SMARTGRIDS

European Technology Platform

SmartGrids

Strategic Deployment Document
for Europe's Electricity Networks of the Future

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Explanatory Remark

The SmartGrids Strategic Deployment Document (SDD) has been produced by the Advisory Council in collaboration with the Member States Mirror Group. It builds on the SmartGrids Vision and Strategic Research Agenda and incorporates the intensive work and discussions within the four SmartGrids Working Groups and three General Assembly meetings. It is the result of the combined efforts of many stakeholders, organizations and individuals involved in the SmartGrids Technology Platform.

An evaluation of the costs for SmartGrids deployment – and, just as importantly, an estimate of the related benefits for the European electricity supply system and for society as a whole – has been high on the agenda during the preparation of the document. However, it has been recognized during the review phase, that a detailed evaluation of costs (and benefits) depends on the future development of the European electricity supply and for that a scenario-based approach is required, which goes well beyond the scope of the SDD. These scenarios would cover a number of potential future developments. For example, for a future massive deployment of electric vehicles, one key focus of SmartGrids deployment would be the supply of power for such vehicles; in the case of extensively increased penetration of wind generation (e.g. under support of provisions from the new Green Package), the connection / grid integration of the offshore wind will be crucial; finally, with those and other scenarios possibly going on in parallel, the scope and priorities of SmartGrids deployment will differ and so will the actual costs and benefits of the deployment.

Therefore a rather general view of SmartGrids' deployment costs in the process of renewal of the European electricity grids has been proposed in Chapter 2.

A number of proposals and projects in the FP7 have already utilized inputs from the SmartGrids Vision and Strategic Research Agenda. The Strategic Deployment Document further supports the related activities, contributing thus to meeting the needs and challenges of the practical implementation and deployment projects to come.

Foreword

In April 2006 the Advisory Council of the European Technology Platform (ETP) for Europe's Electricity Networks of the Future presented its Vision document for SmartGrids. The Vision, encompassing both transmission and distribution networks, is driven by the combined effects of market liberalization, the change in generation technologies to meet environmental targets and the future uses of electricity.

Together with the Vision, the Strategic Research Agenda, published in 2007. describes the main areas to be investigated, technical and non-technical, in the short-medium term in Europe. Since then these documents have inspired several Research and Development programs within the EU and National institutions.

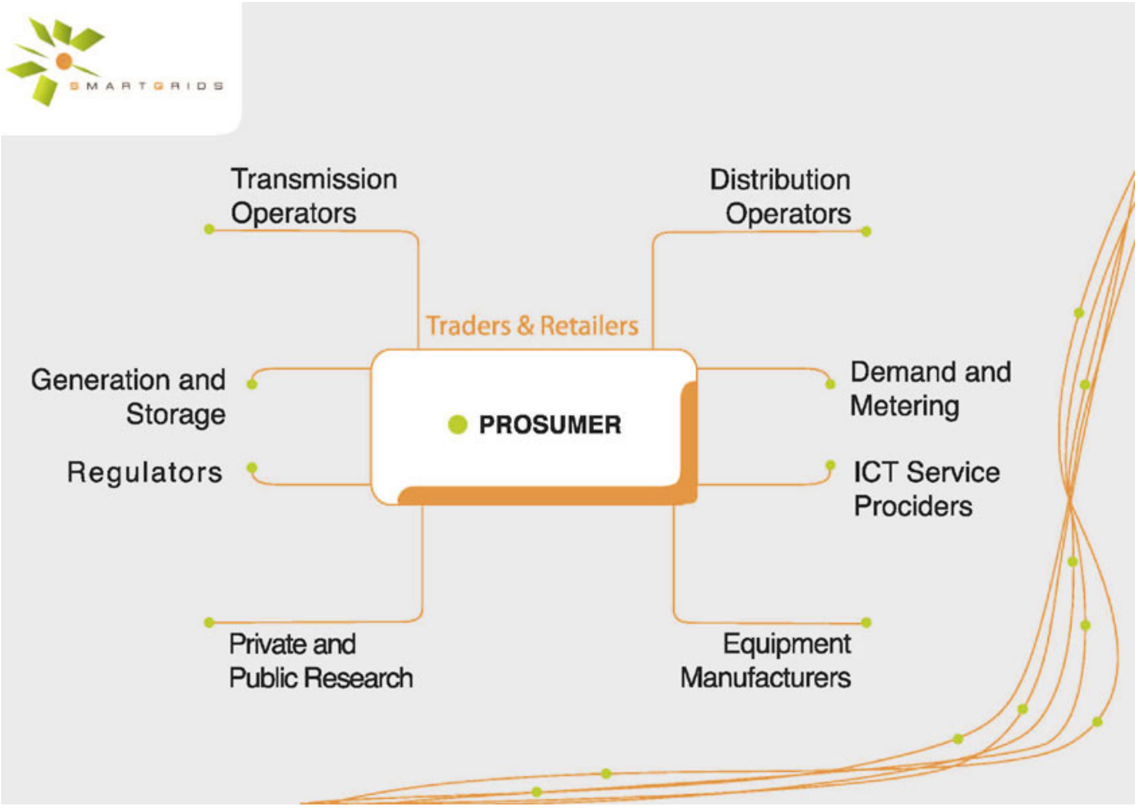
At the end of 2008, based on the contributions and discussions of many people in the EU Member States, the first draft of this Strategic Deployment Document (SDD) was released, under the Chairmanship of Pier Nabuurs, the CEO of N.V. KEMA. Today this document is formally finalized, and describes the priorities for the deployment of innovation in the electricity networks and the benefits that such innovations will deliver for all stakeholders. It also gives a timeline for deployment.

The Strategic Deployment Document has also benefited from input from a Mirror Group of Member State representatives, and as other activities and documents of the ETP SmartGrids, it has been main source of inspiration for many institutions, and key stakeholders in Europe over the last years.

With the EU SET-Plan, current focus is on concrete projects to jump start the deployment of the SmartGrids in Europe. In order to better respond to the needs and requirements for coordination of SmartGrids in Europe, the ETP SmartGrids has entered in an process of restructuring of its original internal organisation.

The recently created SmartGrids ETP Forum will substitute the previous Advisory Council, taking the lead of the platform structure and setting the agenda of activities of the platform. The working groups that were still active have been retained, but new ad-hoc groups shall be set-up when appropriate. This new structure has been established to support and lead the role and mission of the SmartGrids Platform.

The structure of the SmartGrids ETP Forum is an executive group of 12 individuals representing the various groups of stakeholders: TSOs, Electrical systems manufacturers, DSOs, ICT service providers, Regulators, Metering manufacturers, Centralized generation, Customer interaction and metering, Renewable generation, Industrial R&D, Users, Academic and governmental R&D.



SmartGrids ETP Forum Mission

To foster and support the deployment of SmartGrids in Europe advising and providing coordination to the various SmartGrids Forum stakeholders (European Commission, TSO, DSO, Energy System and Component providers, Energy Research Centres, Smart Metering Industry, Energy Consumers, Utilities Telecom Providers, Grid Regulators) among projects and related initiatives, to facilitate the smooth and efficient running of the European Technology Platform SmartGrids ensuring its strategic relevance and its consistency with EU policy. To link with relevant technology platforms dealing with energy matters that have an impact both at the generation and the demand side, on the future of the grid. To provide relevant input to the EU initiatives such as SET-plan and its European Industrial Initiatives.

On behalf of the European Technology Platform SmartGrids, I would like to thank everyone who contributed to its work, and the development of this SDD. Special acknowledgment goes to Tahir Kapetanovic and Duncan Botting, who took the responsibility for the writing of this document, Gareth Evans and Nick Jenkins who assisted with the editing and the representatives of the Commission for their advice and facilitation.

Ronnie Belmans

Executive Summary

The SmartGrids Strategic Deployment Document is the third in a series of reports produced by the SmartGrids Technology Platform (www.smartgrids.eu). The first document, "Vision and Strategy for Europe's Electricity Networks of the Future", set out the need for and vision of the future European electricity networks. The second, "Strategic Research Agenda", consolidated the views of stakeholders on the research priorities necessary to deliver these networks. This SDD completes the series and focuses on the deployment of new network technologies and the delivery of the SmartGrids Vision.

The aims of the SDD

The aims of the SDD are simple – to reinforce the need for and benefits of SmartGrids technologies and solutions, to highlight the barriers that are currently constraining deployment and to make recommendations that will address these barriers. SmartGrids will be a major part in the delivery of the energy security policies and sustainability targets mandated by the European Council for 2020 and 2050. It is therefore vital to communicate their benefits to all stakeholders in the electricity supply chain.

What is a SmartGrid?

A SmartGrid is an electricity network that can intelligently integrate the actions of all users connected to it - generators, consumers and those that do both – in order to efficiently deliver sustainable, economic and secure electricity supplies.

A SmartGrid employs innovative products and services together with intelligent monitoring, control, communication, and self-healing technologies to:

- better facilitate the connection and operation of generators of all sizes and technologies;
- allow consumers to play a part in optimizing the operation of the system;
- provide consumers with greater information and choice of supply;
- significantly reduce the environmental impact of the whole electricity supply system;
- deliver enhanced levels of reliability and security of supply.

SmartGrids deployment must include not only technology, market and commercial considerations, environmental impact, regulatory framework, standardization usage, ICT (Information & Communication Technology) and migration strategy but also societal requirements and governmental edicts.

This SDD is intended to engage with all stakeholders in the electricity supply chain: governments, regulators, network operators, network users – both generators and consumers - network equipment manufacturers, consultants, suppliers of household appliances and ICT, and other service providers. In the competitive environment of the electricity market each stakeholder must play its part if the deployment is to be successful.

The need for SmartGrids

It is vital that Europe's electricity networks are able to integrate all low carbon generation technologies as well as to encourage the demand side to play an active part in the supply chain. This must be done by upgrading and evolving the networks efficiently and economically. It will involve network development at all voltage levels. For example, substantial offshore and improved onshore transmission infrastructure will be required in the near term to facilitate the development of wind power across Europe. Distribution networks will need to embrace active network management technologies to efficiently integrate distributed generation (DG), including residential micro generation, on a large scale. There are many other examples but all will require the connectivity that networks provide to achieve the targets for energy security and environmental sustainability.

A combination of effective legislation and regulation will be needed to secure these developments in a timely way. The SmartGrids Technology Platform has identified ten key challenges that impact on the delivery of the mandated targets for utilization of renewable energy, efficiency and carbon reductions by 2020 and 2050. They are also interlinked with the targets for one common European electricity market, for reducing European dependency on energy imports and for maintaining security of supply with minimum costs.

The Key Challenges for SmartGrids

- **Strengthening the grid** – ensuring that there is sufficient transmission capacity to interconnect energy resources, especially renewable resources, across Europe;
- **Moving offshore** – developing the most efficient connections for offshore wind farms and for other marine technologies;
- **Developing decentralized architectures** – enabling smaller scale electricity supply systems to operate harmoniously with the total system;
- **Communications** – delivering the communications infrastructure to allow potentially millions of parties to operate and trade in the single market;
- **Active demand side** – enabling all consumers, with or without their own generation, to play an active role in the operation of the system;
- **Integrating intermittent generation** – finding the best ways of integrating intermittent generation including residential microgeneration;
- **Enhanced intelligence** of generation, demand and most notably in the grid;
- **Capturing the benefits of DG and storage**;
- **Preparing for electric vehicles** – whereas SmartGrids must accommodate the needs of all consumers, electric vehicles are particularly emphasized due to their mobile and highly dispersed character and possible massive deployment in the next years, what would yield a major challenge for the future electricity networks.

Security of European energy supply has come into sharp focus in recent years for a number of reasons. Examples include the concerns over secure gas supplies and the power system disturbances that affected substantial parts of Europe. The need for modernized, robust and adequate European electricity networks – i.e. the need for SmartGrids - has never been greater. Moreover, there are complex interactions between the demands of the network users, which require a more secure and sustainable electricity supply system. Finally, also market and regulatory challenges need to be addressed. The guiding principle for the SDD is to cut through this complexity and set out clear recommendations that stakeholders need to understand and act on to achieve the SmartGrids Vision. The underlying aims of SmartGrids remain the same.

Aims of the SmartGrids – the Vision

- Provide a user-centric approach and allow new services to enter into the market;
- Establish innovation as an economical driver for the electricity networks renewal;
- Maintain security of supply, ensure integration and interoperability;
- Provide accessibility to a liberalized market and foster competition;
- Enable distributed generation and utilization of renewable energy sources;
- Ensure best use of central generation;
- Consider appropriately the impact of environmental limitations;
- Enable demand side participation (DSR, DSM);
- Inform the political and regulatory aspects;
- Consider the societal aspects.

The SmartGrids priorities for strategic deployment

In order to help facilitate the timely deployment of SmartGrids, this SDD sets out six "deployment priorities". Through these, the opportunities to develop SmartGrid solutions are outlined and evidence is provided that will assist stakeholders in designing the real "business cases" to justify actual deployment projects.

These SmartGrids generic deployment priorities are defined at a "meta level", i.e. they describe a number of activities and developments in terms of strategic deployment steps, which when completed will contribute effectively to the fulfillment of the SmartGrids Vision.

The starting point in the identification and definition of the generic deployment priorities has been, besides the requirement of reaching the 20/20/20 targets[1], the growing focus on services and users, a process strengthened by liberalization and development of the European electricity market.

The generic deployment priorities were elaborated in a stepwise approach by the four SmartGrids Working Groups - WG1 Network Assets, WG2 Network Operations, WG3 Demand and Metering and WG4 Generation and Storage:

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[1] 20% more renewables, 20% less CO_2 emissions and 20% higher energy efficiency by the year 2020 in the EU.

- During 2007, each of the four Working Groups completed a number of "SDD application sheets". These described detailed and specific activities which were considered priorities to achieve the SmartGrids Vision;
- The SDD application sheets were then compiled in the first outline of the SDD; the key elements of each sheet referred to what / when / by whom to deploy;
- The first SDD outline was the subject of workshops held by the SmartGrids Working Groups at the second General Assembly in November 2007;
- The resulting six SmartGrids deployment priorities were then defined:

SmartGrids Deployment Priorities

- Deployment Priority #1: **Optimizing Grid Operation and Use**
- Deployment Priority #2: **Optimizing Grid Infrastructure**
- Deployment Priority #3: **Integrating Large Scale Intermittent Generation**
- Deployment Priority #4: **Information & Communication Technology**
- Deployment Priority #5: **Active Distribution Networks**
- Deployment Priority #6: **New Market Places, Users & Energy Efficiency**

In short, the approach adopted for the development of the generic deployment priorities takes full account of the complexity of SmartGrids, creates a robust strategic deployment framework, providing at the same time a precise scope, sharp focus and effective progress monitoring for the subsequent practical deployment.

To reflect the real world needs, a time-line is used to indicate when each particular deployment step needs to be completed or commenced, if the required outcomes are to be realized. The milestones of the time-line, building upon the defined EU targets are shown in Figure 1 below.

Figure 1: Timeline for SmartGrids deployment

Analysis of missing knowledge was performed in the SmartGrids Strategic Research Agenda (http://www.smartgrids.eu/documents/sra.pdf) and research and development proposed. However the timeline to achieve the required R&D and deployment was not explicit and this SDD now provides guidance.

Recommendations and Conclusions

In order for the SmartGrids Vision to become a reality, a plan of actions is needed to allow the many facets of technical, regulatory, environmental and cultural issues to be addressed in an optimized manner. This will provide a coherent deployment of research and development results, integrated with existing infrastructure and technology, delivering early benefits, while maintaining the steady progress and evolution towards the main goals.

The SDD defines this process to allow all stakeholders to take action to meet the urgent timetable driven by the mandated targets, the proposed new European energy market legislation (Third Legislative Package), the new framework for renewables (Green Package) and compliments the Strategic Energy Technology (SET) plan.

The SDD not only outlines the SmartGrids deployment steps in terms of technology and time; the roles and responsibilities of different stakeholders, the funding and support options, the required communication strategies are also proposed to promote the SmartGrids deployment.

Key recommendations on the way forward, intended for the European Institutions, Member States, regulators, operators and users of the electricity grids and all other relevant stakeholders are suggested, which when followed, will help mitigate climate change and ensure security of supply to the European Union at the minimum possible cost.

A further key action will be to promote the formation of a SmartGrids Association (SGA) as a delivery vehicle to ensure that the correct focus and resources are provided to drive the SDD objectives forward. Industrial partners willing to fund the Association will be instrumental in driving the SDD agenda forward. This model has successfully delivered the desired outcomes in other sectors.

Finally, while emphasizing the high ambition and priority goals of the SDD, it is important to stress that the SDD does not propose political measures like e.g. creation of one single European transmission system operator or one single European regulator. Whereas such developments might impact the SmartGrids deployment, it is clear that any related decision must be made by the responsible European and Member States' institutions.

The Recommendations

- **Promote the SmartGrids Vision to all stakeholders** – it is vital that there is 'buy-in' to the SmartGrids vision across all stakeholders for it to be successful.
- **Encourage innovation by network companies and stakeholders** – only the network companies can actually deliver the vision. They must be motivated for that.
- **Encourage a pan-European approach to the SmartGrids 'project'** – a sustainable future for Europe will increasingly depend on open energy trading. Co-operation between Member States will be increasingly important.
- **Encourage early deployment of SmartGrids technologies and solutions through demonstration projects** – "de-risking" technologies requires demonstration on real networks. Demonstration projects are vital to achieve widespread adoption.
- **Further develop the SmartGrids Business Opportunities to build the case for deployment** – new approaches are needed to take account of the wider benefits of Smartgrids.
- **Engage the demand side** – it is a vital part of the SmartGrids vision to promote an active demand side / user participation.
- **Address technical standards in the electricity and telecommunications sectors** – engage the standards and regulatory bodies from both sectors to ensure that they are in line with the SmartGrids vision and its needs.
- **Understand and manage the environmental impacts of network development** – stakeholders' concerns must be understood and addressed appropriately.
- **Promote open access to network performance data** – vital for effective functioning of the market, for grid operational security but also for the effective R&D.
- **Develop the "skills" base in the electricity networks sector** – without resolving this problem of resources, any progress will be severely constrained.

