# Integration of Renewable Energy Sources in the Electricity System

## - Grid Issues -

Brussels, 30 March 2005

**Background**

At European and national level mid-term plans exist to increase the share of electricity produced by renewable energy sources (RES) significantly. They shall contribute to meet the targets of the Kyoto protocol and support the security of supply with respect to limited energy resources in Europe.

At European level the directive for the promotion of RES sets the framework for the national targets und support mechanisms. In 2005, 4 years after entering into force, a report by the EU will show the experiences made up to now and might give some recommendations for future steps to be undertaken.

One major topic in this discussion is the grid integration of Wind. ETSO as an Association of the European Transmission System Operators addresses the issues related to this subject from the TSO's perspective.

**Scenarios**

The situation in Europe differs from country to country. Circumstances may also differ as between synchronous interconnected systems and island systems. The capacity targets and the future portfolio of RES depend on the national situation. Nevertheless the biggest growth potential is for wind energy, especially offshore-wind energy. The expectations of the European Wind Energy Association show an increase from 28.5 GW in 2003 up to 180 GW in 2020. Due to different support-schemes for RES restrictions in licensing and a limited number of suitable locations, this capacity tends to focus on very few regions in Europe. This, together with the stochastical in-feed characteristic of wind energy raises the big challenge of integrating it.

**Challenges**

1. Grid extension

Problem:

New RES need new grid infrastructure. New wind farms will normally be built far away from the main load centres. New overhead lines will therefore be necessary to transport the electricity to where it is consumed. These investments are exclusively or at least mainly driven by the new RES generation sites. The intermittent contributions from wind power must be balanced with other back-up generation capacity located elsewhere. This adds to the requirements for grid reinforcements.

In Germany i.e. 850 km of new 380-kV-lines will be needed in the coming ten years to integrate the wind farms expected to be built.

The licensing procedures for new lines are lasting several years, some even far more than ten years. A delay in grid extension will result in a delay of RES investments because wind farms cannot earn an adequate return on investment without an adequate grid connection. New lines are therefore critical for the success of new RES.

Moreover, this new infrastructure could be a significant investment which increases the asset base of the TSO. There is no European-wide harmonised rule yet who should pay for it.

Action:

Licensing procedures for new RES sites and for grid infrastructure must go hand in hand. The legal framework and administrative procedures have to be set properly to speed up the licensing of grid infrastructure.

The legal and regulatory framework needs to be properly set for the investments in new infrastructure.

2. System stability

Problem:

Wind farms behave different from conventional plants with respect to grid stability. In case of a fault in the grid causing a voltage drop conventional plants normally continue to generate electricity and by this support the system stability while wind farms tend to shut down and increase the stability problem. Simulations in Germany i.e. show that a generation outage of more than 3000 MW is possible in the coming years which might result in a blackout scenario.

This situation is true in any other country with an increasing share of wind energy and unsuitable grid codes.

Action:

As counter measures, suitable European-wide harmonised grid codes for new wind farms and other RES defining their electrical behaviour in critical grid situations are needed in all countries expanding their share of RES. By this the best available technology for wind farms shall be used. Furthermore it might be necessary that existing wind farms not fulfilling the actual grid code requirements must be upgraded or replaced (i.e. electrical behaviour of wind turbines in case of grid faults). Finally, a sufficient capacity of conventional generation has to be in the system at any time to keep it stable. An unlimited priority of wind in-feed as laid down in some national legislations is therefore impossible with respect to the detrimental effects on the security of supply. It should at least consider exceptions in case of security risks of the system.

3. <u>Balance management and system adequacy</u>

Problem:

The day to day forecast of electricity production from wind energy is just possible to a limited extend. To balance the difference between generation and demand balancing power is needed. In Germany i.e. in 2015 at the latest about 20 % (=7000 MW) of the installed wind capacity of 36000 MW has to be provided as balance power. This amount increases significantly with on-going wind capacity installation.

Depending on the different national rules different parties are responsible for providing the balance power. In case the TSO has to contract it the costs will be part off the tariff and by this be paid by all customers. As a consequence there is no incentive for the wind farms to reduce the costs of integration in the electricity system.

Furthermore, a considerable amount of reserve capacity - being paid by the consumers - is needed for system adequacy and security.

Action:

The TSO's must rely on a generation portfolio that provides the balance power capacity needed at any time and at a high level of security. Grid capacities must be available for balance management.

To let the market solve the problem of imbalance management wind generation should be made responsible for unbalances they create and provide adequate resources for balancing from the market, as already in place in some countries. That will encourage them to keep the integration costs as low as possible and will promote suitable R&D activities in this field. Otherwise, a noticeable increase in grid tariffs due to cost for balance management has to be taken into account.

In addition it should be analysed to what extend energy storage could contribute to ease the integration.

4. Impact on cross-boarder electricity transits

Problem:

In situations of strong wind regions with a high density of wind generation and low load 'export' electricity can cause flows in neighbouring grid regions. As an example wind farms in northern Germany have led to significant negative operational impacts in the Dutch and Polish system. The physical flows from Germany to The Netherlands i.e. have in some situations in December 2004 been more than twice as high as the expected exchange programme – causing a critical grid situation.

In addition, such flow patterns reduce the capacity for cross-border trade. This situation is even promoted by the priority dispatch for RES since additional RES generation causing flows in bottlenecks forces the TSO to cut the tradable capacity.

This effect is the bigger the more wind generation is concentrated in small regions. For that reason non-harmonised support schemes for renewables in Europe could lead to a national and by this, regional allocation of RES causing additional congestions in the system.

Action:

The integration of wind energy is no more a national subject. It has to be analysed with an European scope:

1) What is the impact of the integration on the electricity system?

(The German situation mentioned is just an example of what the effect will be in other countries having a high percentage of wind energy in their electricity system.)

2) What influence does unlimited priority dispatch for RES and non-harmonised support schemes have?