WG1 topics for SRA

FINAL 17-03-2006
The original 9 key issues are restructured into 5 main topics during the WG1 meeting on March 10th. Contribution and comments from all the attendees are included.

Original 9 key issues (first draft document)
1. Multi-directional communications & control
2. Standardisation of equipment and subsystems (obtain cost reduction + modularisation) including connection (protocols)
3. Ageing network components, tools for risk based asset management including monitoring residual life & proper pricing
4. Quality (and reliability) control at connection point Include the customer (all stakeholders) in the feedback loop e.g. with real time price signals
5. Include the customer (all stakeholders) in the feedback loop e.g. with real time price signals
6. Realise a stable pan-European network (renewal and expansion) with fluctuating generation
7. Make the network more intelligent / flexible / reliable / robust with advanced technology
8. DSM and Demand Response schemes operational
9. Integrate / merge gas + electricity + (district) heat and in the future hydrogen into one single energy infrastructure

New 5 main topics
1. Pan European network
   (original issue 6)
2. Network asset management
   (original issue 3)
3. Customer integration
   (original issues 5, 8 and parts of 1)
4. The NEW distribution network
   (original issues 2, 4, 7 and parts of 1)
5. Multiple energy carrier systems
   (original issue 9)

Note: ICT (standards) and multi-directional communication and control is to “broad” to serve as a topic on its own.

1. Pan European Network

Situation (*what to achieve and why)*

The situation to achieve is to establish a reliable and stable backbone for European internal electricity markets. This PAN European Network can be seen as an instrument to organise the coexistence of intelligent local, self-controlling (smart) grids with high amounts of DG on the one hand and large-scale centralised power plants and renewable bulk power injections respectively on the other hand (Balancing function). The Pan European network also has to fulfil control functions that cannot be decentralised e.g. Frequency-Control.

The interconnection of the system can be increased e.g. with selective reinforcements or by creating an ultra high voltage transmission level or DC backbone. Upgrades in the network should preferably be communicated between the European transmission system operators in order to reach a pan European network development plan stated in a blueprint. The future global (European) situation is similar with the present day situation, except that due to trading and the presence of large-scale (off shore) wind power plants more power flows across Europe can be expected. Better utilisation and more fluctuating power infeed from renewable sources calls for increased power flow steering at the transmission (bulk power) level, the ability of renewable bulk power generation facilities to provide ancillary services and for methods to safeguard the stability of the transmission system. Also the regional interconnection and local distribution (e.g. including mini and micro grids) might have to be reconsidered (power flow, control & protection).

Problem (what has to be resolved)
Local congestion as well as (new) organisations and responsibilities with possibly different political background are problems to be dealt with. Uniform data exchange formats are essential for communication between European system operators. For the transition of nowadays system into a pan European network, planning, economics and security issues also Power Flow control, integration of virtual power plants and the differences between renewable bulk power injections (e. g. offshore wind) and conventional power plants have to be addressed.

Solution and Implementation
Key deliverables:

- Blueprint for a future power system (including time frame, responsible parties, economic vs. ecological aspects)
- Development of more intelligent devices to control power flows that can economically compete with today's solutions (like PST)
- Harmonisation of market rules and grid codes
- New scientific models and methods (simulation tools, forecasting tools for load and RES power production, etc)
- Improved information and communication infrastructure

Enablers:

- Coordinated Asset Management (with regard not only to company-specific aspects but also to the objectives of the PAN European Network)
- Integration of Power Electronic Devices in Transmission System
- International Cooperation on Congestion Management Methods
- Availability and sharing of information on a European Level

- European Market for Balancing Energy
- Storage devices and opportunities

Measures of Success:

- Well established Pan European networks seem to be a crucial prerequisite for the Smart Grids concept. Thus, specific measures of success cannot be defined independently.
- Of course, realisation of the targets described above

Time horizon

Medium/long 2020+

On the short/medium term: congestion management and an European market for balancing energy, information sharing and agreement on long term network structures and integration of power electronic devices. On the long term a coordinated asset management.