1. Introduction

SmartGrids are dealt with in the European Technology Platform for Electricity Networks of the Future which has been created under the same name in 2005 (www.smartgrids.eu). The first step undertaken by the SmartGrids Advisory Council (AC), supported by the Mirror Group (MG) of the Member States was to create a common vision in 2005. The SmartGrids Vision was discussed at the first SmartGrids General Assembly in April 2006.

In order to pave the path towards reaching the Vision, it was necessary to specify the areas of research required to reach the final goals. This was accomplished in the Strategic Research Agenda (SRA) published in 2007. The SRA defines the technical solutions and applications belonging to the different SmartGrids areas of deployment. A number of lighthouse projects and activities were identified and suggested, that helped to develop the call for the EU Framework 7 in the area of transmission and distribution networks.

With the SmartGrids Vision and SRA complete, a plan for deployment to make the Vision a reality was required. The SDD delivers hence a clear timeline of actions, recommendations and conclusions for that purpose, taking into account the drivers from the EU targets to meet the climate challenges and maintain security of supply in an economical way. The SDD is also both, consistent with and relying upon the recommendations from the Strategic Energy Technology (SET) Plan for Europe.

The main components of the SDD are:

1. **Introduction** – this chapter;

2. **Deployment plan with priorities** required to achieve the SmartGrids Vision and building upon the Strategic Research Topics and "lighthouse" projects from the SRA;

3. **Recommendations and conclusions** on necessary actions that will facilitate innovation and create achievable deployment pathways; that will enable new functionality to be converted into commercially deployable applications;

4. **Roadmap** with a high-level timeline setup for the defined deployment priorities, required to practically pursue the SmartGrids deployment;

5. **Stakeholders and external initiatives** which are involved with the future intelligent electricity grids; for each stakeholder, a model of cooperation within the SmartGrids framework is suggested;

6. **Funding options** to achieve the deployment of key SmartGrids elements;

7. **Communication strategy** for the key messages about SmartGrids deployment and benefits of that;

8. **Next steps** and the way forward for the Technology Platform itself and how it might best enable progress along the pathway.

The evolution from the SmartGrids Vision, over specification of project and research areas in the SRA, towards the future practical deployment and realization, is shown in Figure 2 below.

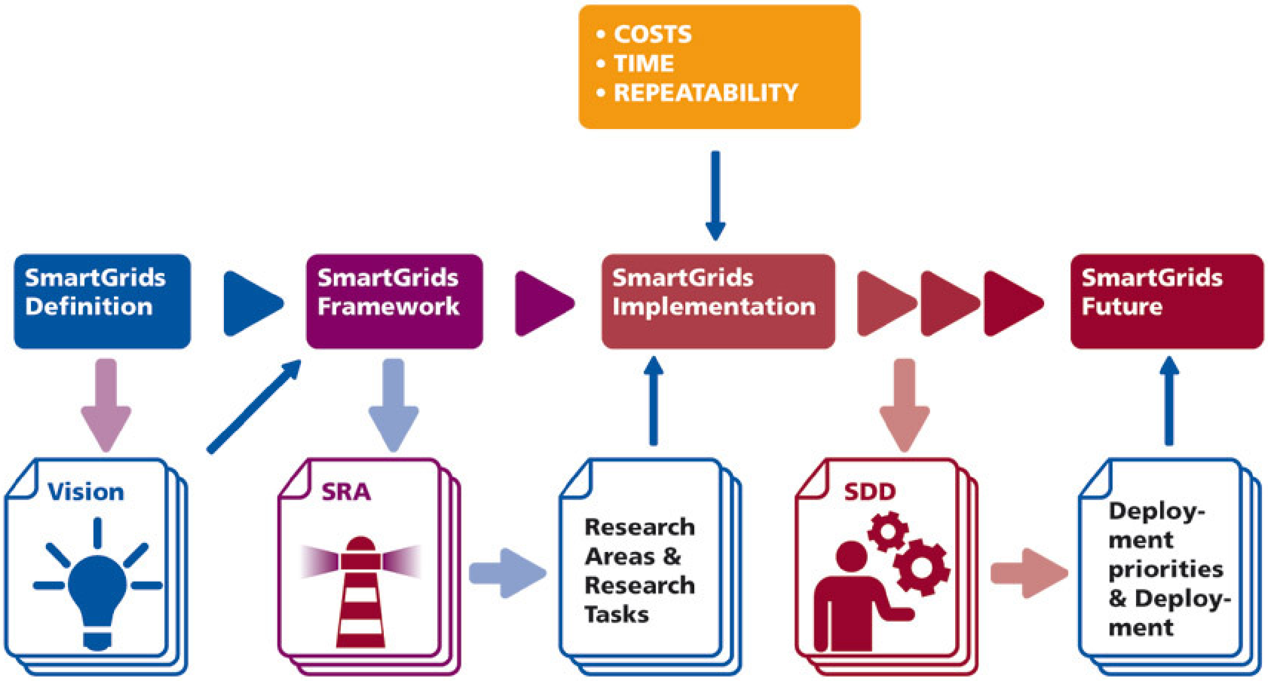


Figure 2: SmartGrids evolution

The SmartGrids SDD is intended for a wide audience. It is especially useful for those with a core interest in investing into research, development and deployment of the SmartGrids technologies and solutions, but also to political decision makers, law makers and regulators. It is also intended as a guideline in making choices.

The SmartGrids Technology Platform is guided by the Advisory Council, with support from the Member States' Mirror Group. The AC hosts senior representatives of major stakeholders throughout the electric power supply chain and in relation to it: consultants, manufacturers, research institutes and universities, service providers, generators, network operators, regulators, etc.

The TP has included the views and recommendations of a wide range of experts and knowledgeable participants who contribute through four Working Groups (WG1 Network Assets, WG2 Network Operations, WG3 Demand & Metering and WG4 Generation and Storage) and finally sought validation via General Assembly meetings. However, the Advisory Council has no executive authority in its own right and therefore presents the recommendations for consideration and action by the relevant parties.

The SmartGrids Technology Platform seeks therefore to inform advice and inspire those involved with solving challenges ahead. It is committed to provide analysis, facilitation and information to help secure effective outcomes in this important area and to address the key issues for the deployment in the most efficient way.

The Key Issues

The SmartGrids Advisory Council and Mirror Group are convinced that without completion of activities specified in the SDD, the European initiatives in relation to renewables, carbon reduction and efficiency will not yield results. The SmartGrids are the key enabler for those initiatives - without them most effort will be in vain and arguments in favor of "keeping business as usual" will prove to be right. In order to reach the defined targets, urgent action is required in terms of short-term technology deployment and in terms of medium to long-term research and development. The following 10 key issues identify what this means in reality.

1. ***"NIMBY – Making grids much more acceptable to society or why we need, but do not want to see electricity grids"***

Expansion of grid infrastructure by building of new lines is delayed and / or obstructed by different reasons, the NIMBY ("Not In My BackYard") attitude in public being the most often and common one; the solutions for replacement, enforcement and maximization of utilization of the existing infrastructure must therefore be exploited as much as possible, with technology and methods for that already available at hand.

2. ***"New planning for new, decentralized grid-based architectures"***

"Democratization" of the electricity networks of the future is best observed in the decentralized, new architectures – to accommodate them, new design and planning tools are needed, relying on heuristics, probabilistic approaches, scenario analyses, etc. Technical solutions are in advanced stages of R&D.

3. ***"Strengthening the grid integration, for disturbances prevention"***

Growing physical power flows across the control area borders, intensified trading activities and massive intermittent generation (notably wind) require advanced integration of European transmission grids. To avoid disturbances and large scale supply interruptions, WAM and WAC (Wide Area Monitoring and Wide Area Control) solutions in combination with power electronics to manage the flows should be deployed on a wide scale. Better grid integration, with power flows control and enhanced operational security are achievable in the short term.

4. ***"Moving grids offshore, when onshore grids become crowded and/or generation cannot be onshore"***

Large offshore wind farms, and in the future wave and tidal technology-based generation, require coordinated offshore networks to maximize opportunities for interconnection and utilization of generated electric power. The offshore generation integration is achievable in the short term, with possibly some application research yet to complete.

5. ***"Active users need active grids"***

User-centric distribution grids of the future will require new active network technology to enable massive deployment and control of industrial and residential generation in combination with demand side participation. Economic solutions for the communication infrastructures envisaged to support these active networks are expected to be major areas of investigation. There are a number of R&D projects currently under way to prove concepts and validate deployment through pilot projects. Further research and development will be required as initial deployment identifies further challenges.

6. ***"Adequate communication for new services & new players"***

New market players will emerge, such as VPP (Virtual Power Plant) operators, energy management service providers, etc. These new players require in turn major communication infrastructure improvements for data exchanges, technical support services, in order to foster accessibility, security and controllability. There are a number of R&D projects currently under way to prove concepts and validate deployment through pilot projects. Further research and development will be required as initial deployment identifies further challenges.

7. ***"Enhanced intelligence for enhanced efficiency"***

Active demand participation in houses and by SMEs (Small & Medium Enterprises) will contribute to the efficiency of electricity usage but only if there is a coordinated activity between the network, the intelligent gateway (sometimes referred to as a Smart Meter that will be required to go further than just Automatic Meter Reading (AMR) or Automatic Meter Infrastructure (AMI)), the user and the manufacturer of the home appliances and electronic devices. Revenue streams will be required to be in place for such developments to take place, not to mention the technology to achieve it. In this issue, technology and product R&D is required on a longer term basis.

8. ***"For dispersed generation, dispersed storage is indispensable"***

The intelligent electricity networks of the future will have a greater share of dispersed and intermittent generation capacity. More efficient storage technology at small and large scales is likely to be of great importance to facilitate the operation of the system in the new context. Existing storage technologies will need to be complimented with new innovative research to find economic and environmentally acceptable solutions.

9. ***"Mobility Flexibility in the grid, for sustainable mobility of the society"***

Much more sustainable transportation is likely to have a major impact on the SmartGrids, especially at the residential and industrial level. In order to enable the plug-in and hybrid electric cars of the future, network design will need to allow for large, mobile generation and storage possibilities. Novel and applied R&D is required in order to address this issue accordingly.

10. ***"The long-term SmartGrids future starts today"***

A number of further R&D activities need to be initiated now, in order to deliver applications and solutions for the long term perspective of 2050 and beyond. To move towards an increasing low-carbon economy, European electricity networks will need to evolve to provide support for possible future energy vectors such as hydrogen, for effective introduction of carbon credits, taxes and trading, for generating buildings integrated with energy distribution, for offshore supergrids connecting offshore resources, for integration of geothermal generation and finally for massive combination of solar/hydro/wind/wave/tidal generation from Europe and outside. This R&D needs to commence now and in parallel with the deployment of the short term SmartGrids solutions for 2020, in order to be ready to deliver and achieve the 2050 targets.

The SDD provides guidance for a stepwise plan towards understanding **what** is needed and by **when**, with an indication of **how** it will be deployed. The question of **who** is to a large extent left to the market and involved stakeholders to decide; nevertheless, where no ambiguity exists (e.g. in setting the legal framework by government and in implementing the regulatory framework by regulator), the indication of "who" has been given.

Whereas the general awareness in Europe that the intelligence of the electricity grids needs to be further developed has increased, most stakeholders will nevertheless require a justification for why they should implement the proposals from the SDD.

In order to help facilitate the timely deployment of SmartGrids solutions and to "model" the SmartGrids deployment, the SDD sets out six "deployment priorities". By that, the opportunities are outlined to develop SmartGrid solutions and to provide evidence that will assist stakeholders to build a number of real deployment priorities for actual deployment projects.

The SmartGrids priorities for strategic deployment are therefore defined at a "meta level", i.e. they comprehend a number of required activities and developments into the strategic deployment steps, which when completed by stakeholders will effectively result in fulfillment of the SmartGrids Vision. This will in turn vary, dependent on stakeholder position within the supply chain and taking cognizance of relevant national and regional variations. The rewards and benefits will be different for different stakeholders and will need to be assessed on an individual basis.

It is important to emphasize the two advantageous features of the approach with generic strategic deployment priorities:

(i) Comprehending the deployment process into a relatively small and well observable number of "generic" priorities enables involved stakeholders to remain focused when pursuing the deployment through their real deployment cases and – provided they follow the guidance and framework from the generic deployment priorities – to effectively monitor and compare the results achieved with the expectations / requirements both, within their particular area of interest and from the overall SmartGrids perspective;

By this feature, one key requirement from the second SmartGrids General Assembly in 2007 is taken into account: to take the SRA as the basis but to narrow the scope and sharpen the focus in order to ensure SmartGrids acceptance and feasibility.

(ii) Maintaining the necessary width, depth and complexity of each deployment priority and preventing prohibitive simplifications which would compromise the outcome and yield trivial and rather theoretical outcome instead of technically and practicably viable approach, guarantees that the priorities for the SmartGrids strategic deployment indeed address accordingly all the critical and mandatory issues required to make SmartGrids a reality.

The starting point in the identification and definition of the deployment priorities has been – besides the requirement of reaching the 20/20/20 targets - the growing orientation towards services and users, a process strengthened by the liberalization and the European electricity market.

The path towards the generic deployment priorities has been paved by the four SmartGrids Working Groups:

- During the year 2007, each of the four Working Groups has completed a number of the so called "SDD application sheets" – detailed and specific outlines for the particular activities which were considered mandatory in the respective WG area of concern, in order to achieve SmartGrids Vision;

- The SDD application sheets have then been compiled together in the first outline of the SDD; the key components contained in each sheet were on what / when / by whom is to be deployed;

- The first SDD outline has been a subject of the workshops by the SmartGrids Working Groups at the second General Assembly in November 2007; the resulting discussions have combined the functional split of activities within the electric power supply chain into a matrix with the mentioned user/service centric migration and paradigm shift which the electric power supply industry and market are undergoing since more than a decade in Europe; the 20/20/20 targets remain the key driving force;

The resulting six generic SmartGrids deployment priorities for the short term, highest priority deployment by 2020 have eventually been identified as listed below:

- Deployment Priority #1: **Optimizing Grid Operation and Usage**
- Deployment Priority #2: **Optimizing Grid Infrastructure**
- Deployment Priority #3: **Integrating Large Scale Intermittent Generation**
- Deployment Priority #4: **Information and Communication Technology**
- Deployment Priority #5: **Active Distribution Networks**
- Deployment Priority #6: **New Market Places, Users and Energy Efficiency**

The relationship between the SmartGrids deployment priorities and their dependency on the various stakeholder groups within the electricity supply chain are shown in Figure 3.

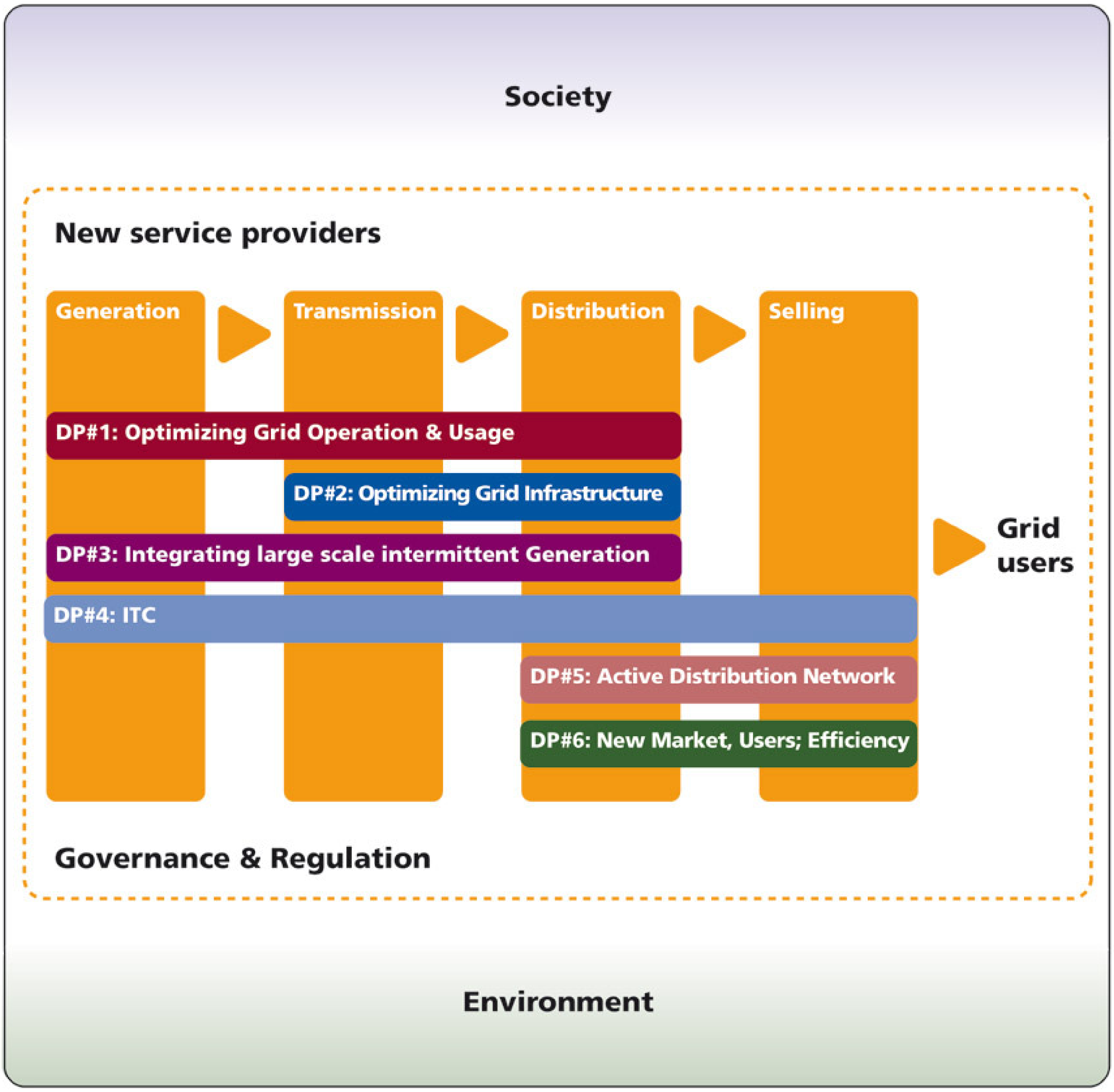


Figure 3: SmartGrids deployment priorities' (DP) relations and external dependencies

It must be emphasized that the six deployment priorities focus mainly on the SmartGrids deployment until 2020 and address the development beyond that only in very general terms of RD&D that needs to be commenced now in order to achieve the 2050 targets. The SDD will therefore be amended accordingly in the future, in order to accommodate the key deployment steps for the time beyond 2020.

