COMMENTS FROM BEUC ON THE REPORTS FROM EU COMMISSION TASK FORCE FOR SMART GRIDS EXPERT GROUPS 1-3

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BEUC is pleased to have the opportunity to participate in the smart grids task force, in order to identify and address consumer needs up front. BEUC's smart meters working group has participated to the extent that its resource limitations and technical expertise has allowed.

To this end, below are some of the general comments on the Expert Group documents which we hope will prove useful (further details are provided in the report).

I. Expert Group 1 Paper (Functionalities of smart grids and smart meters - EG 1)

In Section 6 (High Level Services Of Smart Distribution Grid):

- It is incorrect to highlight consumers as the primary beneficiaries of all the listed high level services: This appears to be based on the assumption that improvements in company efficiencies and services will automatically be passed on to consumers in the form of price reductions. We would rather point the Commission to the list identified by Working Group 2. Section 5. P.11. Consumers can benefit - at best - indirectly, subject to effective governance and intervention. If consumers are included here, a short explanation should be included as to how they will directly benefit.

- With effective communication of load signals consumers will be able to play an active role in load management by modifying their behaviour and potentially benefiting from lower cost tariffs. However, consumer groups are mindful that remote load management tariffs must be optional. There will be many low income and vulnerable groups who could be adversely impacted by their mandatory introduction.

- Smart metering and smart grids could prompt a radical change in the way energy retail markets operate and in consumers' relationship with energy. Consumer benefits can only be realised if effective regulations and safeguards are put in place. Consumer protections will need to be reviewed to ensure they are fit for purpose in a smart world. Services and functionalities offered to consumers must be designed to the benefit of consumers, which have different needs and energy consumption patterns. Consumers will also need to have access to appropriate tools and information to help them engage in this new energy market. Particular consideration must be given to the impact of new offerings on low income and vulnerable consumers - Consumers have to have the possibility to opt out, if they are faced with unjustifiable financial burdens.

  Included in our comments are cases from the US, Australia and Scotland demonstrating that there is an erroneous assumption in the report that the energy retail market and customer service will change for the better without additional action by policy makers and regulators. We strongly feel that this should be addressed somewhere in the report.

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- Smart grids are likely to facilitate greater choice of new smart tariffs and engagement in the market. While choice is welcome, the introduction of new offerings including time of use energy pricing, dynamic energy pricing and critical peak pricing will add another level of complexity, potentially hindering consumers' ability to switch to the best energy deals. In order to navigate and engage in this increasingly complex market, consumers should be offered a choice of appropriate feedback (and support) mechanisms on their energy consumption, including a free stand alone display and free hardcopy feedback. Consumers should have free access to a minimum of a year's worth of their own consumption data (to cover all seasons) in a format that enables them to make like for like comparisons with other deals in the market. Clear complaint handling and redress systems will have to be set up to ensure that when problems arise that they are dealt with efficiently. Also there should be clear lines of responsibility when things go wrong. Consumers should have the choice in whether they adopt new tariffs or energy deals. When they don't have a choice due to member states circumstances, a strategy must be put in place to protect consumers from bill hikes, particularly those on low incomes

- Careful consideration must be made of the consumer experience and impact, as the drivers for new functionalities and innovation most of the time do not come from consumers. Therefore a systematic review of existing protections and safeguards and a strategy to ensure the delivery of potential consumer benefits is always necessary.

In Section 8 (Functionalities of Smart Metering):

- Consumers should be offered a choice of appropriate feedback mechanisms on their energy consumption, including a free stand alone display and free hardcopy feedback.

- There is a role for the EU to play in setting guidance for national decisions on data flows and the nature of data

- There must be protections in place to:

    - Protect consumers from unfair tariffs and to ensure that benefits to utilities arising from advanced tarification and payment are also passed to the consumer

    - Prevent misuse of remote disconnection and remote switching of payment method functionality

- Use of data must be carried out in accordance with data protection and privacy rules

- Some of the comments related Section 6 above are relevant to smart meters as well as smart grids.

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In Section 11 (Standardisation: recommendations and priorities for a strategy towards smart grids deployment)

- As regards the "key issue" of interoperability: The consumer experience must be at the heart of decisions in this area. It is essential that customers can switch energy supplier without having to change their display, in- home smart appliances or communications systems. In-home products must be compatible with all meters. Failure to ensure compatibility will result in increased costs to consumers, increased environmental waste, and inconvenience to consumers. It can act as a barrier to competition in energy and the wider energy services market as well as related sectors.

In section 12 (Conclusions and further recommendations)

- The recommendation concerning the acceptability of new services by consumers should highlight the importance that they are involved in the smart grid decision making processes, i.e: this acceptability will be facilitated by a systematic review and updating of consumer protections including around data protection and privacy – to ensure they are fit for purpose in the smart world. Member states will also need to develop strategies for the delivery of consumer benefits, especially where customers are expected to pay for new technology. Roles and responsibilities must be clearly defined so that when consumer issues arise they are quickly and efficiently resolved. Careful consideration will be needed around the tools and information that consumers will need to enable them to engage in this evolving energy retail market. This type of action is essential to build and maintain consumer trust and therefore acceptance and engagement

- The recommendation concerning communication and education programmes for citizens must be designed to meet consumer needs and behaviours. Added to policy concerns, therefore should be other issues such as to:

    - help empower consumers act on energy information from smart metering and grids to change their behavior in order to go green and reduce their energy bills
    - help consumers make well informed purchasing decisions when selecting whether or not to sign up to new smart tariffs to ward against potential detriment
    - ensure that consumers are aware of their rights and responsibilities in relation to smart meter roll out and smart grid interaction
    - ensure that consumers are aware of complaint handling and redress systems should problems arise.
    - help promote customer trust, acceptance and engagement, which is a cornerstone to the success of smart grids.
    - acknowledge that it is not possible to engage all audiences on the same level: consideration must be given on how best to segment and approach the respective consumer groups
    - acknowledge that educational messages do not equate to behavioural shifts. To achieve the desired outcomes campaigns must comprise a call(s) for action that is fun, easy and popular

- The recommendation relating to demand response programmes must give domestic customers a choice in whether to participate. Where no choice is available there must be a clear national benefit for mandation. In both instances effective protections must be put in place.

- Finally, as regards interoperability and standardisation, it is essential to ensure compatibility of technology within customers' homes. Consumers should not face barriers when seeking to switch supplier – they should not have to switch display, or in-home smart appliances or other technology. If this happens it will result in inconvenience for customers, additional and unnecessary cost, environmental waste from obsolete or incompatible appliances and potential barriers to competition.

II. Expert Group 2 Paper (Regulatory Recommendations For Data Safety, Data Handling And Data Protection - EG 2)

In the executive summary

- An amendment is recommended to accommodate the approach favoured in the UK to bring in a central data base to store personal data. This raises concerns as it does not sit well with privacy by design. Arguably it is not necessary and will limit competition as governance of the central data store looks likely to be industry dominated

In the summary of recommendations

- Further work needs to be done around how consumers are able to control the use of their own data and around the potential monitoring and enforcement mechanisms around data protection and privacy rules. A review of the terms and conditions offered by all the suppliers in the GB with smart meters was carried out by one of our UK members. This found that all suppliers abided by the letter of the law in telling consumers how they were going to use their personal data, often going to several pages in small print (more than the vast majority of people would not read). No supplier gave consumers the opportunity to opt out of that data being used by them for commercial or other purposes. In effect, customers had no choice, because there is no supplier that does things differently

In Section 3 (Definitions)

- Re Technical Data (Smart Grid): Data should be able to be linked to individuals <u>or households</u>. Recent evidence demonstrates that it is not enough to distinguish between personally identifiable information and anonymised data - c.f. the US Federal Trade Commission assessment that restricting protection to personally identifiable information does not recognise the developments in profiling technology. They concluded that it is clear that so called anonymised data can be used to identify individuals. This must be taken into consideration when defining technical data. It is becoming apparent that in rural areas where there are only a handful of supply points it may be possible to identify individuals <u>even</u> when the data is not gathered from an individual point.

- The definition for Consumer Data should be deleted or amended: The current wording is misleading: At a recent conference, this provision in this report was

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cited as the basis that the definition of personal data is dependent upon the usage of the data, i.e. for marketing communications purposes. This is not correct. It does not matter what the data is intended to be used for, the fact that it has been collected makes it subject to application of data protection rules personal. We suggest removing this text, or adding the amendments suggested.

In Section 4 (Current European Framework - Privacy)

- As stated for Section 3 above, we are concerned that it is not enough to distinguish between personally identifiable information and anonymised data. According to the US Federal Trade Commission's, it is clear that so called anonymised data can be used to identify individuals. They believe the distinction is no longer meaningful. This must be taken into consideration when defining technical data.

In Section 9 (Data Privacy)

- We would question whether it is correct to focus on the collection of consumer data only from individual metering points. This should be expanded e.g. to any electrical point in the home. We are aware that other devices can also collect personal data. At least one company has developed a device that plugs into the plug socket in the home which can control key appliances. This is coming onto the market next year.

III. <u>Expert Group 3 Paper (Roles and Responsibilities of Actors involved in the Smart Grids Deployment - EG 3)</u>

In Section 3.2.4 (Interfaces of DSOs, Customers, Suppliers and other Actors concerned with Smart Meters (Interfaces around the Meter)

- A distinction should be made for data for additional services that should require the explicit consent of the consumer

- The comments on the role of the DSO should acknowledge that some countries (ie. the UK) have taken a different approach with the roll out through suppliers and the introduction of a central data and communications provider.

In Section 3.2.5 (Flexible Energy Pricing and Grid Tariffs' Systems)

- Recommendation # 9 should highlight that it is the role of regulators to ensure that there are adequate safeguards in place to enable consumers to effectively engage in this evolving energy services and smart market in order to make well-informed purchasing decisions. This is particularly the case for low income and vulnerable consumers

  For example, the underlying assumption is that smart grids will improve the energy retail market and customer service. In practice the consumer experience may be very different. (C.f. anecdotal evidence provided from Australia and US) Smart grids are likely to facilitate the introduction of a range of new tariffs – multiple rate time of use, critical peak pricing, remote demand management, along side energy services deals. While this increased choice is welcome, it is

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also likely to make the market more complex and confusing for many consumers, making it hard to identify the best deal. In GB a third of customers already switch to a worse deal. When it comes to doorstep sales the figure is even higher. There are relatively few tariffs compared to what will happen in a smart world. Also in GB, companies are starting to offer longer term contracts in exchange for a smart display, as with the mobile phone contracts. This is not a problem as long as consumers are aware of the long term implications if they change jobs, have families etc of locking themselves into longer contracts. We need to ensure that consumers have a choice in whether to adopt new deals as not everyone will benefit.

In Section 4.2 (Benefits and criteria)

- Facilitation of switching between providers will depend upon the availability of historic energy consumption data to customers for free in a format that allows them to make like for like comparisons with tariffs and deals available in the market. This should be elaborated as one of the criteria to benefit 8 enable consumers to make informed decisions related to their energy.

- Effective consumer complaint handling and redress (including clear lines of responsibility when things go wrong) should be a criteria for benefit 9 (create a market mechanism for new energy services). Recent anecdotal evidence from Scotland is provided to demonstrate the need for this.

In Section 4.4 (Regulation)

- We would welcome the extension of ERGEG's recommendation 4 (promote mechanisms favouring an improved consumer awareness of their electricity use) to encourage governments to pick up this objective as well at some point

In Section 4.5 (Recommendations for funding), including Funding Recommendation #3

- An analysis of the distributional impact of the benefits of smart grids should be carried out to ensure that low income and vulnerable consumers are not unfairly carrying the burden of costs and to put in place safeguards. Positive discrimination should be considered to ensure a fair and equitable cost allocation; there is a risk that low income households could end up footing the bill when they are the least likely to be able to benefit from it.

In Section 5 (Roles and Responsibilities - Recommendations on Scope, Policy and Regulatory Decisions)

- It should be stressed that many of the potential consumer benefits will not be realised without adequate safeguards and a strategy to deliver these benefits. A systematic review of retail market protections will need to be carried out to ensure that they are fit for purpose in a smart world.

- National communication campaigns must acknowledge that it is not possible to engage all audiences on the same level: consideration must be given on how best to segment and approach the respective consumer groups.

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Furthermore, educational messages do not deliver behavioural shifts. To achieve the desired outcomes campaigns must comprise a call(s) for action that is fun, easy and popular.

In Section 5.4 (providers of Technologies, Products and Services)

- Compatibility of in home technology including appliances, communications networks and meters is key for consumers. Consumers should be able to switch energy company without having to change their display or other in-home smart products or services. Failure to address this would result in increased inconvenience to consumers, barriers to competition, additional cost of purchasing new equipment and environmental waste from obsolete technology which is thrown away.

In Section 5.5 (Influencers)

- Regulators have a responsibility for systematically reviewing customer protections to ensure that they are fit for purpose in a smart world. For example, new safeguards will need to be put in place to protect customers from misuse of remote disconnection, remote switching, misselling of complex new tariffs alongside new data protection and privacy rules. They have a particular responsibility to protect the interests of low income and vulnerable consumers to ensure that all customers are able to access the benefits of smart grids.

- Policy makers must put in place the appropriate regulatory framework to protect consumers and enable them to access the full benefits of smart grids and metering - consumer/citizen concerns should be put at the heart of the decision making process. Some actions are elaborated in the bullets above. Additionally, work will need to be done around the accreditation of new technologies, products and services to ensure that customers can have the peace of mind that they deliver their proposed benefits e.g. around micro-generation.

ANNEX 1

EU Commission Task Force for Smart Grids

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Expert Group 1 :
Functionalities of smart grids and smart meters

Final Deliverable

for Steering Committee on 2010 June 22nd

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Table of Contents

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1. SCOPE AND MISSION OF THE DOCUMENT

The tasks and scope of work of the Expert Group 1 (EG1) of the EC Task for Smart Grids (TF) are defined on the basis of the Mission and Vision and Work Programme documents that were presented at the second meeting of the TF Steering Committee on 16th December 2009.

According to that, the key deliverable of the EG1 is the ***services and functionalities of smart grids*** together with initiatives related to ***standardization***. The work, taking into account stakeholders inputs from the group, considers the following topics:

- Smart Grids concepts and definitions (chapter 3);
- Need for smarter transmission networks (chapters 4 and 5);
- High-level services from Smart Distribution Grids (chapter 6);
- Functionalities of Smart Distribution Grids (chapter 7);
- Functionalities of Smart Meters, highlighting that smart metering is a pillar for building a number of smart grids functionalities and focusing on mandate M/441 (chapter 8);
- State of the art of demonstration projects and industry solutions already available related to the above services and functionalities (chapter 9);
- Reference to the wide set of existing standards, codes and guidelines, and related to smart grid services and functionalities and the international activities for mapping them (chapter 10).
- Main areas where further efforts are needed (chapter 11);
- Concluding remarks and recommendations for next steps (chapter 12).

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2. INTRODUCTION

High-level drivers for smart grids

Smart grids have an essential role in the process of transforming the functionality of the present electricity transmission and distribution grids so that they are able to provide a user-oriented service, supporting the achievement of the 20/20/20 targets and guaranteeing high security, quality and economic efficiency of electricity supply in a market environment. Their development will be facilitated by the wide-scale deployment of electricity smart metering, as envisaged in 3rd Energy Package, Directive 2009/72/EC.

In order to achieve the European and national energy policy objectives, a new global approach in the generation, transmission, distribution, metering and consumption of electricity is necessary. Massive renewable integration and power energy storage technologies will have to be deployed. Energy efficiency will have to be a general driving vector, demand will become an active player within the electrical system and the increasing electrification of transport (E-mobility or Electric Vehicles) will be a challenge. These latter drivers will require far-reaching changes in the area of distribution networks and will determine modifications in system operation, with consequent impact on design, planning and operation of transmission networks.

Renewable generation will increasingly affect electricity networks. In particular, large wind farms (possibly offshore) will be connected to transmission networks; in addition, many dispersed

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generation units, mainly fed by renewable energy sources (photovoltaic, small wind, biomasses, CHP) will be hosted by distribution networks, both at MV and LV levels.

The whole electrical system will have to develop in the most efficient way to address the new challenges and needs of its users. The future scenarios are based on the development of a sustainable energy model where the carbon emissions will have to drastically decrease, with massive renewable energy integration.

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Main assumptions and principles adopted by Expert Group 1

In this report EG1 assumes that:

- Services and functionalities defined by EG1 are focused on electricity networks, while EG1 recognizes that some smart grid concepts are likely to be applicable to gas, heat and other networks, such extensions have not been taken into account in the report.
- Transmission networks are considered to be already in a process of increasing their "smartness". As further discussed in chapter 3, "smartness" is here intended as a path to an economically efficient, sustainable power system with low losses and high levels of quality and security of supply and safety. Therefore, chapters 4 and 5 of this document summarize the current European policy framework for transmission and highlights the new needs for smarter transmission networks, coordination requirements and potential changes coming from their interaction with distribution networks.
- The document will essentially focus on MV and LV distribution networks. DSOs must take into account expectations of all users and actors in order to increase efficiency in grid operation and planning.
- Some smart grid functionalities will depend also on certain of the additional functionalities provided by smart meters. Indeed the latter will allow the full capabilities of a smart grid system to be realised and the two projects may share the same telecommunications system. For this reason, close co-ordination with the work currently being done within the M/441 mandate will be essential.
- Area network facilities (home, building, commercial and industry) and smart devices are not within the scope of EG1; however the interface between the smart grid and these facilities (signals and data needed for e.g. demand response and load control) is in the scope. Attention is being paid to standardisation in this area in the M/441 mandate work overseen by the Smart Meters Co-ordination Group (SMCG)[1]. While it is thus not necessary for the Smart Grid TF to cover this aspect in detail, it must particularly consider the issue of communication protocols to be employed in smart grid and smart metering systems and ensure the necessary services are available.
- Smart grid functionalities and services must not impose any specific market model; different market models are assumed in this report to be treated on equal basis.
- The report does not evaluate the business model of each service. The current demonstration projects will help to assess the economics of each service and the societal and environmental benefits (e.g. energy saving, efficiency) by a better knowledge of the costs.
- The acceptability of new services involving customers is not yet fully known. The demonstration projects will also help to evaluate the customers' feedback and interest. This will help to determine precise target of the services and the final business models for such services.

[1] SMCG is tasked with supporting M/441 standardization work in the general area of smart metering.

- Smart grids will also help network operators and national regulatory authorities to focus network investment in the most efficient way. However, considering the aging European infrastructure, smart grids will not remove the need for significant DSO investment in traditional network renewal in the next years, according to the age of the present network.

3. SMART GRIDS CONCEPT AND DEFINITIONS

A Smart Grid is an electricity network that can cost efficiently integrate the behaviour and actions of all users connected to it – generators, consumers and those that do both – in order to ensure economically efficient, sustainable power system with low losses and high levels of quality and security of supply and safety ([5] [2] based on [6]).

Though elements of smartness also exist in many parts of existing grids, the difference between a today's grid and a smart grid of the future is mainly the grid's capability to handle more complexity than today in an efficient and effective way. A smart grid employs innovative products and services together with intelligent monitoring, control, communication, and self-healing technologies in order to:

- Better facilitate the connection and operation of generators of all sizes and technologies.
- Allow consumers to play a part in optimising the operation of the system.
- Enable consumers to be provided with greater information and options for how they use their supply.
- Significantly reduce the environmental impact of the whole electricity supply system.
- Maintain or even improve the existing high levels of system reliability, quality and security of supply.
- Maintain and improve the existing services efficiently.
- Foster market integration towards European integrated market.

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The implementation of this concept will be made possible by the participation of all smart grids actors, according to their specific roles and responsibilities which are described in greater detail in the report of the Expert Group 3. Accordingly, smart grid participants are categorized in this report as follows:

– Network operators: transmission and distribution system/network operators (DSOs/DNOs).
– Grid users: generators, consumers (including mobile consumers), storage owners.
– Other actors: suppliers, metering operators[3], ESCOs, aggregators, applications and services providers, power exchange platform operators.

Conceptually, some smart grid participants provide services, based on a combination of functionalities, to other smart grid participants.

A smart grid service identifies, and can be commonly considered as, the outcome a user needs/will need from the electricity grid in a fully developed liberalised market; it is associated to one provider and to one or more primary beneficiaries, recognizing that the benefits will ultimately be reflected in consumer societal and environmental terms.

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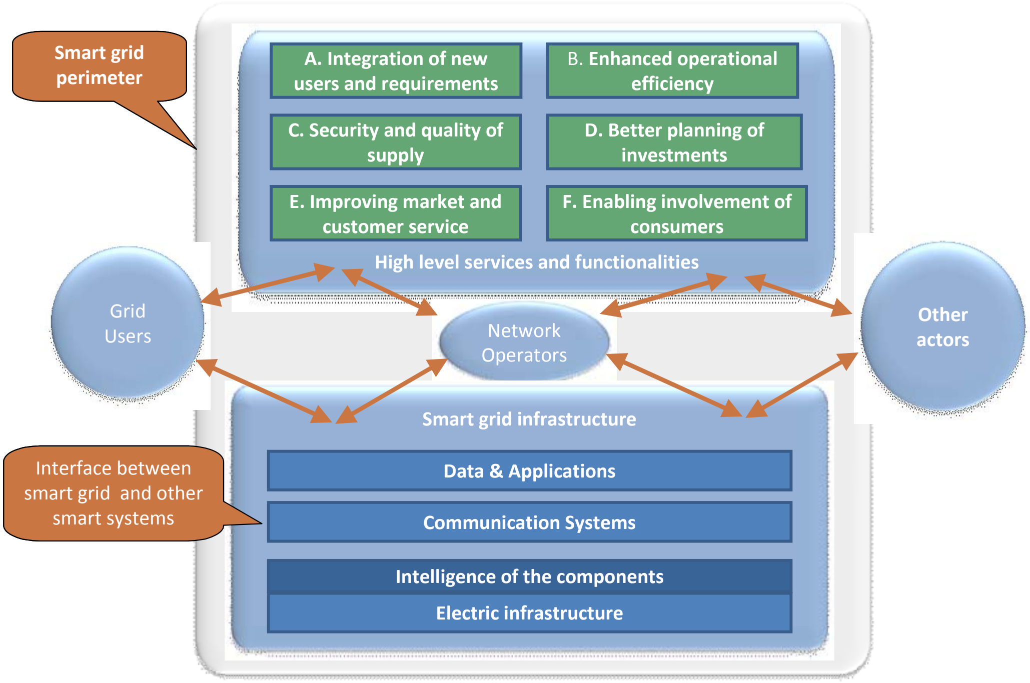
[2] Square brackets contain references listed in chapter 13.

[3] Depending on the national market model, the metering operators may be distribution companies, suppliers or meter companies.

The achievement of service outcomes is possible only through smart grids functionalities, that represent elementary bricks through which services can be implemented and delivered to beneficiaries.

Chapters 6 and 7 develop a series of high-level services and functionalities that should be carefully taken into consideration for the deployment of smart grids. Deployment can be facilitated by the availability of standards, codes and guidelines (see chapter 11) covering the identified high-level services and functionalities.

The following drawing shows the inter actions between services and functionalities, actors and smart grids infrastructure.



4. OPTIMIZATION OF TRANSMISSION NETWORKS

Transmission network will have to be developed and enlarged, incorporating new technologies that give them the flexibility needed to accommodate new generation sources, their dispersion nature and bidirectional flows. Interconnections, energy corridors, the ability to control the power flows and storage systems will have to reach a mature stage before they can be put in place and so contribute to giving the system the necessary flexibility.

European energy policy sets out a clear path towards smarter transmission networks to achieve these objectives.

Directive 2009/72/EC identifies the responsibilities of transmission system operators (TSOs), including the submission to the regulatory authorities of a non-binding Community-wide 10-year network development plan, every two years. The Regulation (EC) 714/2009 mandate TSOs to cooperate at Community level through the ENTSO for Electricity. Among other tasks, the ENTSO for Electricity shall elaborate network codes for cross-border network issues and market integration issues related to 12 areas. As far as harmonization and standardization are concerned, these areas include data exchange rules and interoperability rules.

The technological innovation required is encouraged both by TSOs and by the regulatory authorities. Indeed, according to article 8 of the Regulation (EC) 714/2009, the ENTSO for Electricity shall adopt research plans and a yearly plan of research and development activities within the annual work programme[4]. Further, according to article 37.8 of the Directive 2009/72/EC, the regulatory authorities shall ensure that transmission and distribution system operators are granted appropriate incentive, over both the short and long term, to support the research activities related to increasing efficiency, fostering market integration and security of supply.

From the TSO perspective, research, development and demonstration activities related to smart grid solutions will allow the development and validation of advanced network technologies to improve system flexibility and security and delay future investments, prepare an investment plan for the network evolution in the long term, and enable the active participation of the consumers and energy efficiency, within an innovative market place.

For the TSO perspective, the smart grid must consider the following effects and benefits:

- Increased transmission capacity of existing facilities based on close to real time system data
- Improved real-time monitoring and controllability of the operational status of the system.
- Enhanced flexibility and controllability of power flows, also permitting increased transmission capacity.

[4] European Network of Transmission System Operators for Electricity published in March 2010 the first edition of its "Research and Development Plan", after a public consultation in the first months of 2010.

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- Improvement of international coordination: in addition to the need for interconnection, the smart grid will foster the single European Market by designing e.g. cross-border balancing mechanisms and new options for congestion management.
- Mitigated the social and environmental impact of the transmission infrastructure.
- New methodologies and criteria for power system operation and planning, allowing the use of new technologies to be optimized and supporting cost-benefit analyses and impact assessments of new transmission infrastructures and smart grid solutions.
- Optimal integration of innovative transmission technologies within the existing transmission grid.

5. ENHANCED INTERACTION AND COORDINATION BETWEEN TRANSMISSION AND DISTRIBUTION

From the TSO perspective, strong coordination between transmission and distribution will be needed especially for issues concerning demand and operation but in general any distributed energy resource (small PV, EV, etc.), to ensure the suitable contribution of local resources to the global system security.

- Virtual Power Plants (VPP[5]): strong coordination is necessary on DG management (DERs and storage, the latter considered part of VPPs): for frequency control and system stability improvement (TSO), voltage control, better control the power flow, improving system security and network reliability (TSO & DSO). Utilization of VPP is a resource to improve the power system control. VPP could be a source for the system operation (TSO & DSO).
- Demand Response: The integration of demand side management in TSO operations requires the development of specifications by TSOs for ensuring the successful contribution of active demand at system level, while DSOs (together with suppliers, energy service companies and consumers) will play a very relevant role in final implementation.
- Improved coordination in system security and emergency situations: defining common procedures, to designing more effective defense plans and managing the contribution of RES, DG and active demand during emergency situations throughout Europe, specifying the responsibilities of new actors towards the grid operators and the overall power system.

Smart grids will increase network flexibility by the development of additional intelligence (e.g.: temperature control of transformers, real time thermal monitoring of cables, etc) integrated within network equipments and will improve the existing communication systems. This will increase the current level of 'smartness' in the network, while optimizing its operation and boosting its security.

Therefore it will be necessary to develop an adequate infrastructure for operation and control to provide scalable, adaptable and interoperable solutions.

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5 VPP: From the technical point of view it is an entity that provides location-specific services to the network operators by aggregating local DER. From the commercial point of view it offers services to the market or system operator. See also Annex A for more details.

6. HIGH LEVEL SERVICES OF SMART DISTRIBUTION GRIDS

Smart grid services in the liberalised market

The detailed services to be provided in smart grid solutions will have to be agreed in discussion between the relevant parties. However the following represents a list of the broad services envisaged, showing the provider of the service and the primary beneficiaries.

A provider of a service is a participant that is responsible for such a service alone or in combination with other participants. Primary beneficiaries are participants that require or directly benefit from the services, recognizing that the full benefits from these services are shared among a much wider group of participants.

High-level services

Comment [A1]: We are uncomfortable with consumers being identified as the primary beneficiaries of all of these services. This appears to be based on the assumption that improvements in company efficiencies and services will automatically be passed on to consumers in the form of price reductions. We would rather point the Commission to list identified by Working Group 2. Section 5. P.11. Certainly they do not 'directly' benefit from many of these as outlined in the paragraph above. At best, indirectly, subject to effective governance and intervention. If these are included we would like to see an short explanation of how consumers will directly benefit.

A. Enabling the network to integrate users with new requirements

Outcome: Guarantee the integration of distributed energy resources (both large and small-scale stochastic renewable generation, heat pumps, electric vehicles and storage) connected to the distribution network.

Provider: DSOs
Primary beneficiaries: Generators, consumers (including mobile consumers), storage owners.

B. Enhancing efficiency in day-to-day grid operation

Outcome: Optimise the operation of distribution assets and improve the efficiency of the network through enhanced automation, monitoring, protection and real time operation. Faster fault identification/resolution will help improve continuity of supply levels.

