Stochastic Unit Commitment with Significant Levels of Wind Power Penetration

Summary: Operating a power system with significant amounts of installed wind power presents many challenges to the system operator. These range from a time scale of seconds and minutes (e.g. frequency issues) to hours (e.g. unit commitment) to years (e.g. transmission system planning). To meet renewable energy targets, many power systems are installing large amounts of wind power. The main focus of the thesis is on the issues which are affected in the hourly timescale. Due to its uncertain nature, extra reserve needs to be planned to cover any shortfall in the predicted levels of wind power. The nature of the unit commitment of a system with wind is changed from a deterministic problem to a stochastic one due to wind’s stochastic properties.

The WILMAR tool was developed to schedule the system with significant levels of wind. This uses multiple scenarios of wind and load in a stochastic optimisation using rolling planning, i.e. the system is re-optimised when wind and load forecasts are updated (e.g. every 3 hours). Due to its weakly interconnected nature and the ambitious goals for wind energy (33% of electricity by 2020), the Irish system is an interesting case, as most of the challenges associated with wind have to be dealt with within the island. A possible plant mix for the Irish system in 2020 is examined to analyse the issues associated with unit commitment for high levels of wind power.

Firstly, the method of scheduling is examined, i.e. whether the system is optimised deterministically based on one wind and load forecast, or stochastically based on multiple scenarios for wind and load. Both of these cases are compared to an (unrealistic) case whereby wind forecasting is assumed to be perfect. The main results are that cost savings of approx 0.75% of system costs are achieved by using stochastic optimisation, due to the more robust solutions provided. Perfect forecasting results in a further cost...
decrease of 1%. The change in unit behaviour, operation of the interconnector and reliability is also examined.

The effect of uncertainty of wind forecasts on the planning of the system is examined\(^6\). WILMAR, as a planning tool, assumes that the time between one planning loop and the next has a perfect forecast. If the system is planned more frequently, more of the uncertainty of wind can be captured in the model due to the decrease in length of this perfect forecast stage. This causes an increase in planning costs as more uncertainty is captured. When the forecast error is accounted for by carrying extra replacement reserve, the costs decrease as the system is planned more frequently. The change in scheduling of units and interconnector is again examined.

The increased levels of wind power also have an effect on the cycling of units on the system, due to units being pushed down the merit order as the production of wind on the system is increased. This is examined by taking the dispatch of the units produced by the planning tool in previous work and examining the effect that cycling would have on their costs and operation.


[4] Taken from All Island Grid Study (available [www.dcenr.ie](http://www.dcenr.ie)).
