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Smart electricity transmission systems needed to achieve the full potential of renewable energies

Smarter power grids have a central role to move Europe towards a low carbon energy economy, as underlined by the European Union's Strategic Energy Technology Plan Information System (SETIS)¹, led by the Joint Research Centre (JRC). A new JRC lead-authored report on transmission network planning² highlights that a radical change in coordinated network planning and operation is needed to accommodate market liberalisation and the increasing integration of renewable power sources. The key issues to obtain a reliable and effective European grid are integrated strategic planning and cross-border coordination.

The importance of electricity transmission grids – the backbone of the European Union's economy – is higher than ever. These networks are getting older, are confronted with complex market liberalisation processes and have to host increasing amounts of renewable energy sources. Furthermore, in order to address the challenges of energy security and climate change, transmission grids need to become more interconnected and 'smarter' by seamlessly integrating a wide range of users (generators, consumers and/or other grids).

In the European Union, electricity grids are included among the low carbon energy technologies assessed as part of the strategy to achieve the energy and climate change policy targets (which include a 20% reduction of CO₂ emissions and a 20% share of renewables in overall EU energy consumption by 2020; this translates to 30-35% of electricity consumption covered by renewable energy sources).

According to SETIS, if the maximum potential is realised, the electricity grids could avoid up to 30 Mt/year CO₂ in 2020 and 60 Mt/year CO₂ in 2030 in the EU. The corresponding maximum cumulative CO₂ emissions avoided for the period 2010 to 2030 would be up to 600 MtCO₂.

The importance of better planning

Existing transmission planning methods commonly make use of a worst-case scenario approach: power flow analysis is performed for a small number of cases selected by experienced network planners. With the increased uncertainty and the many assumptions necessary for the analysis, the need to include more combinations of load, (renewable) generation and international exchange is becoming essential and a probabilistic approach to deal with such uncertainties is needed.

¹ SETIS, the Strategic Energy Technology Plan Information System, is continuously tracking and monitoring the global development and progress of energy technologies and makes this information available "on-line": <http://setis.ec.europa.eu>

² *Review of existing methods for transmission planning and for grid connection of wind power plants*. REALISEGRID, Seventh Framework Programme, June 2009.

The way forward...

In particular, the planning criteria for expanding the transmission and distribution grids (which could be compared to the main arteries and the capillaries in the human body) have to be rethought, and more robust methodologies for network planning must be pursued.

Current transmission and distribution systems in Europe “do not talk to each other”. It is therefore critical to improve the two-way interactions between electricity transmission and distribution. Recent disturbance and disruption events in Europe (for example the disturbance on the 4 November 2006 which originated in Germany and then spread all over the continent), clearly call for this type of improved coordination. One of the causes of the disturbance was in fact the inadequate monitoring and control by transmission operators of small sized generation units installed at distribution level. The uncoordinated action during the disturbance worsened the situation and introduced a risk of more severe instability.

Such disturbances prove that, without properly coordinated system interfaces between transmission and distribution, and real time information exchange (e.g. concerning generators connected to the distribution network), the consequences of a power disruption at the distribution level may also be suffered, if not amplified, at the transmission level.

The recent JRC review of existing methods for transmission planning and for grid connection of wind power plants presents the state of the art in this field and points the way for future developments. The report’s findings and recommendations include:

- Transmission planning must change drastically to accommodate market liberalisation and increased integration of wind and other sources of renewable power.
- Grid expansion should focus on achieving better coordination between Transmission System Operators (TSOs) through integrated strategic planning and cross-border cooperation.
- Transmission planners should take a smarter approach to integrating ‘variable’ power sources such as wind, solar, hydro and wave, which do not generate consistent levels of power (e.g. by balancing the variable power with storage technologies).
- TSOs should prioritise the emerging challenge of integrating the future transmission system (hosting large-sized generation, both conventional and renewable) with smart distribution grids (embedding dispersed small sized energy sources and storage).
- A more harmonised and market-based framework is required to overcome planning and regulatory differences at national level, and to realise the potential synergies between offshore energy projects and cross-border trade in electricity.

Background

Today, the EU systems require significant upgrade, replacement and addition of infrastructure to ensure a reliable electricity delivery and supply, in particular to integrate the increasingly deployed renewable energy sources. EU economic stimulus initiatives have reaffirmed the role of a reinforced transmission grid in addressing the challenges of energy security and climate change.

Further information

- The REALISEGRID Report on methods for transmission planning and for grid connection of wind power plants in Europe is available at: <http://realisegrid.erse-web.it>.
- The 2009 Technology map descriptions of the European Strategic Energy Technology Plan (SET-Plan), including the section addressing electricity grids, can be downloaded in the website: <http://setis.ec.europa.eu/>

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