Better understanding and management of technical and non-technical losses, and optimised asset maintenance activities based on detailed operational information.

Provider: DSOs, metering operators
Primary beneficiaries: Consumers, generators, suppliers, DSOs.

C. Ensuring network security, system control and quality of supply

Outcome: Foster system security through an intelligent and more effective control of distributed energy resources, ancillary back-up reserves and other ancillary services. Maximise the capability of the network to manage intermittent generation, without adversely affecting quality of supply parameters.

Provider: DSOs, aggregators, suppliers.
Primary beneficiaries: Generators, consumers, aggregators, DSOs, TSOs.

D. Enabling better planning of future network investment

Outcome: Collection and use of data to enable more accurate modeling of networks especially at LV level, also taking into account new grid users, in order to optimise infrastructure requirements and so reduce their environmental impact. Introduction of new methodologies for more 'active' distribution, exploiting active and reactive control capabilities of distributed energy resources.

Provider: DSOs, metering operators.
Primary beneficiaries: Consumers, generators, storage owners.

Comment [A2]: Why?

E. Improving market functioning and customer service

Outcome: Increase the performance and reliability of current market processes through improved data and data flows between market participants, and so enhance customer experience.

Comment [A3]: How?

Comment [r4]: The causalities are not clear at all.

Provider: Suppliers (with applications and services providers), power exchange platform providers, DSOs, metering operators.
Primary beneficiaries: Consumers, suppliers, applications and services providers.

F. Enabling and encouraging stronger and more direct involvement of consumers in their energy usage

Outcome: Smart meters (with displays) and smart grids will facilitate greater consumption awareness and enable consumers to manage their energy more effectively. With effective communication of load signals consumers will be able to play an active role in load management by modifying their behaviour and potentially benefiting from lower cost tariffs. Consumer groups are mindful that remote load management tariffs must be optional. There will be many low income and vulnerable groups who could be adversely impacted by their mandatory introduction.
Enable the active participation of all actors to the electricity market, through demand response programmes and a more effective management of the variable and non-programmable generation. Obtain the consequent system benefits : peak reduction, reduced network investments, ability to integrate more intermittent generation

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Deleted: to modify their behaviour according to price and load signals and related information.

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Deleted: Obtain the consequent system benefits:

Deleted: peak reduction, reduced network investments.

Provider: Suppliers (with metering operators and DSOs), ESCOs.
Primary beneficiaries: C where involvement is optional and well informed, generators.

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7. FUNCTIONALITIES OF SMART DISTRIBUTION GRIDS

As described in chapter 3, the delivery of smart grid services require specific network functionalities. This chapter lists a series of functionalities grouped according to the high-level services identified in chapter 6. In some cases these functionalities could be broken down further into smaller sub-functionalities. However it is preferred to adopt this level of detail in order to:

– specify a limited number of items; and
– avoid the imposition of any specific market model with respect to other options, as a very detailed list could inhibit some business possibilities.

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A. Enabling the network to integrate users with new requirements

1. Facilitate connections at all voltages/locations[6] for all existing and future devices with SG solutions through the availability of technical data and additional grid information to:
    - o simplify and reduce the cost of the connection process subject to maintaining network integrity/safety;
    - o facilitate an 'open platform' approach – close to 'plug & play';
    - o make connection options transparent;
    - o facilitate connection of new load types, particularly EV;
    - o ensure that the most efficient DER connection strategies can be pursued from a total system perspective;
2. Better use of the grid for users at all voltages/locations, including in particular renewable generators.
3. Registers of the technical capabilities [7] of connected users/devices with an improved network control system, to be used for network purposes (ancillary services).
4. Updated performance data on continuity of supply and voltage quality to inform connected users and prospective users.

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B. Enhancing efficiency in day-to-day grid operation

5. Improved automated fault identification and optimal grid reconfiguration after faults reducing outage times:
    - o using dynamic protection and automation schemes with additional information where distributed generation is present;
    - o strengthening Distribution Management Systems of distribution grids.
6. Enhanced monitoring and control of power flows and voltages.
7. Enhanced monitoring and observability of network components down to low voltage levels, potentially using the smart metering infrastructure.

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[6] Technical constraints permitting and according to the price signal.

[7] Network users/devices, in order to actively participate/be managed in network's operations and energy management, must be characterized by adequate technical capabilities. Considering the active control and demand-response of Distributed Energy Resources (i.e. generators, controllable loads and storage) some of the most relevant technical capabilities that have to be taken into account are:

- Active – reactive power capabilities.
- Dynamic response.
- Electric storage capacity in terms of energy and power.

For example, referring to the renewable generators participation in the network voltage regulation or power flows control, the generator reactive power capability curve and the other capabilities aforementioned, are technical constraint that have to be managed.

8. Improved monitoring of network assets in order to enhance efficiency in day-to-day network operation and maintenance (proactive, condition based, operation history based maintenance).

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9. Identification of technical and non technical losses through power flow analysis, network balances calculation and smart metering information.

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10. Frequent information on actual active/reactive injections/withdrawals by generation and flexible consumption to system operator.

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C. Ensuring network security, system control and quality of supply

11. Solutions to allow grid users and aggregators to participate in an ancillary services market to enhance network operation.

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12. Improved operation schemes for voltage/current control taking into account ancillary services.

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13. Solutions to allow intermittent generation sources to contribute to system security through automation and control.

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14. System security assessment and management of remedies, including actions against terrorist attacks, cyber threats, actions during emergencies, exceptional weather events and force majeure events.

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15. Improved monitoring of safety particularly in public areas during network operations[8].
16. Solutions for demand response for system security purposes in required response times.

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D. Better planning of future network investment

17. Better models of DG, storage, flexible loads (including EV), and the ancillary services provided by them for an improvement of infrastructure planning.

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18. Improved asset management and replacement strategies by information on actual/forecasted network utilization.

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19. Additional information on supply quality and consumption made available by smart metering infrastructure to support network investment planning.

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E. Improving market functioning and customer service

20. Solutions for participation of all connected generators in the electricity market.

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21. Solutions for participation of VPPs in the electricity market, including access to the register of technical capabilities of connected users/devices.

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22. Enable consumer participation in the electricity market, allowing market participants to offer:
    - time of use energy pricing, dynamic energy pricing and critical peak pricing;
    - demand response / load control programmes;

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23. Grid solutions for EV recharging:
    - Open platform grid infrastructure for EV recharge purposes accessible to all market players and customers.

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8 e.g.: control of access to the equipment, detection of fault on overhead networks, protection of the contents of the buildings.

- smart control of the recharging process through load management functionalities of EV.

24. Improved industry systems for settlement, system balance, scheduling and forecasting and customer switching.
25. Grid support to intelligent home/facilities automation and smart devices by consumers.
26. Individual advance notice to grids users for planned interruptions.

Customer level reporting in event of interruptions (during, and after event).

F. Enabling and encouraging stronger and more direct involvement of consumers in their energy usage through smart metering services

27. Sufficient frequency of meter readings, measurement granularity for consumption /injection metering data (e.g. interval metering, active and reactive power, etc).
28. Remote management of meters.
29. Consumption/injection data and price signals via the meter, via a portal or other ways including home displays, as best suited to consumers and generators.
30. Improved provision of energy usage information, including levels of green energy available at relevant intervals and supply contract carbon footprint.
31. Improved information on energy sources.
32. Individual continuity of supply and voltage quality indicators via meter, via portal or other ways including home displays.

It should be noted that the benefits to consumers will only be realised if effective regulation and safeguards are put in place. Consumer protections will need to be reviewed to ensure they are fit for purpose in a smart world. Thus, services and functionalities offered to consumers must be designed to the benefit of consumers, which have different needs and energy consumption patterns. Consumers will also need to have access to appropriate tools and information to help them engage in this new energy market. Particular consideration must be given to the impact of new offerings on low income and vulnerable consumers - Consumers have to have the possibility to opt out, if they are faced with unjustifiable financial burdens.

Smart grids are likely to facilitate greater choice of new smart tariffs and engagement in the market. While choice is welcome, the introduction of new offerings including time of use energy pricing, dynamic energy pricing and critical peak pricing will add another level of complexity, potentially hindering consumers' ability to switch to the best energy deals. In order to navigate and engage in this increasingly complex market, consumers should be offered a choice of appropriate feedback (and support) mechanisms on their energy consumption, including a free stand alone display and free hardcopy feedback. Consumers should have free access to a minimum of a year's worth of their own consumption data (to cover all seasons) in a format that enables them to make like for like comparisons with other deals in the market. Clear complaint handling and redress systems will have to be set up to ensure that when problems arise that they are dealt with efficiently. Also that there are clear lines of responsibility when things go wrong. Consumers should have the choice in whether they adopt new tariffs or energy deals. When they don't have a choice due to member states circumstances, a strategy must be put in place to protect consumers from bill hikes, particularly those on low incomes.

Further aspects are of paramount importance in smart grids deployment:

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Comment [A5]: We would point the Chair to the experiences in America where the compulsory introduction of time of use tariffs in some places has led to a consumer backlash and legal action. We would also point the Chair to the experiences in Victoria, where there has been a moratorium on time of use tariffs because of the impact on vulnerable and low income groups. In Ontario they staggered the introduction of time of use tariffs to ensure that customers are fully aware of the implications in terms of the cost of their energy bills in order to prevent bill shock and enable consumers to learn how to keep their bills low. Anecdotal evidence from smart grid trials in Scotland reported problems when customers did not receive the price signals to change behaviour. They then received a huge bill. The supplier ... [2]

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- Possibility of easy updating and implementation of new technologies.
- System stability, system security, continuity of supply and voltage quality[9] must be safeguarded. In the framework of the national legislations, performance based incentive regulatory schemes are recommended.
- The introduction of tailored contracts (curtailment, quality of supply) between the users or their suppliers and the network operator is an opportunity to meet the preferences of some users.
- The publication and transparency of actual/expected performance of the grid are a means to foster performance improvements and to inform grid users.
- The presentation to consumers of electricity prices and grid tariffs with appropriate frequency that complements smart grid functionalities and integrates/improves high-level service F.
- Starting levels of network conditions and smart grids functionalities are country-specific. This must be taken into account in order to allow a cost-efficient development and a medium/long term common pattern towards smart grids.

In general it can be observed that the functionalities of smart grids are today at different level of development: in addition to basic grid functionalities there will be supplementary functionalities and emerging functionalities. As the process towards smart grids deployment will be a continuous learning process, some aspects need further investigation, e.g. the use and deployment of microgrid control to allow for local distributed intelligence in managing local network balances. The smart grid infrastructure shall provide enough flexibility for new functionalities and services to be deployed. Careful consideration must be made of the consumer experience and impact, as the drivers for new functionalities and innovation most of the time do not come from consumers. Therefore, a systematic review of existing protections and safeguards and a strategy to ensure the delivery of potential consumer benefits is always necessary.

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[9] For continuity of supply and voltage quality the European standard in force is EN50160 ratified in March 2010.

8. FUNCTIONALITIES OF SMART METERING

Overview

Smart metering is covered by a specific Mandate by the Commission to the European Standardization Organisations (ESOs), within the framework of the following Directives:

– 2006/32/EC Directive on energy end-use efficiency and energy services.

– "Third Energy Package" with requirements for intelligent metering of electricity and Gas.

– 2009/72/EC Directive for the Internal Electricity Market (replaces 2003/54/EC).

– 2009/73/EC Directive for the Internal Electricity Market (replaces 2003/55/EC).

– 2004/22/EC Measuring Instruments Directive.

The general objective of the mandate (M/441) is "To create European standards that will enable interoperability of utility meters (water, gas, electricity, heat) which can then improve the means by which customers' awareness of actual consumption can be raised in order to allow timely adaptation in their demands".
The work undertaken in response to that mandate considers the high-level smart metering functionalities which are additional to the traditional metrological functions of electricity and other meters.

Thus the major focus of the M/441 work is the provision of improved information and services to customers and enabling customers to better manage their consumption.

However, in addition, in relation to electricity metering, there is a particular objective to facilitate smart grid applications. In such uses, the meter acts as a remote sensor, providing information relevant to grid operators, especially in the case of low voltage grids (< 1000 Volt).

The scale of smart meter deployment and their data capabilities offer the prospect for vast amounts of detailed data to be gathered. However in this context, the meter is only one of the sensors or actuators in a smart grid - other data will also be available and used by grid management and control systems.

Smart grids thus encompass a much wider area than smart metering, but smart metering is an important first step towards a smart grid:

- Smart meters bring intelligence to the "last mile" between the grid and the final customer.
- Without this key element, the full potential of a smart grid will not be realized.

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Deleted: develop an open software and hardware architecture for utility meters (electricity, gas, water and heat) that includes

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Communication protocols (for bidirectional communication)¶
allows full interoperability and provides consumers and suppliers additional information and suitable management and control systems".¶

Deleted: The M/441 mandate covers smart metering in electricity, gas, water and heat. The work undertaken in response to that mandate considers the high-level smart metering functionalities which are additional to the traditional metrological functions of electricity and other meters. ¶

Comment [r6]: They do not bring "intelligence". Consumers do not have a need for "intelligence" but for appropriate feedback on their consumption. This should be the main advantage of the meter as well as enable to consumer to take part in demand response.

Comment [r7]: Can this statement be proved? It is still not clear whether demand response measure on consumer side really keep up to the theoretical potential of load shifting. As many measures of automation might not be feasible on household level, it has to be questioned whether households can play such a big role within the smart grid.

Smart metering data

No attempt at increasing energy efficiency either through consumption reduction or load shifting will be successful without final customer involvement. In order to unlock this potential direct feedback is essential.

Smart Metering with displays enable direct communication to the customer, and two-way communication is a necessary prerequisite.

In relation to the data from smart meters, some will be relevant to suppliers and their services to customers e.g. the provision of detailed consumption information. Some data will be only of interest to grid operators and other data will be relevant to meter operators (who – depending on the national market model – may be distribution companies, suppliers or meter companies). Certain data may be relevant to more than one party.

The deployment of smart meters thus prompts decisions at national level about the requirements of the various market participants, the nature of data (individual or aggregated) and how dataflows should be managed. Decisions in this area will reflect national market structures and industry systems, but they will also affect the commercial and customer services that smart meters will enable.

Comment [A8]: If you don't have an appropriate feedback mechanism that a customer can engage with you will be communicating with the meter, not the customer

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Comment [r9]: Especially with regard to data flows and the nature of data the EU should not leave everything to the member states but set clear requirements on this,

Smart meter functionalities

The current work being undertaken in response to the M/441 mandate has identified six high-level additional functionalities. In terms of level, these functionalities correspond to the high-level services identified in this report for EG1.

1. Remote reading of metrological registers and provision of these values to designated market organisation(s)
   This includes export metering (i.e. the provision of consumption and injection data and on net flows exported)

2. Two-way communication between the metering system and designated market organisation(s)
   This includes data which permits e.g. monitoring of supply quality, outages, identification of possible meter malfunction, tamper & fraud detection and diagnostics. It will enable remote configuration of the meter or meter parameters. In addition it will enable the metering system to receive messages both standard and ad hoc, e.g. on planned interruptions or price changes.

3. Meter supporting advanced tariffing and payment systems
   In addition to supporting prepayment or other payment options, this will permit multiple registers within the metering system or recording of interval reads.

4. Meter allowing remote disablement & enablement of supply
   This can be used in case of incidents and to help manage maximum capacity. It is also an aspect of the prepayment options noted above.

5. Communicating with (and where appropriate directly controlling) individual devices in the home/building

This can be used to permit remote load management applications and demand side management. In association with smart appliances, it can potentially be used by the customer (remote control of his own equipment), by the supplier (as a service to the customer) or by the network operator.

6. Meter providing information via portal / gateway to an in-home/building display or to auxiliary equipment
By means of an information display or pc, the customer is able to view his consumption information and for the latter to be linked to other information services.

This list shows that the smart metering Infrastructure can also support the development of smart grids through many of the additional functionalities.
Accurate measurement through smart metering is essential to building a new set of functions to support the smart grid. Again, the support for advanced tarification and payment enable utilities to manage the grid in close contact with their customers, by using pricing signal to reduce peak loads. Remote disablement and enablement of power supply gives an additional tool to enhance system reliability in critical load situations but protections must be put in place to prevent misuse of remote disconnection and remote switching of payment method functionality.
Information through home portals and gateways, or direct communication to other devices in home empowers customers to make choices about energy consumption.
Data collected through smart metering systems, that include consumption profiles, outage data, distribution network status can be further used for smart grid strategic planning, asset management and improvement, trough data analysis and forecasting. Again, use of data must be carried out in accordance with data protection and privacy rules.

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Comment [r10]: It has to be guaranteed that utilities make use of this in order to benefit their customers. Firstly, this means that there have to be mechanisms in place that avoid unfair tariffs (consumer fear high cost when they are not able to shift loads). Secondly, it has to be guaranteed that benefits on utility side are also passed on to the consumer.
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Load and small scale generation control

Of particular concern to all participants including the customer is the potential for the smart meter to be the gateway by which the electricity supply can be controlled remotely – either the entire supply (through remote disablement or load/small scale generation limitation) or individual appliances (e.g. through signals sent to chips in the equipment to effect load limitation or time-shifting). There is likely to be considerable industry debate about how this area of functionality is to be provided and this will have implications for the commercial, technological, industry and regulatory structures within which such services will be made available.

Use cases

Starting with these smart metering functionalities, a number of high-level use cases are being developed to support the M/441 standardisation activity, recognising these can be further analysed into more detailed use cases as required.

Those high-level use cases (as currently defined) which are relevant to smart grids (in whole or in part) include:

- Monitor supply disruptions: provision of information on supply interruptions
- Monitor diagnostics of electrical components: detection of inconsistent metering results
- Monitor meter system status: routine communications checking
- Remote configuration: parameters for local generation set by network operator
- Customer display unit receiving messages from e.g. the network operator
- Communication related to multiple-rate tariffs within the meter: setting of tariff schedules
- Remote connection/disconnection: local disconnection when emergency load exceeded

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- Remote power limitation
- Load management by network operator (or supplier) as agreed by customer
- Load management made available by customer
- Meter interface to home communications systems
- Meter interface to sophisticated energy management systems

The standardisation work being undertaken by M/441 therefore covers both the communications and metering requirements for the above purposes insofar as they affect the smart meters and associated infrastructure to be deployed.

In addition, the standardisation work will cover the information likely to be required by meter operators (who may be distribution companies, suppliers etc) in the management of their meter population.

Smart grid services

Smart grid services / functionalities / use cases for the Smart Grid Task Force project are still in the course of development.

On the assumption that the services and functionalities in section 6 and 7 above are a reasonable indication, the main smart grid aspects already being addressed via M/441 are:

On the assumption that the services and functionalities in section 6 and 7 above are a reasonable indication, the main smart grid aspects already being addressed via M/441 are:

- Improving market functioning and customer service (in part), in particular supporting the widespread use of distributed generation.
- Enabling and encouraging stronger and more direct involvement of consumers in their energy usage and improving customer service

In particular, the following functions that are of paramount importance for the implementation of smart grids are anticipated in the work being undertaken under M/441.

- M/441 will address the capability of smart meters to support import/export metering: i.e. the metering of active energy withdrawn/injected and reactive inductive/capacitive energy, and the provision of consumption and injection data and on net flows exported.
- The standards developed under the mandate will support time of use and dynamic pricing and, information display (including display of dynamic pricing information[10]).
- The availability for the consumer of consumption/injection and other data via the metering system or web portal (e.g.: towards an in-house display or energy management device) will facilitate the adoption of home automation.
- A fundamental M/441 functionality is two-way communication with the meter (with appropriate data encryption and security), e.g. for meter reading and remote management of the supply, including disconnection/connection, demand reduction and changing contractual parameters (contractual power, price scheme, etc

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<#>Manage tariff settings on the metering system.¶
<#>Manage the network using metering system data.¶
<#>Enable and disable the metering system.¶
<#>Facilitate demand response.¶
<#>Interact with devices at the premises (and so facilitate demand response).¶
<#>Facilitate distributed generation actions.¶
<#>Manage efficiency measures at the premises using metering system data.¶
<#>Manage power quality data.¶
<#>Manage outage data.¶

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[10] Dynamic pricing information is a use case that requires deeper investigation as It implies a frequent (e.g.: hourly) communication between the central system and all (or a very high number of) smart meters and metrology aspects such as the use of interval metering for billing purposes.

- Relevant information e.g. on quality of supply will be able to be communicated to designated market organisations via the communication systems envisaged to support smart metering.

Functionalities identified for smart grids and smart meters must not be limited by smart metering solutions which use data.

9. STATE OF THE ART OF DEMONSTRATION PROJECTS AND AVAILABLE INDUSTRY SOLUTIONS

Many demonstration projects are currently in place, and some results are already available.
In this chapter the main projects are summarized and cross referenced with the high level services defined in the previous chapters.

9.1. European initiatives

More information is given in the Annex B of this document. This does not replace however the more detailed information on the different projects, available by the different projects partners, also though specific websites.

By analyzing the available information, some conclusions can be drawn:

- Demonstration projects are available whose results will cover a broad range of smart grid functionalities.
- Solutions are available as building blocks to suit most of the smart grid functionalities; however they are still lacking harmonization in a “system” view.
- Standards are available to cover many smart grid functionalities. Analyses are being performed by several bodies (see chapter 10) to understand any overlap and gaps in such standards.
- Smart metering is a reality under the mandate M/441. Notwithstanding the different scope, smart metering provides support to some smart grid functionalities.

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<#>Improving market functioning and customer service (in part), in particular supporting the widespread use of distributed generation.¶
¶
M/441 will address the capability of smart meters to support import/export metering i.e. the provision of consumption and injection data and on net flows exported. This and other information will be communicated to designated market organisations via the communication systems envisaged to support smart metering.¶
¶
<#>Enabling and encouraging stronger and more direct involvement of consumers in their energy usage ¶
¶
In particular the following functions, that are of paramount importance for the implementation of smart grids, are covered within M/441:¶
<#>TOU registers.¶
<#>Metering of active energy withdrawn/ injected and reactive inductive/capacitive energy.¶
<#>Dynamic pricing information[11].¶
<#>Quality of supply information available from the meter.¶
<#>Availability of consumption/injection and other data via the metering system or web portal (e.g.: towards an in-house display or energy management device).¶
<#>Remote management of the supply, including disconnection/connection, demand reduction and changing contractual parameters (contractual power, price scheme, etc.);¶
<#>Two-ways communication with the meter, including meter reading, and ensuring data encryption and security.¶
¶

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High level services	RD&D Projects (see also Annex B for more details)	T&D industry comments
A. **Enabling the network to integrate users with new requirements**	EEGI RD&D projects (1) "Mobi-E" project (Portugal) (2). "Wind demonstration project" ESB (Ireland) (6) Orkney project. Scottish & Southern (UK) (9) DG DemoNetz (AT) (15) emporA (AT) (17) OPEN NODE (EU) (19)	Most of European network were designed to support conventional energy flows, with predictable energy production. T&D Industry can provide upgrade path to fulfill the proposed requirement, however large scale deployment leads to some in-depth change in distribution networks in order to keep efficient network protection, voltage control, reduced losses, fault detection and network reconfiguration. Many T&D projects already provided parts of the answer. Today's solutions such as • Replacement/refurbishment of Power Components • WAMS/WACS & Upgrading Protection and Control Devices for Communication • Installation of Power Quality Devices (Distribution Networks) • Deployment of all types of HVDC • Installation of FACTS (Transmission Networks) can provide measurable benefits
B. **Enhancing efficiency in day-to-day grid operation**	EEGI RD&D projects (1) UK projects (4) "Wind demonstration project" ESB (Ireland) (6) DG DemoNetz (AT) (15) ISOLVES:PSSA-M (AT) (16) MetaPV (EU) (18) FENIX (EU) + zUQde (AT) (20)	Harmonized data modeling and communication services are a must to let all these actors exchanging efficiently meaningful information. T&D Industry is already very active in this field thanks to the availability of new standard such as IEC 61850. However this same level of modeling and interoperability for "secondary networks" is not available yet. Neither it is to embrace condition monitoring applications.
C. **Ensuring network security, system control and quality of supply**	EEGI RD&D projects (1) E-Energy ICT-based Energy System of the Future Project (Germany) (5) "Wind demonstration project "ESB (Ireland) (6) GROW-DERS (8) DG DemoNetz (AT) (15) MetaPV (EU) (18) FENIX (EU) + zUQde (AT) (20)	Harmonizing and Extending the scope of existing standard (IEC 61850 and CIM, mainly) to this domain (secondary network) and

Comment [A11]: We would welcome a column for consumer comments

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D.	Better planning of future network investment	EEGI RD&D projects (1) ISOLVES:PSSA-M (AT) (16)	application (conditioned monitoring) will certainly leverage the spreading of such solutions.
E.	Improving market functioning and customer service	EEGI RD&D projects (1) EDP INOVGRID (Portugal) (3) ADDRESS project (EU) (10) EcoGrid (DK – EU) (21)	Standardized real-time interface between all these actors is a condition to reach the objective on a large scale. Cyber Security must be addressed in priority by standards
F.	Enabling and encouraging stronger and more direct involvement of consumers in their energy usage	EEGI RD&D projects (1) "Connected Home /empowering customer choice" ESB (Ireland) (7) DEHEMS (11): BeyWatch (12) Smart-A (13) Energy@Home (14)	T&D Industry can efficiently contribute to fulfill the requirement, by acting as a communication path between DER, spread consumers and market. It would be even more efficient if the communication infrastructure enabling all these transactions can be shared by the communication infrastructure used for monitoring and controlling the distribution network.

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Comment [A12]: It should be noted that smart metering and smart grids could prompt a radical change in the way energy retail markets operate and consumers relationship with energy. The benefits to consumers will only be realised if effective regulation and safeguards are put in place. Consumer protections will need to be reviewed to ensure they are fit for purpose in a smart world. Consumers will also need to have access to appropriate tools and information to help them engage in this new energy market. Particular consideration must be given to the impact of new offerings on low income and vulnerable consumers.

For example, smart grids are likely to facilitate greater choice of new smart tariffs and engagement in the market. While choice is welcome, the introduction of new offerings including time of use ene ... [3]

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9.2. Smart grids programs in some other countries outside EU

Japan

Japan is aiming at reducing CO_2 emissions by 25% compared with the level in 1990.
As for the "smart grid," the next-generation power distribution grid, Japanese administration will be supporting it financially as soon as possible.
Japan's existing electricity network is already considered to be reliable, and so Japan's objective is more focused – to enable further introduction of renewable energy and create a new infrastructure for EVs and new services through the utilisation of smart meters and ICT network.

METI's 2009 projects included a 'Remote Island Smart Grid Project' (micro-grid project), a 'Smart Charge Project' (with a focus on EV), and a 'Smart House Project' (an element of 'Community Grid system'). In November 2009 a discussion forum was established, involving a wide range of stakeholders, to facilitate discussion through various relevant study groups.

China

The China market is a very important market for smart grid. The requirements there are for a stronger and smarter grid with massive investments focused on increasing capacity, reliability, efficiency and integration of renewable.

End of 2008, the Chinese government approved a US $586 billion stimulus plan focused on large-scale investment in low-income housing, water, rural infrastructure and electricity in China. A secondary effect of this stimulus plan is to increase investment in renewable energy and energy efficiency in China. This effort would include accelerating efforts to achieve the goal of reducing China's energy consumption per unit of GDP by a cumulative 20% by 2010. One very promising approach for China to build energy conservation into its infrastructure is the construction of a "smart grid."

China's overall federal stimulus investments in smart grid projects will surpass the United States' in 2010: the Chinese government will spend $7.3 billion dollars in the form of stimulus loans, grants and tax credits compared to $7.1 billion by the United States government.

Korea

South Korea aims to build the world's first nationwide smart grid system to reduce its emissions by monitoring energy use more carefully.

The grid, to be set up by 2030, is part of the country's $103bn initiative to increase its generation of green energy from the current 2.4 % of total power to 11 % in the next two decades. According to a government-led committee, South Korea could lower its greenhouse gas emissions by 40 million tonnes annually with a national smart grid.

The committee's findings estimate that smart grids would reduce overall energy use by 3 % and lower the peak load for electric power by about 6 %. The electricity savings would be equal to the output of seven 1GW nuclear power reactors.

The committee comprises government officials, company executives and representatives and researchers. It did not provide a cost estimate for the project. Consumers could reduce their electricity bills by an average of 15 % by charging their appliances and cars during off-peak hours, as indicated through the use of smart meters. State-run electricity monopoly Korea Electric Power Corp plans to set up a $65m smart grid pilot project in the country's southern Jeju Island by 2011. It would act as a test-bed for the nationwide initiative. The grid will incorporate two 10MW substation transformers and four power distribution lines located near an area with 3,000 households, commercial districts and green energy facilities that include a wind farm.

