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Subject: Summary Report on the Hearing of the Smartgrids Energy Technology Platform

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1 SmartGrids: current state of the sector and anticipated developments

European society and industry depend upon the availability of a cost-effective electricity supply and on the efficient operation of the electricity systems. The EU average growth rate of electricity demand has been around 1.8% per year since 1990. In the last decade most EU electricity systems have been challenged by the following issues and trends:

- Mounting social and environmental oppositions hamper the erection of the main infrastructure components of the European traditional electricity system: large and vastly carbon-based power generators injecting power via long extra high voltage lines to substations marking the border with the distribution networks.
- Increasing renewables-fed (RES) and cogeneration-based electricity production technologies - generally less predictable and continuous in terms of electrical power output and predominantly small-medium sized - have already made their way in distribution systems; historically distribution was not designed to handle dispersed generation tending to push the power upstream towards the transmission system.
- Rising international power flows have to be managed by EU countries' transmission systems, which - though mutually interconnected - are operated on a national basis and lack a structured coordination.
- In the medium term (2030) the EU electricity demand is projected to grow at least by 1.5% per year, and electricity will maintain its role as the energy carrier of choice[1].

The EU countries' electricity systems are expected to evolve in the following aspects:

- European electricity markets and networks provide consumers with a reliable power supply, based both on large centralized generators and smaller distributed power sources. End users become significantly more interactive with both markets and grids; network systems are predicted to enable greater interaction with demand side participants and to provide greater flexibility and security.
- The electricity power scheme shifts from the present numerous and varied national-based systems towards a common European electricity system.
- In particular Wind and Combined Heat Power (CHP) generating units record the highest penetration level among the emerging generation technologies and, though they continue

[1] IEA World Energy Outlook 2006 – Predicted European expenditure for new and replaced transmission and distribution networks between 2005 and 2030: $566 Billion (in the most conservative scenario)

to inject power into local distribution networks, parts of them (e.g. off-shore wind) tend to be connected at transmission level due to their increase in size. This is likely to increase the need for reinforcement of the transmission infrastructure combined with the need for a greater deployment of mature innovative technologies - such as FACTS (Flexible AC Transmission Systems) and WAMS (Wide Area Monitoring) - to optimise the capacity of the networks.

- Along with already largely deployed technologies (Hydro, Wind and CHP), other forms of efficient electricity generation (including biomass, photovoltaics and fuel cells) increase their penetration share.
- Several alternative architecture models may coexist at distribution grid level - like virtual power plants and micro-grids - since different schemes may better fit different regional needs, but are all likely to be interconnected by a trans-national transmission grid.

2 Technology penetration targets and the expected impact on energy policy goals

It is recognised that each Member State has different levels of market liberalisation, infrastructure, age profile of equipment and local needs: this needs to be accommodated in any future EU initiative on electricity networks. The SmartGrids Energy Technology Platform (ETP) aims to inform policy makers and stakeholders, and to ensure a consistent framework is developed and deployed providing Europe with a competitive and world class energy delivery mechanism for the future.

EU electricity grid systems can contribute to the three European energy policy objectives:

- Security of Supply, in terms of primary energy availability, reliability and quality of networks' operation and capacity (adequacy) to deliver electrical power to the end-user.
- Sustainability, in terms of nature and wildlife preservation, climate change mitigation and pollution reduction.
- Competitiveness of the European Market, in terms of support to the liberalisation process, innovation and competitiveness, impact on electricity prices and efficiency.

A preliminary set of indicators to monitor the sector evolution and the compliance with the targets of the Platform's Vision was put forward:

- RES penetration in the transmission and distribution grids, classified by primary energy source, degree of power output controllability and predictability.
- Number and capacity of interconnectors between national networks.
- Lead time needed to connect RES to the network.
- Amount of short-term (e.g. in the next five minutes) load balancing potential in the electrical system.
- Number of congested lines.
- Global level of quality of service.
- Level of Active Network deployment at distribution level
- Amount of export/trading from residential power sources
- Number of smart metering devices installed at distribution level.

3 Interactions with other competing or synergetic technologies and community policies and initiatives

- **Wind and intermittent RES.** With increasing shares of wind energy injected in the grids (and therefore with growing level of intermittency), the system operation and development philosophies have to be modified accordingly. This shift requires a shared vision for the future between all generation and the grid system stakeholders.

  Wind penetration in the network can be increased, as soon as common regulations governing the European electricity systems (e.g. grid access and operation rules) are put in place and in particular, real-time monitoring mechanisms aiding the system operators are set up.

  The technical challenges associated with building off-shore supergrids may be overcome without new technological advances. Anyhow undersea and High Voltage Direct Current (HVDC) transmission technology - currently quite expensive - could deliver greater efficiencies if considered and optimised as part of the overall transmission system. Today

the network development generally follows the new generation authorisation. Increased investment in off-shore transmission networks is justified when considered as an overall architecture including appropriate regulatory and grid code connection agreements.