The deployment priorities have been supplemented and further specified in terms of technical architecture, regulatory issues, environmental impact and societal value.

The specification has followed a manner that resembles the methodologies and approaches used to justify real-world deployment cases in industry, with the key difference in the level of detail of quantification: the SDD deployment priorities are the "templates" for practical projects and deployment and the exact cost figures and other issues will have to be defined in detail at the time of practical application.

The deployment of the SmartGrids priorities is considered as the key and mandatory precondition to make SmartGrids a reality, achieving thus the 20/20/20 targets and, most importantly, to realize the needed customer and societal benefits.

As the SmartGrids Technology Platform has no executive powers it falls to a cast of many to deliver the vision and strategic research. It is envisaged that the Advisory Council and Mirror Group continue to play a lead role going forward and in facilitating the many different groups of stakeholders in the deployment of this plan.

Communication with all stakeholders and European society as a whole is vital for SmartGrids to become a reality. An outline of the communications strategy has been developed as part of this SDD.

Identification of key organizations and individuals to champion the SmartGrids is further developed in the chapter on stakeholders.

The achievement, or not, of the 20/20/20 targets will depend on the ability of electricity networks to be modified and to adapt quickly enough to the changing needs, in a transparent, sufficiently automated and "holistic" way.

2. Deployment Plan with Priorities

Facts, Figures & Costs

Europe's electric power system is one of the largest technical systems in the world serving 430 million people, with 230,000 km of transmission lines at the highest voltage levels of between 220kV and 400 kV and 5,000,000 km of distribution lines at medium and low voltage levels. With all the stations, support systems, etc., the investment in the European electricity grids until now exceeds EUR 600 billion (some EUR 1,500 per citizen).

A significant proportion of the European electricity grids were built over 40 years ago. Renewal is necessary and is already happening - according to the International Energy Agency, approximately EUR 500 billion will be invested by 2030. Without deployment of new – "smart" – technologies and solutions, this renewal will become a mere replacement programme, based on old solutions and extant technologies, with little utilization of the potential for efficiency gains and might eventually lead to stranded assets, lost opportunities and failure to achieve the ambitious energy targets for Europe.

The electricity networks of the future will have to accommodate large scale distributed generation, enable widespread use of renewable energy sources and facilitate the connection of large scale centralized generation at suitable locations (e.g. close to the coast to get access to cooling water). Moreover, massive electrification of transportation vehicles (both, public and private), customer-centric and service-oriented electricity supply must be supported and actively enabled.

The pace of implementation is hard to predict for such a diversity of developments, particularly when they are dependent on related R&D progress and on the impacts from (often politically driven) decision making. It is therefore impossible to elaborate a fully detailed breakdown of costs for SmartGrids to happen, but some general and rough estimates are suggested:

- In general, industrial spending on Research, Development & Deployment for improving the price/performance ratio of a given technology totals between 5% and 10% of revenue. For breakthrough and / or disruptive technologies this figure is often higher, whereas for a traditional technologies and "slow" growth it might be lower.

- Because the electricity supply industry – electricity grids in particular, including grid owners, operators, manufacturers automation companies, etc. - is perceived in general as moving at a lower pace (partly due to the comparably high costs and long depreciation times), the RD&D expenditures are estimated at 3% of total revenue with a reference to the "old", proven and conservative technologies.

- However, taking into account that the European electricity networks of the future will blend together rather "classical" technologies, with the disruptive / breakthrough technologies and eventually accommodate real time prototyping and testing at the beginning, one can estimate the final Research, Development and Deployment expenditures at some 7 to 10% of total revenue, that is approximately EUR 35 to 40 billion until the year 2030.

It is obvious that this is only a very rough estimate. For better and more accurate figures and for a more detailed costs breakdown for each of the SmartGrids deployment priorities, an in-depth study, based on assumptions and scenarios is needed. An important challenge for such a study lies in the fact that the costs evaluated would have to cover a complex mix: the application of developed technology where R&D has been already completed by 2020, the development of new technology based on the completed research, research for new technology to be deployed after e.g. 2020 or 2030, etc. This challenge stems from the very nature of the SmartGrids evolution and deployment – whereas urgent and practical solutions are needed now (or in the near term), fundamental research and innovation must be initiated and running today in order to deliver in the future.

While addressing costs, it is necessary to consider benefits too. However, it is hard to quantify the benefits from the SmartGrids deployment due to a number of influences: commitment to reaching the 20/20/20 targets might contradict some other political goals of the EU; dependency on geopolitical position of Europe and relationships with the primary energy suppliers (notably oil and gas); non-completed and (still) not sufficiently effective and integrated electricity market of Europe.

Moreover, not just the customer benefits but also the benefits for industry appear to be difficult to quantify – one of the important reasons for this is the contemporary move towards SmartGrids in other regions and other continents, that will affect the potential for export and industrialize the new solutions. It follows clearly that the success of SmartGrids for European industry is directly dependent on the rapid and effective deployment.

In the follow-up after the 3rd GA, the AC and the succeeding Smart Grids Forum have decided to conclude finally the SDD with the present level of consideration of costs, also bearing in mind the already existing and coming activities and Smart Grids deployment projects with their diversity of scenarios and cost aspects.

The Way Forward

The likelihood of any commercial organization or company being able to deploy their part of the SmartGrids without the evaluation of a deployment priority is very low. The same is true for national bodies and authorities, although their objectives may be weighted towards societal and environmental outcomes rather than mainly commercial.

The EU 20/20/20 targets have been identified as a major driving force behind the efforts towards deployment of SmartGrids. It is about the benefits for European customers and society in the first instance and any technology-driven initiatives must serve these goals. These have been the main criteria when identifying and designing the SmartGrids deployment priorities:

- The first SmartGrids General Assembly resulted in a Vision, to support the thinking and streamline the imagination of all stakeholders
- The second SmartGrids General Assembly, together with relevant inputs from the four Working Groups have been used to streamline and focus on a number of strategic research topics and the "lighthouse" projects identified in the SRA.
- Different development activities have been validated against criteria for the 20/20/20 targets and customers' and society benefits, resulting in the definition and detailed specification of the SmartGrids deployment priorities.

SmartGrids deployment is a key issue for the European economy, society and way of life. The six deployment priorities presented here will facilitate achieving those goals.

The Way Forward

Failing to address the key issues from the deployment priorities will directly impact the deployment of SmartGrids and jeopardize timely and effective achievement of the European targets. The resulting delays, or only partial SmartGrids deployment, imply not just that the 2020 targets may not be met and customer and societal benefits are not achieved - other drawbacks emerge too:

- Without effective deployment of the SmartGrids concepts, European security of electricity supply in general, and the operational security of the European electricity grids in particular, may not be maintained. This is crucial not just for the large scale development of renewables, but also because of the steady demand growth and more onerous environmental requirements which conventional grids and methodologies will increasingly find difficult to meet.

- The SmartGrids deployment creates new business opportunities for (grid) companies, service providers, and manufacturers. It also creates an exciting new environment for government, politicians and regulators and, most notably, customers. Furthermore, achievement and benefits of the European Internal Electricity Market (IEM) are strongly dependent on SmartGrids of the future: without adequate embedding of dispersed / distributed generation, without a non-discriminatory and effective grid access and service to the customers, the IEM will not deliver the expectations of it.

The deployment priorities are described in the following terms:

- Synopsis
- Definition of challenge
- Key elements and priority components
- Roles, responsibilities and stakeholders
  - Who are the prime movers to make it happen and what is their motivation
  - Who are the beneficiaries
- Risks and opportunities
- Technical architecture
- Regulatory framework
- Benefits, environmental and societal impacts

The deployment priorities are designed to build on existing developments. They have therefore been classified along a timeline to demonstrate how they can contribute towards the 2020 and 2050 objectives:

- **Technology R&D completed** – these solutions are expected to utilize current, or about to be released, technology products and solutions to achieve the 2020 objectives. It is highly likely that application of these products and solutions will require further R&D. Whether this is necessary should be determined from demonstration and deployment in real situations. It is important to be aware that research alone will not deliver effective outcomes, without adequate industrialization, implementation and deployment.

- **R&D ongoing** – new products and solutions are likely to be in an early development stage and further application validation will be required in a laboratory environment before deployment in real network situations.

- **New R&D required** - indicates a need for new research and development to be commissioned to identify new innovative solutions to meet the 2050 challenges.

2.1. Deployment Priority #1: Optimizing Grid Operation and Use

Timeline: Technology R&D completed - deployment 2008-2012 - high priority

Synopsis

This deployment priority is about decentralized but well coordinated grid operation, operational security and market-based treatment of electric power flows.

Definition of challenge

In order to manage the ever increasing demands for energy trading and security of supply, the existing transmission and distribution networks require improved integration and coordination across Europe. To control electric power flows across Europe and/or national borders, advanced applications and tools, that are already available today, should be deployed to manage the complex interaction of operational security and trading and to provide active prevention and remedy of disturbances.

Key elements and priority components

- Wide Area Monitoring (WAM) and Wide Area Control (WAC) systems with regulation of static VAR compensators, optionally in a closed loop, to maximize the use of available transmission capacity while reducing the likelihood of disturbances;

- Distributed state estimators for large synchronous areas with real-time power system security assessment and optimized dispatching with dynamic constraints ;

- System operators' staff training covering traditional issues (e.g. power system control) and emerging issues (e.g. electricity market and regulation);

- Coordinated ancillary services, including integration of balancing markets and coordination of reserves throughout the EU grids/control areas - the integration of balancing markets is of particular importance both, for enhanced power system security and for improved market liquidity;

- Steady state and dynamic (transient) simulators with modeling of Renewable Energy Sources and non-linear devices;

- Coordinated operation of power flow control systems (FACTS, phase shifters, etc.) with devices for automatic countermeasures/system defense. These applications exist in component form today but, unless encouraged, not many more will be deployed in the short time. Further work is urgently required to understand how to deploy and validate these solutions in 'closed-loop' operation;

- Regulatory issues of relevance for the defined EU targets should be re-considered to ensure innovative technological solutions are adequately promoted and deployed;

<u>Roles, responsibilities and stakeholders</u>

<u>Prime movers who must act to make it happen</u>

- TSOs and DSOs
- Universities and research institutes
- Consultants

<u>Who are the beneficiaries</u>

- Electricity customers (secure and reliable supply)
- Generators and traders (enhanced trading and market operation opportunities)
- Market participants such as new electricity service providers (new business)
- Society as a whole (security, sustainability, economy)

<u>Risks and opportunities</u>

- Knowledge acquisition must be encouraged. A clear understanding must be developed and actions defined in order to improve understanding of existing tools and solutions.

- Major disturbances and blackouts lead to distrust in electricity grids and their operators, but could help to acknowledge the needs and foster the deployment of the required solutions.

- Measuring the acceptable level of operational security (e.g. in terms of "a number major disturbances per year") is still a "non-standardized" activity. It is in that context that more clear and unambiguous definition of acceptable "insecurity" is needed, especially since in the electricity market environment, the traditional technocratic view of security of supply is complemented by risk management approaches and hedging instruments which have already been used in other sectors like banking.

- Co-operation between competing suppliers/generators at the level of operational security is unavoidable in the case of emergency operation or system restoration. The legal and contractual arrangements for this must be developed.

- Data volumes/quantity vs. quality of information (the well known "power system control gap"), originating from the human capabilities in information processing, are a risk.

Type of processing	Bit rate
Reception by sensitive organs	10^9 - 10^{11} bit/s
Perception - understanding	16 bit/s
Permanent memory	0,7 bit/s
Associative memory - associations	5 - 50 bit/s

Figure 4: Control gap and human capabilities in information processing

- Increased co-operation between the grid operators – both horizontally (between TSOs, between DSOs) and vertically (between TSOs and DSOs).
- The lower degree of automation of distribution networks compared to transmission networks will need to be addressed.
- Lack of recognition of the key differences between automated and human intervention prevents effective implementation of "hybrid" approaches where human and automated intervention are combined to achieve optimal results.

Technical architecture

Many of the technical solutions and key concepts required are already available today or easily retrievable from other industrial areas. They can be purchased as over the counter products, ready for use and deployment[2].

The tools and solutions for training, including simulators presently exist. The key issue here is their systematic and coordinated deployment throughout European power systems/networks and based on that, the implementation of the necessary certification and approval systems to ensure continuity and knowledge transfer.

An example for the key concepts and elements of the technical architectures and solutions to be achieved by the Deployment Priority #1 is shown in Figure 5.

[2] A number of discussions between the vendors of equipment and solutions and the network operators have yet to be finalized and this will remain a subject of the activities within the defined deployment priorities

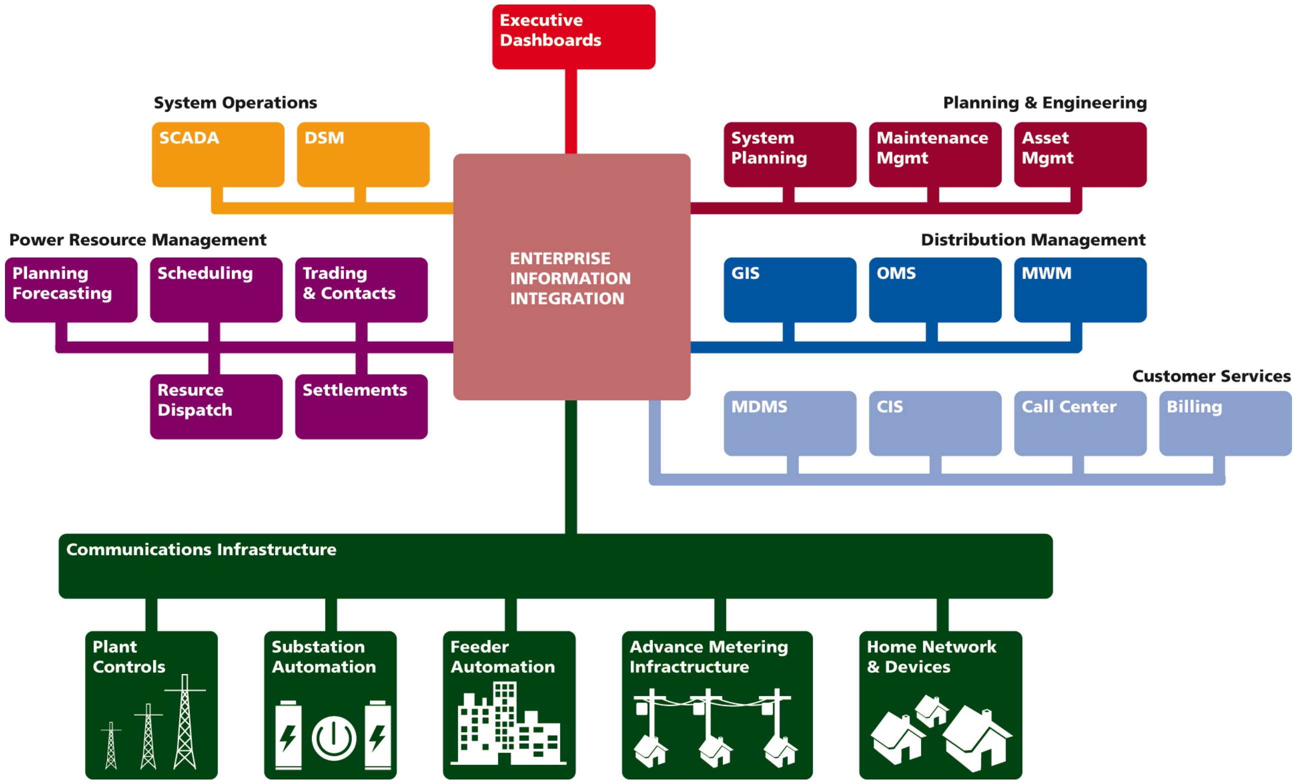


Figure 5: Illustration of key concepts and elements of the Deployment Priority #1

Legend:

MWM	= Material World Modules	OMS	= Outage Management System
GIS	= Geographical Information System	MDMS	= Maintenance Data Mgmt System
CIS	= Customer Information System	DSM	= Demand Side Management

Regulatory framework

The present regulatory framework in the EU provides the basis for the solutions and measures in this deployment priority (e.g. the possibility of the European Commission proposing guidelines for operational security within Article 8 of the Regulation (EC) 1228/2003), but a comprehensive legal and regulatory framework is still needed.

It is expected that the forthcoming new EU legislation for the electricity market (Third Legislative Package) will cover some issues such as setting up a general framework for guidelines on detailed operational security rules, their implementation, compliance monitoring and enforcement procedures.

It is nevertheless important not just for the grid operators but also for regulators and other stakeholders, to ensure that the issues required to create the pre-conditions for this deployment priority, are adequately addressed in all relevant EU legislation and a comprehensive regulatory framework developed.

