Background

Wind power penetration is increasing rapidly in many countries worldwide. In the countries currently leading the field in wind energy deployment, wind power capacity penetrations of up to 30% have been attained. The interaction of wind energy and the power system has emerged as a potentially significant obstacle to increased penetration. There are issues ranging from operating reserves and frequency control, to the ability of the current grid system to accommodate additional generation. Individual countries with high wind power penetration may currently rely upon interconnection with neighboring countries for provision of ancillary services that support the high local penetration. As power systems and markets are not necessarily delineated by political boundaries, the technical assessment of the effects of high wind penetration upon these may better be carried out on a system-wide, rather than individual country, basis. In some cases the cost (both direct and external) of providing required ancillary services (including various classes of reserve) exhibits an exponentially increasing relationship with wind penetration. Thus, the availability of system ancillary services may be a limiting factor on the rate of deployment of wind power.

In addition to creating environmental benefits, it has been suggested that the nature of wind generation may impact on the operation of electricity systems in such a way as to increase the requirement for reserve. This is because wind generation has a number of physical and technical characteristics that are very different to the conventional generation it displaces.

Summary

The meeting gathered 28 participants, representing Denmark, Finland, Ireland, Italy, North Ireland, Norway, Portugal, Sweden, the Netherlands, UK and USA.

The meeting started with a presentation of the related IEA Annex XXI, Dynamic models of wind farms for power system studies. The following presentations covered both general descriptions of current situations in different regions and more detailed research presentations. Presentations were grouped in the following categories:

1. National presentations
2. Impacts of large scale on system operation
3. Dynamic simulation

List of mentioned topics/questions:
- Smoothing effects over large geographic areas
- How to calculate reserve requirements
- Ride through standards, is this possible
- Cost of integration has to be discussed for all energy sources, not only wind
- Reliable and validated models of wind turbines are required for power system analysis
Summary of discussion of a new annex

The discussion was preceded by a short presentation by Hannele Holttinen, VTT Finland, listing out some possible ideas for the new annex. See last presentation.

System integration of wind power is a large area of research, so the scope should be reduced. This could be done for example by taking only the impacts that require system-wide analyses, which would leave out impacts that are dealt with locally (distribution efficiency, voltage management). The goals could include:

- State-of-the art of research made so far
- Guidelines for the study methods and data used
- Quantifying the impacts of wind power on power system
- Information exchange between the participating countries and institutions

Guidelines could include study methods for stability analyses and reserve needs as well as how to incorporate wind power in grid analysis and energy system models. Rules of thumb that could be used as first step when considering large penetration of wind power in power systems would be useful. The annex should try to come up with quantification of the range of impacts and costs for different power systems (relative to system size, wind power dispersion, amount of flexibility).

The discussion was centred around defining the scope of the annex. Below is a short list of issues brought up in the discussion:

- Reducing the scope of the annex was considered essential.
- High penetration of wind power in the system is interesting. Definition of what is large amount of wind power is also needed (relative to installed generation capacity, consumed energy, interconnection capacity etc.)
- Larger areas are relevant, for example the Nordic system can trade reserves between the countries. System operation issues should be addressed in both the small systems, like Ireland, and the larger interconnected systems.
- Guidelines for input data for studies, especially how wind data is to be used was agreed to be useful
- Guidelines for methodologies for studies was considered more relevant than guidelines for which (commercial) models should be used.
- It should be noted that increasing other forms of energy also involve integration costs.
- Operating impact studies could be one major focus. Actual costs, not so much how the costs are implemented. List of best practices would be useful and possible to come up with (NREL/USA have already started).
- Recommendation on ideal features on market could be given (for in-depth market analyses, IEA group is not very suitable). With the wrong design of the market, the "integration cost" does not correspond to real system costs. The economic limits on wind penetration will depend upon how costs are allocated within a market, but the scope of the annex may become too broad if it includes consideration of market designs for large wind penetration.
- The effects and value of wind forecasting are important, especially for forecast horizon of 4–12 hours ahead. Wind power production forecast techniques as such should not be included in the scope of the proposed annex.
Mitigation measures like DSM and storage: their role in helping to integrate high penetration of wind power is relevant to take up also in this annex, however, not as much detailed work as in other IEA Implementing agreements.

This annex could end where the grid studies start. Stability analyses could be part of the annex, depending on for example where the reserves are taken (if reserves from different area, stability should be addressed).

Limits to wind power penetration: there are no technical limits to how much wind power can be integrated, so the limits come from how much can be integrated at socially acceptable costs. Maximising the energy that can be delivered by wind in a power system is important. The ultimate objective could be to facilitate the highest economically feasible wind energy penetration within electricity power systems worldwide.

The links to other ongoing work is very important to take into account in the proposed annex:

- Annex XXI Grid integration where models are tested and verified. Time scale division (second/minute versus 10minutes/hour) is not necessary, as the proposed annex has wider scope than models. Same participants in both two help to make this link work.
- Annex XXIV Wind and hydro: the proposed annex has a broader scope, also thermal systems. Most of the results from wind&hydro annex are relevant to this annex as well. Same participants in both two help to make this link work.
- CIGRE: workgroups do technical assessments, the same work should not be duplicated. System operation good focus in relation to that.
- ETSO link also important, like UWIG in USA (UWIG work will be linked to the proposed annex when USA participates in the annex)
- Other IEA implementing agreements than IEA R&D Wind: DSM, storages. This annex should not look into too detail on DSM and storages. However, their role in helping to integrate high penetration of wind power is relevant to take up also in this annex.

“System operation/ consequences with large amounts of wind power/high wind power penetration” were suggestions for the working name of the proposed annex, as the name should reflect that it is large amounts of wind power and “system operation” was preferred to “system integration”. Planning aspect will not be excluded if the name is “operation”.

It was decided to form an ad-hoc group to work further on the scope of the annex and make a draft proposal. The group is led by Hannele Holttinen/VTT (hannele.holttinen@vtt.fi) Finland and the following volunteered to participate: Jack Cadogan/DTI, USA; Ana Estanquero/Ineti, Portugal; Karsten Burges/ecofys, Holland; John McCann/SEI, Ireland and Lennart Söder/KTH, Sweden.

TSO participation in this annex was considered highly important and that would also help create a working link between Cigre and annex work.