US

The US view is that the Smart Grid concept for the electric power grid integrates digital computing, and communication technologies and services, with the power-delivery infrastructure, supporting sophisticated new energy-related applications. Some example new Smart Grid-enabled applications include real-time consumer control over energy usage; increased reliance on solar and other clean or renewable energy sources; controls for large-scale energy storage; mobile billing for charging electric vehicles; security for critical infrastructure protection and for privacy, and more.

Obama administration economic stimulus funding, measured in the billions of dollars, has launched or accelerated Smart Grid technology initiatives that are developing and implementing the new concepts. In late October 2009, President Obama announced 100 Smart Grid Investment Grant Program awards totaling $3.4 billion. This federal investment leveraged an additional $4.7 billion in commitments from private companies, utilities, cities, and other partners that are forging ahead with plans to install Smart Grid technologies and enable an array of efficiency-maximizing and performance-optimizing applications. At the end of 2009, the number of Smart Grid projects in the United States exceeded 130 projects spread across 44 states and two territories.

A recent forecast projects that the U.S. market for Smart Grid-related equipment, devices, information and communication technologies, and other hardware, software, and services will double between 2009 and 2014—to nearly $43 billion.

Key US Public/Private Strategic Activities: the National Institute of Standards and Technology (NIST) Smart Grid Initiatives (May-November 2009) and the NIST Smart Grid Interoperability Panel (November 2009 to Present)

US law, in the form of the 2007 Energy Independence and Security Act (EISA), assigned the National Institute of Standards and Technology, a division of the US Department of Commerce, to coordinate development of a framework of standards for Smart Grid. See their website at www.nist.gov/smartgrid . The concern was that the US's 3600 utilities (power companies), and the 50 state and 3 territorial Public Utility Commissions that regulate them, could follow many different paths in implementing Smart Grid. The result could be a collection of solutions that did not interoperate, limiting value and reducing the opportunity for implementing innovations nationwide. A framework of standards for implementation would help to reduce the implementation paths to a manageable number, increasing market sizes, stimulating innovation, and speeding deployment by lowering prices and increasing reuse.

From May 2009, NIST gathered industry experts from utilities (power companies) and the ITC industry, as well as from regulators, in three massive meetings in May, June and August. These experts analyzed communications and information technology applications for the Smart Grid, proposed use cases and architectures for the SG information networks, and identified industry standards needed to implement these architectures. This work resulted in a report published in January, 2010, titled *NIST Framework and Roadmap for Smart Grid Interoperability Standards, Release 1.0* (see http://www.nist.gov/public_affairs/ releases/smartgrid_interoperability_final.pdf).

In November 2009, to carry this work forward, and to shift much of the responsibility for it to the private sector, NIST launched a public-private partnership, the Smart Grid Interoperability Panel (SGIP). Since then, almost 500 companies and other organizations have joined the SGIP, with 1,350 individuals from member organizations participating in the panel's technical activities. Membership is open to organizations based outside the US as well.

Chief among the SGIP's technical activities are the 16 Priority Action Programs. PAPs are chartered to address areas in which standards require development or revision to complete the Framework. The PAPs gather experts from industry segments related to their charters. For example, PAP #1 (Internet) and PAP #2 (Wireless) are cooperating to quantify SG network requirements, and then identifying standard Internet and radio technologies that meet these requirements. The SGIP work occurs openly, visible in a TWiki website, http://collaborate.nist.gov/twiki-sggrid/bin/view/SmartGrid/WebHome .

In addition to the PAPs, the SGIP also hosts working groups on special topics, including one on Smart Grid security for both critical infrastructure protection and privacy, the Cyber Security Coordination Task Group. This 300-person TG has produced a draft report, *DRAFT NISTIR 7628 Smart Grid Cyber Security Strategy and Requirements*, at http://collaborate.nist.gov/twiki-sggrid/pub/SmartGrid/NISTIR7628Feb2010/draft-nistir-7628_2nd-public-draft.pdf . Finally, the SGIP is launching two new standing committees, on Architecture and on Testing and Certification.

The goal is to complete most strategic and study work by late 2010 and then to move to implementation of a US national, interoperable Smart Grid.

10. INTERNATIONAL INITIATIVES RELATED TO SMART GRID STANDARDIZATION: STATE OF THE ART

At present there are many activities running in parallel which are related to the field of smart grid standardization. Since these activities are relevant to the same subject, there is inevitably some overlapping and duplication of activity and opportunities for learning from the work of others. Among these initiatives are:

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- Smart Grids European Technology Platform
- M 441 Smart metering mandate
- OPEN meter project
- NIST Smart Grid mandate
- IEC Smart grid (SMB Strategic Group)
- IEEE Smart grid initiatives

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<#>Smart Grids European Technology Platform¶

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10.1. SG ETP

The European Technology Platform is engaged "*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 vendors, Energy Research Centres, Smart Metering Industry, Energy Consumers, Utilities Telecom Providers, Grid Regulators) among projects and parallel 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."

Work began in 2005. Its aim was to formulate and promote a vision for the development of European electricity networks looking towards 2020 and beyond.
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 Smart Grids.
In the Strategic Research Agenda, published in 2007 it described the main areas to be investigated, technical and non-technical, in the short-medium term in Europe.
At the end of 2008, the first draft of this Strategic Deployment Document (SDD) was released. Today this document is formally finalized, and describes the priorities for the deployment of innovation in the electricity networks and the benefits that such innovation will deliver for all stakeholders. It also gives a timeline for deployment.

10.2. Smart Metering Mandate (M/441)

Smart metering is covered by a specific Mandate by the European Commission (M/441 Standardization Mandate to the European Standardization Organizations - ESOs). It is described in chapter 8 above and its results will ensure EU-level standards are available for a number of the core services to be provided by smart grids.

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To this mandate are also linked standards relevant to Home automation. In details these are CENELEC EN 50090 series to prepare necessary performance requirements and necessary hardware and software interfaces for all aspects of home and building electronic.

10.3. OPEN meter project

Open meter is a project supported by the European Commission's DG Research”[12], within the EU's Seventh Framework Program. It has the main objective to specify a comprehensive set of open and public standards for advanced metering infrastructure (AMI), supporting electricity, gas, water and heat metering, based on the agreement of all the relevant stakeholders in this area, and taking into account the real conditions of the utility networks so as to allow for full implementation.

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The scope of the project is to address knowledge gaps for the adoption of open standards for smart multi-metering equipments. All relevant aspects – regulatory, environmental, smart metering functions, communication media, protocols, and data formats – are considered within the project.

The result of the project will be a set of draft standards, based on already existing and accepted standards wherever possible. Existing standards will be complemented with new standards, based on innovative solutions developed within the project, to form the new body of smart metering standards. The resulting draft standards will be fed into the European and international standardization process. The project is closely coordinating with the Mandate M/441 initiative. This project officially started on 1st January 2009 and will be accomplished in 30 months, by 30th June 2011.

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10.4. NIST Smart grid Mandate

In 2009 the American Recovery and Reinvestment Act (the Stimulus Bill) directed National Institute of Standards and Technology to address Smart Grid. NIST had had a mandate under the Energy Independence and Security Act of 2007 (EISA).
It foresees a three phase approach:

- identification of applicable standards / specifications.
- Resolution of “gaps”.
- Creation of a conformance regime.

The number of selected standard is significant:

- Twenty-five standards / specifications selected.
- Fifty standards for “further study”.
- Fifteen, (to be sixteen), “Priority Action Plans”.

NIST focuses on the following issues:

- Demand Response and Consumer Energy Efficiency.
- Wide-Area Situational Awareness.
- Energy Storage.
- Electric Transportation.

[12] “Open” is an acronym for Open Public Extended Network

- Advanced Metering Infrastructure.
- Distribution Grid Management.
- Cyber Security.
- Network Communications.
- On January 25, 2010 NIST published the Framework and Roadmap for Smart Grid Interoperability Standards, Release 1.0: a conceptual reference model to facilitate design of an architecture;
- an initial set of 75 standards;
- priorities for additional standards;
- action plans for standards-setting;
- an initial cyber security strategy

10.5. IEC Smart grid initiative

A special group of the International Electrotechnical Commission IEC, namely Strategic Group 3 (SG3) was started in 2009.
The selected approach to standardization foresees five phases:

- Identification of the individual parts and applications of the Smart Grid system.
- Definition of new requirements based on the above description.
- Mapping of existing standards to the requirements.
- Identification of gaps.
- Recommendations for IEC actions. (Filling the gaps / managing a standard framework).

The number of listed standards for consideration reached the impressive number of more than 100.

IEC SG3 focuses on:

- Interoperability.
- Transmission.
- Distribution.
- Metering.
- Connecting the consumers.
- Cyber Security.

The following investigation points are being addressed:

- Communication.
- Security.
- HVDC/FACTS.
- Blackout Prevention/EMS.
- Advanced Distribution Management.
- Distribution Automation.

- Smart Substation Automation.
- Distributed Energy Resources.
- Advanced Meter Infrastructure.
- Demand Response and Load Management.
- Smart Home and Building Automation.
- Electric Storage.
- Electric transportation.
- Condition Monitoring.
- General Topics: EMC, LV Installation, Object Identification, PPC, Engineering / Planning, Use Cases.

In the framework of harmonizing standards ad avoid duplication of work, a significant initiative is the proposal by IEC SG3 to put in place a formal liaison between NIST SGIP and SMB SG3.

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First conclusions can be summarized by the following key issue: to enforce use of concepts/methods from the horizontal committees:

- IEC 61850 and CIM suite of solutions across the entire portfolio framework.
- IEC 61850 (existing and extended) will be used for all communications to field equipment and systems, while the IEC 61970 and IEC 61968 will be used within control centers for managing information exchanges among enterprise systems.

10.6. IEEE Smart grid

The IEEE is engaged in a number of smart grid initiatives globally.
IEEE P2030 is an IEEE project developing a "Draft Guide for Smart Grid Interoperability of Energy Technology and Information Technology Operation with the Electric Power System (EPS), and End-Use Applications and Loads"
The IEEE-SA P2030 guide will provide a knowledge framework for understanding and defining smart grid interoperability of the electric power system with end use applications, setting the stage for future standards related to the smart grid.

10.7. IETF Smart Energy activities

In addition to the IP protocol suite at large, the IETF created a set of activities pertaining to sensor technologies: 6Lowpan, roll. These activities are aiming at bringing the Internet Protocol to sensor and M2M devices needed to build a monitoring infrastructure for the Smart Grid. The IETF work is moving up the layers to introduce an HTTP equivalent for sensor devices (CoAP protocol). Recently the IETF created the smart grid directorate aiming at steering the different Smart Energy activities within the IETF

10.8. 3GPP and ETSI work on M2M

Both ETSI and 3GPP are working on M2M Technology which is believed to be a major building block for the Smart Grid as a means to deploy a wide scale monitoring and control infrastructure. ETSI M2M work aims at providing an architecture that allows the management of the sensor and M2M networks and the deployment of new services on top :

- Data collection and storage
- Communication mediation
- Lifecycle management (incl. software and firmware upgrade)
- Security

In addition ETSI M2M is specifying a set of enablers that will facilitate the deployment of the Smart Grid service layer such as compensation and billing or transaction management. These enablers will be exposed towards Applications through a set of specified and open interfaces.

On the 3GPP side work has been ongoing on the optimising of access and core network infrastructure to allow cost efficient delivery of M2M services. This work is aiming at increasing the scalability and cost effectiveness of the network taking into account fundamental characteristics of M2M communications such as:

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- Stationary devices
- Small amount but frequent data transmission
- Different charging models,

ETSI is one of the organizational partners of 3GPP. In addition all 3GPP standards are transposed into ETSI standards once approved.

11. STANDARDIZATION: RECOMMENDATIONS AND PRIORITIES FOR A STRATEGY TOWARDS SMART GRIDS DEPLOYMENT

EG1 believes that the scope of smart grids is large, thus the risk is that too many bodies work on this issue and that the priorities will not be precisely defined.

The challenge of smart grids deployment will require changes to existing standards, industry rules and processes. These changes are responsibilities of numerous bodies and levels according to Member States arrangements.

Standardization road map

For efficient deployment it is necessary all these changes to be coordinated within a coherent framework road map.

The road map should address:

- Devices;
- Interfaces;
- Communication;
- Cyber security and system integrity;
- System model(s);
- Network and system management;
- Grid codes and Industry rules;

and must take into account the market rules.

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According to this a harmonization of models and standards is necessary. Technical standards have to be defined clearly and fast; if not the desired effect will not occur in the expected time frame. Due to this reason it is necessary to prioritize some key issues and define “fast track” solutions for the core set of standards (see below).

The different domains (Energy Market, Transmission and Distribution, DER, E-Mobility) need to define common interfaces through telecommunication and service standardized and interoperable architectures.

Use cases and standards in development under the Mandate M/441 for smart metering shall be taken into account to ensure coexistence of smart meters and smart grids applications.

Standardization methodology

Concerning standardization, EG1 recommends a top-down approach in order to organize the priorities as proposed below:

1st level: Harmonize the Smart Grid use cases according to roles of each actor in Member States

- mandate one group to host and harmonize Smart Grid use cases in order to support that standardization bodies are working on the same understanding;
- define one formalization method of use cases;
- describe a common set of cross-cutting requirements into the standards to facilitate exchange of confidential and authentic information.

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2nd level: Harmonize Smart Grid data modeling and description language

- common data modeling and description language will allow machine-to-machine understanding;
- an intermediate target could be to get formal and validated translation rules from one machine to another (including wording, semantic and grammar).

3rd level: Harmonize communication protocols

- if protocols are well structured[13], applications can be written in a way they are independent from the protocol:
    - one first step could be to harmonize an abstract definition of communication services;
    - a second step could be to validate mapping of this abstract communication services set on selected "communication layers;

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Standardization area

An indicative list of possible items to address is shown below. Items are grouped according to the high level services identified in chapter 6.

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A. <u>Enabling the network to integrate users with new requirements</u>

[13] Well structured protocols should avoid that different constraints lead to different solutions.

- Physical and electrical connections for generators and consumers;
- Physical and electrical connections for electrical vehicles;
- Physical and electrical connections for heat pumps;
- Physical and electrical connections for storage;
- Metering codes;
- Communication protocols for generators protection relays;
- Technical data and other grid information for the choice of optimal connection points;

B. Enhanced efficiency in day-to-day grid operation

- Communication protocols for protection relays;
- Communication protocols for HV/MV Substation automation;
- Communication protocols for RTUs in HV/MV substations;
- Communication protocols for RTUs in MV/LV substations;
- Common and standardized quality indicators (e.g.: SAIDI, SAIFI, MAIFI weighted on LV consumers) with appropriate grouping rules for interruptions recording;
- Guidelines for maintenance and standardized indicators for unavailability of electrical elements;
- Guidelines for information to consumers about interruption restoration time;
- Guidelines for losses calculation;

C. Ensuring network security, system control and quality of supply

- Standardized data models for load flow analysis, short circuit analysis, selectivity analysis, distance protection, reliability analysis, etc.
- Communication protocols for dispatching and balancing services;
- Communication protocols for storage;
- Guidelines for generation forecasting;
- Grid codes for ancillary services, system balance, scheduling;
- Grid codes for interoperability rules;
- Grid codes and other codes for data exchange rules and settlement;
- Guidelines for improving monitoring of safety in public areas;
- Grid codes and defence plans;
- Guidelines for cyber security;
- Grid codes for operational procedures during emergencies;

D. Better planning of future network investment

- Standardized data models for planning;
- Telecommunication systems;

E. Improving market functioning and customer service

- Standards for communication with EV and loading stations;
- Procedures and interfaces for demand response/load control programmes;

– Procedures for switching;

F. Enabling and encouraging stronger and more direct involvement of consumers in their energy usage

– Communication protocols for smart metering systems, including interfaces towards home/building area networks (at all OSI levels, included data encryption, through each communication way - smart metering systems, other gateways, portal);

Some priorities in the relevant standards to allow Smart Grids deployment

A huge set of standards relevant to Smart Grid is already available from different organizations, some of these standards are identified as core of any present and future implementation of Smart Grid.

Here below the standards identified as having core relevance are listed, other standards with high relevance also follow.

The complete list can be found in Annex C that includes all the standards of the families mentioned below, as well as other standards with relevance identified as low.

Standards identified as having Core relevance:

- IEC 62357 - Reference Architecture – SOA
- IEC 61970 - Common Information Model
- IEC 61850 "Substation Automation"
- IEC 61968 "Distribution Management"
- IEC 61970 "Energy management system application program interface (EMSAPI)"
- IEC 62351 "Security"
- IEC TR 62357 Power system control and associated communications –Reference
- architecture for object models, services and protocols
- IEC 60870-5 Telecontrol

Standards identified as having High Relevance:

- IEC 60870-6 TASE2
- IEC/TR 61334 "DLMS" Distribution Line Message Specification
- IEC 61400 – Wind Turbines
- IEC 61850-7-410 "Hydro Power"
- IEC 61851 "Electrical vehicle charging"
- IEC 62051-54 and IEC 62058-59 "Metering"
- IEC 62056 "COSEM"

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The main focus of activities in development are AMI (including standards of the families IEC 62051-62059; IEC/TR 61334); DER (e.g. IEC 61850-7-410: -420) and EV (e.g. IEC 61851). There are also areas that have not been traditionally matter for standardization such as market and service systems.

The above analysis does not constitute a gap analysis, however it is indicative of the scope of work required and identifies new challenges for standardization. This is then a key area to be developed with the cooperation of the relevant organizations.

Standards referring to data safety, data handling and data protection are considered in the EG2 report.

A key issue : **Interoperability**

A smart grid, and within that smart metering, consists of numerous components provided by different actors, working together to provide a smart power system. For such a system to operate and the desired services and functionalities to be provided, these components will need to be linked together. In this context, interoperability becomes of major importance, not least in the interest of ensuring greater competition.

Interoperability can be defined as the ability of a system or a product to work well with other systems or products. While there are many ways to achieve interoperability, one common way is via interface standards. A good example of this is the set of standards developed for the World Wide Web, including TCP/IP, HTTP and HTML, by which information is seamlessly exchanged over the Internet between devices of all sorts and brands, for the benefit of users and businesses.

Interoperability can be achieved through standardisation of communications in terms of interfaces, signals, messages and workflows. This does not mean unifying all data protocols or applications to a single technology but defining them in a detailed and unambiguous manner and agreeing on the usage and interpretation of standards in such a way as to ensure interoperability between systems and devices.

The introduction of smart grids and smart meters clearly requires the specification of an evolving interoperable framework to support secure bidirectional communications both upstream and downstream of the meter. Interoperability between devices and equipment is key, as the introduction of smart grids and smart metering should not create a barrier to competition or unnecessary cost.

The consumer experience of interoperability must be at the heart of decisions in this area. It is essential that customers can switch energy supplier without having to change their display, in-home smart appliances or communications systems. In-home products must be compatible with all meters. Failure to ensure compatibility will result in increased costs to consumers, increased environmental waste, and inconvenience to consumers. It can act as a barrier to competition in energy and the wider energy services market as well as related sectors.

- Upstream communications must be supported from the meter to the designated market organisation(s). In a smart power system, relevant information will be required to flow to a number of different actors for the requisite functionalities to be achieved

  At an individual level, remote meter reading will be able to be accomplished irrespective of the meter's type or kind, as long as it is a smart meter supporting standard telecommunication interfaces to be specified and agreed upon. What is then important is that the customer is able to choose a new supplier and continue to receive essential smart metering services without the need for the meter {at least) to be changed. Similarly there is a need to ensure that the customer is able to enjoy a comparable level of service after moving house.

- Downstream communications from the meter into the home are also needed in order to provide services for consumers through in-home displays or any other home automation device. This highlights the need for high level security and safety relevant to the distribution network

There are numerous definitions of interoperability which could be adopted. For the purposes of this report, it is not envisaged necessary to go beyond a level of interoperability which is sufficient to meet the above objectives and which ensures that processes are seamless from the perspective of network operators, grid users and customers.

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To facilitate economies of scale in the market, consideration should be given to relevant communications standards in use (or considered for use) elsewhere in Europe as well as to international developments in the standardisation market.

Some other guiding principles :

- Because of the large scope, of the size of the work, of the numerous bodies involved, it is necessary to :
  - Reuse existing standards and learn from existing initiatives
    - Several initiatives are already underway for developing the Smart Grid. The work being done by the relevant organizations, as described in chapter 10 to drive standards gap analysis and standards areas have to be taken into account.
    - In addition existing standards developments need to be fully taken into account
  - Adhere and seek the development of international standards: will allow to reduce product and investments costs.
  - Ensure and maximize collaboration and coordination among the different stakeholder organisations: Smart Grid work is clearly very wide in scope. Its development needs also a wide range of expertise. Ensuring a coherent set of standards will mandate a strong collaboration spirit both in the development of the roadmap as well as during the standards development process.

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- Models, use cases and standards in development under the Mandate M/441 for smart metering shall be taken into account to ensure coexistence of smart meters and smart grids applications.

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- Backward compatibility with the existing home installations should be taken into account.

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- Streamline and speed-up the development of European requirements for Smart Grids: several activities are in place to standardize the Smart Grid. Ensuring a timely effective coordination and standards eco-system is urgently needed so that European requirements can be included in ongoing standards developments.

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- Standardise applications enablers, but not applications: while some smart grid services are known, it is not possible to think of all possible services on top of the Smart Grid. In order to promote innovation, standardisation should focus on service enablers and avoid specification of technical solutions.

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12. CONCLUSIONS AND FURTHER RECOMMENDATIONS

1. **EG1 identified the services that Smart Grids are expected to deliver** to different network users. The agreement of all stakeholders on that core is a priority. After

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validation by the Steering Committee, the **communication and the standardization process** by DG ENER must be organised.

2. **Services and functionalities defined in the report represent the basis that smart grids are expected to offer to all electrical network users in Europe** over time. The implementation of the services allowed by functionalities must be deployed according to the present situation of each Member State, using a ranking method including a cost / benefit analysis for each implementation.

3. To this purpose **EG1 recommends that the level of deployment is assessed at National level**, taking also into account the initial status of networks and their "smartness". For each functionality defined by EG1, this assessment at national level should be based on criteria and indicators developed and recommended by EG3.

4. Furthermore EG1 believes that the process towards **smart grids deployment will be a continuous learning process,** therefore a transparent oversight of demonstration projects is fundamental to assess the current and future status of deployment for each functionality listed by EG1. This oversight should take advantage of project indicators, cost-benefit assessments and dissemination of results.

5. **Smart metering systems are a key factor** for including residential customers in the energy efficiency improvement process. However, **without such a program, some Smart Grids functionalities can still be implemented,** for example for decentralized generation connection, electric vehicle charging infrastructure, network monitoring and network automation.

6. Functionalities for smart metering systems as defined in **mandate M441** include the necessary requirements for implementation of services on smart grids. **An update of this mandate is not necessary.**

7. **Transmission and distribution network operators** have their own program for implementing smart grids. However, **they must increase the level of coordination between them**: VPP management, demand response program, security of supply and emergency process are key issues for a successful coordination.

8. The **acceptability of new services by customers** is a main concern. Consumers must be involved in the smart grid decision making process. All opportunities for evaluating customers' interest must be used, specially involving them in **demonstration projects** planned or in progress in different Member States. This acceptability will be facilitated by a systematic review and updating of consumer protections including around data protection and privacy – to ensure they are fit for purpose in the smart world. Member states will also need to develop strategies for the delivery of consumer benefits, especially where customers are expected to pay for new technology. Roles and responsibilities must be clearly defined so that when consumer issues arise they are quickly and efficiently resolved. Careful consideration will be needed around the tools and information that consumers will need to enable them to engage in this evolving energy retail market. This type of action is essential to build and maintain consumer trust and therefore acceptance and engagement.

9. As smart grids and their benefits still represent broadly misunderstood concepts by most of end consumers, and as many initiatives related to smart grids or smart metering have

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created concerns and questions towards the usefulness and relevance of such developments, EG1 would recommend encouraging member states **to address communication and education of member states citizens and to develop a smart grid communication roadmaps** to:

- familiarize citizens with the EUC 20/20/20 targets and the motivations behind those targets, in particular environmental motivations
- familiarize citizens with the operational and economic aspects of energy systems and how different technologies can positively impact energy use to achieve stated objectives
- familiarize citizens with the meaning of smart grids and how those will support different initiatives to make our energy supply systems and energy use more efficient, including the contribution of smart metering
- addressing identified concerns related to safety, security, privacy that many consumers may have expressed as well as the economic impact on their anticipated bills
- familiarizing citizens with the proposed roadmap
- to help empower consumers act on energy information from smart metering and grids to change their behavior in order to go green and reduce their energy bills
- to help consumers make well informed purchasing decisions when selecting whether or not to sign up to new smart tariffs to ward against potential detriment
- to ensure that consumers are aware of their rights and responsibilities in relation to smart meter roll out and smart grid interaction
- to ensure that consumers are aware of complaint handling and redress systems should problems arise.
- to help promote customer trust, acceptance and engagement, which is a cornerstone to the success of smart grids.
- acknowledge that it is not possible to engage all audiences on the same level: consideration must be given on how best to segment and approach the respective consumer groups
- acknowledge that educational messages do not equate to behavioural shifts. To achieve the desired outcomes campaigns must comprise a call(s) for action that is fun, easy and popular

10. **Demand response programs** will represent a main part of energy efficiency approaches. **All types of customers must be encouraged to be involved in this process: industrial, commercial and residential** consumers. The focus of smart metering programs on residential users must not induce the demand response program to be limited to houses and flats consumption. Domestic customers must have a choice in whether to participate. Where no choice is available there must be a clear national benefit for mandation. In both instances effective protections must be put in place.

11. As smart grids will increase the role of telecommunications in the electric system, **cyber security will become a major concern** and the dialogue between equipments outside and inside public network must be structured to exclude any possibility for external equipment or actors to jeopardize the electric system entering into the electrical telecommunications system.

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<#>The **standardisation of the interface between the public network and the HAN is a key issue**, including protocols, messages and workflow. This interface will be the gateway between electrical system and home equipments. To facilitate the development of new functionalities in these equipments, the interface must be precisely defined in order to fulfil the service performance level required by end users and in-house appliance manufacturers.¶

12. Particular care must be given to **defining the level of performance of the telecommunication infrastructure for smart grids** and smart metering systems, in relation to to the real time level expected, its cost and its interest. The standardisation actors must define some reference levels corresponding to two or three performance levels for the whole system. Some uniformity between European actors is expected, especially to help the interaction between Transmission and Distribution.

13. Further aspects are of paramount importance in smart grids deployment regarding **transverse functionalities** (already recommended in chapter 7):
   - o Possibility of easy updating and implementation of new technologies.
   - o System stability, system security, continuity of supply and voltage quality[14] must be safeguarded. In the framework of the national legislations, performance based incentive regulatory schemes are recommended.
   - o The introduction of tailored contracts (curtailment, quality of supply) between the users or their suppliers and the network operator is an opportunity to meet the preferences of some users.
   - o The publication and transparency of actual/expected performance of the grid are a means to foster performance improvements and to inform grid users.
   - o While some smart grid services are known at this stage it is expected that new services will be developed and deployed over time. The smart grid infrastructure shall provide enough flexibility for new services to be deployed.

Specific recommendations on **standardization issues** (partly coming from chapter 11) are highlighted:

14. EG1 believes that the scope of smart grids is large, thus the risk is that too many bodies work on this issue and that the priorities will not be precisely defined. It is necessary to **ensure and maximize collaboration and coordination among the different stakeholder organisations.** The different domains (Energy Market, Transmission and Distribution, DER, E-Mobility) need to define common interfaces through telecommunication and service standardized and interoperable architectures. At the heart of the decision making must be the consumer experience. Customer representation is essential as part of the process.

15. According to this a **harmonization of models and standards is necessary**. Technical standards have to be defined clearly and quickly; due to this reason it is necessary **to prioritize some key issues and define "fast track" solutions for the core set of standards.**

16. 16. Models, use cases and standards in development under the Mandate M/441 for smart metering shall be taken into account to ensure coexistence of smart meters and smart grids applications.

Standardization work is necessary for an efficient and fast smart grid implementation, but considering that the impact of smart grid is not only technical, but more on the services and the process linked to, **the involvement of all actors working on codes, rules and global regulation is quite important.**

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[14] For continuity of supply and voltage quality the European standard in force is EN50160 ratified in March 2010.

17. **Interoperability between systems is an expectation from all the industrial actors.** Standardisation actors must take that requirement into account. However they must be careful not to restrict innovation and competition by an excessive level of requirements.