The following legal and regulatory issues require consideration at the EU level:

- Sustainable and harmonized regulatory models throughout the Member and Associated States (including e.g. market compatibility)
- Alignment of the RES support schemes with markets and regulation
- Transparent and effective internalization of external costs, where they occur

- Establishing an adequate investment climate by stable regulation with flexibility and incentives for effective innovation

Benefits, environmental and societal impacts

- Increased efficiency of provision of ancillary services in technical, economic and environmental terms
- Improved efficiency of grid operation followed by many further benefits
- Increased operational security with reduced probability and frequency of disturbances and, in the long term, higher reliability of SmartGrids

2.2. Deployment Priority #2: Optimizing Grid Infrastructure

Timeline: Technology R&D ongoing - deployment 2008-2020 - high priority

Synopsis

This deployment priority is about building new infrastructure, improving and optimizing use of existing facilities.

Definition of challenge

All stakeholders, the EU Institutions and MS must address expanding and building new transmission and distribution infrastructure. The provisions of the urgently needed projects from the European Priority Interconnection Plan should be implemented as soon as possible (http://ec.europa.eu/energy/energy_policy/doc/11_priority_interconnection_plan_en.pdf)

New and efficient asset management solutions for the EU transmission and distribution grids are required, as well as coordinated and coherent grid infrastructure planning.

Rather than being only deterministic, coordinated planning should be based on scenarios and include the necessary elements of risk management in order to cope with the increased volatility and uncertainty in location and size of generation and growing intermittent generation.

Key elements and priority components

- Expanding the EU grids (notably transmission) with new infrastructure (e.g. HVDC) will depend on accelerating permitting procedures and making them much more efficient than today, especially in the sense of national implementations of the European Environmental Impact Assessment (EIA) Directive (http://ec.europa.eu/environment/eia/home.htm).
- New overhead line configurations to increase capacity and reduce electromagnetic fields are required
- Refurbishment/enforcement of the existing high voltage lines by innovative network assets including superconductivity technology
- New asset management and grid planning methods for transmission and distribution

- Development of systems and components to maintain power quality at acceptable levels while encouraging the integration of new types of generators

Roles responsibilities and stakeholders

Prime movers who must act to make it happen

- Grid operators (TSOs and DSOs)
- Scientific institutions, universities and engineering undertakings
- European Commission, Member States / ministries and regulators (legal and regulatory framework)
- Equipment and solution suppliers

Who are the beneficiaries

- Market participants, notably generators (through improved transparency and availability of grid access and connection)
- Electricity customers and the EU society as a whole (through enhanced sustainability, security of supply and economic and efficient grids)
- Grid operators, through improved adequacy of the grid infrastructure

Risks and opportunities

- More complex role and increased responsibilities of network operators for planning and asset management.
- Comprehensive integrated system solutions required from suppliers
- A stable and predictable regulatory framework is required
- Lack of EU-wide standards for integrated asset management and network planning

The risks and opportunities of future asset management systems are summarized in the following diagram offering four different directions of future development.

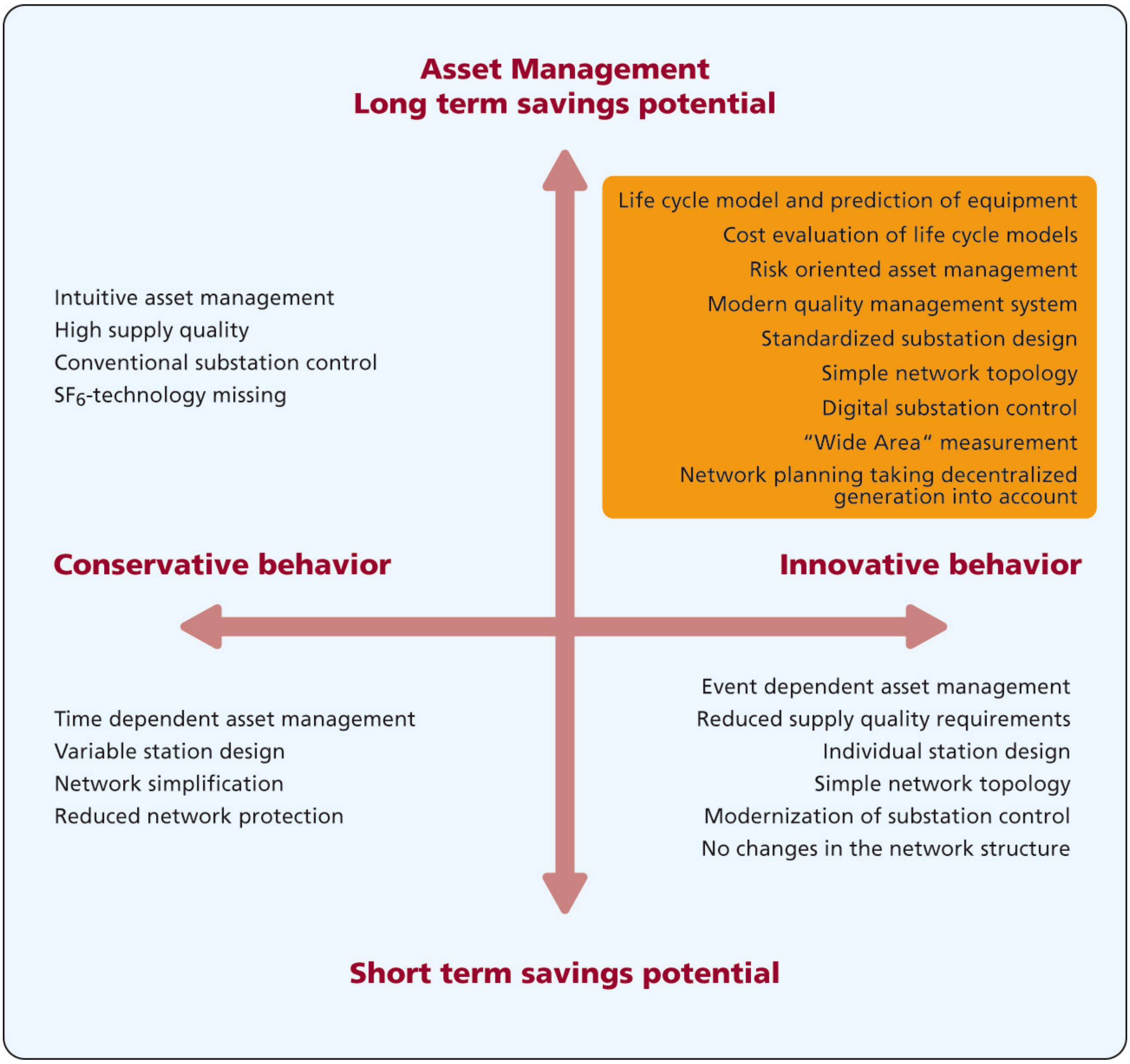


Figure 6: Innovative asset management development paths

Technical architecture

- The projects of the present EU Priority Interconnection Plan should be completed as soon as possible.
- The technologies and solutions for increasing the capacity and lifecycle of existing infrastructure should be developed further including improved monitoring tools (e.g. infra-red recording of transmission lines) and enhanced design and use of circuit capacity.
- A risk management approach in asset management and network planning may help achieve the objective of efficient and optimized SmartGrids in a changing environment.

Regulatory framework

- A stable and predictable regulatory framework is necessary to achieve:

- Long-term investment in SmartGrids
- Incentives for innovation
- A pan-European perspective

Benefits, environmental and societal impacts

- Increased cost effectiveness of electricity supply
- Strengthening European industry through access to cost-effective electrical energy
- Reduced dependence on imported fuels

2.3. Deployment Priority #3: Integrating Large Scale Intermittent Generation

Timeline: Technology R&D completed - deployment 2007-2020 - high priority

Synopsis

This deployment priority is about integrating large scale on-shore and off-shore intermittent generation, notably wind power.

Definition of challenge

Large-scale forms of generation, e.g. wind farms and in the future (concentrated) solar thermal generation, require networks to enable efficient collection of the power generated and enable system balancing, either by energy storage, conventional generation or by demand side participation. Off-shore wind energy needs marine power collection networks and re-enforcement of the European terrestrial networks. This deployment priority is hence also about promoting and fostering the large-scale integration of renewable energy resources in a manner that meets the requirements of grid security while considering economic efficiency.

Key elements and priority components

- Technically viable and commercially affordable solutions for offshore networks for collection of wind power
- Grid connection from offshore networks to the European mainland should consider security and quality of supply, economy and environmental sustainability
- Transnational and cross-border grid re-enforcements on the European mainland should be considered. The present long licensing procedures should be shortened
- Solutions should be developed to allow for efficient and secure system operation of future grids with significant intermittent generation, heavy bulk power and/or not easily dispatchable (e.g. CHP) generation

Roles, responsibilities and stakeholders

Prime movers who must act to make it happen

- TSOs and their associations (ETSO, UCTE, Nordel)

- Offshore wind farm owners and operators
- Equipment suppliers
- Public authorities granting licenses and permissions for grid enforcements

Who are the beneficiaries

- Offshore windfarm owners and operators (generators), CHP and equipment suppliers
- European society as a whole by increasing the use of renewables.

Risks and opportunities

- Insufficient rate-of-return and too high risk for the investments to be made
- Costs of the developments to EU citizens and lack of progress in cost reductions with increase in deployment volumes
- Lengthy licensing procedures for expansion of the EU transmission grids
- Availability and cost of balancing power and energy reserves to balance the intermittent generation

Technical architecture

- A simple schematic illustration of an offshore wind farm connection to the grid is shown in the Figure 7.

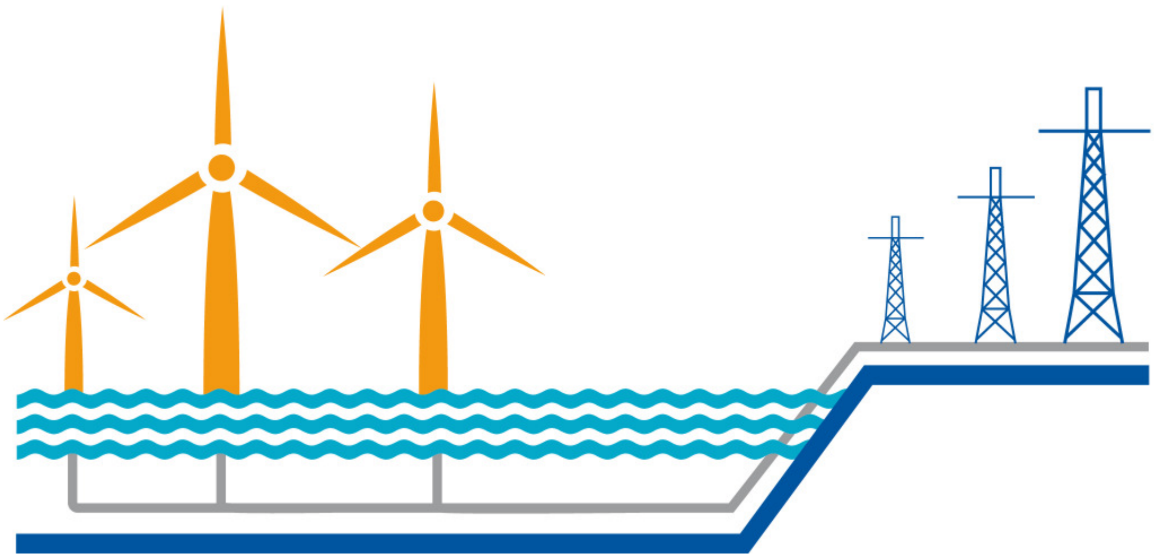


Figure 7: Offshore windfarm connection to the mainland grid

Regulatory framework

- The Third Legislative Package foresees a number of components necessary for the increased efficiency of grid expansion and planning
- Non-discriminatory and transparent grid connection conditions are mandatory
- A coherent and equitable approach to connection and use of dispersed / small generation in active distribution networks and large offshore wind farms should be ensured in the future EU legal and regulatory framework

Benefits, environmental and societal impacts

- Strong contribution to the fulfillment of the 20/20/20 targets (emphasis on renewables)
- Coastline impacts and other related issues will be addressed within the appropriate environmental assessment procedures (according to the EU Environmental Impact Assessment Directive)

2.4. Deployment Priority #4: Information and Communication Technology

Timeline: Technology R&D and standardization ongoing, deployment 2008 -2015 - high priority

Synopsis

This deployment priority is about defining the tasks and implementing the necessary standards for Information and Communication Technology solutions in future SmartGrids. The application of ICT is a pre-requisite for data exchange between the different market players in the electricity supply chain and for the secure, economic and environmentally benign operation of SmartGrids.

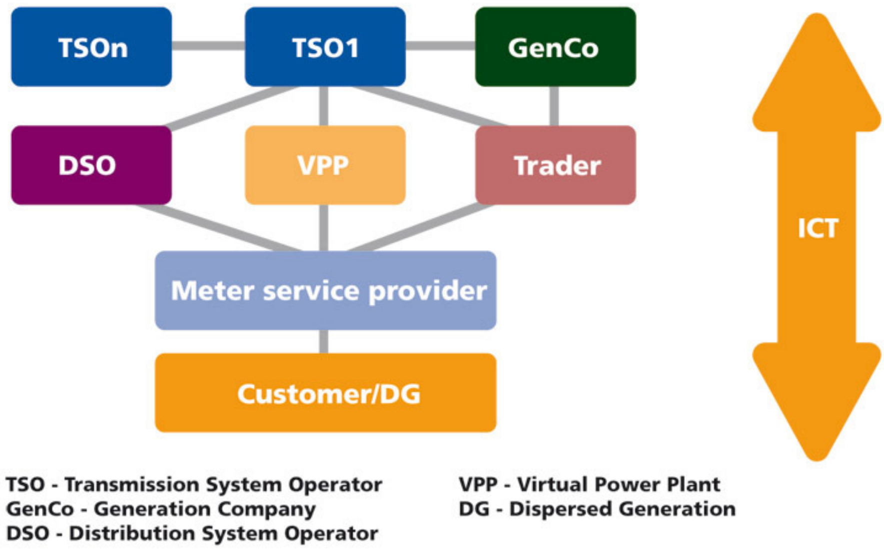


Figure 8. The role of ICT in the liberalized electricity market

As illustrated in Figure 8, the area of Information and Communication Technology covers a wide range of stakeholders and virtually all market participants.

The data exchange is realised in two ways:

- On-line data communication for supervisory control and data acquisition in real time,
- Off-line data exchange for operational planning and business purposes (e.g. between TSOs: defence plans, power flow estimation, protection coordination)

ICT enables the market players to receive data from the network and to send out data for its control and/or influence. Different market participants need information about power consumption and generation for various purposes e.g. for billing (suppliers), for monitoring of network load (TSO and DSO) or e.g. for real time dispatch (VPP as an aggregator of DG, storage and DSM).

Also the distribution of the relevant data activities is required for different market players: customer / end-user of electricity, traditional generator, DG, DSO, VPP, trader, balance group coordinator, TSO.

In the transmission and sub-transmission (110 kV) level ICT facilities are installed and usually are the responsibility of the TSO and DSO.

For medium and low voltage distribution networks the information provider may become a market player who offers communication services to all other market participants.

This task of the off-line exchange of data for planning, business and management purposes requires the implementation of a forward-looking common information model, the development of data base management for effective data transfer and the integration of different existing data management systems.

Definition of challenge

A comparative overview of the ICT challenge in terms of status quo and future needs is presented in Figure 9.

Today ICT is applied at the transmission and sub-transmission level and ends at the bus-bars of the sub-transmission (110 kV)/medium voltage substations. Different standard protocols at various voltage levels and for different kinds of equipment are used. By large, the medium and low voltage levels are characterized by limited ICT, for economic reasons (left side in Figure 9)

Standardized, open information models and communication services for all data exchange within the whole electricity supply chain and electric power supply system are needed.

Different ICT technologies should be investigated and tested on site with the goal towards the introduction of ICT into the distribution level relying on the existing communication infrastructure (radio, power line, copper or fibre optics), applied in a cost effective way (right side of Figure 9)

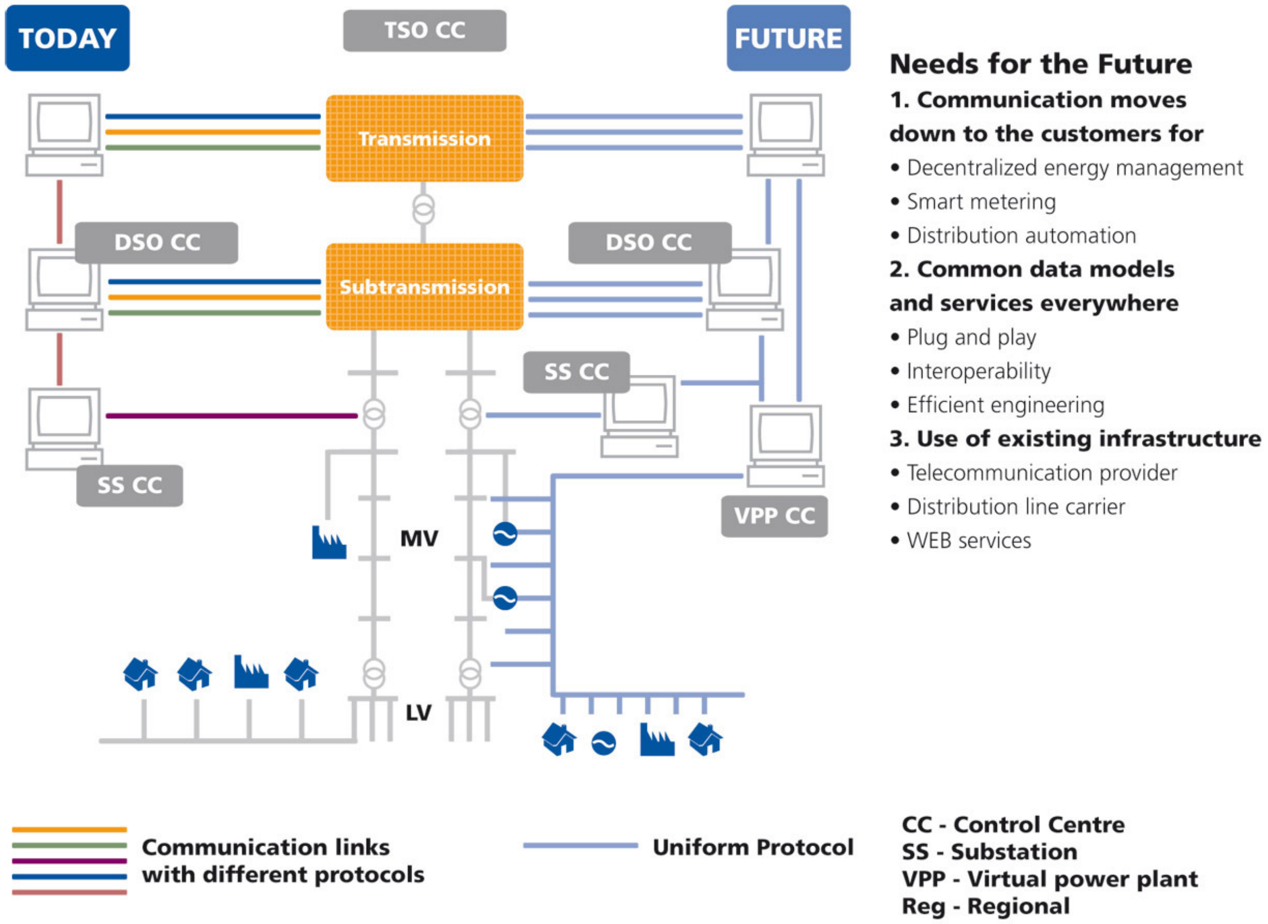


Figure 9: Current status and future needs for ICT application

Deployment and large-scale implementation should follow a stepwise approach at a rate determined by the needs of other SmartGrids deployment priorities, of the different market players and by relevant developments of the electricity market in Europe.

