BALANCING POWER SYSTEMS WITH LARGE SHARE OF WIND POWER

Task 25

Design and Operation of Power Systems with Large Amounts of Wind Power

Task 25 Fact Sheet

The task of power system operation is to balance supply and demand at each instant. This is done by adjusting output levels of some of the power plants. Wind power will introduce more uncertainty and variability in the system and increase balancing needs. In the future, demand side and storage options also can be used to balance power systems.

How are power systems balanced?

Power generation is scheduled at least one day ahead. The generation scheduling process provides sufficient capacity to meet the electricity consumption (load) at each hour. This means having enough power plants on-line to meet the load, taking into account that some of these plants need several hours from scheduling request to power generation. The dispatch (output levels) of power plants can still be fine-tuned close to real time when more accurate knowledge of demand level is known.

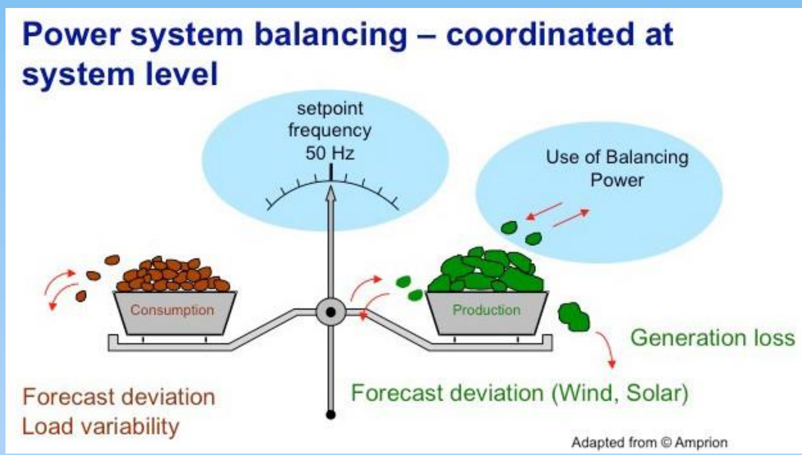

Figure 1. Keeping the frequency of the power system means balancing generation and demand in real time.

When generation and demand are in balance, the frequency of the power system is close to the nominal frequency (50 or 60 Hz). When generation is higher or lower than demand, the frequency will start to increase or decrease. Sufficient flexibility—the ability to change the output level of generation—needs to be available to balance the demand in time frames of seconds and minutes to maintain the frequency. The real-time balance of generation and demand during the operating hour is maintained by operating reserves. Reserves are kept in power plants to enable adjusting the output level quickly in response to balancing needs (Figure 1). Power systems are balanced at the system level. This means that minute-to-minute variability and uncertainty are combined, from all wind power plants, other power plants, and all the consumers. Only the net system imbalances between demand and generation are corrected by using the balancing power.

How to manage increasing and decreasing winds?

Adding wind power will impact the scheduling and operation of other power plants as well as the operating reserve (Figure 2). Increasing or decreasing winds are

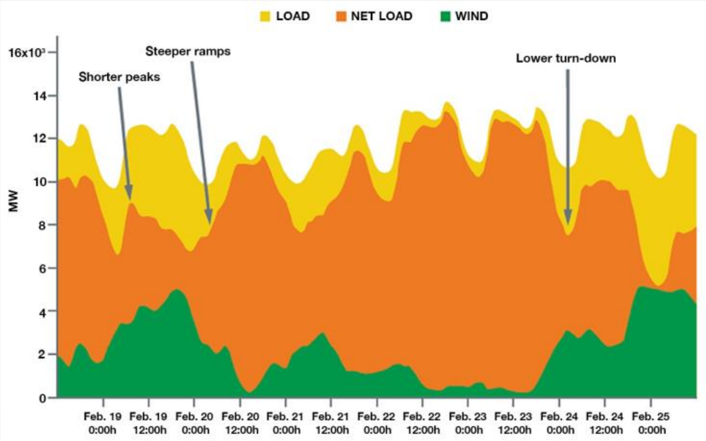

Figure 2. Example of how wind power changes the demand that conventional generation follows (Source: 21st Century Power Partnership 2014).

usually seen in the generation forecasts day-ahead. These will impact how much other generation is scheduled. Unforeseen variations and wind forecast errors will be handled by operating reserves. The reserves will be called upon based on total system imbalances (Figure 3). Variations of demand and wind generation often cancel each other out, and other times wind generation will cause more reserves to be activated**.**

How to make sure there is enough flexibility to balance power systems with large share of wind power?

