour.

The ratification of the Paris Agreement and the 5th Carbon Budget by the UK Government has committed the UK to achieving significant reductions in Greenhouse Gas emissions, particularly Carbon Dioxide (CO_2), to minimise climate change. A key producer of CO_2 is the supply of electricity from fossil fuel sources e.g. gas and coal. Reducing emissions from electricity generation can be achieved by increasing the use of renewable energy in the generation mix, increasing energy efficiency, and demand side management to reduce consumer energy use.

The development of the smart grid in the UK has a key role to play in enabling a transition to a lower carbon society. In a technical sense, a smart grid is a modernised electricity grid that uses information and communications technology to monitor and actively control generation and demand in near real-time, which provides a more reliable and cost effective system for transmitting electricity from generators to homes, businesses and industry (Smart Grid Forum 2014).

Smart grids provide the opportunity for the UK to meet its carbon reduction targets, ensure energy security and wider energy goals minimising costs to consumers while empowering and incentivising them to manage their demand, adopt new technologies and minimise costs to their benefit and that of the electricity system as a whole (Smart Grid Forum 2014).

How can the technology deployed in homes be utilised to encourage better demand side management and support the integration of more renewable energy sources?

What the IDC did

In partnership with Toshiba Research Europe Ltd (TREL), the IDC initially set out to determine how communications could be used to develop home energy management systems. Very quickly the project moved from developing technological interventions to understanding all of the system constituents and their interactions.

The team applied multidisciplinary modelling approaches including agent based and sociotechnical modelling to investigate optimal energy management solutions. Many existing energy models simply consider the technical side but the IDC considered the human capital within the system and the wider policy environment to develop a simulation environment and study individual and collective user behaviour of the system.

TREL became partners in the highly successful 3e Houses project in Bristol, which allowed the Research Engineer to expand a trial to install smart grid technology in 100 homes by designing interventions with participants and gathering data for 12 months. The evidence gathered from the trial supported the development of new concepts based on the theory of planned behaviour. After the roll out of the trial an initial positive step change in behaviour was observed, which tailed off before finally regression to habitual behaviours was seen.

The outputs from the project produced both significant technical information regarding the technology installed, householder interaction with technology and behavioural change over time.

The Impact

The outputs of the project enabled Toshiba to increase their visibility and expand their capability in the area of smart grids to support the development of technologies and services in this field:

- TREL used the learning from the project to support the development of their Home Energy Management System (HEMS).
- The 3E Houses project was rated outstanding by the European Commission with the RE's work being identified as providing a very significant contribution.
- The 3E Houses project was runner up at the LGC (Local Government Chronicles) Awards 2014 – Energy Efficiency Category.
- The RE was recruited by TREL and became the first "systems research engineer" in the company.
- The RE also became the first person at TREL to undertake a secondment to another group company using the taught courses from their EngD to help develop product strategy for a new business for Toshiba in Austria.
- The 3E Houses project was Toshiba's first smart metering project in Europe which had undertaken "testing in the wild"
- TREL have undertaken 2 further EngD's with the Systems Centre using the underpinning methodologies and approaches from the project and applying them to other business challenges.

The Future

The REPLICATE project (Renaissance in Places with Innovative Citizenship And Technology) is a €25M European Smart Cities and Communities Lighthouse project that aims to deploy integrated energy, mobility and ICT solutions in city districts across Europe. The project aims to "increase the quality of life for citizens across Europe by demonstrating the impact of innovative technologies used to co-create smart city services with citizens, and prove the optimal process for replicating successes within cities and across cities." TREL and the University of Bristol are partners in the project which will use the experience from 3E Houses and apply it to the HEMS system being used in homes across the city.

Related publications

Saraansh Dave, Mahesh Sooriyabandara, Mike Yearworth, System behaviour modelling for demand response provision in a smart grid, Energy Policy, Volume 61, October 2013, Pages 172-181, ISSN 0301-4215.

P. Kulkarni, T. Lewis and S. Dave, "Energy Monitoring in Residential Environments," in IEEE Technology and Society Magazine, vol. 33, no. 3, pp. 71-80, Fall 2014.

doi: 10.1109/MTS.2014.2345201,

Dave, S., Denic, S., Sooriyabandara, M., & Yearworth, M. (2012). Understanding Causal Effects of Technology on Energy Use Behaviour. Paper presented at the 8th Conference of the European Social Simulation Association (ESSA 2012), Salzburg, Austria.

Dave, S. J. K., Sooriyabandara, M., & Yearworth, M. (2011). A systems approach to the Smart Grid. Paper presented at the First International Conference on Smart Grids, Green Communications and IT Energy-aware Technologies (ENERGY 2011), Venice, Italy.

3E HOUSES

The 3E Houses (Energy Efficient e-Houses) project was an EU-funded project which linked Bristol with cities in Spain, Germany and Bulgaria with the intention of supporting social housing residents to reduce their energy consumption by up to 20% over a year. Smart meters were installed in 100 social houses across the city, and the residents provided with tablet computers so they could monitor their energy consumption in real time.

The overall average energy savings achieved in the pilots was 12.3% with variance across the areas with some achieving greater than the 20% target and others significantly less. Further details can be found at: **www.3E-Houses.com**