Furthermore, technology development in ICT will drive this deployment priority to ensure interoperability between various devices of different vendors.

Different data management systems are in use for grid operation and enterprise management. They are developed and installed by different vendors, each providing proprietary solutions. Generally, a common standard for data formats and data base management is not applied. The enterprises still suffer from data and productivity islands, the lack of which can be compensated by extensive use of data warehouse concepts (Figure 10).

In this situation, the same data is often present in different data systems but is differently modelled in many different ways. Changes of the data require changes in all systems at the same time. Otherwise, data consistency will be lost.

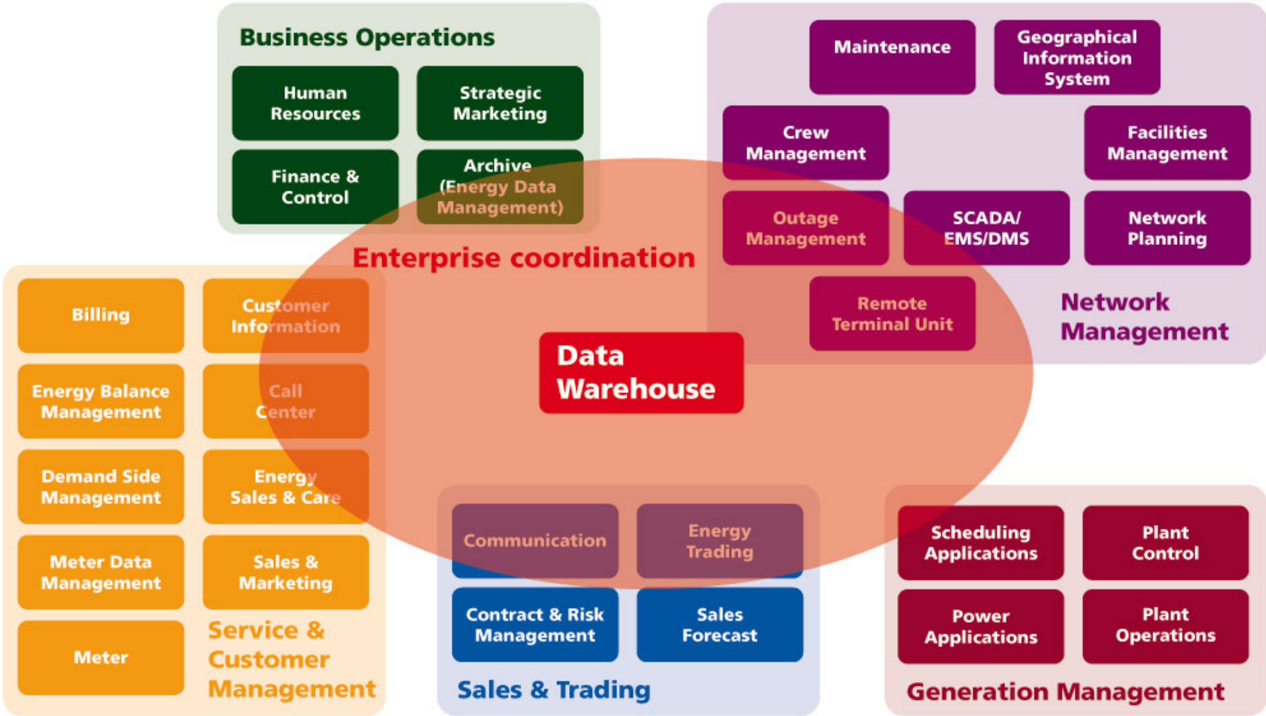


Figure 10. Enterprise coordination by data warehouse

The challenge will be to coordinate all these data bases through one overlaying data warehouse based on common information models (CIM). The data warehouse concept interconnects to all other data bases ensuring this way the necessary data consistency.

Key elements and priority components

- Simple, robust, secure and flexible communication infrastructure to allow monitoring, management, control and dispatching operations at all levels down to the distribution and customers
- Common information and data models for all information building blocks, in order to ensure consistent database management, need to be defined at all levels of the power system and electricity supply chain
- Well functioning ICT solutions are essential for maintaining the security of supply and for the efficient interaction of the market players
- A truly competitive situation for all kinds of products relying on multi-vendor strategies can only be achieved with well defined and standardized ICT solutions
- Standardized interfaces are needed between different market participants generators, TSOs, DSOs, VPPs, traders, customers.

Roles, responsibilities and stakeholders

Prime movers who must act to make it happen

- Communication service provider and information providers.

- Traders, VPPs, DG, traditional generators
- Customers in a wider sense, as prosumers (producers and consumers)
- TSOs, DSOs and their associations
- Research institutions, universities
- "Open Energy System" and component manufacturing industry (vendors)

Who are the beneficiaries

- Advanced ICT will bring benefits to all stakeholders: Communication service providers and information providers, all kinds of market participants, grid operators and most notably customers.

Risks and opportunities

- Many competing parties must cooperate in a successful standardization process. Bringing competition and standardization together is a challenge.
- Different technical committees and working groups for standardization (e.g. of IEC) are involved, so accomplishing consistency over all the required standards is a complex and challenging task.
- The economic benefit of ICT at the distribution level still needs to be demonstrated; high quality but, low priced solutions must become available.
- The first deployment projects could still be exposed to high cost ICT solution. Therefore, availability and flexibility of low cost ICT solutions even for the first deployment projects is crucial.
- Conservative attitude of many involved stakeholders and potential key actors could impose a barrier and challenge for the necessary ICT evolution
- Possibility of degraded reliability due to increased number of components will need to be taken into account accordingly in the systems' design and implementation
- (Customers') data protection must be considered adequately

Technical architecture

The ICT for smart distribution grids may use the services of an independent communication provider and consequently the communication channels available in the existing infrastructure.

Therefore future communication standards should offer uniform data models and services at the application layer but with flexibility for the use of different physical and link layers according to the ISO/OSI communication model. Figure 11 demonstrates this principle.

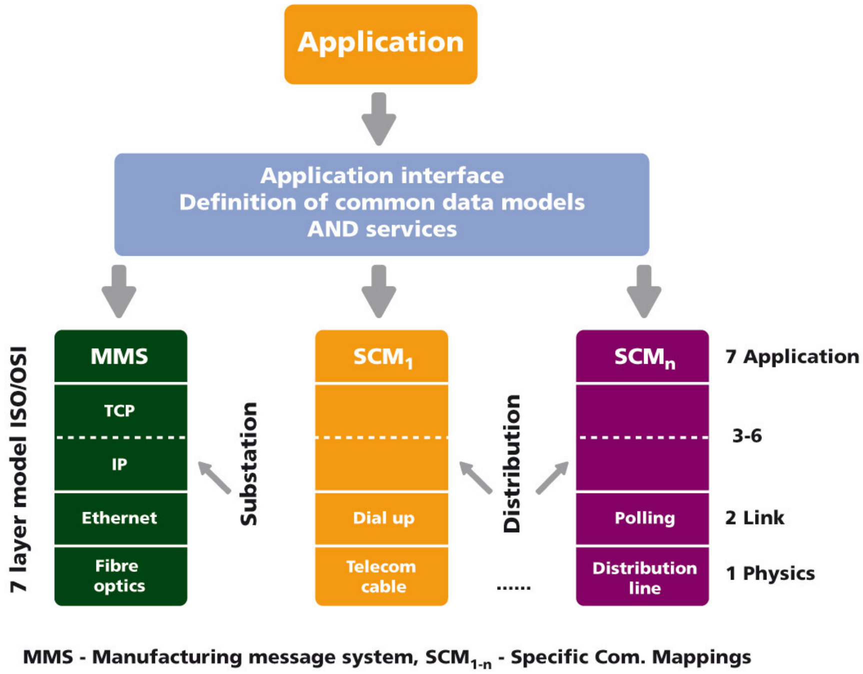


Figure 11. Specific communication mappings of common application interfaces

The left side of Figure 11 presents the current standard IEC 61850-8.1 which is applied worldwide for communication in substations. Its data models and services may also be used for communication between the substations and the control centres. Therefore, it is useful to apply the same standards for communication at the distribution level but in combination with different physical and link layers as shown. Furthermore, a sustainable ICT architecture requires the linking of data models of communication standards with the common information models managed in the data bases. This is shown in Figure 12.

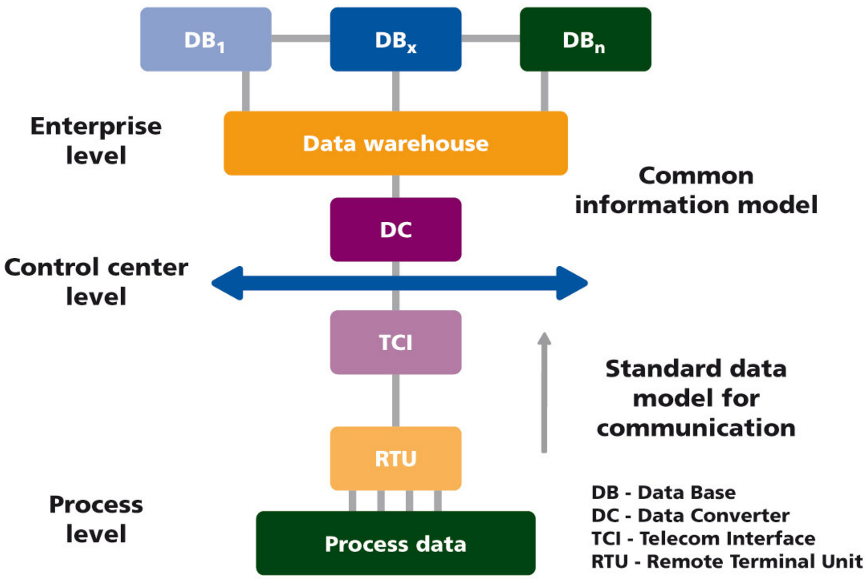


Figure 12. Relation between communication data and data base information

Data acquisition happens at the process level and the communication of the data to the control level requires protocols with standardized data models including description of data, value of data, time stamp, quality indicators, etc.

Most of the on-line data is required to be communicated to the data bases for further consideration however, with different representation. Therefore, a format conversion from data model for communication into a standardized format (e.g. the CIM format) is required. The data format serves all relevant data bases with the incoming data using their own format.

Finally, it is important to emphasize that the link between communication data and CIM needs to be standardised.

Regulatory framework

- Collaboration of energy and telecom regulation is necessary in order to avoid "grey areas" e.g. in the case of power line communication
- Collaboration of ICT standardization bodies (e.g. IEC, ITU) and electricity/energy standardization (e.g. CENELEC) institutions is also essential for ICT deployment

Benefits, environmental and societal impacts

ICT deployment is a key enabler for a range of functions and services of SmartGrids

- Smart Metering
- Online collection of customer data and support to customers' participation in the market
- Aggregation of DG into VPPs,
- Distribution automation (e.g. to enable self healing as the capability of the electricity grid to autonomously identify, localize, manage and repair an unforeseen disturbance or interruption),
- Consistent data management within and between the enterprises.
- Finally, deployment of the necessary ICT solutions is largely a pre-condition for Deployment Priority #1 (operational issues) and a necessary feature for most Value Added Services to SmartGrids Customers.

2.5. Deployment Priority #5: Active Distribution Networks

Timeline: Technology R&D ongoing for solution availability - deployment 2010 - 2020

Synopsis

This deployment priority details the change in the distribution network, from being "passive" and dependent on human operator's intervention to an "active" one. This is required due to the increasing complexity of network operations, to the wide deployment of distributed generation and to the increasing challenges in ensuring security and quality of supply.

Definition of challenge

Transmission networks have always provided a balancing and management role in the electric power supply chain, whereas distribution networks have been designed to be passive ("fit-andforget") in operation. The challenge is now to provide many of the services found in transmission grids, such as power flow and constraint management, contingency analysis, balancing, in distribution networks. This is required not just because of the increasing deployment of distributed generation, but also because of emerging intelligent building services in both residential and commercial premises, the need for utilizing local generation to support the local network at times of stress on the main grid and because of the anticipated future wide usage of electrical transportation vehicles.

Distribution networks will need to be able to respond or adapt in real-time to the complex interactions of all of these challenges and provide enhanced information to various actors to enable the real-time trading of the various services being provided. This will also enable new actors, such as aggregators, to enter the market to provide VPP and balancing services.

Key elements and priority components

- An active network requires effective and coherent visibility of the various devices connected to it in order to allow timely decision making and information flow.
- Centralized manual control needs to be replaced by a distributed control architecture which will be coordinated and integrated into existing control methodologies in order to take advantage of the intelligence that will enhance the networks of the future
- It is necessary to ensure compatibility of all functions and devices also during the transition from the present to the future active distribution grids.
- Besides on-line control and management, the active distribution network will introduce new functionalities, enabled by new tools and solutions relying on dynamic and multi-faceted optimization. Modeling of uncertainties in planning and operation required to achieve that, will build upon:
    - Standardization of the data models and communication protocols to ensure minimum overhead and capacity to expand and encompass future requirements;
    - Communication systems capable of coping with the needs in terms of capacity, reliability and costs induced by the new functions.

Roles, responsibilities and stakeholders

The prime movers who must act to make it happen

- End users and communities becoming producers and service providers.
- DSOs and their associations – especially in requirements specification
- Research institutions and universities – studies / conceptual analyses
- Industry in general, with particular emphasis on power system components' manufacturing industry

Who are the beneficiaries

- Customers by being offered a wider product portfolio, better opportunity of choice, and a possibility to better manage costs / prices
- Society as a whole through a more efficient use of RES

- Investors in renewable energy generation, by a more efficient market access

Risks and opportunities

- Finding adequate / optimal solutions to many challenging and often contradicting technical problems
- Enabling but not "blindly subsidizing" technically and economically viable solutions - active distribution networks are not a purpose on their own but are there to serve grid users / customers
- Data volumes / quantity vs. quality of information – it is essential to ensure optimum here and consider all relevant interdependencies
- Cooperation among the grid operators is crucial – both, between the DSOs but also, where required with TSOs

Technical architecture

- A typical active distribution networks' structure, coordinated by the Central Controller (CC) and interfaced to the Distribution Management System (DMS) is shown below

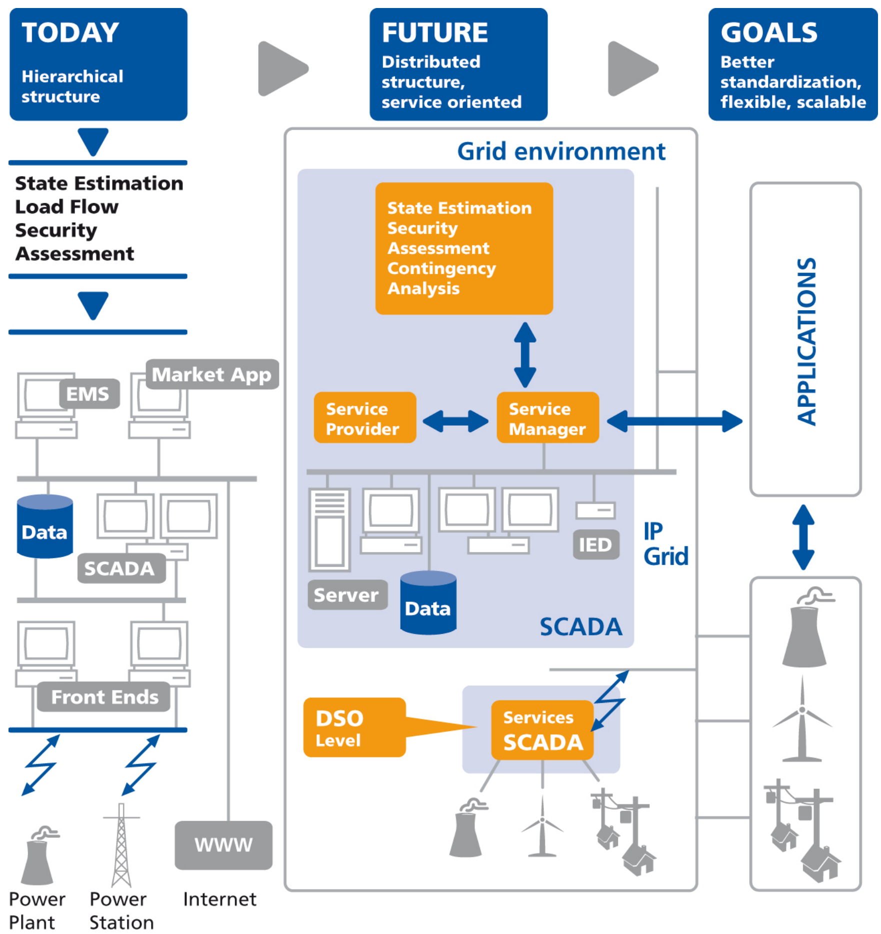


Figure 13: An example structure of an active distribution network

- The technical architecture for an active distribution network has three layers:

1. Copper based energy infrastructure (electricity)

The actual electricity infrastructure needs to optimize its topology and be adapted through the implementation of power electronic elements in order to cope with the new functions.

