



Design and Operation of Power Systems with Large Amounts of Wind Power

1.0 Introduction

Wind power will introduce more uncertainty into operating a power system; it is variable and partly unpredictable. To meet this challenge, there will be need for more flexibility in the power system. How much extra flexibility is needed depends on the one hand on how much wind power there is and on the other hand how much flexibility exists in the power system.

The existing targets for wind power anticipate a quite high penetration of wind power in many countries. It is technically possible to integrate very large amounts of wind capacity in power systems,

the limits arising from how much can be integrated at socially and economically acceptable costs. So far the integration of wind power into regional power systems has mainly been studied on a theoretical basis, as wind power penetration is still rather limited in most countries and power systems. However, already some regions (e.g. West Denmark, North of Germany, and Galicia in Spain) show a high penetration and have significant practical experience with wind integration.

In recent years, several reports have been published in many countries investigating the power system impacts of wind power. However, the results on the costs of integration differ substantially and com-

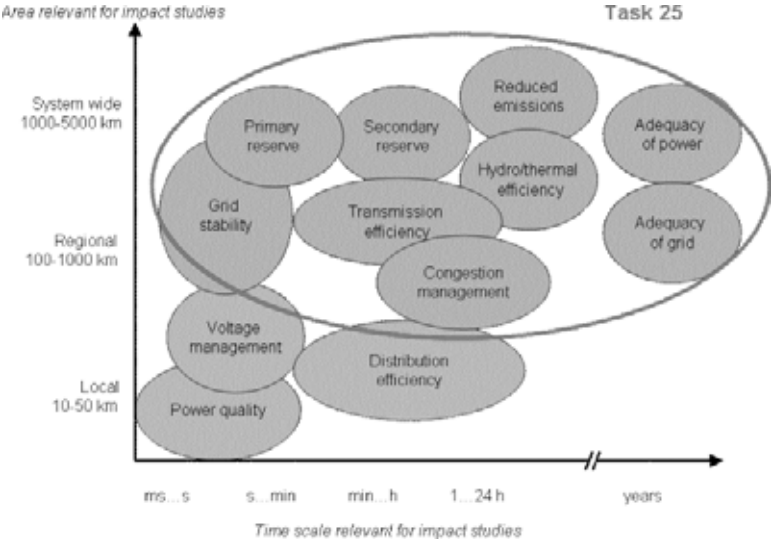


Figure 1 Impacts of wind power on power systems, divided in different time scales and width of area relevant for the studies. Primary reserve is here denoted for reserves activated in seconds (frequency activated reserve; regulation) and Secondary reserve for reserves activated in 5–15 minutes (minute reserve; load following reserve).



Comparisons are difficult to make due to using different methodology, data and tools, as well as terminology and metrics in representing the results. Estimating the cost of impacts can be too conservative for example due to lack of sufficient data. An in-depth review of the studies is needed to draw any conclusions on the range of integration costs for wind power. This requires international collaboration. Because system impact studies are often the first steps taken towards defining wind penetration targets within each country, it is important that commonly accepted standard methodologies are applied related to these issues.

2.0 Objectives and Strategy

The ultimate objective is to provide information to facilitate the highest economically feasible wind energy penetration within electricity power systems worldwide. This task supports this goal by analysing and further developing the methodology to assess the impact of wind power on power systems. The Task will establish an international forum for exchange of knowledge and experiences related to power system operation with large amounts of wind power. The challenge is to create coherence between parallel activities with Transmission System Operators other R&D Task work.

The participants will collect and share information on the experience gained and the studies made up to and during the task. The case studies will address different aspects of power system operation and design: reserve requirements, balancing and generation efficiency, capacity credit of wind power, efficient use of existing transmission capac-

ity and requirements for new network investments, bottlenecks, cross-border trade and system stability issues. The main emphasis is on the technical operation. Costs will be assessed when necessary as a basis for comparison. Also technology that supports enhanced penetration will be addressed: wind farm controls and operating procedures; dynamic line ratings; storage; demand side management DSM etc.

The task work has started with a state-of-the-art report collecting the knowledge and results so far. The task will end with developing guidelines on the recommended methodologies when estimating the system impacts and the costs of wind power integration. Also best practice recommendations will be formulated on system operation practices and planning methodologies for high wind penetration.

The Annex 25 to the IEA Wind Implementing Agreement was approved at ExCo 56 in September 2005 and will run for three years 2006–2008. Table 1 shows the countries that have officially committed in 2006. Spain, France, and Australia are still considering participating in the task.