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18. The **standardisation of the interface between the wide area network and the HAN is a key issue**, including protocols, messages and workflow. This interface will be the gateway between electrical system and home equipments. To facilitate the development of new functionalities in these equipments, the interface must be precisely defined via M/441 in order to fulfil the service performance level required by end users and in-house appliance manufacturers.

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19. Interoperability and standardisation is essential to ensure compatibility of technology within customers' homes. Consumers should not face barriers when seeking to switch supplier – they should not have to switch display, or in-home smart appliances or other technology. If this happens it will result in inconvenience for customers, additional and unnecessary cost, environmental waste from obsolete or incompatible appliances and potential barriers to competition.

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20. Concerning **standardization** methodology, **EG1 recommends a top-down approach** in order to organize the priorities:
   - o 1st level: Harmonize the Smart Grid use cases to roles of each actor in Member States
   - o 2nd level: Harmonize Smart Grid data modeling and description language
   - o 3rd level: Harmonize communication protocols

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ANNEX A –LIST OF ABBREVIATIONS AND DEFINITIONS

List of abbreviations

Term	Definition
3GPP	Third Generation Partnership Project
AMI	Advanced Metering Infrastructure
CEN	European Committee for Standardization Comité Européen de Normalisation
CENELEC	European Committee for Electrotechnical Standardization Comité Européen de Normalisation ÉLECtrotechnique
CHP	Combined Heat and Power
CIM	Common Information Model
CoAP	Constrained Application Protocol
COSEM	COmpanion Specification for Energy Metering
DER(s)	Distributed Energy Resource(s)
DG	Distributed Generation
DG ENER	Directorate General Energy
DLMS	Distribution Line Message Specification
DNO(s)	Distribution network operator(s)
DSO(s)	Distribution system operator(s)
EC	European Commission
EEGI	European Electricity Grid Initiative
EG1	Expert Group 1 (of the Task Force)
EG2	Expert Group 2 (of the Task Force)
EG3	Expert Group 3 (of the Task Force)
EIA DOE	Energy Information Administration (US) Department of Energy
EISA	(US) Energy Independence and Security Act
EMC	Electromagnetic compatibility
EMS	Energy management system
EN	European Norm
ENTSO for Electricity	European Network of Transmission System Operators for Electricity
EPRI	Electric Power Research Institute
ERGEG	European Regulators Group for Electricity and Gas
ESCO(s)	Energy Service COmpany(ies)
ESO(s)	European standardisation organisation(s)
ETP	European Technology Platform
ETSI	European Telecommunications Standards Institute
EU	European Union
EV(s)	Electric vehicle(s)
FACTS	Flexible alternating current transmission systems
FERC	US Federal Energy Regulatory Commission
HAN	Home Area Network

Term	Definition
HTML	HyperText Markup Language
HTTP	Hyper Text Transfer Protocol
HV	High Voltage
HVDC	High Voltage Direct Current
ICT	Information & communication technology
IEC	International Electrotechnical Commission
IEEE	The world's largest professional association for the advancement of technology - former Institute of Electrical and Electronic Engineers
IETF	Internet Engineering Task Force
IP	Internet Protocol
IT	Information technology
LV	Low Voltage
M2M	Machine to Machine
MAIFI	Momentary average interruption frequency index
MV	Medium Voltage
NIST	National Institute of Standards and Technology
OSI	Open Systems Interconnection
PPC	Product Properties and Classification
PV	Photovoltaic
R&D	Research and development
RES	Renewable energy sources
RTU	Remote Terminal Unit
SAIDI	System average interruption duration index
SAIFI	System average interruption frequency index
SET-Plan	Strategic Energy Technology Plan
SG3	(IEC) Strategic Group on Smart Grid
SGIP	Smart Grid Interoperability Panel
SMB	(IEC) Standardization Management Board
SOA	Service-Oriented Architecture
T&D	Transmission and distribution
TCP	Transmission Control Protocol
TF	Task Force
TR	Technical Report
TSO(s)	Transmission system operator(s)
VPP(s)	Virtual Power Plant(s)

Deleted: Standard Interface

Definitions

Aggregator (with dispatching service functions of DER)
Market participant purchasing/selling electricity products on behalf on two or more consumers/generators/DERs.

AMI - Advanced Metering Infrastructure [9]

Infrastructure which allows two way communications between the Head-End data collection system and the meter(s) and other in-house devices. This infrastructure enables alternative ways of data collection and implementation of mechanisms for remote control of in-house devices. It consists of systems, communication devices and communication networks.

Ancillary services (from FERC order 888-A, April 1996)
Those services that are necessary to support the transmission of capacity and energy from resources to loads while maintaining reliable operation of the Transmission Service Provider's transmission system in accordance with good utility practice. FERC Order 888 identified the following six ancillary services to be included in an open access transmission tariff:

- Scheduling, System Control and Dispatch Service;
- Reactive Supply and Voltage Control from Generation Sources Service;
- Regulation and Frequency Response Service;
- Energy Imbalance Service;
- Operating Reserve - Spinning Reserve Service;
- Operating Reserve - Supplemental Reserve Service.

FERC Order 888 does not preclude the transmission provider from offering voluntarily to provide other interconnected operations services to the transmission customer along with the supply of basic transmission service and ancillary services.
During the consultation process towards Order 888, NERC proposed interconnected operations services were 12 as follows:

- system control and dispatch services;
- accounting;
- regulation service;
- energy imbalance service;
- frequency response service;
- backup supply service;
- operating reserve service: spinning reserve and supplemental reserve services;
- real power loss service;
- reactive supply (from generation resources) and voltage control service;
- restoration service;
- facilities use;
- reactive supply (from transmission resources).

Application and service provider
Provider of applications and services in the Information and Communication Technology world.

CoAP = Constrained Application Protocol (Source IETF).

A specialized transfer protocol for use with constrained networks and nodes for machine-to-machine applications such as smart energy and building automation.

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Demand Response (by FERC)
Changes in electric usage by end-use customers from their normal consumption patterns in response to changes in the price of electricity over time, or to incentive payments designed to induce lower electricity use at times of high wholesale market prices or when system reliability is jeopardized.

Demand Side Management (from EIA DOE)
The planning, implementation, and monitoring of utility activities designed to encourage consumers to modify patterns of electricity usage, including the timing and level of electricity demand. It refers to only energy and load-shape modifying activities that are undertaken in response to utility-administered programs. It does not refer to energy and load-shaped changes arising from the normal operation of the marketplace or from government-mandated energy-efficiency standards. Demand Side Management covers the complete range of load-shape objectives, including strategic conservation and load management, as well as strategic load growth.

DNO - Distribution Network Operator [9]
Organization responsible for managing the electricity network supplying the grid users premises.

DSO
Distribution System Operator: organization owning distribution assets and acting as DNO.

ESCO – Energy Service Company
Market participant offering new contract based products to consumers based on their individual usage pattern of energy (e.g. related to demand response, energy efficiency, etc.)

Metering operator [9]
Entity which offers services on a contractual basis to provide, install and maintain metering equipment related to a supply. The contract may be with the customer, the supplier or the DNO/DSO The meter may be rented to, or owned by, the customer.

Microgrids (from More Microgrids Project)
Interconnection of small, modular generation to low voltage distribution systems forms a new type of power system, the Microgrid. Microgrids can be connected to the main power network or be operated islanded, in a coordinated, controlled way.

Power exchange platform operator
Operator that provides a market place for trading in physical and financial contracts within defined country or region.

Smart meter [9]
Meter with extra functionality allows the meter to collect usage data and transmit this data back to the via the AMI. Load control and tariff management are also examples of possible extra functionality. The Smart Meter has provisions for a consumer interface that enables the consumer to monitor energy usage

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Smart metering system
System including AMI, smart meters, data concentrators, central system and other devices/systems/interfaces suitable to exchange metering information among all market participants.

Virtual Power Plant – VPP (Source - EU Project FENIX)[15]
A Virtual Power Plant (VPP) aggregates the capacity of many diverse Distributed Energy Resources (DER), it creates a single operating profile from a composite of the parameters

[15] See also the definition of aggregator.

characterizing each DER and can incorporate the impact of the network on aggregate DER output. There are two types of VPP, the Commercial VPP (CVPP) and the Technical VPP (TVPP).

Commercial VPP (Source - EU Project FENIX)
A CVPP has an aggregated profile and output which represents the cost and operating characteristics for the DER portfolio. The impact of the distribution network is not considered in the aggregated CVPP profile.
Services/functions from a CVPP include trading in the wholesale energy market, balancing of trading portfolios and provision of services (through submission of bids and offers) to the system operator. The operator of a CVPP can be any third party aggregator or a Balancing Responsible Party (BRP) with market access; e.g. an energy supplier.

Technical VPP (Source - EU Project FENIX)
The TVPP consists of DER´s placed in the same distribution network region. The TVPP includes the real-time influence of the local network on DER aggregated profile as well as representing the cost and operating characteristics of the portfolio.
Services and functions from a TVPP include local system management for Distribution System Operator (DSO), as well as providing Transmission System Operator (TSO) system balancing and ancillary services. The operator of a TVPP requires detailed information on the local network.

ANNEX B - RESEARCH PROJECTS IN THE FIELD OF SMART GRIDS

(1) EEGI Research, Development and Demonstration (RD&D) projects:

The European Electricity Grid Initiative (EEGI) has proposed a 9-year European research, development and demonstration (RD&D) program, initiated by electricity transmission and distribution network operators, to accelerate innovation and the development of the electricity networks of the future in Europe. The initiative has been launched as an European Industrial Initiative at the SET Plan conference in Madrid on the 3rd of June 2010.

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The cost of the entire program is estimated at 2 B€ covering the expected participation of regulated networks, market players, research centers and universities. It does not cover the costs of deploying the solutions across Europe. A detailed implementation plan is also provided, covering priority projects that should start urgently, in the period 2010-2012. The investment in the priority projects is estimated at 1 B€ to cover their full duration.

The proposed RD&D program focuses on system innovation rather than on technology innovation, and addresses the challenge of integrating new technologies under real life working conditions and validating the results. The demonstrations of new developments will allow evaluating their benefits, estimating their costs, and preparing scaling up and replication for an accelerated take-up by all network operators.

A set of functional project has been defined, covering the main functionalities of the Smart Grids that need to be developed and tested to prepare for the deployment of Smart Grids at European level. Each functional project include a description of the demonstration and/or research activities needed to reach specific functional goals.

The proposed approach takes into account the diversity of existing network architectures, operations and national regulations which constrain network performances all over EU27.

The functional needs described can be served by one or more competing technology-based solutions to meet the same needs. This is why the corresponding RD&D projects have been expressed in functional terms leaving the room to competing RD&D proposals to deliver the required knowledge. Program management at European level will ensure that an appropriate number of projects are launched to cover different local conditions and competitive solutions and to meet the needs of each set of requirements in the functional projects.

I.- Projects dealing with joint TSO-DSO issues over the period 2010-2018:

1.- Increased observability of the electric system for more efficient network interactions

- Use of metering data to deliver DG footprints
- Use of simulation models in substations to identify the state of the system
- Data exchange between TSOs and DSOs to better manage imbalances
- Validation of the SMART GRID data exchange conceptual model for current operations

2.- The integration of Demand Side Management in TSO operations

- The TSO planning tools at pan-European level integrate local active demand data
- Demand Response programs are implemented on a wider scale

3.- Further integration of decentralized generation and storage

- Aggregation of loads and distributed generation to manage imbalances and to provide ancillary services to the system
- System services are provided by DER units at DSO level (voltage control and reactive compensation)
- Coordinated congestion management between TSOs and DSOs

4.- Improved defence and restoration plans

- Validation of the SMART GRID data exchange conceptual model for emergency operations

II.- Projects on DSOs' issues over the period 2010-2018:

1.- Active Demand Response

- Peak shaving and energy saving with a full range of incentives encompassing:
  - Real-time price signals
  - Application of time-of-use tariffs
  - Possibility of visualizing and controlling their own power consumption using the latest technology

2.- Energy efficiency coming from network integration of Smart Buildings

- Promoting energy efficiency by integrating energy management systems, home appliances and the Home Automation Network within the local electricity distribution network

3.- Metering infrastructure

- Finding common, open standard solutions for Identifying and overcoming regulatory, technological and economic barriers
- Proposing solutions that can enable a full roll-out of smart metering systems in Europe at more affordable costs
- Expanding the number of clients that will be metered with the same technology

4.- Smart Metering data processing

- Evaluating new business cases when using metering data
- Metering as an enabler for the integration of future renewable energy sources (RES)

5.- DSO integration of small renewables

- Proposing new network design criteria which extend network hosting capacity while still leading to secure operations and high power quality
- Proposing improved connection criteria
- Addressing grid protection issues with specifications towards manufacturers

6.- System integration of mid-size renewables

- Designing and demonstrating new solutions for medium-scale integration
- Increasing the grid hosting capacity for intermittent renewable energy sources
- Validating active, real-time network management for large-scale integrated management of distributed generation

7.- Integration of storage technologies in network management

- Contributing to active, real-time, large-scale integration of storage in conjunction with renewable energy sources and electric vehicles

- Storage integration to obtain a flattening of the load curve and increased power quality
- New knowledge on which storage solution appears the most effective and efficient at a system level

8.- Infrastructure to host electric vehicles

- Proposals to implement an extended electricity recharge infrastructure in order to both enable the easy, secure and flexible recharging of EV and PHEV and boost and foster EV-PHEV penetration in Europe
- Regulatory recommendations to support EV/PHEV penetration
- Tariff scheme to act as an enabler and incentive to promote nightly recharging when energy costs are lower
- Business models related to EV recharging (Energy Suppliers will benefit from the project by extending their offers and including EV energy special contracts)
- Impacts on the grid, testable via a clustered and enlarged set of EV cars recharging simultaneously

9.- Improved planning, monitoring and control of LV networks

- Mass-production of low-cost devices that allow proper monitoring of the LV network
- European standards for such monitoring and control
- More efficient network architectures leading to more effective outage management, load control, load modelling and data exchanges
- Network regulatory schemes based on reliability and quality of power supply

10.- Automation and control of MV network

- MV Advanced network control functions to allow for self-healing grids
- Mobility Tools
- Targeted, preventive maintenance

11.- Methods and system support

- Revamping programs of IT solutions over the MV and LV life cycles, based on policy definition and implementation of the upgrades using new asset management approaches
- Targeted preventive maintenance (power and IT systems)
- Improving the development of renewables in MV and LV networks
- Improvement renewables forecasting

12.- Integrated communication solutions

- Promoting the IP standard in the industry (product and application supplier for electricity network, including supervision and control solution providers)
- Maximising efficiency of electricity infrastructure operations
- Enabling new services requiring broadband and real time interaction between grid components
- Enabling information exchange between DSOs and TSOs, so improving Electric System security and reliability
- Achieving sustainability of IT solutions (including cyber security and life time management)

(2) “Mobi-E” project (Portugal)

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Project promoted by the Portuguese government for facilitating the introduction of electric vehicles. Twenty one Portuguese cities are involved in “Mobi-E” and the short-term goal is the installation of 320 recharging stations by end-2010 and to have active 1 300 recharging stations at the end of 2011. A consortium of Portuguese companies is organised under the “Mobi-E” initiative **involving EDP**, several industrial and consultant companies and research centres.

(3) EDP INOVGRID (Portugal)

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It is a first pilot demonstration trial, already under implementation. It has the objective of connecting, during 2009, 500 customers in 4 different geographical areas of Portugal and 50 000 customers during 2010. The cost of this pilot demonstration trial (15 M€) was accepted by the Portuguese NRA and incorporated at the actual regulatory period tariffs.

(4) UK projects

A number of smart grid projects are already being pursued under existing incentive arrangements – the Innovation Funding Incentive and Registered Power Zones. Projects employing dynamic line ratings, intelligent generator constraint management and advanced voltage control are already operational.

(5) E-Energy Project (Germany)

"E-Energy: ICT-based Energy System of the Future" is a new part of the technology policy of the Federal Government. "E-Energy" stands for the comprehensive digital interconnection and computer-based control and monitoring of the entire energy supply system. The primary goal of E-Energy is to create E-Energy model regions that demonstrate how the tremendous potential for optimisation presented by information and communication technologies (ICT) can best be tapped to achieve greater efficiency, supply security and environmental compatibility (cornerstones of energy and climate policy) in power supply, and how, in turn, new jobs and markets can be developed. What is particularly innovative about this project is that integrative ICT system concepts, which optimise the efficiency, supply security and environmental compatibility of the entire electricity supply system all along the chain - from generation and transport to distribution and consumption – are developed and tested in real-time in regional E-Energy model projects.
To force the pace on the innovative development needed and to broaden the impact of the results, the E-Energy programme focused on the following three aspects:
1. Creation of an E-Energy marketplace that facilitates electronic legal transactions and business dealings between all market participants;
2. Digital interconnection and computerisation of the technical systems and components, and the process control and maintenance activities based on these systems and components, such that the largely independent monitoring, analysis, control and regulation of the overall technical system is ensured;
3. Online linking of the electronic energy marketplace and overall technical system so that real time digital interaction of business and technology operations is guaranteed.
An E-Energy technology competition was held and **six model projects** were declared the winners. They each pursue an integral system approach, covering all energy-relevant economic activities both at market and technical operating levels. The programme will run for a 4-year term and mobilises, together with the equity capital of the participating companies, some €140 million for the **development of six E-Energy model regions:**
- eTelligence, model region of Cuxhaven,
Subject: Intelligence for energy, markets and power grids

- E-DeMa, Ruhr area model region
Subject: decentralised integrated energy systems on the way towards the E-Energy marketplace of the future
- MeRegio,
Subject: Minimum Emission Region
- Mannheim model city
Subject: Model city of Mannheim in the model region of Rhein-Neckar
- RegModHarz
Subject: Regenerative model region of Harz
- Smart Watts, model region Aachen
Subject: Greater efficiency and consumer benefit with the Internet of Energy

By 2012, the selected model regions are to develop their promising proposals up to the stage at which they are ready for market launching and to test their marketability in everyday application

(6) "Wind demonstration project" ESB (Ireland)

- Exploration of Voltage / Var control on Distribution connected wind farms
- Use of voltage regulators to limit voltage rise
- Single transformer cluster stations for wind farms

Green circuits:
- Self Healing Networks
- Losses Reduction
    - Voltage Upgrading i.e. 20kV Conversion
    - Dynamic re-configuration of networks to minimise losses
    - Re-conductoring
    - Amorphous core transformers
    - Installation of Capacitor banks
    - Lower average supply voltage using line drop compensation

(7) "Connected Home/empowering customer choice" ESB (Ireland)

Objective is 'to ascertain the potential for smart meter technology to effect measurable change in consumer behaviour'. 6400 statistically representative customers: One year profile data per customer (at least 6 actual months) for benchmark period

(8) GROW-DERS: Grid reliability and operability with distributed generation using transportable storage.

Project coordinated by KEMA. Main companies involved Iberdrola, MVV Energie among others. Goal: to demonstrate the technical and economical possibilities of existing electricity storage technologies.

(9) Orkney project. Scottish & Southern (UK)

Goal: how to connect renewable energy quickly and economically to constrained networks.

(10) ADDRESS project: Active Distribution network with full integration of Demand and distributed energy RESourceS

ADDRESS is a large-scale Integrated Project co-founded by the European Commission under the 7th Framework Programme.
its target is to enable the Active Demand in the context of the smart grids of the future, or in other words, the active participation of small and commercial consumers in power system markets and provision of services to the different power system participants.
It is carried out by a Consortium of 25 partners from 11 European countries. Enel Distribuzione (Italy) is the Coordinator.

(11) DEHEMS:

A mix of European local authorities, private business and universities is to develop and test a *Digital Energy Home Energy Management System* (**DEHEMS**) for the home market in the frame of FP7. DEHEMS aims at bringing the current intelligent meters in an 'energy performance model' looking at how energy is used to enable new policies in carbon allowances and support increased localized generation and distribution of energy. It will bring together sensor data on household heat loss and appliance performance and monitor energy usage to give real time information on emissions and energy performance of appliances and services. www.dehems.eu

(12) BeyWatch

BeyWatch is a 30-month research project supported by the European Commission (DG Information Society and Media) aiming at *ICT tools for environmental management and energy efficiency*. BeyWatch will develop an energy-aware and user-centric solution, able to provide intelligent energy monitoring/control and power demand balancing at home/building & neighbourhood level. Website: http://www.beywatch.eu/
Participants: EDF, Sigma Orionis, GL, Gorenje, Telefonica, Fagor, Universita degli studi di Palermo, Synelixis

(13) Smart-A

The Smart-A project, *Smart domestic Appliances in Sustainable Energy Systems,* focuses on assessing the potential for load-shifting by household appliances and analysing possible synergies with local sustainable energy generation as well as the requirements of regional load management. Website: http://www.smart-a.org/
Participants: University of Bonn, Germany; Enervision GmbH, Germany
Imperial College, United Kingdom; Inter-University Research Centre, Austria; The European Association for the Promotion of Cogeneration,
(COGEN Europe), Belgium; EnBW Energie Baden-Württemberg AG, Germany; University of Manchester, United Kingdom.
CECED Member: Miele & Cie. KG, Germany.

(14) Energy@Home (Italy)

This project builds on the capability of a smart grid to deliver energy data such as price through an home gateway to smart appliances; these can give to the customer a suggestion and assistance on how to improve the energy management of the house, or can automatically react taking into consideration all the in-house energy requirements.
Partners: Enel Distribuzione, Telecom Italia, Electrolux, Indesit Company

(15) Project chain DG DemoNet: Active distribution network operation with a high share of distributed generation (Austria)

The main project target is to integrate a maximum of decentralised generation units based on renewable energy resources into the electric distribution network without reinforcement of the network.
In the predecessor projects DG DemoNet-Concept and BAVIS voltage control concepts for medium voltage networks with a high share of distributed generation were developed in numerical simulation environments, based on real network data, as well as their economic and technical efficiency was evaluated compared to a reference scenario. Based on this experience, DG DemoNet-Validation analyses, if the promising results from the simulations are also valid under real network conditions and if the developed concepts are effective.
In the present project DG DemoNet-Validation voltage control concepts will be implemented in reality in the analysed grid sections in Vorarlberg and Salzburg by using test platforms. This will allow validating the simulation results from the former projects.

The detailed results of the project are:

- Development of a technical solution (ICT & ET) that complies with the requirements of the developed control concepts.
- Examination of the general applicability of the results.
- Compilation of an operational concept
- Analysis of the long-term cost savings, compared to traditional network planning concepts

(16) ISOLVES:PSSA-M: Innovative Solutions to Optimise Low Voltage Electricity Systems: Power Snap-Shot Analysis by Meters (Austria)

The objective of the project ISOLVES:PSSA-M is to define and develop the required technical foundations to enable an increasing number of distributed energy feed-in opportunities in low voltage networks. For this purpose a method is developed to take an instantaneous image of the network, the so-called "Power Snap-Shot Analysis by Meters" (PSSA-M), and is applied together with the smart meters to be adapted in the framework of the project.
The basic idea behind this method is to simultaneously display measurement values – caused by a trigger state - which represent an instantaneous image of the whole local network (voltage parameters, asset load, etc.). The following possibilities offered by an analysis of the instantaneous image of physical parameters in a low voltage network will be used: load flow and load distribution, critical voltage states, error location, etc. In order to make use of synergies (avoid installation of additional measurement devices, together with high investment and operational costs) the project requires the adaptation of smart meters as measurement devices.

By analysing the obtained measurement data of up to 100 different low voltage networks (including those with urban and rural structures) the potential for implementing a smart grid approach for an active network operation in low voltage networks can be evaluated.
Results from this analysis contribute to investigate and to model low voltage networks more precisely which leads to an essential improvement of network planning and network operation in distribution networks. The final considerations deducted bring considerable improvement to the field of network planning, especially in the area of new generation and demand installations, and it will contribute to guarantee the power quality for end users.

(17) emporA - E-Mobile Power Austria (Austria)

The emporA project brings together Austria's leading businesses from the automobile industry, infrastructure technology, energy supply and science sectors in order to integrate sub-systems, which are either new or currently in development, within innovative complete systems for electric mobility in a user-oriented and international coordinated way.

Objectives of the project (in relation to Smart Grids)

- Forecast and online estimation of distributed renewable generation and e-car demand
- Control of generation / e-car charging to keep the power balance - VPP
- Data concentration (per balance responsible party) at public / fleet car parks
- Control of e-car charging to keep the network balance / voltage band
- Develop for existing DMS system an advanced distribution voltage control application
- Interface for DSO at public / fleet car parks network node level
- Data concentration (per network node) at public / fleet car parks
- Automation system concepts for concentrated e-cars (e.g. in parking houses)

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(18) Meta PV project: Metamorphosis of Power Distribution: System Services from Photovoltaics (EU)

MetaPV demonstrates the provision of electrical benefits from photovoltaics (PV) on a large scale. Additional benefits for active grid support from PV will be demonstrated at two sites: a residential/urban area of 128 households with 4 kWp each, and an industrial zone of 31 PV systems with 200 kWp each. The enhanced control capacities to be implemented into PV inverters and demonstrated are active voltage control, fault ride-through capability, autonomous grid operation, and interaction of distribution system control with PV systems. A detailed technical and economic assessment of the additional services from PV is carried out. The role of PV in an area fully supplied by renewable sources is to be assessed.

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Main Objectives of the project are:

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- Development of the necessary elements for enabling active grid support from PV, namely:
  - enhanced control capacities implemented into PV inverters,
  - adapted grid control strategies and infrastructure including means of communication where required,
  - an efficient use of distributed storage
- Demonstration of additional benefits from PV in a Belgium distribution system, namely:
  - power quality improvement,
  - increased security of power supply.

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(19) Open Architecture for Secondary Nodes of the Electricity SmartGrid (EU)

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The OpenNode project is focussing on inner parts of the distribution grid, namely the smart **Secondary Substation Nodes (SSN)** as substantial component to monitor and control the distribution grid status. Based on Information and Communication Technology (ICT) three challenges will be addressed by a network of embedded devices – the SSNs – capable of communicate to each other and contribute to the efficient exploitation of the energy resources.

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OpenNode project is focussing on research and development of (1) an **open secondary substation node** which is seen as an essential control component of the future smart distribution grid, (2) a **Middleware to couple the SSN operation** with the Utilities systems for grid and utility operation and (3) a **modular communication architecture** based on standardised communication protocols to grant the flexibility required by the stakeholder diversification and to cope with massively distributed embedded systems in the distribution grid. Developments will be guided by an initial analysis of requirements and definition of the overall architecture and interfaces together with the detailed description of the use cases leading to the technical demonstrations with two functional prototypes of a Secondary Substation Node.

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(20) FENIX - Flexible Electricity Networks to Integrate the eXpected "energy revolution" (EU) + zUQde (Austria)

The goal of the FENIX project was to enable Distributed Energy Resources (DER) to make the EU electricity supply system cost efficient, secure and sustainable through aggregation into Large Scale Virtual Power Plant (LSVPP). Two demonstrations had been successful.

Received results:

- Maximum integration / maximum benefit of Decentralized Generation (Medium Voltage range)
- DSO validates (and if necessary, constrains) the DER power offer schedules
- Sell aggregated DER power to the energy market
- Provide aggregated tertiary reserve to TSO reserve market
- Provide reactive power regulation capability of DER in MV range as service for DSO (e.g. to keep line voltages)

Within the research and demonstration project zUQde the results of the FENIX project will be transferred from an offline into an online (full – active) DMS / DSE application version at an medium voltage branch, within an distribution grid of Salzburg Netz AG.

(21) EcoGrid EU project: A Smart Grid prototype for the Future

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The EcoGrid EU vision:
- To implement high dissemination of multiple renewable energy resources to meet the EU 20-20-20 goals
- To create a new and fine meshed electric system based on bidirectional grid, distributed consumption and generation with real-time control and market prices
- To enhance consumer and local producers (prosumers) to participate in the operation of the electric system through a real-time market, energy storage and savings
- To deploy a full scale demonstration in a real grid with participation of the DSO, industrial partners and Community.

(22) Università degli Studi di Genova – T&D Europe

Study on Criteria for the Quantification of how modern T&D-systems help accomplish the EU 20/20/20 targets

The study is aimed at providing criteria on the evaluation on how the future Transmission and Distribution (T&D) infrastructures (Smart Grids process) contribute to accomplish the "EU 20-20-20 targets", in terms of efficiency increase (+ 20% within 2020), CO_2 reduction (– 20% within 2020) and a wider employ of renewable energy resources (+ 20% within 2020).

In particular, the developed methodology allows to quantify the possible environmental benefits as well as the power quality improvement provided by the application of modern T&D products and systems on the power grids to be renovated/upgraded.

Such methodology seems to be at present the only available in state-of-the-art scientific literature and is based on the identification of suitable "performance (technical) indices" to be used to rank the benefits brought by the different grid upgrading measures and on the definition of suitable "test networks". The criteria applied on the reference test networks can be deployed as benchmarks to perform the evaluation, via the introduced indices, of whatever future grid improvement.