Often there is more flexibility available in the existing generating units than is used today, in both the day-ahead and real-time time scales. However, increasing flexibility will be an important consideration for new power plants when anticipating larger shares of wind power in a power system. Increased flexibility can decrease the operational costs of the power system since there are more options available for balancing. Flexibility can be shared with neighbouring regions through the use of interconnecting transmission (trading electricity between areas). Another new source of flexibility is offered by the consumer side; this is called demand response.

Flexibility is also affected by operational practices. For example, balancing needs can be reduced by using shorter dispatch intervals (the time between requests for generation and actual delivery of power) and providing updated forecasts closer to real-time. In general, operating larger balancing areas helps systems accommodate more wind power by reducing total variability and pooling more sources of flexibility.

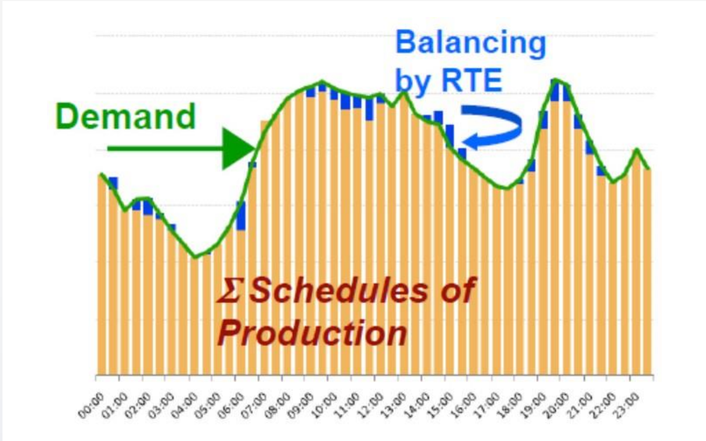

Figure 3. Scheduling the generation units is made to cover the anticipated demand, at least one day-ahead. Dispatch can be fine-tuned closer to real time. During the operating hour, balancing (operating reserves) are used to maintain the balance — load following by manual dispatch and automatic regulation in some power plants to follow the second to minute variability. (Source: RTE, the transmission system operator of France)

Associated publications

Holttinen, H. et al. (2016) **Design and operation of power systems with large y amounts of wind power.** Final summary report, IEA WIND Task 25, Phase three 2012–2014. http://www.vtt.fi/inf/pdf/technology/2016/T268.pdf

International Energy Agency (2014) **The power of transformation: Wind, Sun and the Economics of Flexible Power Systemys**. IEA, Paris, ISBN PRINT 978-92-64-20802-5 / WEB 978-92-64-20803-2

Lew, D., et al. (2013) **The Western Wind and Solar Integration Study Phase 2**. NREL/TP-5500-55588. Golden, CO: National Renewable Energy Laboratory. www.osti.gov/scitech/servlets/purl/1095399

21st Century Power Partnership (2014) **Flexibility in 21st Century Power Systems.** http://www.21stcenturypower.org/publications.cfm

More information

This Fact Sheet draws from the work of IEA Wind Task 25, a research collaboration among 18 countries. The vision is to provide information to facilitate the highest economically feasible wind energy penetration within electricity power systems worldwide. IEA Wind Task 25 works on analysing and further developing the methodology to assess the impact of wind power on power systems.

See our website at
https://community.ieawind.org/task25

See also other fact sheets

Storage Needs and Wind Power Fact Sheet
Capacity Value of Wind Power Fact Sheet
Variability and Predictability of Large-Scale Wind Power Fact Sheet