Highly distributed power systems: distribution network modelling and demand simulation

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Highly distributed power systems: Distribution network modelling and demand simulation

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motivation

Assessing the impact of domestic micro-generation on the electricity distribution network, requires detailed simulation of the existing networks and the power demands.

This project aims to construct a high-resolution model of an actual distribution network, to include the simulation of the minute-by-minute demands, particularly in residential areas, where high penetrations of micro-generation could be deployed.

The resulting model will provide a platform to assess the implications of highly distributed power systems (HDPS) and to examine the network response to demand side management (DSM) measures.

distribution network modelling

The model represents a real 11kV and low voltage distribution network topology, that supplies an area with approximately 35,000 domestic properties, in both urban and rural environments.

A load flow analysis is integrated into the model to calculate the power flows throughout the network.

Each individual electrical load on the network (such as a residential dwelling) is represented using Ordnance Survey address point data. A geographical information tool has been built to integrate the network topology and the demand model.

domestic electricity use demand model

A high-resolution domestic electricity demand model has been constructed that simulates individual appliance categories, including lighting, cooking, cooling and wet appliances.

The demand model is based upon the activity of occupants within a dwelling at a given time of the day. In the case of lighting, the model also takes into account the solar irradiance level. The graph shows an example of a single day lighting simulation for 100 houses.

The aggregated demand output for each dwelling will be integrated into the network load flow model to provide a high resolution simulation of the low voltage network.

validation of the model with measured data

An energy study is being run in Loughborough to examine domestic electricity usage and to obtain real data.

Statistical electricity meters have been installed into a number of domestic properties through the recruitment of energy study volunteers.

Aggregated demand data is also being captured in a number of distribution substations. The data is being used to validate the demand modelling simulation outputs.