Methodology outcomes will be therefore quantities like the saved kilowatt hours, the non-emitted CO_2 Mtons and the evaluation of the increment in renewables' penetration due to the modernization of power grids with interventions like:

- replacement/refurbishment of power components;
- increased use of WAMS/WACS;
- upgrading protection and control devices for communication;
- increase of voltage level;
- installation of power quality devices;
- increased use of compensation devices;
- adoption of new technologies and systems for power transmission (all types of HVDC).

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The results obtained will be used for evaluating the smart grid's potential contribution to EU's goal of mitigating climate change by reducing the carbon footprint of the whole electric power system. The environmental benefits brought by the implementation of each single action listed above will be quantified and used to define new policy directives, covering also the aspect of the identification of suitable incentives and penalties related to each specific investment. All this could be framed in a specific regulation for smart grids, using as a base the solutions deployed in transmission and distribution infrastructures.

TSOs, DSOs and Regulators can use analogous criteria developed to cope with specific concerns in transmission and distribution operation, like power quality indices related to steady-state and dynamic scenarios. In fact, the indices can be used to make comparisons towards a reference configuration. Whenever necessary, the same indices could be analyzed in terms of margins against admissible thresholds, so addressing the meaning of "security".

Focusing quality and security instances could drive towards a dedicated use of renewable volatile resources not only for the primary service provision. Moreover, a reconsideration of rotating and cold power reserve management along the electrical grids will lead to overcome the "n-1" security criterion, so to adapt it to the possible loss of several sparse micro generators.

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ANNEX C – Some relevant standards

This Annex highlights EU, International and Defacto standards identified in the IEC, NIST and ESMIG reports and relevant to smart grid and smart metering applications[16].

European Standards

Electricity Metering (CENELEC)	Description	Interface Reference
EN 50470-1:2006	Electricity metering equipment (a.c.) – Part 1: General requirements, tests and test conditions – Metering equipment (class indexes A, B and C)	N/A
EN 50470-2:2006	Electricity metering equipment (a.c.) – Part 2: Particular requirements – Electromechanical meters for active energy (class indexes A and B)	N/A
EN 50470-3:2006	Electricity metering equipment (a.c.) – Part 3: Particular requirements – Static meters for active energy (class indexes A, B and C)	N/A
EN 61334-3-21:1996	Distribution automation using distribution line carrier systems -- Part 3: Mains signaling requirements -- Section 21: MV phase-to-phase isolated capacitive coupling device	N/A
EN 61334-3-22:2001	Distribution automation using distribution line carrier systems -- Part 3-22: Mains signaling requirements - MV phase-to-earth and screen-to-earth intrusive coupling devices	6
EN 61334-4-1:1996	Distribution automation using distribution line carrier systems -- Part 4: Data communication protocols -- Section 1: Reference model of the communication system	6
EN 61334-4-33:1998	Distribution automation using distribution line carrier systems -- Part 4-33: Data communication protocols - Data link layer - Connection oriented protocol	6,8
EN 61334-4-42:1996	Distribution automation using distribution line carrier systems -- Part 4: Data communication protocols -- Section 42: Application protocols - Application layer	6
EN 61334-4-32:1996	Distribution automation using distribution line carrier systems -- Part 4: Data communication protocols -- Section 32: Data link layer - Logical link control (LLC)	6,8
EN 61334-4-41:1996	Distribution automation using distribution line carrier systems -- Part 4: Data communication protocols -- Section 41: Application protocols - Distribution line message specification	6
EN 61334-4-61:1998	Distribution automation using distribution line carrier systems -- Part 4-61: Data communication protocols - Network layer - Connectionless protocol	6
EN 61334-4-511:2000	Distribution automation using distribution line carrier systems -- Part 4-511: Data communication protocols - Systems management - CIASE protocol	6,8
EN 61334-4-512:2002	Distribution automation using distribution line carrier systems -- Part 4-512: Data communication protocols - System management using profile 61334-5-1 - Management Information Base (MIB)	6,8

[16] This list has been provided by EG2.

Electricity Metering (CENELEC)	Description	Interface Reference
EN 61334-5-1:2001	Distribution automation using distribution line carrier systems -- Part 5-1: Lower layer profiles - The spread frequency shift keying (S-FSK) profile	N/A
EN 61334-6:2000	Distribution automation using distribution line carrier systems -- Part 6: A-XDR encoding rule	N/A
EN 62052-11	Electricity metering equipment (AC) – General requirements, tests and test conditions – Part 11: Metering equipment	N/A
EN 62052-21	Electricity metering equipment (AC) – General requirements, tests and test conditions – Part 21: Tariff and load control equipment	N/A
EN 62053-11	Electricity metering equipment (a.c.) – Particular requirements – Part 11: Electromechanical meters for active energy (classes 0,5,1 and 2)	N/A
EN 62053-21	Electricity metering equipment (a.c.) – Particular requirements – Part 21: Static meters for active energy (classes 1 and 2)	N/A
EN 62053-22	Electricity metering equipment (a.c.) – Particular requirements – Part 22: Static meters for active energy (classes 0,2 S and 0,5 S)	N/A
EN 62053-23	Electricity metering equipment (a.c.) – Particular requirements – Part 23: Static meters for reactive energy (classes 2 and 3)	N/A
EN 62053-31	Electricity metering equipment (a.c.) – Particular requirements – Part 31: Pulse output devices for electromechanical and electronic meters (two wires only)	N/A
EN 62053-52	Electricity metering equipment (a.c.) – Particular requirements – Part 52: Symbols	N/A
EN 62053-61	Electricity metering equipment (a.c.) – Particular requirements – Part 61: Power consumption and voltage requirement	N/A
EN 62054-11	Electricity metering (a.c.) – Tariff and load control – Part 11: Particular requirements for electronic ripple control receivers	N/A
EN 62054-21	Electricity metering (a.c.) – Tariff and load control – Part 21: Particular requirements for time switches	N/A
EN 62055-31	Electricity metering – Payment systems – Part 31: Particular requirements – Static payment meters for active energy (classes 1 and 2)	N/A
EN 62056-21	Electricity metering – Data exchange for meter reading, tariff and load control – Part 21: Direct local data exchange	13
EN 62056-31	Electricity metering – Data exchange for meter reading, tariff and load control – Part 31: Use of local area network on twisted pair with carrier signalling	1
EN 62056-42	Electricity metering – Data exchange for meter reading, tariff and load control – Part 42: Physical layer services and procedures for connection-oriented asynchronous data exchange	2,3,4,5,6,8,9,11,12
EN 62056-46+am1	Electricity metering – Data exchange for meter reading, tariff and load control – Part 46: Data link layer using HDLC protocol	2,3,4,5,6,8,9,11,12
EN 62056-47	Electricity metering – Data exchange for meter reading, tariff and load control – Part 47: COSEM transport layers for IPv4 networks	2,3,4,5,6,8,9,11,12
EN 62056-53	Electricity metering – Data exchange for meter reading, tariff and load control – Part 53: COSEM application layer	2,3,4,5,6,8,9,11,12
EN 62056-61	Electricity metering – Data exchange for meter reading, tariff and load control – Part 61:Object identification system (OBIS)	N/A

Electricity Metering (CENELEC)	Description	Interface Reference
EN 62056-62	Electricity metering – Data exchange for meter reading, tariff and load control – Part 62:Interface classes	N/A
FprEN 62058-11	Electricity metering equipment (AC) – Acceptance inspection – Part 11:General acceptance inspection methods	N/A
FprEN 62058-21	Electricity metering equipment (AC) – Acceptance inspection – Part 21:Particular requirements for electromechanical meters for active energy (classes 0,5,1 and 2)	N/A
FprEN 62058-31	Electricity metering equipment (AC) – Acceptance inspection – Part 31:Particular requirements for static meters for active energy (classes 0,2 S, 0,5 S, 1 and 2)	N/A
EN 62059-31-1	Electricity metering equipment – Dependability – Part 31-1: Accelerated reliability testing – Elevated temperature and humidity	N/A
FprEN 62059-32-1:2008	Electricity metering equipment - Dependability -- Part 32-1: Durability - Testing of the stability of metrological characteristics by applying elevated temperature	N/A
EN 62059-41	Electricity metering equipment – Dependability – Part 41: Reliability prediction	N/A
prEN 62059-51	Electricity metering equipment - Dependability -- Part 51: Software aspects of dependability	N/A
FprEN 61968-9:2008	Application integration at electric utilities - System interfaces for distribution management -- Part 9: Interface standard for meter reading and control	5,6,7,10
Communications		
EN 13321-1 Part 1	Developed by CEN. Open data communication in building automation, controls and building management - Home and building electronic system: Product and system requirements	N/A
EN 13321-1 Part 2	Developed by CEN. Open data communication in building automation, controls and building management - Home and building electronic system:KNXnet/IP Communication	N/A
EN 13757-1:2003 Part 1	Developed by CEN. Communication system for meters and remote reading of meters. Include such communication systems as M-Bus and PLC. Part 1: Data exchange includes Obis and DLMS/COSEM)	1
EN 13757-2:2004 Part 2	Developed by CEN. Communication system for meters and remote reading of meters. Include such communication systems as M-Bus and PLC. Part2: Physical and link layer.	1
EN 13757-3:2004 Part 3	Developed by CEN. Communication system for meters and remote reading of meters. Include such communication systems as M-Bus and PLC. Part 3: Dedicated application layer.	1
EN 13757-4:2005 Part 4	Developed by CEN. Communication system for meters and remote reading of meters. Include such communication systems as M-Bus and PLC. Part 4: Wireless meter read-out (electricity meters are not covered by this standard, as the standardization of remote readout of electricity meters is a task for IEC/CENELEC.	1
EN 13757-5:2008 Part 5	Developed by CEN. Communication system for meters and remote reading of meters. Include such communication systems as M-Bus and PLC. Part 5: Wireless relay.	1

Electricity Metering (CENELEC)	Description	Interface Reference
EN 13757-6 Part 6	Developed by CEN. Communication system for meters and remote reading of meters. Include such communication systems as M-Bus and PLC. Part 6: Local Bus.	1
EN 50090-2-1:1994	Home and Building Electronic Systems (HBES) -- Part 2-1: System overview - Architecture	N/A
EN 50090-2-2:1996	Home and Building Electronic Systems (HBES) -- Part 2-2: System overview - General technical requirements	N/A
EN 50090-2-2:1996/A1:2002	Home and Building Electronic Systems (HBES) -- Part 2-2: System overview - General technical requirements	N/A
EN 50090-2-2:1996/A2:2007	Home and Building Electronic Systems (HBES) -- Part 2-2: System overview - General technical requirements	N/A
EN 50090-2-3:2005	Home and Building Electronic Systems (HBES) -- Part 2-3: System overview - General functional safety requirements for products intended to be integrated in HBES	N/A
EN 50090-3-1:1994	Home and Building Electronic Systems (HBES) -- Part 3-1: Aspects of application - Introduction to the application structure	N/A
EN 50090-3-2:2004	Home and Building Electronic Systems (HBES) -- Part 3-2: Aspects of application - User process for HBES Class 1	N/A
EN 50090-3-3:200X	Home and Building Electronic Systems (HBES) -- Part 3-3: Aspects of application - HBES Interworking model and common HBES data types	N/A
EN 50090-4-1:2004	Home and Building Electronic Systems (HBES) -- Part 4-1: Media independent layers - Application layer for HBES Class 1	1
EN 50090-4-2:2004	Home and Building Electronic Systems (HBES) -- Part 4-2: Media independent layers - Transport layer, network layer and general parts of data link layer for HBES Class 1	N/A
EN 50090-4-3:2007	Home and Building Electronic Systems (HBES) -- Part 4-3: Media independent layers - Communication over IP	1,2 ?
EN 50090-5-1:2005	Home and Building Electronic Systems (HBES) -- Part 5-1: Media and media dependent layers - Power line for HBES Class 1	1,2 ?
EN 50090-5-2:2004	Home and Building Electronic Systems (HBES) -- Part 5-2: Media and media dependent layers - Network based on HBES Class 1, Twisted Pair	1,2, ?
EN 50090-5-3:2006	Home and Building Electronic Systems (HBES) -- Part 5-3: Media and media dependent layers - Radio frequency	1,2, ?
CLC/prTS 50090-6-4	Home and Building Electronic Systems (HBES) -- Part 6-4: Interfaces - Residential gateway model for a home and building electronic system	3,4 ?
EN 50090-7-1:2004	Home and Building Electronic Systems (HBES) -- Part 7-1: System management - Management procedures	N/A
EN 50090-8:2000	Home and Building Electronic Systems (HBES) -- Part 8: Conformity assessment of products	N/A
EN 50090-9-1:2004	Home and Building Electronic Systems (HBES) -- Part 9-1: Installation requirements - Generic cabling for HBES Class 1 Twisted Pair	N/A
CLC/TR 50090-9-2:2007	Home and Building Electronic Systems (HBES) -- Part 9-2: Installation requirements - Inspection and testing of HBES installation	N/A
EN 60870-2-1:1996	Telecontrol equipment and systems -- Part 2: Operating conditions -- Section 1: Power supply and electromagnetic compatibility	N/A

Electricity Metering (CENELEC)	Description	Interface Reference
EN 60870-2-2:1996	Telecontrol equipment and systems -- Part 2: Operating conditions -- Section 2: Environmental conditions (climatic, mechanical and other non-electrical influences)	N/A
EN 60870-5-1:1993	Telecontrol equipment and systems -- Part 5: Transmission protocols - Section 1: Transmission frame formats	3, 4 ?
EN 60870-5-2:1993	Telecontrol equipment and systems -- Part 5: Transmission protocols - Section 2: Link transmission procedures	3, 4 ?
EN 60870-5-3:1992	Telecontrol equipment and systems -- Part 5: Transmission protocols - Section 3: General structure of application data	??
EN 60870-5-4:1993	Telecontrol equipment and systems -- Part 5: Transmission protocols - Section 4: Definition and coding of application information elements	N/A ?
EN 60870-5-5:1995	Telecontrol equipment and systems -- Part 5: Transmission protocols - Section 5: Basic application functions	N/A ?
FprEN 60870-5-6:2008	Telecontrol equipment and systems -- Part 5-6: Guidelines for conformance testing for the IEC 60870-5 companion standards	N/A
EN 60870-5-101:2003	Telecontrol equipment and systems -- Part 5-101: Transmission protocols - Companion standard for basic telecontrol tasks	??
EN 60870-5-102:1996	Telecontrol equipment and systems -- Part 5: Transmission protocols -- Section 102: Companion standard for the transmission of integrated totals in electric power systems	??
EN 60870-5-103:1998	Telecontrol equipment and systems -- Part 5-103: Transmission protocols - Companion standard for the informative interface of protection equipment	??
EN 60870-5-104:2006	Telecontrol equipment and systems -- Part 5-104: Transmission protocols - Network access for IEC 60870-5-101 using standard transport profiles	??
EN 60870-6-2:1995	Telecontrol equipment and systems -- Part 6: Telecontrol protocols compatible with ISO standards and ITU-T recommendations -- Section 2: Use of basic standards (OSI layers 1-4)	??
EN 60870-6-501:1996	Telecontrol equipment and systems -- Part 6: Telecontrol protocols compatible with ISO standards and ITU-T recommendations -- Section 501: TASE.1 Service definitions	??
EN 60870-6-502:1996	Telecontrol equipment and systems -- Part 6: Telecontrol protocols compatible with ISO standards and ITU-T recommendations -- Section 502: TASE.1 Protocol definitions	??
EN 60870-6-503:2002	Telecontrol equipment and systems -- Part 6-503: Telecontrol protocols compatible with ISO standards and ITU-T recommendations - TASE.2 Services and protocol	??
EN 60870-6-601:1995	Telecontrol equipment and systems -- Part 6: Telecontrol protocols compatible with ISO standards and ITU-T recommendations -- Section 601: Functional Profile for providing the Connection-Oriented Transport Service in End System connected via permanent access to a Packet Switched Data Network	??
EN 60870-6-701:1998	Telecontrol equipment and systems -- Part 6-701: Telecontrol protocols compatible with ISO standards and ITU-T recommendations - Functional profile for providing the TASE.1 application service in end systems	??

Electricity Metering (CENELEC)	Description	Interface Reference
EN 60870-6-702:1998	Telecontrol equipment and systems -- Part 6-702: Telecontrol protocols compatible with ISO standards and ITU-T recommendations - Functional profile for providing the TASE.2 application service in end systems	??
EN 60870-6-802:2002/A1:2005	Telecontrol equipment and systems -- Part 6-802: Telecontrol protocols compatible with ISO standards and ITU-T recommendations - TASE.2 Object models	??
EN 61850-3:2002	Communication networks and systems in substations -- Part 3: General requirements	3,6
EN 61850-4:2002	Communication networks and systems in substations -- Part 4: System and project management	3,6
EN 61850-5:2003	Communication networks and systems in substations -- Part 5: Communication requirements for functions and device models	3,6
EN 61850-6:2004	Communication networks and systems in substations -- Part 6: Configuration description language for communication in electrical substations related to IEDs	3,6
FprEN 61850-6:200X	Communication networks and systems for power utility automation -- Part 6: Configuration description language for communication in electrical substations related to IEDs	3,6
FprEN 61850-7-1:2008	Communication networks and systems for power utility automation -- Part 7-1: Basic communication structure - Principles and models	3,6
EN 61850-7-1:2003	Communication networks and systems in substations -- Part 7-1: Basic communication structure for substation and feeder equipment - Principles and models	3,6
FprEN 61850-7-2:2008	Communication networks and systems for power utility automation -- Part 7-2: Basic information and communication structure - Abstract communication service interface (ACSI)	3,6
EN 61850-7-2:2003	Communication networks and systems in substations -- Part 7-2: Basic communication structure for substation and feeder equipment - Abstract communication service interface (ACSI)	3,6
FprEN 61850-7-3:2008	Communication networks and systems for power utility automation -- Part 7-3: Basic communication structure - Common data classes	3,6
EN 61850-7-3:2003	Communication networks and systems in substations -- Part 7-3: Basic communication structure for substation and feeder equipment - Common data classes	3,6
FprEN 61850-7-4:2008	Communication networks and systems for power utility automation -- Part 7-4: Basic communication structure - Compatible logical node classes and data classes	3,6
EN 61850-7-4:2003	Communication networks and systems in substations -- Part 7-4: Basic communication structure for substation and feeder equipment - Compatible logical node classes and data classes	3,6
EN 61850-7-410:2007	Communication networks and systems for power utility automation -- Part 7-410: Hydroelectric power plants - Communication for monitoring and control	3,6
FprEN 61850-7-420:2008	Communication networks and systems for power utility automation -- Part 7-420: Basic communication structure - Distributed energy resources logical nodes	3,6

Electricity Metering (CENELEC)	Description	Interface Reference
EN 61850-8-1:2004	Communication networks and systems in substations -- Part 8-1: Specific Communication Service Mapping (SCSM) - Mappings to MMS (ISO 9506-1 and ISO 9506-2) and to ISO/IEC 8802-3	3,6
EN 61850-9-1:2003	Communication networks and systems in substations -- Part 9-1: Specific Communication Service Mapping (SCSM) - Sampled values over serial unidirectional multidrop point to point link	3,6
EN 61850-9-2:2004	Communication networks and systems in substations -- Part 9-2: Specific Communication Service Mapping (SCSM) - Sampled values over ISO/IEC 8802-3	3,6
EN 61850-10:2005	Communication networks and systems in substations -- Part 10: Conformance testing	3,6
CLC/prTS 61850-80-1	Communication networks and systems for power utility automation - Part 80-1: Guideline to exchanging information from a CDC-based data model using IEC 60870-5-101 or IEC 60870-5-104	3,6
Interface		
EN 61970-1:2007	Energy management system application program interface (EMS-API) Part 1: Guidelines and General Requirements	???
CLC/TS 61970-2:2005	Energy management system application program interface (EMS-API) - Part 2: Glossary	??
FprEN 61970-301:2009	Energy management system application program interface (EMS-API) Part 301: Common information model (CIM) base	???
EN 61970-402:2008	Energy management system application program interface (EMS-API) Part 402: Common services	N/A
EN 61970-403:2008	Energy management system application program interface (EMS-API) Part 403: Generic data access	3,6
EN 61970-404:2007	Energy management system application program interface (EMS-API) Part 404: High speed data access (HSDA)	3,6
EN 61970-405:2007	Energy management system application program interface (EMS-API) Part 405: Generic eventing and subscription (GES)	??
EN 61970-407:2007	Energy management system application program interface (EMS-API) Part 407: Time series data access (TSDA)	3,6
EN 61970-453:2008	Energy management system application program interface (EMS-API) Part 453: CIM based graphics exchange	N/A
EN 61970-501:2006	Energy management system application program interface (EMS-API) Part 501: Common information model resource description framework (CIM RDF) schema	N/A
EN 61968-1:2004	Application integration at electric utilities - system interfaces for distribution management Part 1: Interface architecture and general requirements	6, 11 ?
EN 61968-3:2004	Application integration at electric utilities - system interfaces for distribution management Part 3: Interface for network operations	6 ?
EN 61968-4:2007	Application integration at electric utilities - system interfaces for distribution management Part 4: Interfaces for records and asset management	???

Electricity Metering (CENELEC)	Description	Interface Reference
FprEN 61968-9:2008	Application integration at electric utilities - System interfaces for distribution management -- Part 9: Interface standard for meter reading and control	????
EN 61968-13:2008	Application integration at electric utilities - System interfaces for distribution management - Part 13: CIM RDF Model exchange format for distribution	?????

International

Electricity Metering (IEC)	Description	Interface Reference
IEC/TR 62051	Electricity metering – glossary of terms	
IEC/TR 62051-1	Electricity metering – data exchange for meter reading, tariff and load control	
IEC/TR 61334-1-1 (1995-11)	Distribution automation using distribution line carrier systems - Part 1: General considerations - Section 1: Distribution automation system architecture	
IEC/TR 61334-1-2 (1997-12)	Distribution automation using distribution line carrier systems - Part 1-2: General considerations - Guide for specification	
IEC/TR 61334-1-4 (1995-11)	Distribution automation using distribution line carrier systems - Part 1: General considerations - Section 4: Identification of data transmission parameters concerning medium and low-voltage distribution mains	
IEC 61334-3-1 (1998-11)	Distribution automation using distribution line carrier systems - Part 3-1: Mains signalling requirements - Frequency bands and output levels	
IEC 61334-3-21 (1996-03)	Distribution automation using distribution line carrier systems - Part 3: Mains signalling requirements - Section 21: MV phase-to-phase isolated capacitive coupling device	
IEC 61334-3-22 (2001-01)	Distribution automation using distribution line carrier systems - Part 3-22: Mains signalling requirements - MV phase-to-earth and screen-to-earth intrusive coupling devices	
IEC 61334-4-1 (1996-07)	Distribution automation using distribution line carrier systems - Part 4: Data communication protocols - Section 1: Reference model of the communication system	
IEC 61334-4-32 (1996-09)	Distribution automation using distribution line carrier systems - Part 4: Data communication protocols - Section 32: Data link layer - Logical link control (LLC)	
IEC 61334-4-33 (1998-07)	Distribution automation using distribution line carrier systems - Part 4-33: Data communication protocols - Data link layer - Connection oriented protocol	
IEC 61334-4-41 (1996-08)	Distribution automation using distribution line carrier systems - Part 4: Data communication protocols - Section 41: Application protocol - Distribution line message specification	
IEC 61334-4-42 (1996-10)	Distribution automation using distribution line carrier systems - Part 4: Data communication protocols - Section 42: Application protocols - Application layer	
IEC 61334-4-61 (1998-07)	Distribution automation using distribution line carrier systems - Part 4-61: Data communication protocols - Network layer - Connectionless protocol	
IEC 61334-4-511 (2000-04)	Distribution automation using distribution line carrier systems - Part 4-511: Data communication protocols - Systems management - CIASE protocol	
IEC 61334-4-512 (2001-10)	Distribution automation using distribution line carrier systems - Part 4-512: Data communication protocols - System management using profile 61334-5-1 - Management Information Base (MIB)	
IEC 61334-5-1 (2001-05)	Distribution automation using distribution line carrier systems - Part 5-1: Lower layer profiles - The spread frequency shift keying (S-FSK) profile	

Electricity Metering (IEC)	Description	Interface Reference
IEC/TS 61334-5-2 (1998-05)	Distribution automation using distribution line carrier systems - Part 5-2: Lower layer profiles - Frequency shift keying (FSK) profile	
IEC/TS 61334-5-3 (2001-01)	Distribution automation using distribution line carrier systems - Part 5-3: Lower-layer profiles - Spread spectrum adaptive wideband (SS-AW) profile	
IEC/TS 61334-5-4 (2001-06)	Distribution automation using distribution line carrier systems - Part 5-4: Lower layer profiles - Multi-carrier modulation (MCM) profile	
IEC/TS 61334-5-5 (2001-09)	Distribution automation using distribution line carrier systems - Part 5-5: Lower layer profiles - Spread spectrum - fast frequency hopping (SS-FFH) profile	
IEC 61334-6 (2000-06)	Distribution automation using distribution line carrier systems - Part 6: A-XDR encoding rule	
IEC 62052-11	Electricity metering equipment (AC) – General requirements, tests and test conditions – Part 11: Metering equipment	
IEC 62052-21	Electricity metering equipment (AC) – General requirements, tests and test conditions – Part 21: Tariff and load control equipment	
IEC 62053-11	Electricity metering equipment (a.c.) – Particular requirements – Part 11: Electromechanical meters for active energy (classes 0,5,1 and 2)	
IEC 62053-21	Electricity metering equipment (a.c.) – Particular requirements – Part 21: Static meters for active energy (classes 1 and 2)	
IEC 62053-22	Electricity metering equipment (a.c.) – Particular requirements – Part 22: Static meters for active energy (classes 0,2 S and 0,5 S)	
IEC 62053-23	Electricity metering equipment (a.c.) – Particular requirements – Part 23: Static meters for reactive energy (classes 2 and 3)	
IEC 62053-31	Electricity metering equipment (a.c.) – Particular requirements – Part 31: Pulse output devices for electromechanical and electronic meters (two wires only)	
IEC 62053-52	Electricity metering equipment (a.c.) – Particular requirements – Part 52: Symbols	
IEC 62053-61	Electricity metering equipment (a.c.) – Particular requirements – Part 61: Power consumption and voltage requirement	
IEC 62054-11	Electricity metering (a.c.) – Tariff and load control – Part 11: Particular requirements for electronic ripple control receivers	
IEC 62054-21	Electricity metering (a.c.) – Tariff and load control – Part 21: Particular requirements for time switches	
IEC 62055-21	Electricity metering – Payment systems – Part 21:Framework for standardization	
IEC 62055-31	Electricity metering – Payment systems – Part 31: Particular requirements – Static payment meters for active energy (classes 1 and 2)	
IEC 62055-41	Electricity metering – Payment systems – Part 41: Standard transfer specification (STS) – Application layer protocol for one-way token carrier systems	
IEC 62055-51	Electricity metering – Payment systems – Part 51: Standard transfer specification (STS) – Physical layer protocol for one-way numeric and magnetic card token carriers	
IEC 62055-52	Electricity metering – Payment systems – Part 52: Standard transfer specification (STS) – Physical layer protocol for a two-way virtual token carrier for direct local connection	
IEC 62056-21	Electricity metering – Data exchange for meter reading, tariff and load control – Part 21: Direct local data exchange	
IEC 62056-31	Electricity metering – Data exchange for meter reading, tariff and load control – Part 31: Use of local area network on twisted pair with carrier signalling	

