Kristin Dietrich[1], Jesus M. Latorre[1], Luis Olmos[2], Andres Ramos[1]

ADEQUATE REGULATION RESERVE LEVELS IN SYSTEMS WITH LARGE WIND INTEGRATION USING DEMAND RESPONSE

[1] Comillas Pontifical University, Spain, +3491542-2800, kristin.dietrich@iit.upcomillas.es
[2] European University Institute, Italy

OVERVIEW

Installed wind capacity and contributions of wind to demand supply have grown in Spain in the last decade significantly. Wind is supplying a growing rate of demand. In specific situations it has supplied over 50% of Spanish demand. This has implications on the operation of the energy system. Systems facing large wind integration have to cope with production variability and uncertain predictability of wind resources. It is necessary to adapt reserve requirements to changing system conditions as authors in [1] and [2] explain. Today thermal and hydro plants provide the regulation reserves. In the future, alternative reserve sources may gain more importance. Authors in [3] and [4] mention the response of demand as a possible way to provide reserves. In this article, reserve requirements in a system facing high wind integration will be assessed. Demand response is considered as further reserve source in the system of Gran Canaria, an island belonging to Spain.

METHODS

A Unit Commitment model represents the operation of the system. This model applies mixed-integer linear programming to minimize operation cost.
Additionally to the unit commitment problem demand response is modelled in two different ways:

- on the one hand automatic demand response with a system operator deciding when to shift or reduce demand and
- on the other hand direct consumer response using demand functions including elasticities. Demand shifting and demand reduction are considered separately.

The model is used first to compute the impact in operation of using demand to offer reserve. Currently contracted reserves, are compared to the reserves resulting from the introduction of demand response in load shifting and load reduction. Then, we consider the possibility of demand providing regulation reserves. It is analyzed to what extent demand is capable to offer reserve and how this influences costs.
Second, reserves will include considerations about wind energy being assessed firstly via sensitivity analysis for different levels of wind prediction errors. Impacts on costs will be analyzed. Then, it will be discussed how reserve should be valuated in the context of large wind integration.

EXPECTED RESULTS

Reserve is becoming critical to maintain system reliability. Reserve requirements are linked to the actual expected demand. When demand is responsive to system conditions, consumption of electricity will lower in peak hours and be shifted to off-peak hours. Thus, reserve requirements from conventional reserve sources are reduced in critical peak-hours. This brings a significant cost advantage as expensive peak plants do not need to provide the reserve and possibly go offline (or do not exist at all). Furthermore, demand can offer some reserve more economically than thermal reserve sources do. Applying different tariffs to demand, it can be used to provide reserve in a cheaper way than thermal generation. High installed wind capacity raises costs for providing reserve. This is mainly due to the growing error to be considered. The optimum reserve level is linked to the trade-off between higher cost for providing this reserve and the risk of demand curtailment in critical situations without enough reserves.

TENTATIVE CONCLUSIONS

Renewable intermittent energy sources are becoming an important part of the energy systems worldwide. Adaptations of the systems are necessary. High wind generation capacity normally leads to higher reserve requirements. Therefore, reserve requirements need to be linked to the amount of installed wind capacity. These requirements can be reduced through demand response. Besides this, demand may be able to offer cheaper and more flexible regulation reserves than thermal plants. This can be especially relevant in emergency or critical situations.

REFERENCES

1. Parsons, B.K. , Wan, Y., and B. Kirby Parsons (2001). Wind Farm Power Fluctuations, Ancillary Services, and System Operating Impact Analysis Activities in the United States, *European Wind Energy Conference* Copenhagen, Denmark, July 2–6, 2001.
2. Zhang, Y., Chowdhury, A. A. (2009). Reliability Assessment of Wind Integration in Operating and Planning of Generation Systems, *Power Energy Society General Meeting*, 2009. PES '09. IEEE,July 2009, 1-7.
3. Heffner, G., Goldman, C., Kirby, B., and M. Kintner-Meyer (2007). Loads Providing Ancillary Services: Review of International Experience, ORNL/TM 2007/060, Oak Ridge National Laboratory, May.
4. Spees, K., Lave, L.B. (2007). Demand Response and Electricity Market Efficiency, *The Electricity Journal*, Vol. 20, No. 3, 69-85.