2. Communications layer

   A communication network should be implemented as a layer above that of electricity power infrastructure. This network should facilitate overall electricity system connectivity (internet alike) using different communication technologies at the same time and guaranteeing to meet the requirements of speed, quality, reliability, dependability with costs.

3. Software layer

   Active electricity networks will only be possible with the implementation of intelligent elements at multiple nodes of the network, capable of doing locally and independently the maximum number of functions, reporting/requesting from the upper level the minimum possible information necessary. These elements will coordinate their actions with neighboring ones to cope with the coordinated execution of the operations necessary for the "active network".

   This means multiple software functions for normal operation as well as network reconfiguration, self-healing procedures, fault management and other software tools needed for forecasting, modeling and planning.

Regulatory framework

- Stable and supportive regulatory framework will be essential for the active distribution grids.
- Supporting DG, RES and DSR (Demand Side Response) but also exposing them (for sustainability of the whole system) to the market and price signals as all other market participants will need to be achieved in the most effective and efficient way.

Benefits, environmental and societal impacts

- Transparent market prices, possibly reduced further through the active customer participation e.g. in optimization or energy management
- More competition, more choices and import-dependencies for European energy supply
- Attracting innovation and new business opportunities, including new sustainable services providing benefits for the environment
- Understanding of price and value of energy
- Enhanced energy efficiency, reduced capital investment, improved peak load management, reduced electricity losses
- Improved citizens' awareness and responsibility towards energy consumption, with increased possibility of self-generation
- Enabling new market models with important role for the small consumers and producers

- Reducing CO_2 emissions by giving to the end user the possibility to choose energy suppliers with associated low-carbon primary energy sources
- Attracting innovation and new business opportunities (new sustainable services), achieving benefits for the environment
- Improving the use of the present infrastructures and reducing the need for new installations thus reducing the environmental impact.

2.6. Deployment Priority #6: New Market Places, Users and Energy Efficiency

Timeline: Technology R&D ongoing for solution availability - deployment 2010 - 2020

Synopsis

This deployment priority is about bringing customers as the focus and first line of interest of SmartGrids.

Definition of challenge

Diminishing of the differences between transmission and distribution in areas such as ancillary services, grid connection and access, but also quality and security of supply is one of the important characteristics of the whole SmartGrids concept. At the same time, such "democratization" and "decentralization" requires enhanced and strengthened control and management. This is not only necessary to operate the grid securely – adequate control and management solutions are also required to deploy a number of new and emerging concepts successfully and effectively such as the Virtual Power Plants and end-user energy management concepts.

In order to meet future customer needs, a range of new market participants will evolve, such as VPP operators and energy service portfolio managers. Besides transparent and non-discriminatory grid access and connection for all grid users (generation and demand) this deployment priority is also relying on the necessary technologies in the so called "last mile" of the SmartGrids and is closely related in that sense to Deployment Priority #5.

The customers' needs, interests and benefits are clearly the focus of this deployment priority.

Moreover, white goods in houses will contribute to the efficiency of the electricity networks in the future but only if there is a coordinated activity between the network, the smart meter (or gateway), the user and the manufacturer of the goods. Revenue streams will need to be in place for such developments to take place.

Key elements and priority components

- Innovative Customer Interface Devices as bidirectional smart communicators between the customers and the market
    - To give the customer choice in energy supply, it is necessary to develop solutions to increase and optimize information related to energy consumption, improving the interaction between customers and market players.
    - Such devices shall be able to provide the relevant energy information stored in digital or electronic meters to stimulate the consciousness and generate a

virtuous new behavior toward energy savings, increasing end-users energy efficiency.

- Such devices can also work as "energy data providers" for all the smart appliances installed in house, in order to enable load management services.

- Smart energy management for DG and DSR
  - Effective integration of storage and demand response capacity through distributed control.
  - Verification of the potential of demand profile shaping, through the integration of smart and communication-enabled controls of different loads and appliances and related to the storage capacity linked with distributed generation.

- Intelligent Smart Home Controller, providing information on patterns of behavior, useful for raising awareness of energy consumption and to foster efforts towards real energy conservation / savings
  - Encouraging the customers' active role requires advanced ICT tools able to manage the complexity of multiple inputs, take consequent intelligent actions and provide easy and flexible interaction between the customers and the system
  - The Smart Home Controller should represent the control point and counterpart to smart meters. They will interact closely in order to exchange data.
  - The customers' active role will be focused on setting the rules and priorities of energy use in respect of availability and cost while the daily operations, information and communication will be managed automatically by the Smart Home Controller.

The customers-centric view and their role in the electric power supply chain and market are shown in the Figure 14 below.

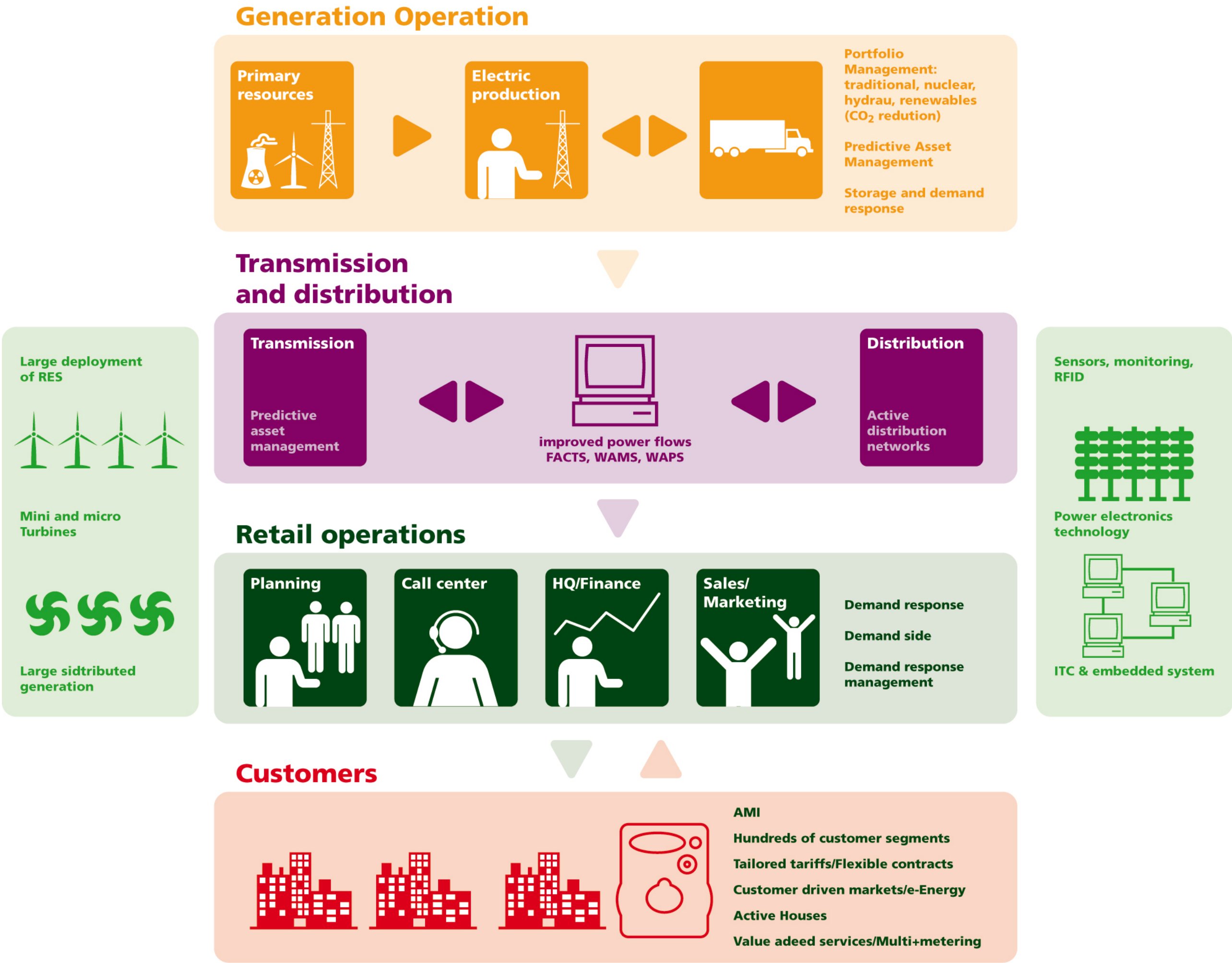


Figure 14: Customer focus of the electric power supply chain and market

Roles, responsibilities and stakeholders

The prime movers who must act to make it happen

- Customer associations, DG associations, DSOs
- Metering companies
- Energy suppliers
- Manufacturers of household equipment

Who are the beneficiaries

- (Small) market participants, DG, DSOs – through increased efficiency, peak load management, better utilization of the distribution network
- Electricity customers in general

Risks and opportunities

- Definition and deployment of the right value added services for customers needs to be well coordinated with the customers' needs on one hand and with the feasibility of grid evolution and improvements on the other

Technical architecture

- Standardized customer interface(s) will be underlying feature for the Deployment Priority #6.
- Robust proven infrastructure for handling intensive volume of data communication is a key enabler for this deployment priority.
- An illustration of customers' involvement through the different stages of SmartGrids deployment at different levels of the technical architecture is shown in the Figure 15

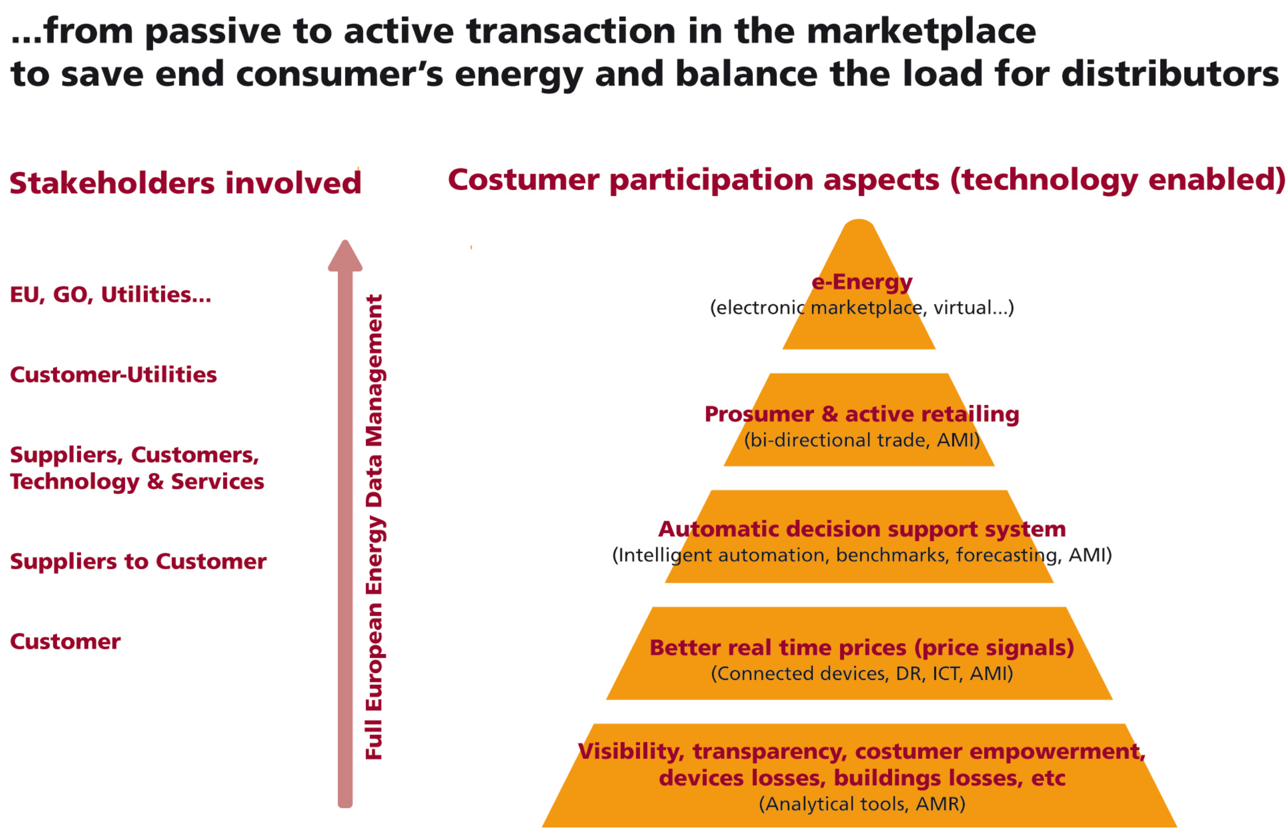


Figure 15: An illustration for the involvement of customers and grid users at the different SmartGrids deployment stages and in relation to different stakeholders

Regulatory framework

- With benefits identified accordingly, customer-driven developments will be supported by all relevant stakeholders; it is then also anticipated that the necessary regulatory framework will be provided and the stable and effective regulation put in place to ensure sustainable and successful deployment.

- Effective unbundling needs to be supported and in place in the Member and Associated states of the EU to achieve a wide deployment.

Benefits, environmental and societal impacts

- Innovation in "last mile" of electricity grids is key for reaching the 20/20/20 targets
- Increased value to European citizens: less CO_2, market conformant and transparent prices, security of supply and most required services made available to the needs
- Provide the customer with enough power to act and react in accordance with the needs

3. Recommendations & Conclusions

In order for the SmartGrids Vision to be delivered, helping to achieve the mandatory targets set by the European Council, the following recommendations are made and are intended to address specific aspects of deployment. Each recommendation seeks to define which stakeholders are involved and what action needs to be completed to better facilitate SmartGrids deployment.

Recommendation 1: Promote the SmartGrids Vision to all stakeholders

For Europe to meet the challenges of both climate change and security of supply, the architecture of existing electricity networks, designed primarily to transport electricity from large centralized power plants to customers, will need to be redefined.

Electricity networks will need to be developed to deliver the services required to accommodate new sources of generation and to meet end-user expectations. They should provide generators and consumers of all sizes with cost efficient connection options. They should facilitate the integration of intelligent devices including sources of generation, energy storage plants and end-use devices. This transformation will only be possible if it can be shown to deliver value to customers and if all stakeholders commit to it.

Building the case for change will involve education of all stakeholders, international cooperation, and the effective development of legislative and regulatory policy. The proposed Third Legislative Package is currently under discussion and has some of the elements to assist in achieving this goal, including the drive for greater European regulatory consistency and for trans-European network coordination.

Research and early deployment also form essential parts of the chain of activities needed to address the SmartGrids challenges ahead such as: cross-border power exchanges; removal of network constraints; connection and operation of intermittent generation; large-scale consumer engagement (e.g. demand efficiency and control, micro-generation, smart metering). Technology to demonstrate many of the SmartGrids concepts is available today. Rapid deployment of available and late stage RD&D technology will enable many of the European Union's ambitions for 2020 to be achieved. There is a need to provide the right long-term incentives and the opportunity to achieve an appropriate return on investment to allow these technologies to be deployed. This is true for all levels of network infrastructure and user connectivity.

Recommended Actions

European institutions and the Member States' Governments need to co-operate to provide widespread education on why electricity infrastructure and technology deployment is needed and the consequences of not doing so. European legislation should reflect the need for greater cooperation between national electricity systems, especially where multiple stakeholders are involved. It should also lead the way in consistent legislative frameworks that are involved in energy provision.

National Governments should align energy, planning and transport policies to ensure that both legislative and regulatory frameworks effectively facilitate the development of electricity networks taking account of the SDD recommendations. Consultation should be used to inform as well as gather information from their citizens.

Transmission and distribution companies should take into account the SDD priorities in their future investment programs and provide education to their customers on the reasons for the changes proposed.

Manufacturers and consultants should communicate how they have used the feedback from their customers and the wider public to better align their products and solutions with the needs and concerns of stakeholders.

In summary, communication with and education of all stakeholders in the supply chain is of paramount importance. If the benefits of the SmartGrids Vision are not effectively communicated to all stakeholders then its delivery will be at risk. The SmartGrids TP should continue to lead this initiative and act as a focal point for the development of the SmartGrids Vision. It is in this context that the currently discussed establishment of the "SmartGrids Association" would seek to maintain the momentum generated by the Technology Platform and act as a catalyst for SmartGrids deployment.

Recommendation 2: Encourage innovation by network companies and stakeholders

The current electricity grids infrastructure has developed over many decades. The assets employed have long life times and so there is considerable technological inertia in the system. This does constrain news ideas and solutions. This inertia makes it difficult to convert successful research into effective products which are then widely deployed. Transmission networks are already highly developed active, intelligent systems. In contrast, distribution networks are simpler, passive systems that will require significant development to deliver the SmartGrids Vision. In particular, small industrial and residential customers, both as power consumers and producers, have not traditionally been integrated into the operation of distribution networks.

New technologies are currently available that are capable of implementing many of the functions identified for a smart electricity grid. Deployment of these technologies will be necessary to help meet the 20/20/20 targets. However, the fact that deployment is not accelerating suggests that barriers exist in forms other than purely technological issues.