Electricity Metering (IEC)	Description	Interface Reference
IEC/TS 62056-41	Electricity metering – Data exchange for meter reading, tariff and load control – Part 41: Data exchange using wide area networks: Public switched telephone network (PSTN) with LINK + protocol	
IEC 62056-42	Electricity metering – Data exchange for meter reading, tariff and load control – Part 42: Physical layer services and procedures for connection-oriented asynchronous data exchange	
IEC 62056-46+am1	Electricity metering – Data exchange for meter reading, tariff and load control – Part 46: Data link layer using HDLC protocol	
IEC 62056-47	Electricity metering – Data exchange for meter reading, tariff and load control – Part 47: COSEM transport layers for IPv4 networks	
IEC/TS 62056-51	Electricity metering – Data exchange for meter reading, tariff and load control – Part 51: Application layer protocols	
IEC/TS 62056-52	Electricity metering – Data exchange for meter reading, tariff and load control – Part 52: Communication protocols management distribution line message specification (DLMS) server	
IEC 62056-53	Electricity metering – Data exchange for meter reading, tariff and load control – Part 53: COSEM application layer	
IEC 62056-61	Electricity metering – Data exchange for meter reading, tariff and load control – Part 61:Object identification system (OBIS)	
IEC 62056-62	Electricity metering – Data exchange for meter reading, tariff and load control – Part 62:Interface classes	
IEC 62058-11	Electricity metering equipment (AC) – Acceptance inspection – Part 11:General acceptance inspection methods	
IEC 62058-21	Electricity metering equipment (AC) – Acceptance inspection – Part 21:Particular requirements for electromechanical meters for active energy (classes 0,5,1 and 2)	
IEC 62058-31	Electricity metering equipment (AC) – Acceptance inspection – Part 31:Particular requirements for static meters for active energy (classes 0,2 S, 0,5 S, 1 and 2)	
IEC/TR 62059-11	Electricity metering equipment – Dependability – Part 11: General concepts	
IEC/TR 62059-21	Electricity metering equipment – Dependability – Part 21: Collection of meter dependability data from the field	
IEC/TR 62059-31	Electricity metering equipment – Dependability – Part 31-1: Accelerated reliability testing – Elevated temperature and humidity	
IEC/TR 62059-41	Electricity metering equipment – Dependability – Part 41: Reliability prediction	
IEC 61968-9 Ed. 1.0	System Interfaces For Distribution Management - Part 9: Interface Standard for Meter Reading and Control	
Communications		
IEC/ISO 14908-1	Open data communication in building automation, controls and building management - Building network protocol - Part 1: Protocol stack	
IEC/ISO 14908-2	Open Data Communication in Building Automation, Controls and Building Management -- Control Network Protocol -- Part 2: Twisted Pair Communication	
IEC/ISO 14908-3	Open data communication in building automation, controls and building management. Control network protocol. Part 3: Power line channel specification	
IEC/ISO 14908-4	Open Data Communication in Building Automation, Controls and Building Management -- Control Network Protocol -- Part 4: IP Communication	
IEEE 802	Standards for Local Area Network and Metropolitan Area Network. The most widely used standards are: Ethernet, Token Ring, Wireless LAN, Wireless PAN (Personal Area Network), Wireless MAN, Bridging and Virtual Bridged	

Electricity Metering (IEC)	Description	Interface Reference
	LANs.	
IEEE 802.1	Overview & Architecture.	
IEEE 802.2	Standard defining Logical Link Control (LLC), which is the upper portion of the data link layer of the OSI Model.	
IEEE 802.3	Standards defining the physical layer, and the media access control (MAC) sublayer of the data link layer, of wired Ethernet. This is generally a LAN technology with some WAN applications. Physical connections are made between nodes and/or infrastructure devices (hubs, switches, routers) by various types of copper or fiber cable.	
IEEE 802.4	The IEEE 802.4 standard defines a bus physical topology which uses a token message to grant the right to access the physical network media. Group has been disbanded	
IEEE 802.5	CSMA/CD Access method (Lists provisions for Ethernet technology - widely used in such countries as Netherlands, Belgium, Bulgaria, Lithuania, etc.)	
IEEE 802.11	Token Ring Access Method	
IEEE 802.15	Wireless Personal Area Network (Lists provisions for Zigbee, PhyNet, Sensinode technology).	
IEEE 802.15.1:2005	Wireless Personal Area Network standard based on the Bluetooth v1.2 specifications.	
IEEE 802.15.2:2003	Addresses the issue of coexistence of wireless personal area networks (WPAN) with other wireless devices operating in unlicensed frequency bands such as wireless local area networks (WLAN).	
IEEE 802.15.3:2003	MAC and PHY standard for high-rate (11 to 55 Mbit/s) WPANs.	
IEEE 802.15.4:2006	A standard which specifies the physical layer and media access control for low-rate wireless personal area networks (LR-WPANs). ZigBee	
IEEE 802.15.5	Mesh Networking of Wireless Personal Area Networks (WPANs)	
IEEE 802.15.6	This task group is focusing on BAN or Body Area Network Technologies. The goal is a low-power and low-frequency short-range wireless standard.[3]	
IEEE 802.16	Broadband Wireless Metropolitan Area Networks	
IEEE 802.17	Resilent Packet Rings access method and physical layer specifications	
IEC/TR 60870-1-1 Ed. 1.0	Telecontrol equipment and systems. Part 1: General considerations. Section One: General principles	
IEC 60870-1-2 Ed. 1.0	Telecontrol equipment and systems. Part 1: General considerations. Section Two: Guide for specifications	
IEC/TR 60870-1-3 Ed. 2.0	Telecontrol equipment and systems - Part 1: General considerations - Section 3: Glossary	
IEC/TR 60870-1-4 Ed. 1.0	Telecontrol equipment and systems - Part 1: General considerations - Section 4: Basic aspects of telecontrol data transmission and organization of standards IEC 870-5 and IEC 870-6	
IEC/TR 60870-1-5 Ed. 1.0	Telecontrol equipment and systems - Part 1-5: General considerations - Influence of modem transmission procedures with scramblers on the data integrity of transmission systems using the protocol IEC 60870-5	
IEC 60870-2-1 Ed. 2.0	Telecontrol equipment and systems - Part 2: Operating conditions - Section 1: Power supply and electromagnetic compatibility	
IEC 60870-2-2 Ed. 1.0	Telecontrol equipment and systems - Part 2: Operating conditions - Section 2: Environmental conditions (climatic, mechanical and other non electrical influences)	

Electricity Metering (IEC)	Description	Interface Reference
IEC 60870-3 Ed. 1.0	Telecontrol equipment and systems. Part 3: Interfaces (electrical characteristics)	
IEC 60870-4 Ed. 1.0	Telecontrol equipment and systems. Part 4: Performance requirements	
IEC 60870-5-1 Ed. 1.0	Telecontrol equipment and systems. Part 5: Transmission protocols - Section One: Transmission frame formats	
IEC 60870-5-2 Ed. 1.0	Telecontrol equipment and systems - Part 5: Transmission protocols - Section 2: Link transmission procedures	
IEC 60870-5-3 Ed. 1.0	Telecontrol equipment and systems - Part 5: Transmission protocols - Section 3: General structure of application data	
IEC 60870-5-4 Ed. 1.0	Telecontrol equipment and systems - Part 5: Transmission protocols - Section 4: Definition and coding of application information elements	
IEC 60870-5-5 Ed. 1.0	Telecontrol equipment and systems - Part 5: Transmission protocols - Section 5: Basic application functions	
IEC 60870-5-6 Ed. 1.0	Telecontrol equipment and systems - Part 5-6: Guidelines for conformance testing for the IEC 60870-5 companion standards	
IEC 60870-5-101 Ed. 2.0	Telecontrol equipment and systems - Part 5-101: Transmission protocols - Companion standard for basic telecontrol tasks	
IEC 60870-5-102 Ed. 1.0	Telecontrol equipment and systems - Part 5: Transmission protocols - Section 102: Companion standard for the transmission of integrated totals in electric power systems	
IEC 60870-5-103 Ed. 1.0	Telecontrol equipment and systems - Part 5-103: Transmission protocols - Companion standard for the informative interface of protection equipment	
IEC 60870-5-104 Ed. 2.0	Telecontrol equipment and systems - Part 5-104: Transmission protocols - Network access for IEC 60870-5-101 using standard transport profiles	
IEC/TS 60870-5-601	Telecontrol equipment and systems - Part 5-601: Conformance test cases for the IEC 60870-5-101 companion standard	
IEC/TS 60870-5-604 Ed. 1.0	Telecontrol equipment and systems - Part 5-604: Conformance test cases for the IEC 60870-5-104 companion standard	
IEC/TR 60870-6-1 Ed. 1.0	Telecontrol equipment and systems - Part 6: Telecontrol protocols compatible with ISO standards and ITU-T recommendations - Section 1: Application context and organization of standards	
IEC 60870-6-2 Ed. 1.0	Telecontrol equipment and systems - Part 6: Telecontrol protocols compatible with ISO standards and ITU-T recommendations - Section 2: Use of basic standards (OSI layers 1-4)	
IEC 60870-6-501 Ed. 1.0	Telecontrol equipment and systems - Part 6: Telecontrol protocols compatible with ISO standards and ITU-T recommendations - Section 501: TASE.1 Service definitions	
IEC 60870-6-502 Ed. 1.0	Telecontrol equipment and systems - Part 6: Telecontrol protocols compatible with ISO standards and ITU-T recommendations - Section 502: TASE.1 Protocol definitions	
IEC 60870-6-503 Ed. 2.0	Telecontrol equipment and systems - Part 6-503: Telecontrol protocols compatible with ISO standards and ITU-T recommendations - TASE.2 Services and protocol	
IEC/TS 60870-6-504 Ed. 1.0	Telecontrol equipment and systems - Part 6-504: Telecontrol protocols compatible with ISO standards and ITU-T recommendations - TASE.1 User conventions	
IEC/TR 60870-6-505 Consol. Ed. 1.1 (incl. am1)	Telecontrol equipment and systems - Part 6-505: Telecontrol protocols compatible with ISO standards and ITU-T recommendations - TASE.2 User guide	

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Electricity Metering (IEC)	Description	Interface Reference
IEC/TR 60870-6-505-am1 Ed. 1.0	Amendment 1 - Telecontrol equipment and systems - Part 6-505: Telecontrol protocols compatible with ISO standards and ITU-T recommendations - Tase.2 User guide	
IEC 60870-6-601 Ed. 1.0	Telecontrol equipment and systems - Part 6: Telecontrol protocol s compatible with ISO standards and ITU-T recommendations - Sect ion 601: Functional profile for providing the connection-oriente d transport service in an end system connected via permanent acc ess to a packet switched data network	
IEC/TS 60870-6-602 Ed. 1.0	Telecontrol equipment and systems - Part 6-602: Telecontrol protocols compatible with ISO standards and ITU-T recommendations - TASE transport profiles	
IEC 60870-6-701 Ed. 1.0	Telecontrol equipment and systems - Part 6-701: Telecontrol protocols compatible with ISO standards and ITU-T recommendations - Functional profile for providing the TASE.1 application service in end systems	
IEC 60870-6-702 Ed. 1.0	Telecontrol equipment and systems - Part 6-702: Telecontrol protocols compatible with ISO standards and ITU-T recommendations - Functional profile for providing the TASE.2 application service in end systems	
IEC 60870-6-802 Consol. Ed. 2.1 (incl. am1)	Telecontrol equipment and systems - Part 6-802: Telecontrol protocols compatible with ISO standards and ITU-T recommendations - TASE.2 Object models	
IEC 60870-6-802-am1 Ed. 2.0	Amendment 1 - Telecontrol equipment and systems - Part 6-802: Telecontrol protocols compatible with ISO standards and ITU-T recommendations - TASE.2 Object models	
IEC/TR 61850-1 Ed. 1.0	Communication networks and systems in substations - Part 1: Introduction and overview	
IEC/TS 61850-2 Ed. 1.0	Communication networks and systems in substations - Part 2: Glossary	
IEC 61850-3 Ed. 1.0	Communication networks and systems in substations - Part 3: General requirements	
IEC 61850-4 Ed. 1.0	Communication networks and systems in substations - Part 4: System and project management	
IEC 61850-5 Ed. 1.0	Communication networks and systems in substations - Part 5: Communication requirements for functions and device models	
IEC 61850-6 Ed. 1.0	Communication networks and systems in substations - Part 6: Configuration description language for communication in electrical substations related to IEDs	
IEC 61850-7-1 Ed. 1.0	Communication networks and systems in substations - Part 7-1: Basic communication structure for substation and feeder equipment - Principles and models	
IEC 61850-7-2 Ed. 1.0	Communication networks and systems in substations - Part 7-2: Basic communication structure for substation and feeder equipment - Abstract communication service interface (ACSI)	
IEC 61850-7-3 Ed. 1.0	Communication networks and systems in substations - Part 7-3: Basic communication structure for substation and feeder equipment - Common data classes	
IEC 61850-7-4 Ed. 1.0	Communication networks and systems in substations - Part 7-4: Basic communication structure for substation and feeder equipment - Compatible logical node classes and data classes	
IEC 61850-7-410 Ed. 1.0	Communication networks and systems for power utility automation - Part 7-410: Hydroelectric power plants - Communication for monitoring and control	
IEC 61850-8-1 Ed. 1.0	Communication networks and systems in substations - Part 8-1: Specific Communication Service Mapping (SCSM) - Mappings to MMS (ISO 9506-1 and ISO 9506-2) and to ISO/IEC 8802-3	

Electricity Metering (IEC)	Description	Interface Reference
IEC 61850-9-1 Ed. 1.0	Communication networks and systems in substations - Part 9-1: Specific Communication Service Mapping (SCSM) - Sampled values over serial unidirectional multidrop point to point link	
IEC 61850-9-2 Ed. 1.0	Communication networks and systems in substations - Part 9-2: Specific Communication Service Mapping (SCSM) - Sampled values over ISO/IEC 8802-3	
IEC 61850-10 Ed. 1.0	Communication networks and systems in substations - Part 10: Conformance testing	
IEC/TS 61850-80-1 Ed. 1.0	Communication networks and systems for power utility automation - Part 80-1: Guideline to exchanging information from a CDC-based data model using IEC 60870-5-101 or IEC 60870-5-104	3,6
ISO/IEC 14543-2-1	Information technology - Home electronic system (HES) architecture - Part 2-1: Introduction and device modularity - **(NOTE: ISO/IEC 14543 aligns with European Standards EN13321-1/2 & EN 50090)**	
ISO/IEC 14543-3-1	Information technology - Home electronic system (HES) architecture - Part 3-1: Communication layers - Application layer for network based control of HES Class 1	
ISO/IEC 14543-3-2	Information technology - Home electronic system (HES) architecture - Part 3-2: Communication layers - Transport, network and general parts of data link layer for network based control of HES Class 1	
ISO/IEC 14543-3-3	Information technology - Home electronic system (HES) architecture - Part 3-3: User process for network based control of HES Class 1	
ISO/IEC 14543-3-4	Information technology - Home electronic system (HES) architecture - Part 3-4: System management - Management procedures for network based control of HES Class 1	
ISO/IEC 14543-3-5	Information technology - Home electronic system (HES) architecture - Part 3-5: Media and media dependent layers - Powerline for network based control of HES Class 1	
ISO/IEC 14543-3-6	Information technology - Home electronic system (HES) architecture - Part 3-6: Media and media dependent layers - Twisted pair for network based control of HES Class 1	
ISO/IEC 14543-3-7	Information technology - Home electronic system (HES) architecture - Part 3-7: Media and media dependent layers - Radio frequency for network based control of HES Class 1	
ISO/IEC 14543-4-1	Information technology - Home electronic system (HES) architecture - Part 4-1: Communication layers - Application layer for network enhanced control devices of HES Class 1	
ISO/IEC 14543-4-2	Information technology - Home electronic system (HES) architecture - Part 4-2: Communication layers - Transport, network and general parts of data link layer for network enhanced control devices of HES Class 1	
Interface		
IEC 61970-1	Energy management system application program interface (EMS-API) Part 1: Guidelines and General Requirements	
IEC/TS 61970-2	Energy management system application program interface (EMS-API) - Part 2: Glossary	
IEC 61970-301	Energy management system application program interface (EMS-API) Part 301: Common information model (CIM) base	
IEC 61970-302	Energy management system application program interface (EMS-API) - Part 302: Common information model (CIM) financial, energy scheduling and reservations	

Electricity Metering (IEC)	Description	Interface Reference
IEC/TS 61970-401:2005	Energy management system application program interface (EMS-API) - Part 401: Component interface specification (CIS) framework	
IEC 61970-402	Energy management system application program interface (EMS-API) Part 402: Common services	
IEC 61970-403	Energy management system application program interface (EMS-API) Part 403: Generic data access	
IEC 61970-404	Energy management system application program interface (EMS-API) Part 404: High speed data access (HSDA)	
IEC 61970-405	Energy management system application program interface (EMS-API) Part 405: Generic eventing and subscription (GES)	
IEC 61970-407	Energy management system application program interface (EMS-API) Part 407: Time series data access (TSDA)	3,6
IEC 61970-453	Energy management system application program interface (EMS-API) Part 453: CIM based graphics exchange	3,6
IEC 61970-501	Energy management system application program interface (EMS-API) Part 501: Common information model resource description framework (CIM RDF) schema	3,6
IEC 61968-1	Application integration at electric utilities - system interfaces for distribution management Part 1: Interface architecture and general requirements	3,6
IEC/TS 61968-2	Application integration at electric utilities - System interfaces for distribution management - Part 2: Glossary	3,6
IEC 61968-3	Application integration at electric utilities - system interfaces for distribution management Part 3: Interface for network operations	3,6
IEC 61968-4	Application integration at electric utilities - system interfaces for distribution management Part 4: Interfaces for records and asset management	3,6
IEC 61968-13	Application integration at electric utilities - System interfaces for distribution management - Part 13: CIM RDF Model exchange format for distribution	3,6
Data exchange security		
IEC/TS 62351-1:2007	Power systems management and associated information exchange - Data and communications security - Part 1: Communication network and system security - Introduction to security issues	3,6
IEC/TS 62351-2	Application integration at electric utilities - System interfaces for distribution management - Part 2: Glossary	3,6
IEC/TS 62351-3:2007	Power systems management and associated information exchange - Data and communications security - Part 3: Communication network and system security - Profiles including TCP/IP	3,6
IEC/TS 62351-4:2007	Power systems management and associated information exchange - Data and communications security - Part 4: Profiles including MMS	3,6
IEC/TS 62351-6:2007	Power systems management and associated information exchange - Data and communications security - Part 6: Security for IEC 61850	3,6

Other Defacto standards, TRs, FDIS, CDs

Standard	Description	Interface Reference
ZigBee Smart Energy Profile	HAN protocol based on IEEE 802.15.4 MAC and PHY.	1
PCI - DSS	Code of practice for payment card Industry for the holding of Credit and Debit Card details and persona data.	4,5,6,7,10,11

Page 3: [1] Deleted	EDF-GDF	16/06/2010 09:46:00

Page 14: [2] Comment [A5]	Administrator	16/07/2010 17:32:00

We would point the Chair to the experiences in America where the compulsory introduction of time of use tariffs in some places has led to a consumer backlash and legal action. We would also point the Chair to the experiences in Victoria, where there has been a moratorium on time of use tariffs because of the impact on vulnerable and low income groups. In Ontario they staggered the introduction of time of use tariffs to ensure that customers are fully aware of the implications in terms of the cost of their energy bills in order to prevent bill shock and enable consumers to learn how to keep their bills low. Anecdotal evidence from smart grid trials in Scotland reported problems when customers did not receive the price signals to change behaviour. They then received a huge bill. The supplier said it was the responsibility of the display manufacturer. The display manufacture the fault of the supplier. The customer was left not knowing who was responsible. The underlying assumption of this document is that the energy retail market and customer service will change for the better. This may not be the consumer experience unless action is taken. We strongly feel that this should be addressed somewhere in the report.

Page 22: [3] Comment [A12]	Administrator	26/07/2010 15:29:00

It should be noted that smart metering and smart grids could prompt a radical change in the way energy retail markets operate and consumers relationship with energy. The benefits to consumers will only be realised if effective regulation and safeguards are put in place. Consumer protections will need to be reviewed to ensure they are fit for purpose in a smart world. Consumers will also need to have access to appropriate tools and information to help them engage in this new energy market. Particular consideration must be given to the impact of new offerings on low income and vulnerable consumers.

For example, smart grids are likely to facilitate greater choice of new smart tariffs and engagement in the market. While choice is welcome, the introduction of new offerings including time of use energy pricing, dynamic energy pricing and critical peak pricing will add another level of complexity, potentially hindering consumers' ability to switch to the best energy deals. In order to navigate and engage in this increasingly complex market, consumers should be offered a choice of appropriate feedback and support mechanisms on their energy consumption, including a free stand alone display and free hardcopy feedback. Consumers should have free access to a minimum of a year's worth of their own consumption data (to cover all seasons) in a format that enables them to make like for like comparisons with other deals in the market. Clear complaint handling and redress systems will have to be set up to ensure that when problems arise that they are dealt with efficiently. Also that there are clear lines of responsibility when things go wrong. Consumers should have the choice in whether they adopt new tariffs or energy deals. When they don't have a choice due to member states circumstances, a strategy must be put in place to protect consumers from bill hikes, particularly those on low incomes.

Page 22: [4] Deleted	EDF-GDF	16/06/2010 12:46:00

Most of European network were designed to support conventional energy flows, with predictable energy production. T&D Industry can provide upgrade path to fulfil the proposed requirement, however large scale deployment leads to some in-depth change in distribution networks in order to keep efficient network protection, voltage control, reduced losses, fault detection and network reconfiguration.

Harmonised data modeling is a must to let all these actors exchanging efficiently meaningful information.

T&D Industry is already very active in this field thanks to the availability of new standard such as IEC 61850. However this same level of modeling and interoperability for "secondary networks" is not available yet. Neither it is to embrace condition monitoring applications.

Harmonising and Extending the scope of existing standard (IEC 61850 and CIM, mainly) to this domain (secondary network) and application (conditioned monitoring) will certainly leverage the spreading of such solutions.

Many T&D projects already provided parts of the answer.

Standardised real-time interface between all these actors is a condition to reach the objective on a large scale.

Cyber Security must be addressed in priority by standards

T&D Industry can efficiently contribute to fulfil the requirement, by acting as a communication path between DER, spread consumers and market.
It would be even more efficient if the communication infrastructure enabling all these transactions can be shared by the communication infrastructure used for monitoring and controlling the distribution network.
Harmonised data modelling and communication services is key to reach the target.
Cyber Security must be addressed in priority by standards.

ANNEX 2

TASK FORCE SMART GRIDS

EXPERT GROUP 2: REGULATORY RECOMMENDATIONS FOR DATA SAFETY, DATA HANDLING AND DATA PROTECTION

REPORT

VERSION: 1.1

ISSUED: JUNE 17, 2010

TABLE OF CONTENTS

Deleted: 7
Deleted: 9
Deleted: 11
Deleted: 11
Deleted: 11
Deleted: 14
Deleted: 14
Deleted: 14
Deleted: 15
Deleted: 16
Deleted: 16
Deleted: 17
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Deleted: 21
Deleted: 23
Deleted: 25
Deleted: 27
Deleted: 28
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Deleted: 30
Deleted: 32
Deleted: 34

1 INTRODUCTION AND SCOPE OF REPORT

To facilitate and support the process of an EU-wide Smart Grid roll-out, the European Commission decided to set up a Task Force on Smart Grids. The Commission invited all relevant institutional actors and market stakeholders to the first Steering Committee meeting. The Steering Committee agreed to establish three Expert Groups who will jointly develop a common vision for the implementation of Smart Grids in Europe and identify regulatory recommendations and key issues that need to be resolved.

The ultimate goal of this Work Program is to identify and produce a set of regulatory recommendations to ensure EU-wide consistent and fast implementation of Smart Grids, while achieving the expected Smart Grids' services and benefits for all users involved.

The key deliverable of the Smart Grid Expert Group two (EG2) is to identify the appropriate regulatory scenario and recommendations for data handling, security and consumer protection. The aim is to establish a data privacy and data security framework that both protects and enables. In particular, the expert group was asked to focus on the following topics:

- Identify the benefits and concerns of customers when becoming active actors in the Smart Grids' retail markets.
- Overview of European legislation on data protection and checking whether further protective measures should be put in place
- Identify possible risks in the handling of data, safety and data protection, include data exchange issues.
- Identify ownership of data and access rights.
- Identify responsible parties for data protection
- Analyse how these issues should be handled along the value chain
- Develop a framework in which data can be used
- Recommendations for Information and Communication of Smart Grid benefits to consumers and politicians

In the report the different areas have not been given equal weighting, focus of the Expert Group has been on data security and privacy.

2 EXECUTIVE SUMMARY

This report is the output of Expert Group 2 which focused on identifying the appropriate regulatory scenario and recommendations for data handling, security and consumer protection.

It was recognized that although there were many common Smart Grid definitions already used in the development of EU Standards and within the legislative framework, that there were no common definitions related to smart grids. The appropriate definitions necessary are specified within the body of the report for such terms as Personal data, location data, etc.

The European legal framework regarding privacy and data protection can be described as a collection of rules and regulations. The basic privacy and data protection issues that derive from the EU Privacy Directives and treaties require that an assessment needs to be undertaken to ascertain if the data being processed is of a personal nature or not. If it is personal data then there are privacy issues that need to be addressed and that this processing of personal data must be based on a sound legal foundation.

Whereas, in Europe energy theft and privacy are the two most important concerns related to Smart Grid implementation, in other parts of the world (e.g. in the US) it is energy theft and malevolent attacks that are the main concerns.

The purpose, design, functionalities and implementation of the smart metering system determines to a large extent whether or not it will comply with privacy and data protection legislation. Therefore, from the beginning, legislation on privacy and data protection must be taken into account as important requirements in the design of smart metering systems.

Introducing Smart Grid/Meter functionalities as laid out in the 3rd Energy Package raises a number of issues and expectations from various stakeholders e.g. Grid Users, End Customers, Consumer Groups, etc. Whilst there is a general consensus that Smart Grid/Meters are beneficial for all involved, as with any new technology there are new risks, these include certain concerns in relation to data security, privacy and data handling.

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Specific for the data privacy aspects, the European consumer groups are asking for clear regulation around frequency of meter reading and usage of data. It is stressed that only data necessary to perform Smart Grid tasks agreed with the consumer, should be collected and utilised. At the same time, whilst acknowledging benefits, Smart Grid/Meters and wider related infrastructure should be designed for privacy and security to levels that are in line with the risks for concerning stakeholders.

Comment [A1]: Inserted this, as GB is proposing to bring in a central data base to store personal data. This raises concerns as it does not sit well with privacy by design. Arguably it is not necessary and it will limit competition as governance of the central data store looks likely to be industry dominated

The report provides detail of other industries experiences in the area of data security, privacy and data handling and draws out specific learning points for smart grid development. A key conclusion from this review was that the Expert Group should recommend to the European Standards Organisations (ESOs) that they should mandate that smart grid products and solutions should be designed from the start with appropriate levels of data privacy and security at their core.

The data security section of the report, together with appropriate parts of the appendices focus on reviewing existing standards and where there might be gaps related to smart grid development. It also identifies appropriate responsible ESOs for each area to oversee any required standards development.

The Expert Group concluded that there was clearly a gap within EU standards relating to the handling and security of data within the area of smart grids. However, there are broader standards, guidelines and codes of practice in place within other industries such as the Banking and Payment Card Industries or the Payment Card Industry Data Security Standard PCI-DSS outlining the management of personal and credit card data by comparing the risks and related requirements, a judgment can be made to what level these solutions are applicable for the Smart Grid processes.

It is clear that, depending on the use of data, a data type can be defined as infringing the data privacy regulations and laws, thus it is recommended that there is a need to differentiate between personal and non-personal data. This can be dictated by the purpose for which this data is to be utilized after being captured. This principle could be applied to Smart grids; in that a piece of data such as a meter reading or load profile could be classified as technical data if its purpose was to assess the loading on a network for safety reasons. However if the use of the data was to assess someone's usage habits with a view to marketing some new product or service, then the same data could be classed as personal (or consumer) data.

Summary of Recommendations

The recommendations made by this expert group are summarized below:

1. The Expert Group recommends that SG-EG2 is tasked with assessing how the privacy and data protection issues of Smart Metering and Smart Grids could be covered by and/or fit into the existing EU privacy and data protection framework or, if this is not possible in a sufficient manner, in detailing out the necessary additional legal framework to regulate those issues and in proposing particular privacy requirements for the stakeholders in Smart Grids to create a EU-wide, detailed privacy standard for Smart Metering and Smart Grids.
2. ESOs should mandate that Smart Grid products and solutions are designed from the beginning with appropriate data privacy and security at their core.
3. Regarding security:

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- ESOs should be tasked with updating, extending or developing new standards covering the security aspects of Smart Grid interfaces based on European requirements.
- ESOs joint working group should review the Expert Group recommendations and list of relevant standards, and add the latest amendments, additions and future work required before starting any new standardisation work, based on still to be defined requirements.
- ESO's are tasked with evaluating the current state of cryptographic primitives through their relevant technical committees and make available the most appropriate technologies within the relevant standards framework. This should ensure
  - o Not to preclude the initial adoption of symmetric key cryptography followed by a further smooth migration to asymmetric cryptography if required;
  - o A business model is investigated to make the creation and maintenance of certification authorities (needed for asymmetric cryptography) possible;
  - o A study is conducted on how to handle multi-national key management (e.g. one supra-national European certification authority certifying national certification authorities) and who should be in charge of performing this key management activity.
- One generic model is adopted by all European countries, for key management, and security and privacy principles, regardless of the communication technology or protocol.
- These security and privacy principles should be relevant to not only smart meters, but also other devices or bodies in the smart grid if communicating consumption data.

