



IEA Implementing Agreement on Electricity Networks Analysis, Research and Development (ENARD)

Annex I Briefing Sheet “System Balancing”

Annex I: Information Collation and Dissemination

Introduction

Unlike most industries that are able to store their end products in a warehouse, electricity requires the instantaneous matching of supply and demand. Keeping supply and demand in balance is essential to ensure security of supply and the quality of the electricity on the network.

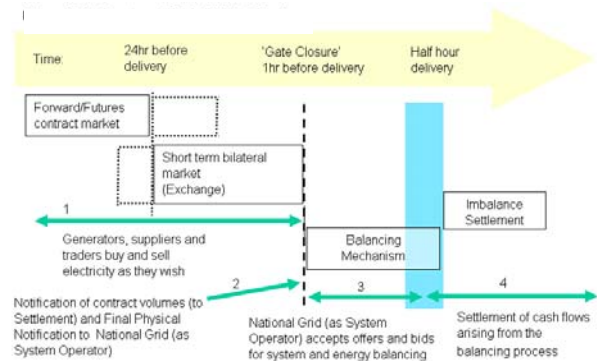
Transmission systems vary dramatically from country to country and have evolved to reflect the energy consumption of the respective population. Some countries, for example, have a single national transmission system which might be controlled entirely from one central control point, such as the UK, whilst others, like France, have regional control centres. Other countries, such as Denmark and the USA, have more than one transmission system which may or may not interact with each other.

Forecasting

In order to be able to balance the system, the System Operator needs to have accurate forecasts of the electricity being put on and taken off of the system. Different approaches are taken to this provision of information.

Many countries have adopted a Day Ahead Gate Closure model where trading and forecasting are finalised the day before delivery. In Italy, for example, participants are required to submit their potential output and prices to the market at different stages on the day before anticipated generation. The System Operator (GRTN) takes the market output and then amends through its Ancillary Services Market to take account of constraints and other transmission issues, before instructing the generators as to the required profile for the following day. A similar system is also used in Spain.

In the UK, in contrast, gate closure is much closer to real-time, with generators only required to provide the System Operator with a firm forecast of their projected output for each half-hour period an hour before that period is due to start.



UK Market Structure [from National Grid Seven Year Statement]¹
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Most System Operators use sophisticated tools to forecast demand requirements. These will largely be based on historical data, which is then amended as real time approaches to reflect variations in weather, cultural events, TV programming, etc.

Balancing Mechanisms

The System Operator also needs a method to vary generators' anticipated output to ensure that demand and supply match. Many systems use the term 'Balancing Mechanism' to describe both the submission of information by generators as to how their power stations' output might be varied as well as the instructions sent to generators by the System Operator to request that they change their output.

The use and structure of Balancing Mechanisms vary but they provide the System Operator with a mechanism for instructing generators and consumers to modify their submitted operating schedule in real

time (or close to real time) to counter problems arising on the system. For countries with an early gate closure, much of this can be done the previous day and notified to the generator.

Many System Operators will use Ancillary Services to assist with system balancing. Ancillary Services may be part of a wider Balancing Mechanism arrangement or procured from the generator by the System Operator, often on a tender basis. They tend to be targeted to address particular concerns of the System Operator. These might be day-to-day issues, such as frequency response, voltage control, or reserve power, or for more significant issues, like restoring the system in the event of a disturbance.

Demand Side Management

Whilst Balancing Mechanisms and Ancillary Services tend to provide System Operator with a way of modifying the output of the generators, Demand Side Management (DSM) is a technique for balancing the other side of the system. Typically, consumers agree to reduce their consumption in specific circumstances in exchange for a reduction in their overall energy costs.

DSM has tended to focus on larger industrial consumers who are able to significantly reduce their demand. However, a number of studies have been carried out as part of the IEA's Demand Side Management Implementing Agreement to investigate the possibility of smaller consumers being involved².

Interconnections

Interconnections between neighbouring systems have both benefits and disadvantages for system balancing. On a day-to-day basis, they provide a benefit by enabling balancing between neighbouring systems so a territory that consumes more than it generates and its neighbour that generates more than it consumes can economically balance their electricity flows. They can also allow market participants to benefit from any price arbitrage opportunities between systems.

Interconnections can allow System Operators to operate with lower reserve requirements than they would need if they were not connected. Given that the probability of a fault occurring on both systems at the same time is relatively low, neighbouring systems can share the reserve requirement and thereby reduce the quantity of part-loaded plant needed at any time. This reserve-sharing also has consequential benefits for carbon reduction, for example.

There are risks associated from being connected to neighbouring systems as a problem on one system can easily spread. Whilst rare, the potential is significant as the system disturbance in November 2006 that affected systems across the continental European transmission grid demonstrated, with disruptions for 15 million households. Some Interconnectors can be decoupled, such as the France-UK connection, which reduces the risk in the event of one system destabilising its neighbour.

Challenges

The integration of intermittent renewable generation presents a significant challenge to system balancing, due to the difficulties in accurately forecasting output. Some countries, such as Japan, are taking the approach of installing storage alongside wind farms to address the intermittency of renewable generation. Other countries, such as the UK, are using their thermal power plant to create reserve by reducing these units' output when the wind blows and increasing it when the wind drops.

The possibility of distribution networks being operated in a similar manner to transmission systems has been proposed as a potential future model, especially with greater volumes of distributed generation being connected in some countries. Distribution Network Operators would then be responsible for balancing their network in a manner similar to that used by System Operators currently.

A general take-up of evolving technologies and systems, such as Microgrids, Energy Storage and Demand Side Bidding for domestic consumers, are likely to have significant impacts for the forecasting of demand and supply on both transmission and distribution systems.

References

1. National Grid, Seven Year Statement (available at http://www.nationalgrid.com/uk/sys_08/default.asp?sNode=SYS&action=&Exp=Y)
2. IEA Demand Side Management Implementing Agreement (more information available at <http://www.ieadsm.org/Index.aspx>)
3. UCTE, Final Report on System Disturbance on 4 November 2006, 2007 (available at http://www.ucte.org/_library/otherreports/Final-Report-20070130.pdf)

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