2. Network Asset Management

Situation (*what to achieve and why)*

Much of the equipment on our electricity networks was designed with a design life of typically 40 years, though allowing for anticipated load increase over that period. Much is therefore increasingly at the end of its design life. Meanwhile, the character of the loads on the networks has changed beyond what we predicted when they were planned and designed. The demand has doubled since the 1960s when most of the current network was installed; peak demand and its timing are also changing and will continue to do so, in less than certain directions. In recent years, environmental policies are increasingly encouraging lower carbon generation including new and renewable energy sources and more efficient use of heat energy. Therefore the critical questions facing networks in the future are "Would our networks be able to cope and how much new investment do we need to make and in what?"

The requirement for investment to replace ageing equipment and reinforce the networks is coupled with an opportunity to facilitate the integration of new and emerging generation and network technologies, which will offer many benefits to increasingly aware and actively engaged energy customers. As very significant investment will be required to simply renew this infrastructure, the most efficient way forward is to incorporate innovative technologies and solutions when planning this renewal. The approach to 'design-in' for greater network capability and functionality will also allow for managing uncertainties and future, as yet unforeseen, changes.

Asset management is traditionally hindered by the old paradigms of reliability and the long pay back periods (> 30 years) for the capital-intensive plant and equipment. The underlying uncertainty associated with recovery of the long-term investments calls in general for a good "knowledge" of the natural life cycles of networks and their existing component assets. Any consideration of future electricity networks is to also take account of the life-expectancies of future installed / refurbished assets – and the functional performance expectations (eg reliability, security, availability, accessibility, flexibility, adaptability, safety, environmental impact, aesthetic impact, operational impact, efficiency, and whole-life cost) of all stakeholders in respect of those assets from installation to disposal.

Problem *(what has to be resolved)*

- To examine and assess the generic age and load-related asset renewal profiles and the potential scope for synergetic refurbishment and replacement with new and innovative plant and equipment so as to bring out the most socio-economic and environmental benefit in the short, medium and long term.
- To identify both synergies and incremental costs of new assets and designs. This will allow for a more reliable measure of the costs of introducing new plant and equipment as opposed to like-to-like renewal and therefore inform the business cases for future asset management.

Solution and Implementation

Key deliverables:

- Advanced methods/models/tools for asset condition monitoring and diagnostics so as to examine and assess equipment residual life including the natural asset renewal profiles, timescales due to asset condition, utilisation and quality of supply improvement drivers.
- New tools for risk and socio-economic based asset management so as to account for the present day possibilities of decentralised generation for grid-support, reliability and power quality enhancement at the connection point.
- Applications to demonstrate ability of improved methods/tools to deliver better 'knowledge' and managemnt of network assets
- A generic business case for introducing new plant and equipment as opposed to like-to-like renewal, and hence the likely migration path and take-up of appropriate technologies
- Demonstration projects using existing network infrastructure combined with existing and new asset management tools and technologies and delivered onto appropriate platforms to demonstrate both their technical feasibility and the business case for each of the identified stakeholders arising from widespread adoption in a liberalised market led industry to show the profitability for all stakeholders.

Enablers:

- New plant and equipment technologies
- The inadequacy and potential higher cost of traditional like-for-like renewal approaches combined with the need to gain greater capability and functionality (flexibility, adaptability and accessibility) from the exisiting infrastructure while delivering socio-economic and environmental benefits.

Measures of success:

- Effective sharing of knowledge and experience on aging assets (materials / components) and new technology and equipment.
- Customer satisfaction measured through ever increasing reliability and quality of supply at an acceptable price and in coordination and understanding with the policy makers, regulators, network operators and customers.
- Adequate pricing for the use of network components and equipment and implement, better financing (cost and performance) models and incentives for innovation and network renewal.

