

Reliability of Power Networks

Wil Thissen
Delft University of Technology
Email: W.A.H.Thissen@tudelft.nl

Several developments impact issues of reliability of (electrical) power systems.

First, the challenge of making energy systems more sustainable, i.e., less dependent on non-renewable resource usage, and with fewer, preferably no, harmful impacts on the environment (such as greenhouse gas emissions and other pollutants or disturbances) has led to development of new technologies and of new primary energy sources. These include wind-powered electricity generation, small-scale solar systems, and micro-CHP systems which combine local heating with power generation for a more efficient use of energy resources. These new inputs to the power net have a serious impact on system properties and controllability. Traditionally, a limited number of large power plants fed into the network. Nowadays, a potentially fast increasing number of smaller generating units feed into the network, leading to a more decentralised structure of power generation and use. While a decentralised system may, in theory, be less vulnerable to large-scale outages, operational control of the network becomes far more complex. Wind- and solar - generated power is not always available, and availability can be quite unpredictable. The various smaller generation units cannot all be easily and centrally adjusted to operational demands.

The challenges to network designers and operators include the provision of sufficient back-up power generation capacity to meet the user needs when wind and/or solar power are unavailable, and meeting the far more complex operational management and control needs to maintain supply and demand equilibrium on the network.

Along with these technological developments have come institutional changes. Where the power systems were, in the past (in Europe, at least), state-owned and controlled and monopolistic, governments have started to deregulate the sector, privatise power systems, and open the power market to competition, also across traditional national boundaries.

In the context of these developments, reliability concerns have risen: privatisation has led to less reserve capacity than was available in the past; the control challenge has become more complex; and international power trading enhanced by opening power markets has not in all cases been matched by adequate cross-border network capacity to transport the power. Symptomatic of the situation are large-scale power outages that occurred in California in 2001 and following years, and more recently in significant parts of Western Europe, notably Germany, in 2006.

The challenges ahead, clearly, require a multi-disciplinary system view, as only an appropriate match of advanced control technology, generation and distribution capacity, and institutional and market designs can guarantee overall system reliability.