- **Storage.** With the increasing amounts of stochastic wind (and other RES) power, storage technologies become key to manage and smoothen power fluctuations. Some significant progresses in batteries performances are expected in the short term, even though the European innovation and industry know-how are lagging behind on this front. This is due to a lack of incentives and funding. Car manufacturers producing plug-in hybrid vehicles may provide momentum. The sector does not consider the storage option of hydrogen a viable solution in the medium term.
  The electricity storage devices play a key role in smoothing generation intermittency and improving the network reliability. Low capacity batteries - primarily deployed to correct local problems and deviations in the system - can already work well with the present network structure; on the other hand, the integration of high capacity batteries - useful even to support the system stability - requires huge investments in the grid.
- **System control and data exchange via ICT systems.** In every sector considered, the introduction of computing intelligence has delivered major advancement and opportunities to improve processes and operational control. The electricity system is no different. Improving the ability to monitor and control areas of our networks not considered before will lead to improved deployment of RES and real-time optimisation and operation of our networks in a more secure and safer way. As indicated above integration of large amounts of intermittent renewables will require increased data exchange in order to deliver the desired reliability with dedicated “platforms” managing the transmission of information among the different electricity system players (e.g. according to the UK model). This in turn will deliver the ability to react in real-time for trading, fault prevention, asset management, residential and industrial generation control and demand side participation.
- **Demand side management and smart metering.** Demand side response is needed to quickly vary the control over the load, with a distinction in terms of the action time - short-term (minutes) and long-term (hours or days) - and of the controlled object - customer side or global generation side.
  Smart meters able to interact at different levels, together with energy demand side management procedures, make it possible to rationalise energy consumption, reduce peak loads and make load more flexible.

In the long-term (around 2050), when the present issues on hydrogen production/conversion will be solved, hydrogen can become a feasible complement to electricity transmission and storage technologies; a significant deployment of High Temperature Superconducting (HTS) wires may be expected as well only in the long-term.

4 The role of innovation

The Smartgrids Vision is not achievable under a “business as usual” scenario and innovation in this field has been somehow overlooked over the last years.
EU Member States will need to spend around 390 b€ in network infrastructures over the next three decades (some 90 b€ for transmission and 300 b€ for distribution networks); a 30% share is planned to come from public funding.
As a benchmark, the investment estimated by the American GridWise council to modernize the US transmission & distribution grids amounts to 450 b$.
Power System networks have design life-cycles in excess of 40 years. In order to meet the European policy goals the need for urgent and immediate action to apply innovative solutions and appropriate policy frameworks is pressing. Technology is not seen as a barrier, in most cases existing technology can enable the changes needed. However other barriers still exist.
The main barriers identified by the SmartGrids ETP are:

- The lack of technical harmonisation and standardisation (e.g. common standards for meters should be in place).
- The non harmonised regulatory framework vested in National laws and codes. The current market structure and regulatory context should be modified to manage the transition

towards the future electricity network architecture. More common rules (e.g. on the network development incentive mechanisms) should be defined for the management of all the components of the electricity system.
- The lack of social acceptance for electricity infrastructures (in particular networks).
- The shortage of qualified workforce in the EU. In the past the electricity sector has benefited from large know-how and skilled technicians. Today more electrical engineers and qualified labour are needed.
- The fragmentation of EU research. More collaboration and simplified cooperation guidelines between different stakeholders should be produced. There is only limited research of Transmission System Operators (TSOs) and Distribution System Operators (DSOs) on increasing RES penetration (in particular wind) and no Europe-wide coordinated research. Whilst in the past long term planning was performed, now the electricity system is looking primarily at the short term profit.

To date, Europe leads the electricity manufacturing industry (ABB and Siemens are world leaders) but EU companies are already operating and investing at the global level. In turn, foreign investors have started to invest in EU. International cooperation is current practice (e.g. with US and Japan), but more cooperation is needed on standardisation and normalisation.
There are some small-scale demonstration projects ongoing in Europe (e.g. in Germany, Greece, Denmark, Spain), testing different schemes for the networks of the future; however there are several technical and engineering barriers in quickly developing and implementing large scale projects.

5 Platform recommendations for Actions to be considered in the SET-Plan

The major challenge for the ETP SmartGrids is its interrelation with many other ETP roadmaps, governments, regulators, electricity stakeholders (all of whom are changing the way they use electricity). SmartGrids connect generation to end users. The ability to forecast the mix of generation (from centralised large thermal units to distributed small generation) and the demand profile for every user in Europe is a very complex exercise. The approach of the SmartGrids ETP has been to identify a “toolbox” that can be deployed by all participants depending on their need and market maturity. The initiatives outlined here are enablers towards a common vision and will assist in its realisation.
A set of potential fields that could be part of the SET-Plan initiative have been identified:
- There is a need to set out standard rules and guidelines on one side and a need for removal of administrative barriers (harmonisation/certification schemes) on the other side to control the system evolution from the present numerous and varied national-based networks towards a common European electricity system.
- The Smartgrids platform and all the other energy technology sectors should work together in conceiving a future European system that takes into account the needs of all the users.
- Collaboration on EU-wide research on RES integration enablers as storage, ICT, metering is essential to make these technologies viable from the technical/economic point of view.
- Market structure and mechanisms should be implemented to support innovative technology deployment (e.g. Active Network Management, Smart Metering. FACTS, HVDC, etc). These would clearly deliver flexibility, security, economy and environmental benefits.
- Improvement of the social acceptance of electricity infrastructures.
- Increasing the number of electrical engineers is required to ensure new knowledge and expertise in the EU research arenas and to provide with skilled workforce the EU industry.

This report includes only a summary of the information exchanged between the Smartgrids Platform experts and the Commission panel during the hearing.