Time horizon
Short-term 2010

3. Customer integration

Situation (what to achieve and why)
Customers have to be the centre of the SmartGrid where they become an integral part of the electricity feedback-loop. As a result the customer becomes a real player in the power system instead of its present-day passive role. Because customers and (households, SME's, industry) are consumer and producer, e.g. of DG, at the same time bi-directional power flow must be able. Customers can make different choices e.g. PQ, reliability and green energy based on their preferences. Customers can engage (individual or as a group) in local electricity markets, often automatically, as they might become generators and become actively involved in load balancing and DSM / DR possibilities. This must be automated without loss of convenience. The changes that occur when the customers (expanded to all stakeholders) are included in the loop are not only technological influencing the (physical) network but also in governance and markets, including the information exchange en control functions. The integrity of the data and its transparency is essential for a well functioning power system and energy market. New plug and play equipment can easily be developed and hooked up to the network because the access is harmonised by means of the multi-directional communication and control protocols (e.g. based on IEC 61850 substation automation).

Problem (what has to be resolved)
Horizontal and vertical communication (ref. ICT challenge: security and integrity), cheap, reliable and accurate sensors (including meters) are needed, permitting integrity, security and safe working. Derive and make available transparent real time price signals. Receptor equipment at the customer for automated DSM/DR response without leading to inconvenience and creating incentives for use. Create market access and local markets. Develop new simulation tools that link technology, markets and human behaviour to investigate this.

Solution and Implementation
Key deliverables:

- Plug and play equipment,
- Real transparent time price information and signals,
- Cheap sensors and intelligent meters,
- Reliable and secure communication, with accepted standards
- Cheap and new communication technologies
- Schemes for DSM/DR incentives
- Validated and accepted integrated market simulation tools.

Enablers:

- Price information and forecasting tools
- Availability of smart consumer appliances
- Variable pricing schemes
- Harmonised access rules for (new distributed and integrated) RES on low voltage and medium voltage networks

Measures of success:

- Share and level of participation e.g. % customers that actively "participate"
- Aggregated savings of energy and money

Time horizon
Short/medium 2015

4. New Distribution Network

Situation *(what to achieve and why)*
By definition the Distribution Network covers all wires and equipment that play a role in giving access to DG and RES technologies and supplying all medium to low consumers (mostly using networks below 50 kV but not limited to). This topic aims to develop a set of plug and play modules using standardisation and modularisation, resulting in lower production costs, material use etc., leading to lower costs throughout the power delivery chain. These plug and play modules are environmentally friendly (e.g. easy to recycle / reuse) and have very little to none unwanted effects on citizens (toxic, interference, acceptable levels of EMF etc.). The modules can, to a high degree, be customized to individual needs. Through the standardisation, modularisation and programmable functionality an economy of numbers can be possible, leading to cheaper production, less inventory costs and for the user easily expandable and maintainable systems. This can offer to Europe a competitive edge in the world market. Enhancing this work with multidirectional communication and control systems for horizontal and vertical integration to facilitate participation of customers and DG to system operation for effective distribution control can result in power quality and reliability at connection point. This can offer the customer choice and quality of supply at relatively cheap prices provided that minimum technical requirements are met and these are measurable enabling network owners to maximize efficiency, flexibility and reliability through the use of smart advance technology.

Problem *(what has to be resolved)*
Derive optimized functionality structure / best practices for equipment (what is the minimum set). New technical (integral) design methods and tools are needed. All manufacturers and users have to agree on and limit themselves to a certain set of building blocks with programmable functionality / specification (including readiness for future needs). Apart from the hardware the "software" has to be standardised using an open architecture and universally accepted protocols. The adequacy and reliability of the modules must be assessed and certified with new simulations and tests using appropriate simulator installations and test facilities. Minimum technical requirements must be agreed that all have to meet at connection point and means need to be established to measure PQ, establish "pollution" sources and develop a shared vision for public and private responsibility for intelligent, effective and efficient control of PQ and reliability at connection point.

Solution and Implementation
Key deliverables:

- New technical design methods and tools (including simulation and testing) available for all manufacturers for testing and operating the new functional blocks.
- Should offer a new planning and design methodology for network companies and consumers meeting the requirements of an acceptable and open architecture of the standardised functional blocks.
- PQ indicators and measuring systems to be universally available to allow better share of responsibility and produce efficient signals for investment.
- Demonstrate how self-controlled grids can positively affect the power exchange layer.

