Energy Management and Controls for the Evolving Smart Grid

Dr. Cherry Yuen
ABB Switzerland Ltd.

Many governments worldwide have set ambitious goals on renewable energy integration in order to reduce carbon dioxide emission and to slow down the depletion of natural resources. In many countries fossil fuel based generation plays an important part of their generation mix. Without significant advancement of carbon capture and storage technologies these plants would gradually need to be replaced by greener energy sources such as wind and solar energy.

The challenges of integration and delivering electricity based on these renewable resources are, however, manifold. Firstly, the location of these generation facilities is usually far away from the load centers, e.g. the wind energy harvested in North Sea or Baltic Sea in Northern Europe needs to be transported over several hundred kilometers before being consumed. It is therefore important to employ electricity transmission technologies which are energy efficient in order to reduce losses. Moreover, renewable energy such as that from wind exhibits the characteristics of being intermittent and not easily predictable. These impose additional technical challenges on the power systems security and operation such as generation and load matching in different time-frames.

This presentation will start with an introduction of the different challenges faced by grid system operators because of the evolving grid operational requirements and constraints. For example, at transmission (high-voltage, e.g. 380kV) level, a sudden loss of wind speed in a large scale wind farm can compromise the frequency stability of the whole power system if no mitigation measures are taken. At distribution (e.g. 11kV) level there is increasing amount of distributed generation. One consequence of this is the cause of voltage excursions which might not be corrigible with existing voltage regulation equipment alone such as tap-changers.

In addition, this presentation will illustrate the role and interaction of the different actors for network control from day ahead scheduling up to real-time power balancing for supply and demand, taking into account the deregulated regime as well as the operational challenges given by the integration of renewable energy sources and the possibility of deploying active demand. It is followed by an illustration of various techniques of the energy management and control which can be applied in order to cope with these technical challenges of electricity transmission and distribution. The choice of the solution depends on the computational and ICT (Information and Communication Technology) requirements of these applications. The concept and control of “microgrids” will also be introduced. The presentation will end with specific examples of pilot projects demonstrating the application of some of these technologies at different places of the world.