4. With regard to data handling
   - Further pilots need to be done in the area of data handling, in consultation with the banking industry and payment card industry to propose a list of high level principles tuned to the Smart Grid environment, by which smart grid operators can design their systems and processes.
   - After the above has taken place a paper should be produced and presented to the CEN, CENELEC, ETSI joint working group, highlighting the additional detailed standardization required in this area.
5. With regard to data privacy
   - Distinguish between consumer and technical data to minimize the vulnerability of private data;
     - o Consumer data is considered as specific data and can be traced back to the individual consumer whereas technical data is aggregated and anonymous and does not contain explicit references to persons or individual metering points.
   - To ensure data safety and security within an intelligent network a clear division of roles and responsibilities regarding ownership, possession and access to data, read and change rights, etc. has to be defined.

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- This expert group (SG-EG2) should be tasked with providing the relevant detail necessary for the different data elements and define roles and responsibilities, including handling, possession and access to data.
- Further work needs to be done around consent models – how consumers are able to control the use of their own data
- Further work will be needed on potential monitoring and enforcement mechanisms around data protection and privacy rules.

Comment [A2]: A review of the terms and conditions offered by all the suppliers in the GB with smart meters was carried out by one of our UK members. This found that all suppliers abided by the letter of the law in telling consumers how they were going to use their personal data, often going to several pages in small print (more than the vast majority of people would read). No supplier gave consumers the opportunity to opt out of that data being used by them for commercial or other purposes. In effect, customers had no choice, because there is no supplier that does things differently.

3 DEFINITIONS

Data Types
There are many data types already in existence and commonly recognised within the EU standards and legislative framework. However there are no common definitions relating to smart grid data. It would appear that in other areas of data protection, given data can have different classifications dependent on what it is to be used for (*ICO- Data Protection Technical Guidance determining what is personal data, 2007)*.

Personal data
Source: Directive 95/46/EC European Union Directive on Data Protection:
Definition of personal data Article 2: For the purposes of this Directive: 'personal data' shall mean any information relating to an identified or identifiable natural person ('data Subject'); an identifiable person is one who can be identified, directly or indirectly, in particular by reference to an identification number or to one or more factors specific to his physical, physiological, mental, economic, cultural or social identity. Note that definition of personal data under the UK Data Protection Act 1998 is wider than the definition under the directive.

Personal data is defined in the UK DPA (at section 1(1)), as “data which relate to a living individual who can be identified from those data; or from those data and other information which is in the possession of, or is likely to come into the possession of, the data controller and includes any expression of opinion about the individual and any indication of the intentions of the data controller or any other person in respect of the individual”.

Location data
Absolute location is the actual spot on the planet where something is. A good example would be the latitude and longitude of a place. For instance, Lake Maracaibo of Venezuela is at 10°39' N latitude and 71°36' W longitude. In addition, an IP address is also a way to locate physical equipment. For Smart Grids the position of individual assets can be identified via a Global Information system (GIS). GIS is a system of hardware and software used for storage, retrieval, mapping, and analysis of geographic data. Spatial features are stored in a coordinate system (latitude/longitude, state plane[1], UTM[2], etc.), which references a particular place on the earth. Descriptive attributes in tabular form are associated with spatial features. Spatial data and associated attributes in the

[1] State Plane Coordinate System (SPCS). The SPCS is primarily used in engineering applications by utility companies and local governments for doing accurate surveys

[2] (UTM) Universal Transverse Mercator. .A map projection system for global mapping. UTM divides the world into 60 zones each of 6 degrees longitude wide, extending from 80 degrees latitude south to 84 degrees latitude North.

same coordinate system can then be layered together for mapping and analysis.

Technical data (Smart grid)
Data that is gathered from metering, distribution, or transmission assets in order to assess the performance of the energy network, network problems, or potential future problems, security breaches and energy theft. The data is used for safety, revenue protection (i.e. fraud detection), and security of supply purposes. This data can be linked to individual supply points or aggregated data representing substation supply lines.

This data should not be able to be linked to individuals or households. When this data can be linked to a person it becomes personal data and rules regarding personal data should apply.

It is not enough to distinguish between personally identifiable information and anonymised data. The US Federal Commission acknowledged that restricting protection to personally identifiable information does not recognise the developments in profiling technology. They concluded that it is clear that so called anonymised data can be used to identify individuals. This must be taken into consideration when defining technical data.

Consumer data
Data which is gathered from individual metering points is personal data. Any subsequent use of this data, whether for billing purposes or to provide value added services to consumers must be with their consent. This is is because this is considered personal data.

Metering Ownership
In many European States the Distribution Network Operator provides and operates the relevant electrical infrastructure and they also own and provide the meter. In countries such as UK, Germany and France there are variants to this meter ownership model. The most disaggregated example of this is provided by the UK where competition has been introduced across the services provided by metering. Key players are:

- *Meter Operator* is split into
  - *Meter Asset Provider (MAP)* – organisation that provides the funds and provides the meter;
  - *Meter Asset Manager (MAM)* - responsible for installation, commissioning, maintenance etc.
- Data Collection Agent or *Data Collector* - Collects data from the meter responsible for remote measurement and communications equipment.
- Data Aggregation Agent or *Data Aggregator* - Aggregates all the meter readings for each Party to the Balancing and Settlement Code (BSC).

Comment [A3]: It is becoming apparent that in rural areas where there are just a handful of supply points it may be possible to identify individuals even when the data is not gathered from an individual point. Hence the amendment.

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Comment [A4]: The original wording is misleading. At a recent conference, this provision in this report was cited as the basis that the definition of personal data is dependent upon the usage of the data, i.e. for marketing communications purposes. This is not correct. It does not matter what the data is intended to be used for, the fact that it has been collected makes it personal. We suggest removing this text, or adding the amendments suggested.

4 CURRENT EUROPEAN FRAMEWORK - PRIVACY

The European legal framework regarding privacy and data protection can be described as a collection of rules and regulations. It has to be noted, that each country has the latitude to implement the directives in national laws, with national flavor. Therefore, a country has the possibility to be more protective. A common denominator of the regulations has to be defined to approach an EU wide Smart Grid.

The basic privacy and data protection issues that derive from the EU Privacy Directives and treaties and that need to be taken into account when discussing smart metering are:

a.) An assessment must take place to ascertain if the data processed in smart metering is personal related or not; meaning that the data can be related to an individual or not. (For example: the meter ID is personal related data because the grid operator could link it to a customer). If it is personal related, there are privacy issues that need to be solved. Therefore, one issue is to assess if and how smart metering technology could be designed to avoid the use of personal related data to avoid privacy issues from the beginning at the same time satisfying the needs and requirements of all stake holders involved.

b.)If personal related data is processed, there must be a legal basis for such processing which as to smart metering could be:

(i) a legal duty to install smart meters to be imposed by the EU or the member states (which would need to be in conformity with current law and regulations)

(ii) consumer consent

(iii) the necessity to use the data to fulfil the contract with the consumer

(iv) the prevailing interest of the data controller, which for example could be the need for grid operators and energy distributors to collect some "technical" data to optimize the network, assure network functioning, optimize energy savings etc.

The privacy concept depends as well on a clear definition of the roles of the stakeholders in the smart grid. "Players" in privacy are the data subject, the data controller, the data processor and any third party that might get the data. Expert Group 2 is depending on the results of this "players" definition of the other Expert Groups.

It furthermore should not be overlooked that privacy does not only concern consumer privacy, but as well the privacy of the other stakeholders in the smart grid as some countries within the EU, like Austria, explicitly protect the data of

Comment [A5]: As above, we have concerns about this in the light of the US Federal Commission's approach. It is our understanding that the Commission decided that it is not enough to distinguish between personally identifiable information and anonymised data. They acknowledged that restricting protection to personally identifiable information does not recognise the developments in profiling technology. They found that is clear that so called anonymised data can be used to identify individuals. They believe the distinction is no longer meaningful. This must be taken into consideration when defining technical data.

Deleted: If it is not personal related - either because it is collected in a non personal related way or because it is anonymized (for example by aggregating it), there is no privacy issue companies (legal entities) as well. Therefore, access to data and exchange of data should not only be assessed from the consumer perspective, but as well from the perspective of DSOs, which not only need to protect the consumer data they store, but as well as their own (business) data.

c.) Directive 2002/58/EC[3] and 2006/24/EC[4]

Directive 2002/58 supplements Directive 95/46/EC regarding electronic communications services. Amongst others, the Directive lays down provisions regarding confidential communications, the processing of traffic data and location data.

These data might be personal data, traffic data and/or location data, depending on the technologies used and the specifications of the system

The applicability of these specific data protection Directives in relation to smart metering needs to be assessed.

The purpose, design, functionalities and implementation of the smart metering system determines to a large extent whether or not it will comply with privacy and data protection legislation. Therefore, from the beginning, legislation on privacy and data protection must be taken into account as important requirements in the design of smart metering systems.

Recommendation 1:

The Expert Group recommends that SG-EG2 is tasked with assessing in how the privacy and data protection issues of Smart Metering and Smart Grids could be covered by and/or fit into the existing EU privacy and data protection framework or, if this is not possible in a sufficient manner, in detailing out the necessary additional legal framework to regulate those issues and in proposing particular privacy requirements for the stakeholders in Smart Grids to create a EU-wide, detailed privacy standard for Smart Metering and Smart Grids.

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[3] Directive 2002/58/EC of the European Parliament and of the Council of 12 July 2002 concerning the processing of personal data and the protection of privacy in the electronic communications sector (Directive on privacy and electronic communications), OJ L 201, 31.7.2002, p. 37–47.

[4] Directive 2006/24/EC of the European Parliament and of the Council of 15 March 2006 on the retention of data generated or processed in connection with the provision of publicly available electronic communications services or of public communications networks and amending Directive 2002/58/EC, OJ L 105, 13.4.2006, p. 54–63.

5 STAKEHOLDER ANALYSIS

5.1 Smart Grid Stakeholders

- Grid users including/composed of grid operators, grid customers and meter operators
- End customer (domestic or commercial)
- Municipalities including energy retailers
- Politics
- Industries
- Consumer organizations
- Politics/society

Comment [A6]: Private is ambiguous – domestic covers both private rented, private home owner and social housing. Industrial suggests commercial of a certain kind – not sure what is intended

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Introducing Smart Grid/Meter functionalities as laid out in the 3rd Energy Package raises a number of issues and expectations from various stakeholders. Whilst there is a general consensus that Smart Grid/Meters are beneficial for all involved, certain concerns are raised. These can be summarized around security, privacy and data handling.

Specific for the data privacy aspects, the European consumer groups are asking for clear regulation around frequency of meter reading and usage of data. It is stressed that only data necessary to perform Smart Grid tasks agreed with the consumer, should be collected and utilised. At the same time, whilst acknowledging benefits, Smart Grid/Meters should be designed for privacy and security.

5.2 Smart Grid and Smart Meter benefits – generic comments

The Smart Meter is key for the introduction of some services and functionalities of Smart Grids. Thus it has been agreed on dividing the benefits of Smart Meter and Smart Grid for each stakeholder group.

Smart Grid benefits for stakeholders

Grid operator	• Distribution network stability & performance can be managed within the limits of an ever changing market • Cost savings due to an optimized facility utilization and enhanced efficiency • Predictive maintenance and “self-healing” responses to system disturbances • Automated maintenance and operation • New opportunities to improve grid security

	• Improved resilience to disruption • Increased lifespan of existing infrastructure • Reduction of technical losses
Grid customer	• Expanded deployment of feed-in tariffs by renewable energy sources • Peak energy demand is met more efficiently and with less detriment to the environment • Increased sustainability • Effective support of transnational electricity markets by load-flow control to alleviate loop-flows and increased interconnection capacities • To enable new services still to be defined and developed
End customer	• Option to plug-in electric vehicles and new energy storage options • Increasing reliability of power supply (fewer and shorter outages) • Decentralized energy (micro generation)
Municipalities	• Advanced ability to feed-in decentralized Renewable Energy Sources • Positive image as an innovative community • Cost reduction through energy conservation and efficiency • Sustainability
Politics/society	• Increased market competition • New jobs • Achievement of climate targets • Securing the business location
Industries	• New product opportunities • New Business areas

Smart Metering benefits for Stakeholder:

End customer	• Enable improved provision of energy consumption information for customers • Increased awareness of energy consumption • Control over energy usage and cost • More transparent pricing strategies • Increased consumer choice • Faster and more efficient switching proves • Flexible and more differentiated tariffs
Grid operator	• Information about changes in consumer consumption patterns • Increased possibility to control demand • Limiting fraud and reducing commercial losses • Flexibility to add metering for EV charging and Distributed Energy Resources (DER)

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Municipalities	• Positive image as an innovative community • Cost reduction through energy conservation and efficiency
Politics/society	• Increased market competition • New jobs • Securing the business location • Reach the EU 20-20-20 goals and comply to related Directives
Industries	• New product opportunities • New Business areas

It should be noted that many of the consumer benefits will not be realised without adequate safeguards and a strategy to deliver these benefits. A systematic review of retail market protections will need to be carried out to ensure that they are fit for purpose in a smart world and action taken to ensure that customers can engage effectively in this new energy services market. This is particularly the case for low income and vulnerable consumers.

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Comment [A7]: For example, the underlying assumption is that smart grids will improve the energy retail market and customer service. In practice the consumer experience may be very different. Smart grids are likely to facilitate the introduction of a range of new tariffs – multiple rate time of use, critical peak pricing, remote demand management, along side energy services deals. While this increased choice is welcome, it is also likely to make the market more complex and confusing for many consumers, making it hard to identify the best deal. In GB a third of customers already switch to a worse deal. When it comes to doorstep sales the figure is even higher. We have relatively few tariffs compared to what will happen in a smart world. Similarly we are seeing GB companies starting to offer longer term contracts in exchange for a smart display, as with the mobile phone contracts. Not a problem as long as consumers are aware of the long term implications if they change jobs, have families etc of locking themselves into longer contracts. In Victoria that had a moratorium on the introduction of time of use tariffs following concerns about the impact on low income and vulnerable consumers. In parts of the States mandatory roll out of time of use tariffs has resulted in legal action. Consumers will need to have free access their historic consumption information in a format that allows them to make like for like comparisons with other tariffs available. We need to ensure that consumers have a choice in whether to adopt new deals as not everyone will benefit.

6 BENCHMARK OTHER INDUSTRIES AND INTERNATIONAL EXPERIENCE

6.1 Other Industries[5]

6.1.1 Banking

Electronic Banking and the Risks it posed for Banks

Banking sought to address the impact that wider introduction and integration of electronic banking would have on their existing risk management policies and processes. The integration of e-banking with their legacy systems meant they needed to reassess their integrated risk management approach to address this new risk.[6] This led to the development of a set of Risk Management Principles for Electronic Banking. These 14 principles were grouped under 3 broad headings of

A. Board and Management Oversight (Principles 1 to 3)
B. Security Controls (Principles 4 to 10)
C. Legal and Reputational Risk Management (Principles 11 to 14)

The key points to be noted from the banks experiences with the introduction of e-banking were to ensure that the security services Authentication, Access Control, Non-Repudiation, Confidentiality and Integrity and the availability were addressed appropriately.

Key findings for Smart Grid:

- *Security is a path, not a destination! Security is about risk management and implementing effective counter measures.*
- *Privacy needs to be considered at the design stage of smart grids, since the industry players in this development do not have the financial muscle of the Financial Sector, and they need to maintain consumers trust to deliver the assumed behaviour changes necessary to fully deliver the potential benefits of smart grids for all of society.*
- *The dilemma the energy sector needs to address up-front is how best to deliver appropriate levels of security and privacy, which are essential to facilitate the consumer's buy-in.*

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[5] The solutions for the benchmarked industries will be considered having the differences in regulation, risks and related requirements in mind

[6] Basel Committee on Banking Supervision – Risk Management Principles for Electronic Banking.

- *For the particular use case of hybrid car charging in the Smart Grid, the privacy issues are similar: someone may know where someone is based on the identification of the location of a given car.*

6.1.2 Telecommunication

Whilst the advent of open systems interfaces has assisted in the acceptance and international deployment of networking technology (Communication and I.T), it has also seen downsides in that it has become easier to intrude on networks designed with such open features. Many of the intruders were assisted in their endeavours by the openness and standardization that the telecommunication industry has undergone.

The following is a list of categories of threats to such networks that have influenced the development of security aspects over time:

1. **Service denial or disruption** - Typically, service disruptions caused by intruders have been brought about by accidental actions rather than malicious attempts. Nevertheless, with the attack in 2007 of Estonia's critical information infrastructure leading to a general denial of service of all internet based services, the need to adopt robust cyber security frameworks has increased.
2. **Unauthorized monitoring and disclosure of sensitive information -** The current approaches that intruders have used are eavesdropping techniques, network monitoring tools, and intrusions into network databases containing customer information.
3. **Unauthorized modification of user or network information and network services -** Intruders have changed user service profiles and affected billing and routing. This can result in unreliable service.
4. **Fraud -** The typical approach is to build upon the previous attacks and masquerade as a legitimate customer to commit fraud.

Key findings for Smart Grid:

- *Need to consider security features developed by telecommunication sector which developed out of threats they encountered and build appropriately into design for smart grids;*
- *Consumers position in smart meter / smart grid is very different from his/her position in the telecoms world, namely:*
    - *They have no choice regarding utility services since they are fundamental to their life and well-being.*
    - *They are the key enabler to delivering all of the policies linked to reducing energy consumption and dealing with climate change in each country. Consequently, alienate them at your pearl!*

- *Although telecommunication provides insight, like potential tracking of movements, into some aspects of the personal world of a consumer, access to utility related data can provide detailed insight into a householder's behaviour in the privacy of their own home.*

This point reinforces the need to integrate consideration of privacy, together with security into the design phase of smart grids.

6.1.3 Automated fare collection

Automated fare collection for public transportation is an application domain where contactless technologies were introduced over the last few years and where privacy and data security became prominent.

The contactless smart card industry addressed the end user privacy issues explicitly by ensuring that the chips they provide will not be the weakest link in the privacy chain and in the data security chain[7]. It also shows that if privacy is addressed straight from the start when defining the chip, it is possible to define security architectures that are both satisfactory from the point of view of manufacturability and profitability while still providing the required level of protection for the various actors of the automated fare collection eco-system. One concrete example of such a design is the MIFARE(R) Plus technology.

GlobalPlatform has also published a white paper[8] that shows the prominent role of privacy and data security for automated fare collection for the public transportation industry.

Key findings for Smart Grid:

- *If privacy is addressed at the design phase of the Smart Grid ("privacy by design"), it is possible to derive user and business friendly solutions.*

6.1.4 Road pricing

Road pricing and other similar telematics services[9] are on the verge of being deployed in several parts of the world for several reasons: better traffic management, safety, environmental concerns (CO2 emissions); fairer charging for the use of the road infrastructures, better tuning of the insurance policies.

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7 [NXPCartes2009] Addressing end user privacy in contactless smart card systems, Henri Ardevol, NXP Semiconductors, CarteS, November 2009.

8 GlobalPlatform's Value Proposition for the Public Transportation Industry: Seamless, Secure Travel Throughout Mulitple Transportation Networks, White Paper, November 2009, freely available on http://www.globalplatform.org in the white papers section.

9 Telematics is the blending of computers and wireless telecommunications technologies, ostensibly with the goal of efficiently conveying information over vast networks to improve a host of business functions or government-related public services.

Road pricing although different from Smart Metering and Smart Grid presents several similarities with respect to

- the need to change consumers behaviour to achieve overall goals;
- the use of a meter (OnBoard Equipment – OBE for road pricing example);
- the transfer of data to a central system where further processing takes place;
- the privacy and data security concerns; having adequate solutions for end-user privacy preservation will be key to the acceptance of the concept.

Key findings for Smart Grid:

- *Issues around aggregating and Anonymization of data will be as important for smart grids as it is for road pricing. There may be some lessons to learn from decisions taken with regard to road pricing options in the Netherlands.*
- *Road pricing shows that taking privacy into account straight from the start with innovative technological solutions helps in defining systems that are acceptable from both a business point of view and from an end-user privacy preservation point of view.*

6.2 Introduction to the Dutch privacy and security framework

In The Netherlands, the introduction of smart metering for consumers has not been without challenges. A growing awareness on privacy and security has fueled a broad discussion on the collection and use of detailed metering data and on remote switching functionality in the meter. As laid down in the initial bill to implement Directive 2006/32/EC, consumers were obliged to accept a smart meter. Criticism from the political and scientific community and consumer groups led to the withdrawal of the initial bill in the Senate. An amended version is currently under discussion. This version gives consumers the right to refuse a smart meter and gives them control over the frequency with which metering data is collected.

Grid operators responded to these developments by jointly, and in dialog with all stakeholders, developing a set of guidelines (requirements and measures) to protect the privacy of consumers and the security of the (future) infrastructure. These guidelines will be public to convey to stakeholders that adequate measures are taken.

In the process of developing the guidelines, a methodology and framework for developing privacy and security guidelines were created. All stakeholders participated to foster transparency and trust. The aim of the framework is to establish a data privacy and data security regime that both protects and enables. This framework methodology is attached in the appendix.

Key findings applying the framework

During the process of developing the framework and the guidelines, a number of lessons were learned that may aid in the future development and updating of the guidelines:

- *Define explicitly how smart metering goals, tasks and data needs are linked, so reviewers have a basic understanding of the architecture and information flows.*
- *Be aware of future function creep and incorporate privacy and security considerations early on in the development by applying 'privacy (and security) by design' principles. This means that security & privacy architecture has to be researched and developed.*
- *Be also aware of 'data creep', i.e. gathering more and more (technical) data which can be linked to a person and thus is personal data.*
- *Make sure that guidelines are flexible enough to be applicable to current systems, legacy meters and future developments.*
- *Make sure that implementation of the guideline is flexible by clearly distinguishing requirements ('what to do'), measures ('how to do it'), and giving room for risk management, e.g. by allowing 'comply or explain'*
- *Make relevant privacy legislation part of the requirements and set up a code of conduct.*
- *Make sure that data is protected everywhere in the infrastructure, especially when you are not in control of the infrastructure (e.g. by applying encryption during wireless communications).*
- *Pay attention to organizational measures as well as technical ones, e.g. proper key management when dealing with encryption and limiting access to critical functionality with strong authorization.*
- *Involve stakeholders so they can explain their interests and to maintain support and trust.*
- *Involve experts and make sure that sufficient communication exists between groups dealing with privacy, security, functionality and business goals.*
- *The earlier privacy and security considerations are taken into account, the less expensive and complicated the solution will be.*
- *Define privacy and security guidelines 'top down', instead of defining measures right away.*

6.3 Non-EU Countries

U.S. – National Institute of Standards and Technology- Smart Grid Cyber Security Strategy and Requirements (NISTIR 7268)

The concern in the USA and the focus of NIST was initially firmly on security (e.g. malevolent attacks). Through the consultation process for the "Smart Grid Cyber Security Strategy and Requirements (NISTIR 7268)" document the weakness of the privacy aspects have been enhanced, but from what might be considered a low base point. This reinforces the view that "One can have security without privacy, but one cannot have privacy without security".
When first published this document was reviewed by the 'Electronic Privacy Information Centre (EPIC)' and they specifically commented on the NIST identified principles for the development of appropriate protection for 'personally identifiable information'. EPIC indicate that in their view several of the principles were flawed and they specifically criticised the heavy dependence of NIST on what they see as the discredited 'notice and consent' model of privacy protection. EPIC recommended that the NIST document could be strengthened (e.g. by the use of the OECD Privacy Principles). EPIC specifically recommended that NIST should:

- **Adopt fair information practices**: Information practices should adopt HEW report[10] and OECD Privacy Guidelines[11]
- **Establish independent privacy oversight**
    - recommend enforcement mechanisms
    - recommend that an independent Privacy Office with power over all entities
- **Abandon the notice and consent model**
    - Authorities and organizations must limit collection, use, retention and sharing of information in the first instance, rather than relying on consents
    - Establish a set of approved purposes for which collecting information is permitted
- **Impose mandatory restrictions on use and retention of data**
    - Set expiration dates so information can be retained only for a certain period of time
    - Implement role-based access control to Smart Grid data
    - Explicitly address law enforcement access to Smart Grid data
- **Verify techniques for anonymization of data**
    - Ensure that techniques for anonymization of data are robust, provable and transparent
- **Establish robust cryptographic standards**
    - Cryptography should be applied to secure all electronic communications
    - Cryptographic techniques do not rely upon hiding the cryptographic process

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[10] HEW Report – U.S. Department of Health, Education and Welfare's seminal 1973 report entitled "Records, Computers and the Rights of Citizens".
[11] http://www.oecd.org/document/18/0,3343,en_2649_34255_1815186_1_1_1_1,00.html

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Key findings for Smart Grid:

- *U.S. has made considerable strides in addressing the security aspects of smart grids. For European implementation, this should be combined with an enhanced treatment for Privacy of personal data along the lines articulated above (which links to Netherlands approach).*

- *Whereas, in Europe energy theft and privacy are two important concerns related to Smart Grid implementation, in other parts of the world (e.g. in the US) it is energy theft and malevolent attacks that are the main concerns.*

Recommendation 2:

The Expert Group recommend that ESOs mandate that Smart Grid products and solutions should be designed incorporating agreed data privacy and security principles at their core.

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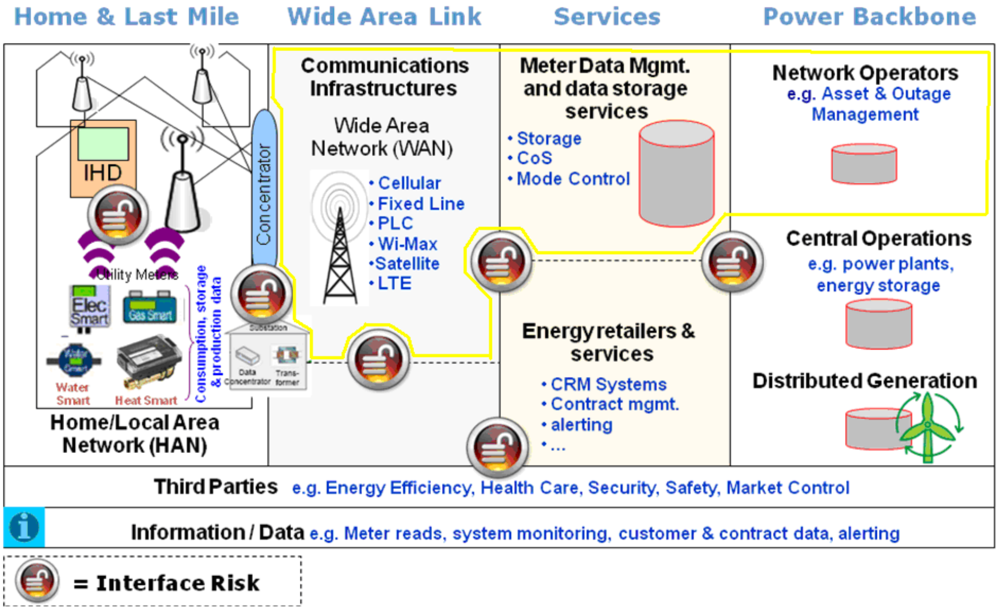
7 DATA SECURITY

7.1 Introduction

The scope of this section is to identify European Standardization Organizations (ESO) and current standards in existence related to security and privacy in the area of Smart Grids. The scope is further to identify areas where there are no standards in existence which may result in recommendations to ESOs to start new standardization work.

7.2 Architecture

The different functions today performed by most DSOs in the EU (Network Operation, Meter Data Management and Data Storage together with operating communication infrastructures) are (artificially) split up in order to provide the overview on the architecture of the market. Central operations belong to the non-regulated part of market structure, together with retail and (distributed) generation.
The yellow marked area comprises the functions that are currently performed by most DSOs in the EU (with an exception for UK and very recently Germany).



7.3 List of Interfaces

This Section attempts to define the interfaces in the diagram above and identifies which type of data is used and the associated risks which could be incurred. The types of data considered are Consumer (Con) and Technical (Tech). The table below also considers whether the interfaces mentioned are physical interfaces between devices within the smart grid (i.e. a meter communicating with an in home display), or data interfaces where data is moved from one legal entity to another (i.e. meter reading data bulk transported into settlements, or a data collection company allowing access to third parties such as Energy Service Companies).