Enablers:

- Required ICT technology to be available.
- Agreement on a European scale on standard characteristics of system building blocks and system architecture.
- Testing and measurement techniques facilitating simulation.
- Adequate and effective electricity energy storage devices.

Measures of success:

- Degree of acceptance and usage of open architecture solutions and protocols.
- Effective and efficient use of sustainable and low carbon technologies.
- New (modularized) equipment made available by manufacturers and accepted and incorporated in the network.

Time horizon

Short/medium 2015

5. Multiple Energy Carrier Systems

Situation (*what to achieve and why*)

As the main focus is on the development of the electricity network for the future, the existence of the other energy distributing networks cannot be neglected. These are the networks for natural gas, district heating (large schemes and/or local), biomass (e.g. supply chain for wood pellets, upgraded biogas into the natural gas pipeline) or other fossil or renewable fuels. Also attention has to be paid towards the possible development of a hydrogen infrastructure. Actually there is no common understanding, which network or which combination of networks offers the best technical solution, the best environmental solution and the overall most economic solution. It is still an open question, whether all networks are competing with each other or whether specific combination offer synergetic potential. Chances for merging different technologies for the supply of primary energy (natural gas, synthetic fuels), electricity and heat are obviously there, but there is no instrument to assess the individual competiveness in a given local situation (rural, densely populated, northern Europe, Southern Europe). Solutions have to be adopted to the customers needs.

The transition of energy supply towards the hydrogen path at least for mobility mainly driven by renewable conversion technology must also be assessed under the complete energy supply picture.

The build up of networks calls for large investments in infrastructure. The merging and interaction between the different supply structures should therefore also offer potential for economic gains.

Find an optimisation of the three infrastructures together / combined and their internal dependencies because to maintain separate infrastructures is too expensive. Furthermore all renewable sources produce electricity and since electricity cannot be stored in large quantities directly a coupling with the gas infrastructure with its easy storage capabilities is advantageous.

In the far future we can foresee a merging of the mobile infrastructure (e.g. hybrid and fuel cell cars) with the stationary infrastructure and realise a "hydrogen dream" based on "protons" and "electrons"

The strategy of integration of the different networks need to be coupled with other technical developments in the field of Demand Side Management, metering and billing and new automation and control options. This is meant to realise the essential energy savings and increase in energy efficiency to safeguard the European security of supply during the transition to a sustainable energy future.

Problem *(what has to be resolved)*
Integrated (energy) models and (technical) methods to "couple" / "interconnect" the different infrastructures and their internal dependencies. Modelling has to address the new situation and the dynamics of interchanges. Still open: which strategy is technical, economically and/or environmentally advantageous? The degree and influence of regulation need to be known and the regional (national) infrastructure is different under differing circumstances.
The newly developed automated systems must benefit the customer without compromising convenience and user behaviour.

Solution and implementation
Key Deliverables:

- present a solution and justify investments and operational strategies
- Collection of what is possible in networks, followed by development of criteria to assess opportunities. The network model has to connected with the consumption model
- Assess demand structure, rural, industrial, dense populated areas
- Find a multiple approach solution, develop a decision making tool
- Accepted DSM and DR schemes (automatic) and delivering benefits to the customer (and network company).
- Formulation of a transition path with supportive technology

Enablers:

- Real Option Analysis
- Methods incorporated in software, decision type, library of different objects, information on opportunities for storage, transmission, investment relies heavily on IT, communication and advanced electronics and last but not least on behaviour of European citizens
- advanced IT and "expensiveness" of operating multiple infrastructures separately.

Measures of Success:

- Developed tools are in use

- Better environmental situation
- Regulator is satisfied
- Documented decisions on efficiency, CO_2 reduction or reduction of external costs
- Integration and merging experiments with network infrastructures
- Number of DSM /DR schemes operational (amount of energy saved).

Time Horizon
Medium/long 2020+

On the Short to medium term development of models for interaction between different technological networks, Increase on information on opportunities and preparation of the hydrogen network. Implementation is foreseen in the longterm.