3.0 Progress in 2006

The meetings organised by Task 25 have established an international forum for exchange of knowledge and experiences. In the three meetings organised in 2006, all countries have presented the national results so far and the work on-going and also the first report gathering the results has been discussed. Two meetings have been organised in conjunction with wind integration workshops: Nordic Wind Power Conference in May in Finland and

Table 1 Countries that have joined Task 25 of IEA Wind

Country	Institution
Denmark	Risø National Laboratories; Energinet.dk
EWEA	European Wind Energy Associations
Finland	VTT Technical Research Centre of Finland
Germany	ISET; RWE; E.ON Netz
Ireland	To be confirmed
Netherlands	ECN
Norway	SINTEF; Statkraft
Portugal	INETI; REN
Sweden	KTH
UK	Centre for Distributed Generation & Sustainable Electrical Energy
United States	NREL; UWIG

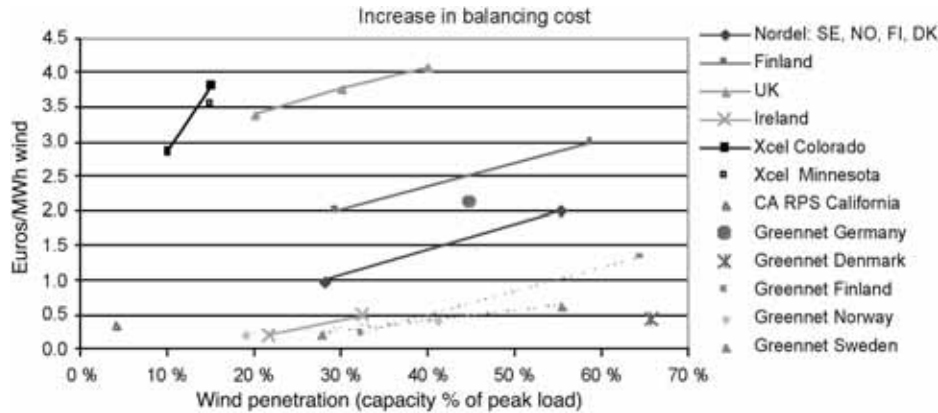


Figure 2 Results from estimates for the increase in balancing and operating costs due to wind power. The currency conversion used here is 1 € = 0.7 £ and 1 € = 1.3 USD.

Utility Wind Integration Group UWIG fall workshop in Oklahoma City, United States. The system operators of Denmark, Germany, Ireland, and Portugal have joined the meetings. Also the TSO organisations CIGRE and ETSO have been contacted and informed of Task 25 work. In addition to Task 25 overall presentations, case studies from Denmark, Finland, Norway, Portugal, Sweden, and the United States were presented in special sessions for Task 25 in NWPC and in UWIG conferences.

The Task 25 web site has been opened at www.ieawind.org gathering the Task 25 publications as well as literature related to system integration.

A poster outlining the task objectives and strategy was presented in EWEC'06 conference, March 2006 and Nordic Wind Power Conference NWPC in May, 2006.

A paper collecting experience on wind integration issues was presented in NWPC, with experience from Denmark, Germany, and Sweden. It was further expanded to a journal article with added experience reported from Ireland and New Mexico in the United States and was submitted to IEEE Transactions on Energy Conversion.

Work on the state-of-the art report started in spring 2006, analysing the existing results. This report was the main subject of the two R&D meetings in Helsinki and Oklahoma City. A draft version of the state-of-the art report was distributed to participants in December 2006.

The first results were presented at the Global Wind Power Conference GWPC2006 18–22 September 2006 and at the fall seminars on wind integration: UWIG seminar 24–25 October, Delft workshop for offshore and large scale integration 25

October and EWEA Grid Conference 7–8 November 2006.

Drawing from the first results of Task 23, Figure 2 illustrates the difficulties in comparing the results from existing studies. The range for integration costs due to increased balancing needs is large. This is due to different power systems in question, different time scales for reserve allocation, and different methodologies applied in the studies.

4.0 Plans for 2007 and beyond

The second year, 2007, will see the publication of the state-of-the-art report in the spring. It has been agreed with EWEA that a special session for Task 25 will be made for EWEC'2007 in Milan. National case studies will be worked on; more results will be collected, and work with analysing the results will be continued. The library in the web pages of Task 25 will be complemented and updated. Journal articles from some of the issues in the state-of-the-art report will be written.

The spring meeting will take place in May in Milan in conjunction with EWEC'2007. A joint meeting with Task 24 Integration of Wind and Hydropower Systems has been suggested for Norway in fall 2007.

The results will be drawn together during the last year, 2008. Simple rules of thumb stating the probable impacts and cost ranges with different levels of wind penetration will be sought. Guidelines and best practices will be formulated.

Author: Hannele Holttinen, Operating Agent Representative, VTT Technical Research Centre of Finland, Finland.

