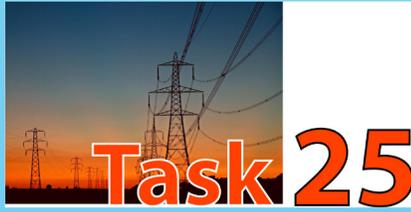


# Storage Needs and Wind Power



## Design and Operation of Power Systems with



**W**ind power will increase balancing needs in the power system. Today system operators balance by adjusting output levels of some of the power plants. In the future, storage options can also help with the balancing task; however, their use will depend on whether or not they are cost effective compared with other options.

### What are the benefits of storage?

Storage provides a flexible element in the balancing task of power system operation. Storage can act as either generation or demand, helping with the task of maintaining the balance between demand and generation at different time scales (Figure 1). Storage also has value in power systems without wind. About 100 GW of pumped hydro storage has already been built worldwide.

### Why is storage not used more in power systems?

The benefit of storage must be weighed against its cost. Building storage means investing to something that does not generate new energy, but actually wastes part of the energy when storing it. This is why generators that change their output levels as needed will usually provide flexibility more cost efficiently. Storing fuels, or water in reservoirs, is the most cost effective form of storage today. Thermal storage is also more cost effective than electrical storage. Storage technologies are still developing. Storages may have several revenue streams, from electricity markets (storing energy for hours or days) to grid support markets (providing quick responses to manage the frequency).

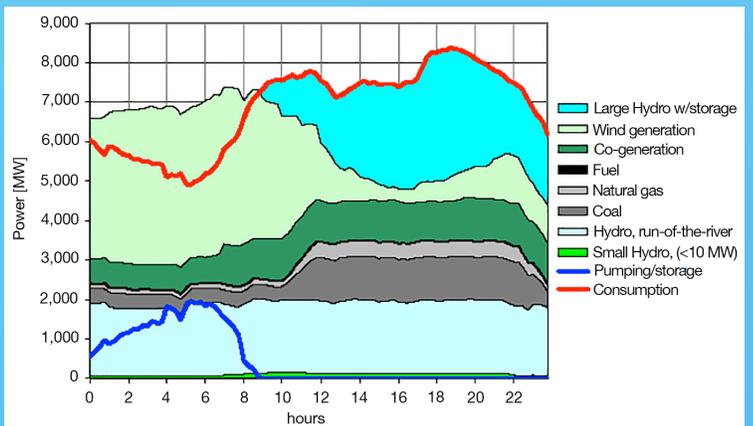


Figure 1. Example of pumped hydro usage in Portugal, during one night of high wind generation and low load (Source Estanquero et al. 2012).

### Is storage needed in power systems with wind power?

The fact that “the wind doesn’t always blow” is often used to suggest the need for dedicated energy storage to handle fluctuations in wind power. Dedicated energy storage to handle fluctuations ignores the realities of both grid operation and the performance of a large, spatially diverse wind-generation resource. Because power systems are balanced at the system level, no dedicated back-up with storage is needed for any single technology. Storage is most economic when operated to maximize the economic benefit to an entire system. So far there has been more challenge in power system operation when “wind blows too much

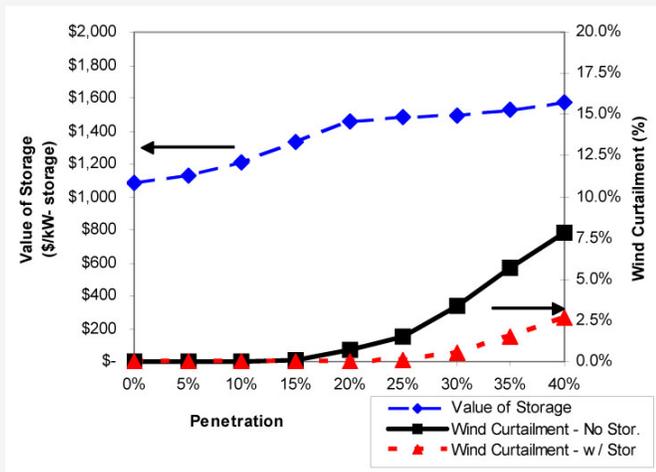


Figure 2. Value of storage will increase when share of wind increases. At higher shares of wind power, storage capacity will also reduce curtailments needed for wind power in situations where wind is high and demand is low. (Source: LBNL, US)

at low demand” than “no wind at high demand”. There is already experience of surplus energy that is curtailed (wasted) in times of low demand. New storage that could reduce curtailed energy (Figure 2) and can also have value in grid support (Figure3). Additional wind could increase the value of energy storage in the grid as a whole. How much storage is needed in the future is a competition among more flexible generators, demand side options (consuming more when surplus energy

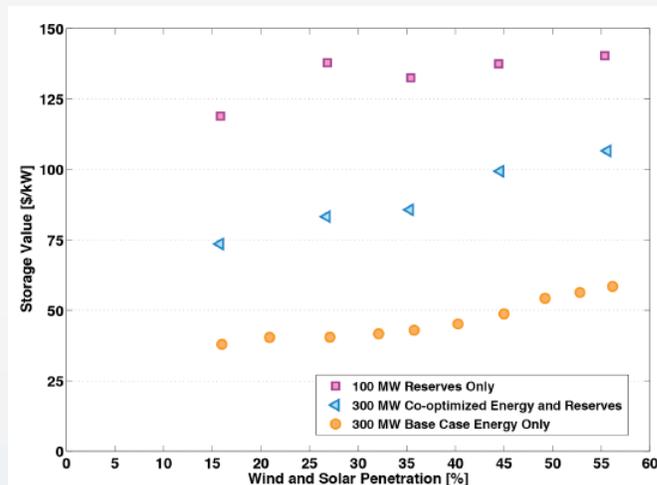


Figure 3. Example from western United States on cost effectiveness of storage – using storage for Reserves Only would be more cost effective than using it for energy and reduction of curtailed renewable energy. (Source Denholm et al, 2013)

exists) as well as transmission lines enabling larger areas to be balanced (surplus energy may not occur simultaneously with neighboring areas). Research work suggests that the share of wind needs to be more than 50 % of yearly demand before storage options become cost efficient at current storage cost and especially if transmission between areas can be increased. For solar PV storage is an enabler in lower shares than for wind (IEA, 2014).

## Associated Publications

See also Balancing Power Systems with Wind Power

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

Denholm P. et al (2013) Impact of Wind and Solar on the Value of Energy Storage. NREL report available at <http://www.nrel.gov/docs/fy14osti/60568.pdf>

Nyamdash, B., Denny, E., O’Malley, M.J. (2010) The viability of balancing wind power with large scale energy storage. Energy Policy, Vol 38 pp 7200-7208

Estanqueiro, A.I. (2012). Wind Integration in Portugal. In: Wind Power in Power Systems. Chapter 25. T. Ackermann (Ed.). 2nd Edition. John Wiley and Sons, Chichester . pp 569-593.

## More Information

This Fact Sheet draws from the work of IEA Wind Task 25, a research collaboration among 16 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 [http://www.ieawind.org/task\\_25.html#](http://www.ieawind.org/task_25.html#)

See also:

[Wind Integration Issues Fact Sheet](#)

[Capacity Value of Wind Power Fact Sheet](#)

[Balancing Power Systems with Wind Power Fact Sheet](#)

[Variability and Predictability of Large-Scale Wind Power Fact Sheet](#)