This SDD makes specific proposals designed to encourage the successful conversion of research outputs to commercial applications through the active participation of a wide number of stakeholders. These include manufacturers, network operators and owners, government policy makers, regulators and end customers.

For those stakeholders that invest in the supply chain infrastructure, there is a requirement to make deployment priorities happen – i.e. to have them resulting in practical projects and business cases - to win support for a change from the 'status quo'. It is usually easier to employ proven solutions than to risk introducing new products and ideas that may bring higher initial costs and higher overall business risk.

One of the main barriers to widespread deployment is the lack of a common or shared vision of the future amongst stakeholders. Also, it can be highly challenging to identify a deployment priority to support innovative investment proposals in low risk utility businesses. The deployment priorities have been developed as part of this SDD to help stakeholders identify a profitable and efficient outcome. This does, however, rely on each part of the electricity supply chain delivering their piece of the solution.

Recommended Actions

Governments and regulators should pursue policies that foster network innovation as a coherent part of wider energy policies. Economic regulation of network businesses can deliver unintended outcomes and at worse stifle innovation if quality is not considered appropriately. Best practice should be adopted to avoid this and incentives such as the recent Innovation

Funding Initiative (IFI) and the Registered Power Zone (RPZ) from Great Britain are examples of how regulation can stimulate innovation and new thinking.

Governments and regulators should identify potential national barriers to innovation and put in place the necessary steps to overcome obstacles to the rapid deployment of network innovation that can deliver real value.

Network users and system providers should be rewarded if they test and create innovative SmartGrids solutions. Governments and regulators should ensure that their actions stimulate this behaviour in the right way.

Network companies are urged to deploy innovative technologies for truly enhanced operation. It is not uncommon for innovative plant and equipment to be deployed without making best use of its functionality. Network companies are encouraged to use collaborative approaches to deliver the complex architectures required for constructing a smart electricity grid.

Manufacturers and consultants should be encouraged to work in collaboration with utilities on innovative SmartGrids projects.

States, regions and municipalities can lead by example. Finding new ways of meeting their own energy needs could be a catalyst for SmartGrid solutions, setting examples for others to follow.

End-users will need to embrace the technology that will be required to meet the EU mandated 20/20/20 targets. It is imperative that early adopters are encouraged rather than disadvantaged as a result of their actions.

The already mentioned, SmartGrids Association will be well placed to offer advice and assistance in forming the collaborations necessary to resolve the complex architectural challenges implicit in the SmartGrids Vision.

Recommendation 3: Encourage a pan-European approach to the SmartGrids 'project'

An open, competitive electricity market involves a substantially greater number of parties and interfaces than a traditional, centrally planned, monopoly approach. As a consequence there is a need to establish effective mechanisms for sharing views and collaborative working, while respecting confidentiality obligations. The SmartGrids Technology Platform that developed this SDD is an example of such a facilitating body. If an ambitious program of new technology deployment is to be achieved it is important that such facilitation groups are encouraged and strengthened in Member States and on a pan-European basis. Furthermore, it will be increasingly important to ensure effective liaison between areas of common interest such as those addressing renewable power, transport and the built environment. Separate recommendations are made (Chapter 8) on the future steps and structure of the SmartGrids Technology Platform to strengthen its ability to bring forward solutions to network challenges in the pressing timescales required by energy policy initiatives

The European legislation for an open market in the electricity sector has been implemented in most Member and Associated States for several years. The resulting national legislation, however, varies and is fragmented. In particular, the degree of unbundling of network services from generation, supply and trading of electricity is still very diverse. Also, as a consequence of this, TSO and DSOs do not have clear incentives to evolve into service provider businesses. Harmonized regulation in the Member and Associated States is needed to speed up the necessary changes.

Recommended Actions

It is recommended that Member States' Governments should set up national SmartGrids technology platforms with the goal of strengthening the European SmartGrids platform. These national technology platforms should work together to establish a unified international SmartGrids platform with a clear objective of assisting the member and associated states in the development of their electricity networks. Network developers and their users should be encouraged to actively participate in such national platforms.

The European institutions should consider the need for appropriately coordinated national legislation to develop a homogenous European regulatory framework to facilitate the deployment of SmartGrids - to some extent this may be covered in the Third Legislative Package in discussion as this document goes to print. National Governments should be mindful about how national solutions should evolve towards homogenous EU-wide solutions. Research and studies should be commissioned to analyze national network solutions in the context of the wider development of an efficient and secure SmartGrids-based electricity supply in Europe.

Network operators and owners should be encouraged and rewarded to cooperate with each-other. However, they should also cooperate with the entities which supply and trade energy without violating free market principles for improving the interfaces between them. Opportunities to gain economies of scale should be tested at the same time being aware of negative effects of market dominance. In the early phases of development, regulators should respect the advantages – not compromising their regulatory duties - of a temporary cooperation and collaboration to establish interfaces between entities which should act independently.

Governments and regulators should encourage collaborative working, discourage unnecessary duplication, foster standardization of open systems and establish unified and well interfaced approaches.

Recommendation 4: Encourage early deployment of SmartGrid technologies and solutions through demonstration projects

Electricity networks are by their nature large scale, costly, and complex. All the elements of a network must integrate with one another to form a seamless system. Experience has shown that an essential step in successful innovation in this context is the demonstration of new equipment or network designs (for example a 'Lighthouse Projects' described in the Strategic Research Agenda). Demonstrating successful operation on the network is a vital part of any deployment plan. No new technology is regarded by network companies as proven until this landmark has been successfully reached.

Further, the technical and economic evaluation of new technologies is often hampered by fixed costs such as staff training and providing maintenance resources. This effectively precludes the technology due the high cost placed on initial implementations. Network companies should be able to recover these initial deployment costs in an appropriate way.

Recommended Actions

Network owners and operators should identify, bring forward and deploy demonstration projects within an operational network context that demonstrate SmartGrids concepts.

Governments and regulators should encourage such initiatives by appropriate incentives.

System solution vendors should seize the opportunities of gaining early experience. Research institutions that commit to work with network companies to address demonstration/deployment challenges should be appropriately funded by governments.

Recommendation 5: Further develop the SmartGrids deployment priorities to build the case for deployment

The SmartGrids deployment priorities set out in this SDD are designed to act as a catalyst for real projects. While they cannot provide quantitative financial justifications for the deployment of SmartGrid solutions, they can highlight opportunities where such solutions may be of greatest value. Actual SmartGrids projects will be deployed by network companies and other stakeholders and it is helpful if the business models were developed further.

There are a number of important actions that can be taken to assist network operators and owners make informed and efficient investment decisions regarding the deployment of new technologies. These include the development of new modeling tools and methodologies that enable internalization of external factors, e.g. particular the impact of carbon prices, with greater certainty in cost/benefit and risk analyses. Such approaches will also assist in presenting informed and convincing cases at public hearings, e.g. when seeking planning consent for new infrastructure.

Recommended Actions

Research should be commissioned to develop models and propose methodologies for considering both the direct and indirect costs and benefits related to SmartGrids developments, especially those related to CO_2. This will allow regulators to clarify how network operators and owners are rewarded as the nature and priorities of their businesses change.

Generators and traders should contribute to market based pricing mechanisms which include the pricing of external costs.

Recommendation 6: Engage the demand side

The majority of electricity end consumers today have a passive relationship with the electricity supply system. The complexities of the system, and the operation of the electricity markets, deter customers from taking a more active role. A simple example of this is the fact that after nine years of market opening in Europe the overall rate of customers switching supplier is less than 10%.

An important part of the SmartGrids Vision is therefore the active participation of consumers in the electricity supply chain. It is vital that this important dimension of the future networks is actively developed.

Recommended Actions

In parallel with the implementation of homogenous national legislation, Governments, regulators and suppliers will need to communicate and educate end-users. Incentives should be provided (e.g. grants) to encourage consumers to take up opportunities to produce their own electricity and manage their consumption in ways that improve the overall efficiency and sustainability of the electricity supply system and grids. It will be important to ensure that where new products and services are offered to customers their costs and benefits, including their environmental impacts, are clearly communicated and are comparable with competitive offerings.

Consumers will become producers who want to be paid for both the export and ancillary services they will be able to provide with a SmartGrid interface. This in itself will encourage them to search for the highest return on their investment, providing more impetus to developing a more dynamic electricity market.

Recommendation 7: Address technical standards in the electricity and telecommunications sectors

A coherent standardization in electricity and telecommunication sectors is addressed only briefly in this SDD, but it is of high importance for the SmartGrids deployment. Electric power systems are the most complex technical systems in the world today. There is direct connectivity between every device connected to the electricity networks that are themselves connected across national and other "non-technical" boundaries. This is clearly an environment where technical standards are vital and, while the development of such standards has taken place over many decades in Europe, the existing standards have been designed for a world where most devices connected to the network have been simple, passive loads without extensive and complex functionality.

The SmartGrids Vision is very different to this with potentially millions of devices reacting to both technical and commercial information. It is clear that in the future, technical standards and protocols will need to be put in place to ensure system compatibility, not only in terms of the flow of electricity but also the flow of data.

Recommended Actions

Action is needed, involving the existing standardization bodies (e.g. CENELEC & ETSI), to consider and report on the impacts that SmartGrids will have on the existing standards. This initial evaluation of the current situation should be followed by a commonly agreed program of work to address any requirement to develop existing standards or introduce new standards.

Furthermore, electricity (CEER) and telecom regulators need to cooperate in the fields of standards in relation to regulation, in order to consider the interdependencies between the two sectors resulting from SmartGrids developments.

It will be important to initiate a common study and produce a report with recommendations on whether / where / which common activities on standardization are required across both sectors (electricity and telecoms) to ensure a coherent, holistic approach.

Recommendation 8: Understand and manage the environmental impacts of network developments

The topics related to this recommendation have also not been covered in detail in this SDD. Nevertheless, some obvious ways forward and next steps can be easily recommended even on the basis of the general provisions and considerations.

Recommended Actions

Research and development will need to be initiated to deliver holistic modeling techniques that are able to reliably show the environmental benefits of the SmartGrids Vision. This will extend beyond the networks alone, and will include new energy sources.

Research into cost efficient ways to reduce losses in electricity networks and to accommodate, in a transparent and effective way, the cost of carbon emissions needs to be conducted.

Research into the potential environmental impacts of deploying the SmartGrids Vision, addressing also the question of what physical infrastructure will be required and a proposal of ways to reduce environmental impact are needed. This will apply both to the transmission and distribution networks.

Recommendation 9: Promote open access to network performance data

Electricity networks are 'living' systems and in order to effectively improve their operation we need to learn from operational experience. For example, as the capacity of intermittent generation increases, the behaviour of the system and its need for ancillary services will change. It is therefore vital that operational performance data is collected and analyzed on a system-wide basis and that this data is made publicly available as necessary and appropriate.

Increased transparency in general and the access to the network performance data in particular is consistent with the principles of an electricity market. It facilitates international exchange of important information and research, leads to better coordinated planning and operation, allows the implementation of solutions that operate across national borders and also fosters the development of international standards and technical protocols.

Recommended Actions

European Institutions and Member States need to define the legal framework, to ensure the provision of operational and planning information in order to encourage research into the efficient planning and operation of networks and markets. In a SmartGrids context, this will help ensure the efficiency and effectiveness of networks in the longer term through innovation.

Researchers, regulators, traders, generators and consumers should engage in this to determine the most important information which must be made publicly available.

Recommendation 10: Develop the "skills base" in the electricity networks

Engineering in the energy sector, electricity grids in particular, is seen by many as old-fashioned and "difficult" as it requires a high level of competence in mathematics, physics and other sciences. This discourages the potential new students from studying and pursuing a career in power engineering.

Across Europe there is a shortage of experienced engineers, technicians and craft personnel to match the huge increase in capital spending and complexity of a SmartGrids society. This is compounded by the fact that the retirement rate of experienced engineers exceeds the recruitment rate of new experts into the electricity sector in general.

Recommended Actions

All stakeholders in the electricity sector have a responsibility to improve the image of the sector, e.g. by engaging with educational institutions and explaining in an understandable way the real benefits of being involved with and able to deliver solutions to the energy, climate and environmental challenges of today. There exists a limited scope to attract today's students into the sector, in support of delivering the 20/20/20 targets. Therefore, cross training of staff already engaged will be required to meet the shortfall in skills. Nevertheless, this needs to be complemented by providing incentives for young people to study related subjects – for that effective communication will be required to provide information regarding the exciting careers available in electricity networks. A once-in-a-lifetime opportunity to help achieve a secure supply of energy and help the fight against climate change is exciting enough to attract the "young potentials" of the future, under the condition that it is communicated and presented in an appropriate way.

Governments should work with industry and the professional institutions to encourage all stakeholders, especially network companies, to provide adequate training and experience for their employees. Regulators will then also be able to provide adequate incentives in support of that. Network operators should eventually get much more (and openly) involved at all levels of education and research, to bring more motivated people into the sector, to show that innovation and complexity can be exciting, fun and well rewarded.

Conclusions

The recommendations, with key motivation and benefits are summarized:

- **Promote the SmartGrids Vision to all stakeholders –** it is vital that there is 'buy-in' to the SmartGrids Vision across all stakeholders for it to be successful.
- **Encourage innovation by network companies and stakeholders –** only the network companies can actually deliver the Vision. They must be motivated for that.
- **Encourage a pan-European approach to the SmartGrids 'project' –** a sustainable future for Europe will increasingly depend on open energy trading. Co-operation between Member States will be increasingly important.
- **Encourage early deployment of SmartGrids technologies and solutions through demonstration projects –** "de-risking" technologies requires demonstration on real networks. Demonstration projects are vital to achieve widespread adoption.
- **Further develop the SmartGrids Business Opportunities to build the case for deployment –** new approaches are needed to take account of the wider benefits of SmartGrids.
- **Engage the demand side –** it is a vital part of the SmartGrids Vision to promote active demand side / user participation.
- **Address technical standards in the electricity and telecommunications sectors –** engage the standards and regulatory bodies from both sectors to ensure that they are in line with the SmartGrids Vision and its needs.
- **Understand and manage the environmental impacts of network development –** stakeholders' concerns must be understood and addressed appropriately.
- **Promote open access to network performance data –** vital for effective functioning of the market, for grid operational security but also for the effective R&D.
- **Develop the "skills" base in the electricity networks sector –** without resolving this problem of resources, any progress will be severely constrained.

It is anticipated that the establishment of the SmartGrids Association, which is foreseen after the 3rd General Assembly, will significantly contribute to fostering discussions, to support further steps in SmartGrids deployment and eventually also to implement in the most effective way the recommendations suggested here.

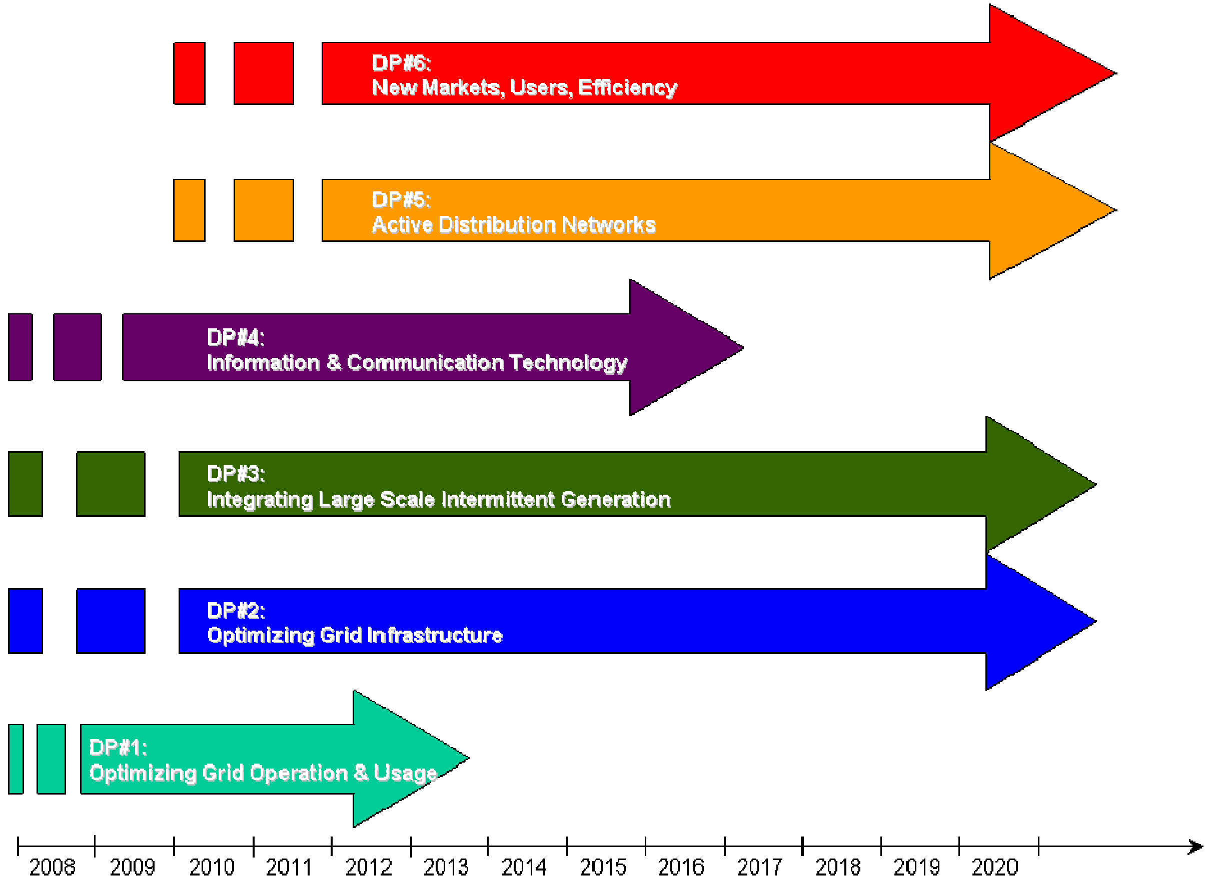
4. SmartGrids Roadmap

Each national electricity system has a unique starting position in terms of age, design and capability. SmartGrids deployment therefore will have a different set challenges and requirements in each of these scenarios. The roadmap here has therefore been designed in a relative format, depicting the anticipated elapsed time for a particular phase of a given deployment priority which needs to be completed in order to move forward; the absolute "year" as the starting / ending point for the SmartGrids deployment will then depend on the practical situation "in the field".

