Energy storage for the integration of large shares of intermittent renewable energy

F. Ferretti[1], M. Bucher[2], R. Bove[1], G. Guidati[1] and M. Zeifang[3]
[1] *Alstom Power AG, 5242 Birr, Switzerland*
[2] *Power Systems and High Voltage Laboratories, ETH Zurich, 8092 Zurich, Switzerland*
[3] *Alstom Power AG, 5400 Baden, Switzerland*

Keywords: energy storage wind renewable integration asset optimization

Abstract

The energy system is facing a great challenge by ensuring the integration of fluctuating wind energy in an efficient, economical and reliable way. The fossil solutions to handle this challenge get more and more obsolete when political targets ask for major renewable energy shares or even pure renewable production. Among the remaining options, energy storage is often indicated as one promising solution.
The present study performed by Alstom investigates the energy storage capacity required for future energy system scenarios with high shares of wind, based on macro-economical considerations. For this purpose, hourly time series of national consumption and wind speed records have been collected over the year 2009 for five European countries. Wind, energy storage and conventional power plant capacities have been varied in order to evaluate several energy scenarios, with wind shares varying from 0% to 100%. An optimization method has been developed in order to 1) determine the optimum schedule of energy storage over the year for each scenario and 2) identify the system configuration that achieves a given target wind energy share with minimum total system costs.
The results from the modeling show that low wind shares can be effectively integrated in the energy system by increasing the dispatchable generators flexibility. With this measure, additional energy storage capacity can be potentially avoided. At high wind penetrations, however, the shift of excess electricity to times of low wind and high demand by energy storage is clearly required to minimize the macro-economical costs for a given target of wind energy share. Similar results have been achieved in all five countries considered for this study, despite different wind patterns and capacity factors and different correlations with the national demand patterns.