Task 25 Fact Sheet

CAPACITY VALUE OF WIND POWER

How much wind is available in high demand situations? Capacity adequacy of the system has to be evaluated to make sure that there is enough power plant capacity available for all peak demand situations. Wind power capacity value indicates how much of the installed wind power capacity can be counted on during peak demand.

How to manage situations of low wind and high demand?

System operators need to plan for sufficient capacity during possible peak demand situations. All power plants have the possibility of failure during critical hours. This is why total installed power plant capacity exceeds plausible peak demand estimates to make sure that there is enough capacity available. An extra margin of power plant capacity that is 12% to 15% of peak demand is normal. Import from neighbouring areas can also be counted. Adding any generation capacity will increase the reliability of the power system (Figure 1). Wind power is often added as an extra energy resource while keeping other power plants in the the system. These other plants will be available at peak times with low wind power production.

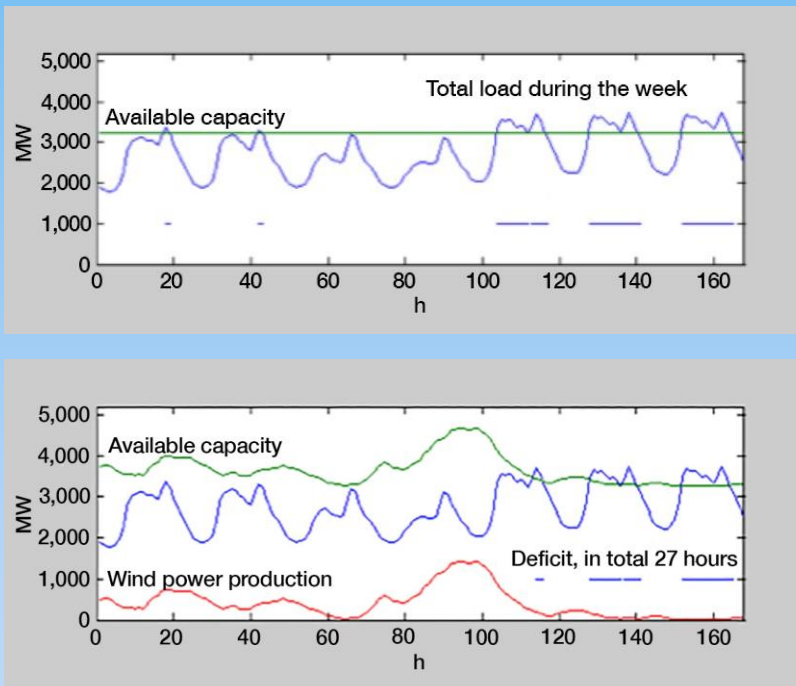

Figure 1. Adding generation capacity to an existing system will increase the reliability – the amount of hours with capacity deficit decrease (Source: Lennart Söder, KTH).

At larger wind shares older power plants may have to retire, and then the capacity value of wind power becomes a relevant question. Wind power usually has some capacity value to the system. But in addition to wind power, enough other power plants have to be kept in the system. In future flexible demand can help.

How to estimate the capacity value of wind power?

The capacity value tells how much a power plant contributes to system reliability. Power system reliability can be estimated by calculating the probability that there is not enough available power plant capacity to meet the demand (Loss-of-Load Probability LOLP).

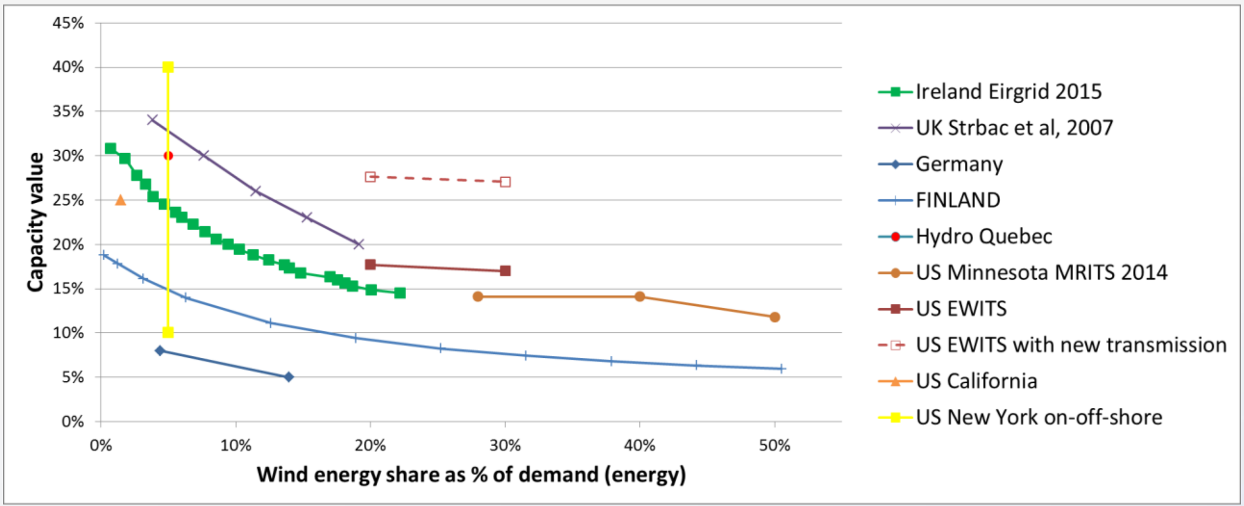

Figure 2. Examples of capacity value result from different wind integration studies. The capacity value will depend on the power system (mainly the available wind power during peak demand periods, the larger the system the higher the value). Capacity value will decrease with increasing amount of wind power. Source. Task 25 (Holttinen et al 2013).

Generation capacity is modelled with the forced outage rates of generators. The aggregate wind power output of a power system is composed of hundreds or thousands of individual turbines, so it is not feasible that all will fail to produce at once. For wind power the risk is whether there will be wind available. Aggregated generation over a large region can still contain days with low wind power generation.

In the simulations, hourly electricity demand and wind power generation from more than 10 years are needed to give a robust estimate. Using historical data makes sure that any correlations that wind may have with demand are captured. Simulating the system with and without wind gives the additional demand that can be served by wind power when the LOLP is kept the same.

How much can wind power be relied upon during peak demand periods?

For wind the capacity value is smaller than for conventional power plants, from 10% to 40% (Figure 2). The capacity value depends on timing of winds: for example it is small on land in New York state where wind usually does not blow in periods of high demand, and it is higher offshore where wind tends to blow at times of high demand. Capacity value of wind power tends to decrease when the share of wind energy increases. For larger areas the capacity value is typically higher, as it is more likely that the winds will blow somewhere during peak demand periods – this is illustrated by the Eastern US case where building transmission to connect larger areas shows a considerably larger capacity value for wind power.

Associated publications

Milligan, M.; Porter, K.; DeMeo, E.; Denholm, P.; Holttinen, Hannele; Kirby, B.; Miller, N.; Mills, A.; O'Malley, M.; Schuerger, M.; Soder, L. (2009). **Wind power myths debunked**. IEEE Power & Energy Magazine, vol. 7, 6, ss. 89 – 99.

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

Holttinen, H. et al. (2016) Design and operation of power systems with large 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

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:
Storage Needs and Wind Power
Wind Integration Issues
Balancing Power Systems with Wind Power
Variability and Predictability of Large-Scale Wind Power