In that sense, the roadmap presented here serves for orientation and initial information, whereas each deployment priority will need a more detailed planning when it comes to real practical implementation.

Furthermore, whereas dependencies (both between the deployment priorities, as well as to/from the "external World") exist, they have been omitted from the roadmap in order to improve readability and to avoid the details which might be unnecessary at the present stage.

Since the SDD is intended to provide guidance for the potential users and "deployers" of SmartGrids, the document is also a living one; dependencies and horizontal links between the different deployment priorities' and phases or even between the specific projects will be added in the future as necessary.



5. Stakeholders / External Initiatives

In most countries the electricity sector is probably one of the most complex and (in liberalized markets) fragmented of all. This provides a major challenge as to how the electricity supply chain can develop in a coordinated and coherent manner in the absence of clear overall direction.

A traditional structure of the industry with generation (centralized), transmission, distribution, end-users (both industrial and residential), provides a framework to identify each of the stakeholder groups needed and involved for SmartGrids deployment. The difference being in the "new world" generators could be at the distribution or end-user level. New stakeholders are likely to emerge too, e.g. Virtual Power Plant aggregators.

There are further organizations, such as governments (national, regional and local), regulators, traders, suppliers, manufacturers, research institutes, academia, construction, service, ICT, Banks and NGO's which play an important part in the SmartGrids deployment.

In this section, all those groups and stakeholders, with the related models of cooperation with SmartGrids have been identified, in order to indicate how the SDD can be supported by them as champions and active stakeholders in the deployment process.

<u>Generation</u>

Whereas generation as such is one of the "users" of the grid, it is on the other hand the key element that "powers" the actual grid; without generation the grid "dies". It is therefore generation in general and new and emerging kinds of generation in particular (intermittent generation like wind power, distributed generation close to urban areas and consumption centers, etc.) that continue to play an active role for many SmartGrids functionalities on the one hand (e.g. advanced ancillary services, balancing at the distribution level, etc.) and remain the key grid user on the other.

<u>Transmission</u>

The transmission is one of the two main subjects of the SmartGrids (besides distribution), it has therefore one central role and responsibility for the deployment and "making SmartGrids happen".

<u>Distribution</u>

The distribution is another of the two main subjects of the SmartGrids (besides transmission). It has therefore another central role and responsibility for deployment and "making SmartGrids happen".

<u>End users</u>

The end-users (consumers) of the SmartGrids are the ones for whom the whole effort and the eventual deployment are trying to serve. It is therefore of utmost importance to properly and transparently communicate and consult with end-users on all aspects of relevance before and during the deployment, but also to allow for the end-users feedback and requests for adjustments after the deployment and during the actual use and operation of a given SmartGrids solution or approach. Since end-users are not so much concerned by the technical and engineering characteristics of the SmartGrids deployment but rather interested in the outcome, an appropriate level of aggregation of information and discussion platform is mandatory to retain effectiveness and efficiency. It is therefore envisaged that the end-users are one of the prime "movers" of the discussions in the future anticipated "SmartGrids Forum" towards which the present Technology Platform could evolve in the future.

Supply Chain with Solution-, Product- and Service-Providers

The solution, service and product providers have a similar position to the end-users in the sense of their position towards the grid, i.e. the ones who make use of the grid and its services; the key difference however is that their markets are actually the grid operators and that they are by nature of their business much more interested in the technical and engineering characteristics of the different solutions and approaches. It is therefore anticipated that this category of stakeholders will remain deeply involved as an active contributor in all phases of the future SmartGrids activities.

Regulators

The national and EU policy and decision makers and regulators are the key addressees of the SDD not just in terms of contents but also in terms of economical and overall societal benefits. It is anticipated on the one side that the SDD contents and deployment priorities are used as a reference and basis in their decisions on what the TSOs and DSOs have to be incentivized towards and on the other side, also to help them in working together with other stakeholders to evaluate the anticipated costs and benefits at least for the first application. Therefore, whereas it can be anticipated that regulators and authorities remain actively involved in the future "SmartGrids Association", they might need to retain a more active and substantial role in the "core" processes and all deployment phases in the future too.

Non Governmental Organization

The role and position of non governmental organization is to a largest extent similar to those of the end-users; it is therefore anticipated that their involvement and cooperation with the future activities of the SmartGrids would to a large extent resemble the ones of the end-users.

Professional bodies, Institutes and Associations

Professional bodies, institutions and associations already play a key role in most technology- and engineering-oriented processes and activities around the SmartGrids deployment. The issues like standardization, feasibility studies and, to that matter, the whole SmartGrids deployment cannot be imagined without their active participation and in many cases even a lead role. It is therefore anticipated that they will – together with the TSOs and DSOs – keep a central role in the SmartGrids deployment in the future too.

In order to engage with all the relevant organizations and stakeholders, future coordination work to advance towards SmartGrids would become a full-time activity and one which the proposed SmartGrids future association ("Forum") would be well aligned to achieve.

The chapter on communication strategy identifies the different messages and ways of interaction that will have to be applied to the different stakeholders identified above. This is based on their particular area of interest in SmartGrids, providing a coherent integration of effort both upstream and downstream of their activity.

6. Funding Options

This section informs the reader of the different options for funding that have been identified as possible routes to leverage resources to enable the deployment of the SmartGrids. Four different options are considered:

1. EC Research and Development funding
2. National funding opportunities
3. Regulator allowances for innovation
4. Private Funding options

These represent the different options for incentives and risk reduction that are either available in member and associated states or can be used as examples of how other member and associated states are providing incentives to their network companies. Each one is designed to provide different support along the research, development and deployment process chain. It is up to the individual company to decide which the right support is for them.

6.1. EC Research and Development Funding

The main objectives of FP7 and specific programs include:

- Knowledge lies at the heart of the European Union's Lisbon Strategy to become the "most dynamic competitive knowledge-based economy in the world". The 'knowledge triangle' - research, education and innovation - is a core factor in European efforts to meet the ambitious Lisbon goals. Numerous programs, initiatives and support measures are carried out at EU level in support of knowledge.
- The Seventh Framework Program (FP7) bundles all research-related EU initiatives together under a common roof playing a crucial role in reaching the goals of growth, competitiveness and employment; along with a new Competitiveness and Innovation Framework Program (CIP), Education and Training programs, and Structural and Cohesion Funds for regional convergence and competitiveness. It is also a key pillar for the European Research Area (ERA).
- The broad objectives of FP7 have been grouped into four categories: Cooperation, Ideas, People and Capacities. For each type of objective, there is a specific program corresponding to the main areas of EU research policy. All specific programs work together to promote and encourage the creation of European poles of (scientific) excellence.
- The non-nuclear research activities of the Joint Research Centre (JRC) are grouped under a specific program with individual budget allocation.

Further information on each of these specific programmes and their sub-divisions is available at http://cordis.europa.eu/fp7/info-programmes_en.html

6.2. FP7 factsheets

The details of the FP7 factsheets are available at
http://ec.europa.eu/research/fp7/understanding/index.html

The "FP7 Fact sheets" help to answer these questions:

What is FP7?
What is its budget?
What is its overall duration?
Which research areas does it cover?
How will citizens, researchers, industry and SMEs benefit from FP7?
Where can I find more information about European research?

6.3. ERA-NET

The ERA-NET scheme is one of the tools of the Seventh Framework Program (FP7) to support the coordination of non-Community research programs. It is implemented under both the Cooperation and Capacities programs of FP7. Annex 4 to the Cooperation work program provides the legal basis for the ERA-NET scheme and its implementation.

The ERA-NET scheme was first introduced in the Sixth Framework Program (FP6). Given its success and long term perspective, the scheme is continued and reinforced in FP7. It is composed of:

1. ERA-NET actions to step up the coordination between national or regional research programs. The description of these actions is the purpose of the issue paper.

2. ERA-NET Plus, a new option added to the ERA-NET scheme in FP7 allowing, in a limited number of cases, Community financial support to be provided for "topping-up" joint trans-national research funding.

3. The modalities of ERA-NET Plus are described in a separate issue paper called "ERA-NET Plus actions – Provisions for the preparation of ERA-NET Plus actions and their practical implementation" published on http://cordis.europa.eu/coordination/fp7.htm.

6.4. National Funding Options

National Funding options vary according to each member and associated state and are numerous and varied in their criteria for design. In order to assist the reader a number web links can be found for many Member States and some Associated State, for example:

- in Great Britain:

http://www.berr.gov.uk/dius/innovation/technologystrategyboard/tsb/index.html

- in Spain:

http://www.plannacionalidi.es/

- etc.

6.5. Funding Allowances within the Regulatory Regime

National regulators approach the issue of innovation from different perspectives. The approach taken by the Great Britain Regulator (Ofgem) to stimulate innovation in the network companies is taken here as an example.

Two funding initiatives have been in operation for distribution companies since the last Distribution Price Review in Great Britain, these are the Innovation Funding Initiative (IFI) and the Registered Power Zone (RPZ). Details of each of these can be found for example at:

- http://ofgem2.ulcc.ac.uk/ofgem/work/template1.jsp?id=10498&section=/areasofwork/ifirpz&isbgpage=yes
- http://ofgem2.ulcc.ac.uk/ofgem/work/index.jsp?section=/areasofwork/ifirpz

It is important also to emphasize that the addressing of innovation within the regulatory framework will also depend on the actual situation in a given Member or Associated State, control area or a group of distribution grids. Finally, an EU-wide approach, providing for a harmonized regulatory framework towards really needed and beneficial SmartGrids features would be the most efficient one.

6.6. Private Funding Options

Each company will have its own preferred funding options. A large number of different facilities exist and it is proposed that further information can best be obtained via the different member and associated state national governments and banking operators in their native language where rules, regulations and constraints can be clearly explained. In order to help the various member and associated states, different links are also provided in Annex 2.

6.7. Deployment Priorities

The ability for companies to progress possible technology solutions is usually defined by the strength, or not, of the deployment priority presented to the board for sign-off. The generic deployment priorities identified within the SDD are therefore designed to assist the reader to assemble a strong case for funding and company support.

7. Communications Strategy

Technical research forms only one part of the chain of activities needed to address market transformation in the grid sector.

The electricity market is strongly driven by legal framework and regulation and hence fundamental market changes are only possible through adequate policies. To provide the stimulating market conditions for SmartGrids is the future challenge for policy makers and governments if rapid deployment should take place.

Challenge 1: Position of SmartGrids in the EU Energy Action Plan

Since the 20/20/20 target is only reachable with a reliable and flexible electricity networks, the integration of SmartGrids in European Energy Action Plan is mandatory. The importance of SmartGrids for EU MS should be acknowledged similarly as it is the case for transportation, where insufficient and inadequate capacities, solutions and management would have catastrophic consequences for economy and society. It seems appropriate to extend thus the goal of 20/20/20 to a goal of 20/20/20/60 where 60% of the European electricity grids have to deploy the key SmartGrids components by 2020.

Challenge 2: Demonstration of Benefits for Customers

The national SmartGrids action plans must contain clear incentives for the customers to stimulate their active participation. For example, easy, effective and simple supplier switching in a liberalized electricity market is an essential feature which can be supported by SmartGrids components. Legal and regulatory framework need to support all customer groups, from the industry to the smallest households.

Challenge 3: National Action Plans for SmartGrids

National action plans have to provide measures and incentives for grid operators and for grid users (generators, consumers and those who do both) to use the electricity grids in a smart way. These incentives should be structured so that they do not significantly increase the electricity price in the long run, what means in turn an effective, robust and stable regulatory framework which will honour both efficiency and quality, equally as it must discourage inefficiencies and quality deterioration in the future electricity grids.

Challenge 4: Energy Efficiency and SmartGrids

It is recommended that the European Institutions develop and put in place a methodology quantifying the value of energy efficiency measures, including carbon saved by renewables, reduction of losses, demand side measures, etc.

Challenge 5: Cross Border Co-operation, Transparency and Information Management

Europe’s transmission grids (synchronous areas) are today among the best worldwide in terms of operational security and reliability. To build on that, the European cross-(control area)-border cooperation must be enhanced, serving interests of all stakeholders and society as the whole. Moreover, transparent and effective access to information is a key for both, market functioning and secure grid operation. A European Management of energy data consolidated from each member state can help forecasting and anticipating peak demand. A European control centre could be the best solution to achieve this challenge.

Challenge 6: Public Funding for Real Environment Demonstration

Electricity networks technologies are commonly perceived as being of large scale, costly, and complex: many elements must integrate with one another to form a seamlessly operating system. Experience shows that an essential step in successful innovation in this context is demonstration and deployment of specific solutions to operate in the real environment. No new technology is accepted network operators as proven, until this landmark has been successfully reached. This is also where the SmartGrids deployment priorities primary use is anticipated.

The chain of: research, demonstration, development and market deployment & usage shall not be discontinued. It is by effective and "clever" funding from research to the market, that the success story of e.g. European mobile communications could be repeated in the European electricity networks of the future.

Challenge 7: Relation between transmission and distribution systems

With the massive intermittent generation steadily growing and increased infeed at the lower voltage levels, sophisticated methods are required to maintain the required technical level of network functionality and operation. For example, the balancing services, now carried out mainly by the TSO's, will in the future rely also on new market players in the DSO's and at the lower voltage levels. An adequate legal and regulatory framework with monitoring and control mechanisms will be required for that too.

8. ETP SmartGrids Next Steps

The European Technology Platform SmartGrids is a voluntary organization and has achieved a great deal of results, initiating positive and encouraging developments in many ways.

To take research, development and deployment to the next stage will require a body that has the ability to provide full-time resource dedicated to the ambition of achieving the SmartGrids Vision created.

Analysis of other organizations that have developed through a similar life-cycle and ambition level provides a good example of how to progress to a more professional organization with executive authority and full-time resources to champion the deployment and ultimate achievement of an efficient and lower-carbon electricity delivery system.

It is proposed that a SmartGrids Association be formed with members representing the stakeholder community interested in ensuring the aims of the SmartGrids Vision, SRA and SDD are achieved.

Further, the formation of a Joint Technology Initiative (JTI) will be reviewed to allow those members of the SGA to enter into a vehicle that will allow public/private funding of particular projects.

Initial work has been completed on the model that the SGA could be established upon, with further work ongoing and interested parties invited to contact the SmartGrids secretariat (www.smartgrids.eu) to register interest in possible membership.

9. Glossary of Terms

The definition of terms provided here serve mainly for the purpose of this SDD. Therefore it is possible to find a somewhat different meaning or a formulation for a given term in different other references and literature outside of the SmartGrids ETP.

Active Network Management .... A common term and notification for the distribution networks capable of e.g. self-healing, integration of VPP and demand response concepts; strongly customer oriented and enabling furthermore also the active customer participation in services' definition and usage and all other relevant aspects

Application research .... stands for the type of research activity required after the technology and fundamental research is completed, in order to check the practical feasibility and initiate a wide deployment of a given new technology or a specific solution; in the example of an advanced software module for operational security decision support in real time, this would involve test operation and adjustments / improvements during that in one or several control areas, before such a system becomes e.g. a standard and obligatory mandatory part of each control room in the future grid.

Demand Side Management .... the way of customer interaction in which the customer takes a rather passive role and "switching on/off" is performed by the grid operator according to some predefined conditions and procedures

Demand Side Response .... the way of customer interaction where customer is more actively involved and incentivized by market oriented mechanisms (i.e. gets paid for participation according to the matching results of cost-related bids real costs and prices in of the market participants) to participate and interact in network management and operation

Dispersed generation .... Decentralized generation, possibly consisting of a combination of smaller generation units ((e.g. large off-shore wind parks) combined together, but which are not necessarily close to the consumption centres (e.g. large off-shore wind parks)

Distributed generation ..... Decentralized generation which is characterized also by the location close to the consumption / customers

Technology research .... stands for the research activity required in order to develop and prove practical applicability of a given new technology or a specific solution; for example this would be a novel development of an advanced software module for operational security decision support in real time and its integration into the standard control room structure of application.

10. Appendix 1: List of Acronyms

AC	Alternating Current
AMI	Advanced Metering Infrastructure
AMM	Automatic Meter Management
AMR	Automatic Meter Reading
AS	Ancillary Services
CHP	Combined Heat and Power
CIM	Common Information Model
CO_2	Carbon Dioxide
DER	Distributed Energy Resources
DG	Distributed Generation
DSM	Demand Side Management
DSO	Distribution System Operator
DSR	Demand Side Response
EIA	Environmental Impact Assessment
ETP	European Technology Platform
E(N)TSO	European (Network of) Transmission System Operators
EU	European Union
FACTS	Flexible AC Transmission Systems
GDP	Gross Domestic Product
GIL	Gas Insulated Line
HVAC	High Voltage Alternate Current
HVDC	High Voltage Direct Current
ICT	Information and Communication Technology

IEA	International Energy Agency
IFI	Incentives for Innovation (Ofgem scheme in Great Britain)
MS	(European Union) Member State
NO_x	Nitrogen Oxides
PLC	Power Line Communications
R&D	Research and Development
RD&D	Research, Development and Deployment
RES	Renewable Energy Source
RPZ	Registered Power Zones
RTD	Research and Technological Development
SCADA	Supervisory Control and Data Acquisition
SO_2	Sulphur Dioxide
SW	Software
TSO	Transmission System Operator
VPP	Virtual Power Plant
WAM	Wide Area Monitoring
WAC	Wide Area Control

11. Appendix 2: SmartGrids Technology Platform

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