nationalgrid

The value of information in managing the electricity system

Introduction

The GB electricity network is organised into the Transmission network and Distribution networks. Distribution networks are in charge of all the distribution within their local area (a local area could be London or South-West England for example). The Transmission network is a high voltage network designed to transport electricity over large distances. Distribution networks connect to the Transmission network at suitable points. As a schematic representation, the Transmission network can be viewed as a central hub, with distribution networks attached radially (see Fig. 1).

Electrical power is provided by generators. Large generating units (shown in Fig. 1 by the green boxes) are known as Balancing Mechanism Units (BMUs) and these units connect either directly to the transmission network or to their local distribution networks. Small generating units, termed non-BMUs, connect directly to their local distribution networks. These latter generators may be solar panels on people's houses, wind farms or local diesel generators/batteries (shown in the Fig. 1 by the red circles). This means that at any given time some of GB's total electricity demand is met by BM units and some by non-BM units.

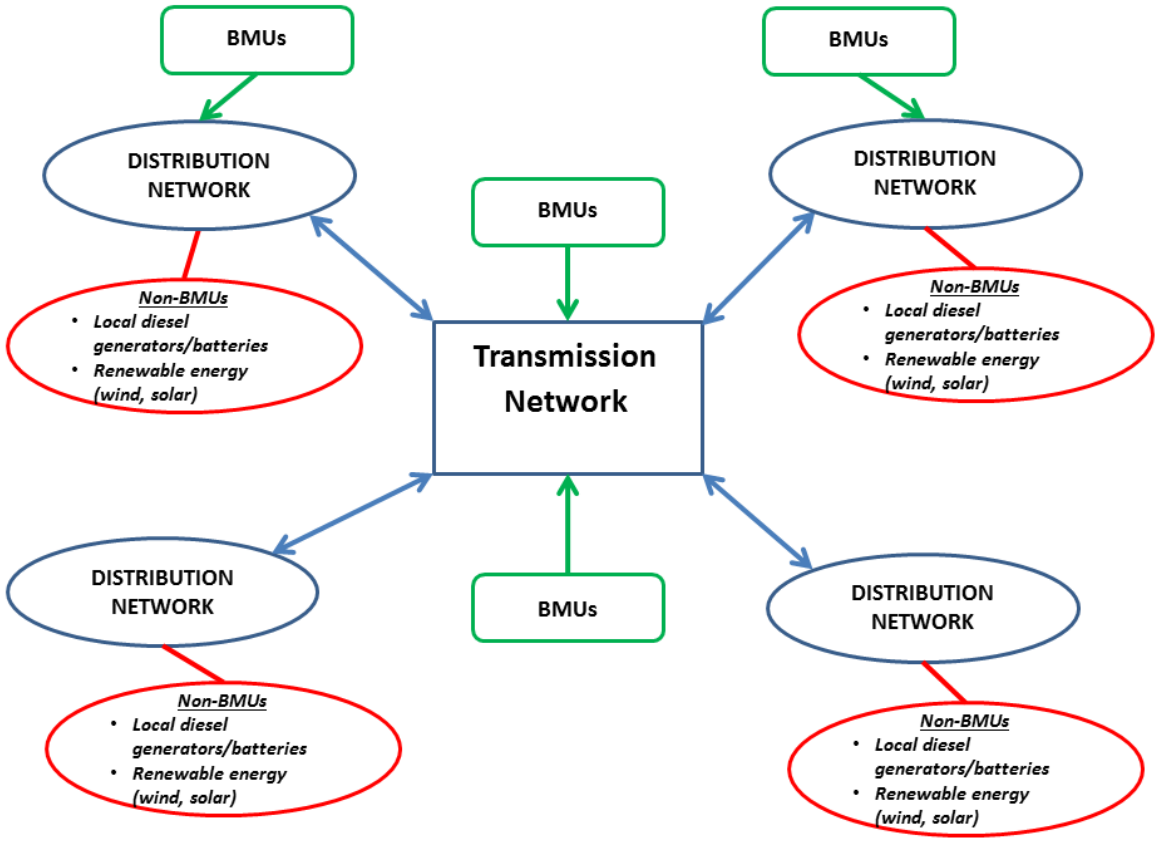

Figure 1: Approximation of the electrical network in Great Britain.

The Transmission System Operator, TSO (in Great Britain this is National Grid Electricity System Operator, NG ESO) has to manage the entire system. It is its job to keep the total supply of electrical power and the total demand throughout the country perfectly in balance at all times. The TSO does this by forecasting the supply-demand balance so that it can accurately schedule generation (this has to be done ahead of real time). The TSO also needs to schedule a certain amount of 'reserve' generation which can be used at short notice in order to meet an unexpected increase in demand or sudden loss of scheduled generation. This adds considerably to the expense of running the system.

However, the problem now faced by the TSO is that it is only aware of – and can therefore only control – the generation being provided by the BMUs. These provide generation schedules ahead of time and real-time output data to the TSO. Therefore, the BMUs are visible to and controllable by the TSO. On the other hand non-BMUs (all connected directly to the distribution networks) do not provide such information to the TSO, and indeed the TSO in general does not know how many non-BMUs there are, their capacity, location and fuel type. Therefore, the non-BMUs are invisible to the TSO and the only way they are 'seen' is as a net change in the total demand on the system. The activities of the non-BMU generators, and in particular the fact that these activities are not known to the TSO, therefore add greatly to the uncertainties involved in managing the system.

Traditionally the impact of non-BMUs on the system has been small. However, the rise of renewable energy, such as wind and solar, has led to a huge increase in non-BMUs. As a result there is now much greater variability in the TSO's forecast of the supply-demand balance (since non-BMUs are invisible to the TSO) and these forecasts are becoming less and less accurate. This in turn means that greater levels of reserve generation must be scheduled, thereby considerably increasing the total cost of running the system.

If there were more information on the activities of non-BMUs this could be incorporated into the TSO's forecasting models and the TSO would then be able to make more accurate forecasts and reduce the required levels of reserve, thus reducing costs. But the question remains - what is the value of this additional information on non-BMUs and how much could this information improve current forecasts?

Problem Question

What is the value of greater knowledge about the activity of non-BMUs versus the cost of needing increased reserves to cope with the increased variability in forecast supply-demand balances?

Data that you might find useful to answer this question are available at -
https://www.nationalgrideso.com/balancing-data/data-explorer

Note: datasets are provided to the working group under a Confidentiality Agreement signed on behalf of the University of Cambridge.