Interface	Type	Notes	Data	Data Type
1) Meter to IHD	Physical interface between two devices	Security risk to consumer data. Prepayment metering risk if network, interface or payment card is unsecured. Risk on firmware upgrade.	Meter Reads (Con) Pricing Info (Con) Tariff Info (Con)	Consumer data
2) HAN to LAN	Physical interface: consumers network and outside world	Used in PLC and long range RF mesh topology. Larger risk to security of data due to visibility of many meters. Risk on prepayment.	Meter Reads (Con) Load Profile (Con and Tech) Alarms (Con)	Consumer data for billing and technical for alarms
3) LAN to WAN	Physical interface: substation / regional data concentrator and central backhaul device i.e. PLC concentrator with IP bridge	Interface represents a higher lever of risk due to data moving out of the home and being combined with data from other consumers. In smart metering this could be an interface between a local data concentrator and the long range backhaul	Meter Reads (Con) Load Profile (Con) Alarms (Con) Meter Reads (Tec) Load Profile (Tec) Alarms (Tec)	Consumer data for billing and technical data for alarms and substation / comms efficiency data
4) WAN to Head Ends / DC businesses	Physical interface: link from backhaul data device to back end systems. Head end systems may communicate with meters directly.	Competitive model	Meter Reads (Con) Load Profile (Con) Alarms (Con)	Consumer data, and technical; data in the form of alarms
5) WAN to Central DC	Physical interface between meter or concentrator to central data collector.	Vertical Model	Meter Reads (Con) Load Profile (Con) Alarms (Con)	Consumer data for billing, technical data for network owners and meter ops
6) LAN/WAN/ DC to Dist. Network Operator	Data service interface from data collector	Substation monitoring	Meter Reads (Tec) Load Profile (Tec) Alarms (Tec)	Technical data for network monitoring
7) LAN/WAN /DC to Energy Retail	Data service interface	For billing and additional services	Meter Reads (Con) Load Profile (Con) Alarms (Con)	Consumer data for billing
8) Consumer Generation to distribution Network Operator	Physical interface into back haul network as supply metering.	For load management	Meter Reads (Con) Load Profile (Con) Alarms (Con)	Technical data for network monitoring
9) Consumer Generation to Energy Retail	Physical interface into back haul network as supply metering.	For billing purposes i.e. Feed In Tariffs (FITs)	Meter Reads (Con) Load Profile (Con) Alarms (Con)	Consumer data for billing purposes
10) Energy Retailer to Third Parties	For provision of outsourced service e.g. prepayment	For additional services	Meter Reads (Con) Load Profile (Con)	Consumer data
11) HAN to Third Parties	Data interface	For Energy Services	Meter Reads (Con) Load Profile (Con)	Consumer data
12)Consumer Generation to Third Parties	Data interface	Distributed generation aggregation services	Meter Reads (Con) Load Profile (Con)	Consumer data
13) Meter to Mop	Physical or data interface depending on topology	Installation data and downloading of tariffs on installation	Meter Reads (Con) Load Profile (Con) Tariff Data	Technical data to ensure meter is functioning

Note: Please not that the above table is not to be seen as a complete risk assessment. There will be e.g. updates to be performed during the life time of the physical equipments of the Smart Grid and these updates should happen securely. Upgradability is also to be foreseen with respect to the cryptography.

ESOs

For the scope of this report we have identified two categories of standards relevant to the Smart Grids field and technical standards. Technical standards are those that are chiefly concerned with the characteristics of the ICT systems, hardware and some communications protocols while the procedural standards are concerned with organisation, policies and management. In the below presentation, standards are grouped into either categories although some cover both aspects to some extent.

7.3.1 Technical Standards

IEC

The IEC 62351 series is focused on adding security mechanisms to the IEC suite of protocols developed within IEC TC57 and used for several purposes within Smart Grids, with the exception of meter reading. TC13 is currently defining the security mechanisms for smart metering

ISO

ISO/IEC joint standards in the 27000 series, especially notable is EN27002, previously ISO 17799 provides best practice recommendations on information security management.

CENELEC

CENELEC are the European Standardization Organisation for Electrotechnical standards within Europe. Many CENELEC committees monitor, feed into and parallel vote on International Standards produced in their corresponding committees in IEC. CENELEC are tasked under the Smart Metering Coordination Group (and Mandate 441) to identify, produce and maintain standards for electricity meters, communication protocols, home automation equipment, Electric Vehicles and other electrotechnical applications.

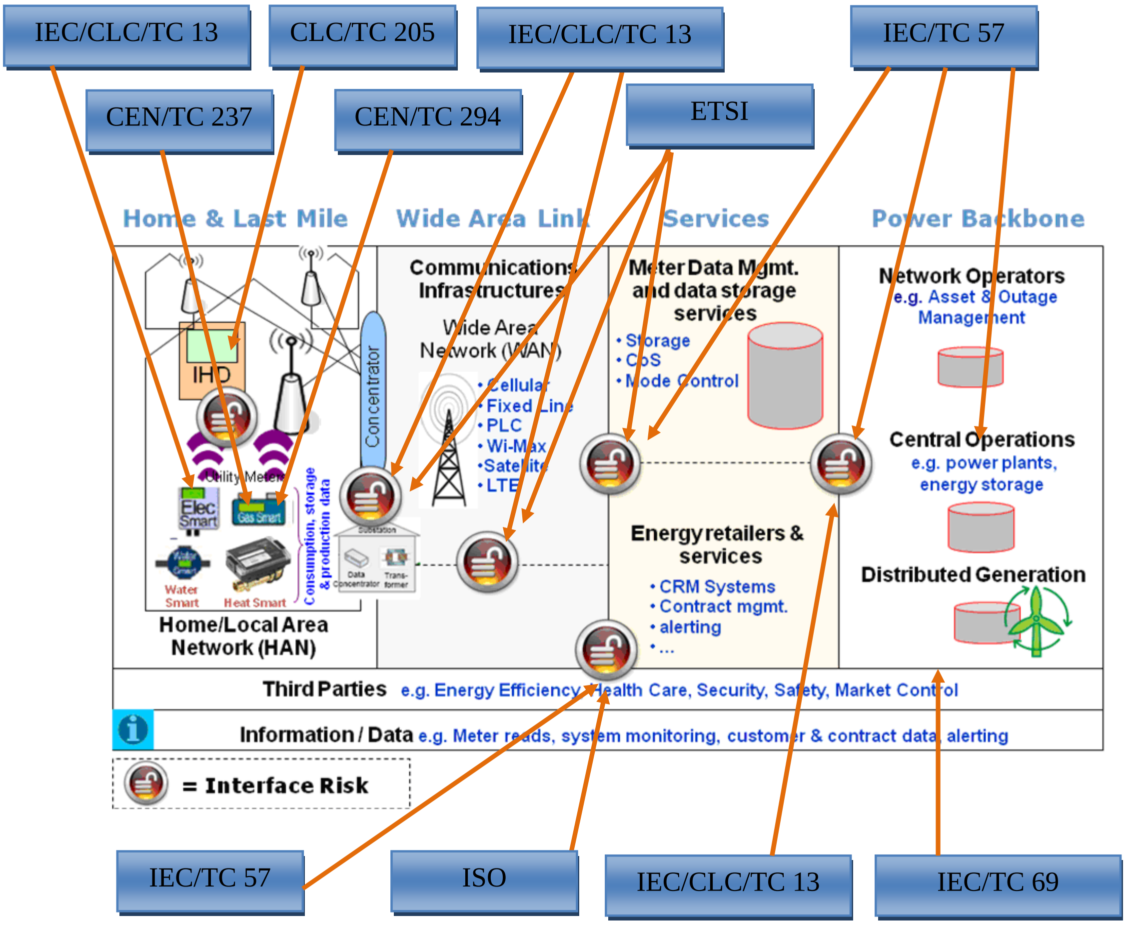
CEN

CEN is responsible for standards that are not Electrotechnical. The International equivalent of CEN is ISO, but there are some differences between the CEN/ISO relationship compared to the CENELEC/IEC relationship. CEN is also recognized by the Smart Metering Coordination group to identify, produce and maintain standards in the area of gas, water and heat meters, communications protocols for battery powered meters, and other non-electrotechnical applications.

ETSI
ETSI covers standards associated with telecommunications media, protocols and physical layers. ETSI are recognized by the Smart Metering Coordination Group for the delivery of standards in the area of telecommunications, as part of the ongoing work to fulfil the requirements of M441.

NERC
The North American Electric Reliability Council NERC is a self-regulatory, non-government organization which has statutory responsibility to regulate bulk power system users, owners, and operators through the adoption and enforcement of standards for fair, ethical and efficient practices. NERC has issued a series of standards NERC CIP 002 to NERC CIP 009 (http://www.nerc.com/~filez/standards/Cyber-Security-Permanent.html).

The diagram below is designed to highlight the responsible standards organizations and technical committees who either have standards now, have standards which need to be extended (most cases), or will need to develop new standards.



Standardization Committee / Organisation	Area of responsibility
IEC TC57	ERP systems interfaces and common information model
IEC TC13	Electricity meters and communications protocols
ISO	Business processes for data security
CEN TC 294	Battery Powered Meter communications
CEN/TC237	Gas Meters
ETSI M2M	Telecommunications
CLC/TC205	Home automation and communication protocols for associated equipment
IEC TC69	Electric Vehicles
PCI – DSS[12]	Payment Card Industry

7.4 Identified Gaps

Many standards (defacto or otherwise) are already available for sections of smart grid allowing communications between devices, and some such as ZigBee Smart Energy have very comprehensive security built into the protocol. Other EU and International standards are in the process of update to encompass higher levels of security such as DLMS COSEM (EN 62056-xx, MBus EN 13757-x). IEC 61968 goes some way to defining a common information model based on objects that are common from end to end in a smart grid system, but the emphasis is still security rather than privacy. There are other industries from which guidelines can be taken in this crucial area, such as the banking industry and payment card industry. The management of personal and credit card data is very well outlined in the PCI-DSS requirements, which could be used as a road map to define principles for responsible storage and use of data in back office systems in other contexts such as Smart Grids.

[12] Standard listed for informational purpose

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Recommendation 3:

The Expert Group recommends that ESOs are tasked with either updating, extending or developing new standards covering on specifically or implicitly the security aspects of SMART GRID interfaces as outlined in section 6.3.1. (a detailed list of relevant standards are available in Appendix “Terms and Definitions”).

When designing the end-to-end security and privacy protection for the Smart Grid, it is clear that more work will need to be done to clearly assess the most appropriate cryptographic primitives to be used: for instance symmetric key cryptography (e.g. AES) or asymmetric cryptography (e.g. RSA or ECC cryptography). The choice of cryptographic privative has a deep impact on the trust provisioning, key generation, key distribution, key protection, key personalization, key revocation or retiring, key protection, key renewal.

We recommend that:

- **The CEN, CENELEC, ETSI joint working group review the EG2 recommendations and list of relevant standards, and add the latest amendments, additions and future works before starting any new standardization work.**
- **The 3 ESO’s (CEN, CENELEC, and ETSI) are tasked to evaluate the current state of the art in cryptographic primitives through their relevant technical committees and make available the most appropriate technologies within the relevant standards framework.**
- **The CEN, CENELEC, ETSI, joint working group on smart grids should play a key role in this standardization work, and be responsible for ensuring continuity of all standardization work.**
- **the specification should not preclude the initial adoption of symmetric key cryptography followed by a further smooth migration to asymmetric cryptography if required.**
- **a business model is investigated to make the creation and maintenance of certification authorities (needed for asymmetric cryptography) possible**
- **a study is conducted on how to handle multi-national key management (e.g. one supra-national European certification authority certifying national certification authorities) and whom should be in charge of performing the key management.**
- **One generic model is adopted by all European countries, for key management, and security and privacy principles, regardless of the communication technology or protocol.**
- **Where appropriate, adequate protection profiles should be defined for security sensitive smart grid components according to ISO/IEC 15408**
- **These security and privacy principles should be relevant to not only smart meters, but also other devices in the smart grid if communicating consumption data.**

8 DATA HANDLING

There is clearly a gap within EU standards relating to the handling and security of data within the area of smart grids, however there are broader standards, guidelines and codes of practice in place within other industries such as the banking and Payment Card Industries. The management of personal and credit card data is very well outlined in the PCI-DSS[13] requirements, which could be used as a road map to define the principles for responsible storage and use of data in back office systems in other contexts such as Smart Grids.

It is the group's recommendation that a further package of work be carried out to develop a number of high level principles for smart grid data security and privacy based on already existing principles in other industries and referencing the Dutch Framework for smart metering. Guidance may also be taken from the EN 27000 series of standards and in particular EN 27002 (an Information Management Security standard)

Recommendation 4:

The Expert Group recommends that:

- **further pilot projects needs to be done in the area of data handling, in consultation with the banking industry and payment card industry to propose a list of high level principles on EU level to be implemented, by which smart grid operators can design their systems and processes.**
- **After the above has taken place a paper should be produced and presented to the CEN, CENELEC, ETSI joint working group, highlighting the additional detailed standardization required in this area.**
- **Security levels to be defined from minimum to advanced and the costs for the different security levels to be estimated**

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[13] Payment Card Industry Data Security Standard.

9 DATA PRIVACY

In the previous sections it has been discussed what regulations and laws govern aspects of data privacy and the translation to the Smart Grid. It is clear that, depending on the use of data, a data type can be defined as infringing the regulations and laws, thus it is recommended to differentiate between personal and non-personal data.
Distinction between technical and personal data is not related to the desired use. If it is clear data can not be related to an individual, i.e. by aggregating on transformer level, the EU Directive is not violated. It is has to be clear, before collecting data, whether they fall in the category personal or technical. This principle could be applied to Smart grids; in that a piece of data such as a meter reading or load profile could be classified as technical data if its purpose was to assess the loading on a network for safety reasons. However if the use of the data was to assess someone's usage habits with a view to marketing some new product or service, then the same data could be classed as personal (or consumer) data.

Applying this principle to the smart grid situation, it is clear that it is not just the data but the purpose of gathering that defines its sensitivity and hence below are a number of new data types defined in the context of smart grids.

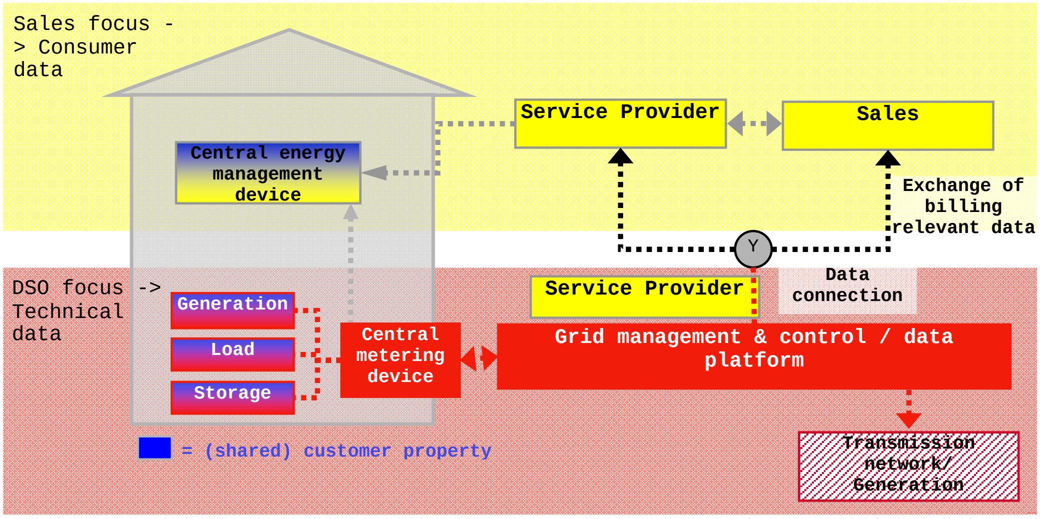
Technical data:

Technical data is gathered from metering, distribution, or transmission assets in order to assess the performance of the energy network, network problems, or potential problems, security breeches or energy theft. The data is used for safety, revenue protection, and security of supply purposes. Examples for technical data are measured values like voltage, current, phase angle and harmonic.
The data collection would be based on aggregated and anonymous data e.g. street or building-related and could not be retraced to the individual end consumer. Regarding network charges, the grid operator would only need to assign the respective data to a supplier. An assignment to an individual customer is not required.

Consumer data:

Consumer data is gathered from individual metering points with the intent to use this data for billing purposes or to provide value added services to consumers with their consent.
Consumer data can be traced back to households, here defined as point of consumption, or the individual consumer and is considered as specific information about personal or material circumstances of an identified or identifiable natural person. Thus it has to be treated as personal data.

Comment [A8]: We have become aware that other devices can also collect personal data. At least one company that has developed a device that plugs into your plug socket in the home which can control key appliances. This is coming onto the market next year. So we would query just talking about metering points – possibly any electrical point in the home?



The smooth operation of an intelligent network requires a clear division of roles and responsibilities - the central question to assess the risk especially for private consumer data is: Which data is used by whom? and for what purpose?

Recommendation 5:

The Expert Group's recommendation is to distinguish between consumer and technical data to minimize the vulnerability of private data.
Consumer data is considered as specific data and can be traced back to the individual consumer whereas technical data is aggregated and anonymous and does not contain explicit references to individual customers.
To ensure data safety and security within an intelligent network a clear division of roles and responsibilities regarding ownership, possession and access to data, read and change rights, etc. has to be defined.

The Expert Group recommends that the SG-EG2 is tasked with detailing out the different data elements and define roles and responsibilities, including handling, possession and access to data under the current legal framework.

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APPENDIX

A. Terms and Definitions

The following table provides a summary of definitions additional to chapter 2 that are important to the work of Expert Group 2. Alignment is to be reached with other expert groups and SM-CG.

Term	Original Source	Suggested Definition
Smart Grid	Task Force Expert Group 1 report	Smart Grid is an electricity network that can cost efficiently integrate the behaviour and actions of all users connected to it – generators, consumers and those that do both – in order to ensure economically efficient, sustainable power system with low losses and high levels of quality and security of supply and safety.
Smart Metering	European Smart Metering Alliance (Updated)	Smart metering is designed to provide utility customers with information about their domestic consumption. This information includes data on how much of a specific product (electricity, gas water or heat) they are consuming, how much it is costing them and what impact their consumption is having on greenhouse gas emissions. When triggered by a grid signal the smart meter will additionally act as a load balancer/mediator between decentralized product providers and the grid.
Data Security	ISO 7498-2 Information processing systems – OSI –Basis Reference Model Part 2: Security Architecture	The term ‘security’ is used of minimizing the vulnerabilities of assets and resources. An asset is anything of value. A vulnerability is any weakness that could be exploited to violate a system or the information it contains. A threat is a potential violation of security (A.2.1). To achieve security basic security services and mechanisms and their appropriate placement are needed. Basic security services are: **Authentication**, **Access control, Data confidentiality, Data integrity, Non-repudiation** Security mechanisms are**:** Encipherment, Digital signature mechanisms, Access control mechanisms, Data integrity mechanisms, Authentication exchange mechanisms, Traffic padding mechanisms, Routing control mechanisms, Notarization mechanisms **The terms mean:** **Authentication**, The corroboration that the source of data received is as claimed (data origin authentication) or that a peer entity in an association is the one claimed (peer-entity authentication) Data access requires the identification of the party performing the

		access **Access control**, The prevention of unauthorized use of a resource, including the prevention of use of a resource in an unauthorized manner. **Data confidentiality**, The property that information is not made available or disclosed to unauthorized individuals, entities or processes **Data integrity**, The property that data has not been altered or destroyed in an unauthorized manner **Repudiation**, Denial by one of the entities involved in a communication of having participated in all part of the communication
Data Controller	Based on [14]Directive 95/46/EC on the protection of individuals with regard to the processing of personal data and on the free movement of such data	'Controller' – shall mean the natural or legal person, public authority, agency or any body which alone or jointly with others determines the purposes and means of the processing of personal data; where the purposes and means of processing are determined by national or Community laws or regulations the controller or the specific criteria for his nomination may be designated by national or Community law. 'Processor' shall mean a natural or legal person, public authority, agency or any other body which processes personal data on behalf of the controller.
Data Processor		'Processor' shall mean a natural or legal person, public authority, agency or any other body which processes personal data on behalf of the controller.
Data Handling		The process of ensuring that data is stored, archived or disposed off in a safe and secure manner during and after the conclusion of a process.
Data Protection	OECD Glossary of Statistical Terms	Data protection refers to the set of privacy-motivated laws, policies and procedures that aim to minimise intrusion into respondents' privacy caused by the collection, storage and dissemination of personal data.
Data Privacy	OECD Glossary of Statistical Terms	It is the status accorded to data which has been agreed upon between the person or organisation furnishing the data and the organisation receiving it and which describes the degree of protection which will be provided.
Integrity	NIST IR 298 Glossary of Key Information Security Terms	Guarding against improper information modification or destruction, and includes ensuring information non-repudiation and authenticity. SOURCE: SP 800-53; FIPS 200; FIPS 199; 44 U.S.C., Sec. 3542 The property that sensitive data has not been modified or deleted in an unauthorized and undetected manner. SOURCE: FIPS 140-2
Authentication	NIST IR 298 Glossary of Key Information Security	Verifying the identity of a user, process, or device, often as a prerequisite to allowing access to resources in an information system. SOURCE: SP 800-53; FIPS 200 The process of establishing confidence of authenticity.

[14] The concept of data controller and its interaction with the concept of data processor play a crucial role in the application of Directive 95/46/EC, since they determine who shall be responsible for compliance with data protection rules, how data subjects can exercise their rights, which is the applicable national law and how effective Data Protection Authorities can be.

	Terms	SOURCE: FIPS 201 Encompasses identity verification, message origin authentication, and message content authentication. SOURCE: FIPS 190 A process that establishes the origin of information or determines an entity's identity. SOURCE: SP 800-21 [2nd Ed]
Non-repudiation	NIST IR 298 Glossary of Key Information Security Terms	Assurance that the sender of information is provided with proof of delivery and the recipient is provided with proof of the sender's identity, so neither can later deny having processed the information. SOURCE: SP 800-53; CNSSI-4009 Is the security service by which the entities involved in a communication cannot deny having participated. Specifically the sending entity cannot deny having sent a message (non-repudiation with proof of origin) and the receiving entity cannot deny having received a message (non-repudiation with proof of delivery). SOURCE: FIPS 191

B. Dutch Framework Privacy & Security

Introduction to the Dutch privacy and security framework

Scope and objectives of privacy and security guidelines in The Netherlands

In the Dutch architecture, smart energy meters collect and transmit detailed usage data and have the ability to switch energy flows. Large scale rollout introduces a number of specific privacy and security risks. These risks include blackouts by accident, system error or on purpose (malevolent attackers) and the disclosure of personally identifiable information. In more general terms, confidentiality, integrity and availability of information and (switching) commands must be protected. The main objectives of the guidelines are to achieve a sufficient level of protection across smart metering infrastructures in The Netherlands and to minimize the damage should an incident occur.

Authorship and review of the guidelines

The framework and the guidelines have been created by the Dutch Association of Grid Operators: 'Netbeheer Nederland'. This organisation is the industry association of all Dutch regional grid operators since 2007. Netbeheer Nederland has taken the initiative to establish a working group to design the guidelines. In this working group all Dutch grid operators have been given the opportunity to contribute.

During the development, the guidelines have been reviewed by experts in the field of privacy and security from within and from outside the industry. The Netherlands Organisation for Applied Scientific Research (TNO) as well as the Radboud University Nijmegen (RUN) have provided valuable feedback. PricewaterhouseCoopers (PWC) has contributed on various aspects of the framework. Stakeholders were identified and then consulted in three informal 'round-table sessions' to listen to their expectations and demands. This included interest groups and government representatives.

Structure of the framework en its use for developing guidelines

Together with stakeholders and experts, the workgroup has come up with a practical and 'easy to fill' framework for developing privacy and security guidelines. This framework helps ensure completeness and correctness of the guidelines, ensures transparency, and makes it easy for third parties to review guidelines (requirements and measures) and understand their background and rationale.

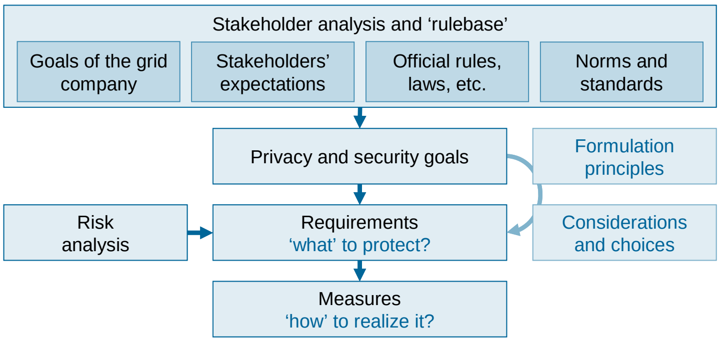

Figure 1: Dutch framework for developing privacy and security requirements and measures

The framework defines the steps to get to a complete and correct set of privacy and security guidelines (see figure 1 above):

1. **Stakeholder analysis and rulebase** - The stakeholder analysis consists of an overview of all relevant stakeholders and their demands and expectations with regards to smart meters. This includes both formal expectations (e.g. legislation) and informal expectations (e.g. opinions expressed in the media). Stakeholders' demands and expectations have been condensed to approximately 30 'rules' as listed in a high level 'rule base'.

2. **Privacy and security goals** - Based on this rulebase, a number of high level goals for the privacy and security requirements have been defined. Approximately ten high-level objectives explain the intended level of security and privacy protection that should be achieved with the set of guidelines.

3. **Risk analysis** - In a parallel process, risks were identified rated on probability and impact. About 60 risks form the basis for the definition of requirements and measures. Since risks depend on available functionality in the infrastructure, a risks classification has been devised. The higher the risk class, the more requirements apply.

4. **Formulation principles -** Four principles are applied drafting the requirements based on the risks and goals:
   - Minimization of information to be secured by limiting communication, storage, retention and locations.
   - Layering of security measures in prevention, detection and resolution.
   - Minimization of impact of incidents by restriction of privileges and influences.
   - Centralization of security for control and maintenance purposes.

5. **Considerations and choices.** In order to track considerations, choices, rationale and evolution of the guidelines all considerations and choices are logged. This is done to provide accountability for these choices.
6. **Requirements** - based on risks and high level goals, requirements have been developed using the formulation principles. These requirements define what has to be done and about 100 are defined.
7. **Measures**. For a number of requirements specific measures are designed in order to aid with implementation choices and to provide consistency over the operators. These define *how* the requirements can be implemented.

By following the steps of the framework, a top-down, risk-based approach is realized during development of the guidelines. In the Dutch case, this resulted in three documents: a main document introducing, explaining and listing the guidelines (requirements and measures), a second document containing the risk analysis, and (third) the stakeholder analysis. A separate database logs all considerations and choices provide transparency and accountability.

C. Existing Standards

This section highlights all identified EU and international standards identified in the IEC, NIST and ESMIG reports related to smart grid and smart metering. Each standard is marked with the interface, if any that relates to the standard with reference to the interface model in section 6.3 of this document. Standards listed are considered to be particularly related or affect by requirements for security and privacy.

European Standards

	Description	**Interface Reference**
EN 61334-3-22:2001	Distribution automation using distribution line carrier systems -- Part 3-22: Mains signaling requirements - MV phase-to-earth and screen-to-earth intrusive coupling devices	6
EN 61334-4-1:1996	Distribution automation using distribution line carrier systems -- Part 4: Data communication protocols -- Section 1: Reference model of the communication system	6
EN 61334-4-33:1998	Distribution automation using distribution line carrier systems -- Part 4-33: Data communication protocols - Data link layer - Connection oriented protocol	6,8
EN 61334-4-42:1996	Distribution automation using distribution line carrier systems -- Part 4: Data communication protocols -- Section 42: Application protocols - Application layer	6
EN 61334-4-32:1996	Distribution automation using distribution line carrier systems -- Part 4: Data communication protocols -- Section 32: Data link layer - Logical link control (LLC)	6,8
EN 61334-4-41:1996	Distribution automation using distribution line carrier systems -- Part 4: Data communication protocols -- Section 41: Application protocols - Distribution line message specification	6

	Description	Interface Reference
EN 61334-4-61:1998	Distribution automation using distribution line carrier systems -- Part 4-61: Data communication protocols - Network layer - Connectionless protocol	6
EN 61334-4-511:2000	Distribution automation using distribution line carrier systems -- Part 4-511: Data communication protocols - Systems management - CIASE protocol	6,8
EN 61334-4-512:2002	Distribution automation using distribution line carrier systems -- Part 4-512: Data communication protocols - System management using profile 61334-5-1 - Management Information Base (MIB)	6,8
EN 62056-21	Electricity metering – Data exchange for meter reading, tariff and load control – Part 21: Direct local data exchange	13
EN 62056-31	Electricity metering – Data exchange for meter reading, tariff and load control – Part 31: Use of local area network on twisted pair with carrier signalling	1
EN 62056-42	Electricity metering – Data exchange for meter reading, tariff and load control – Part 42: Physical layer services and procedures for connection-oriented asynchronous data exchange	2,3,4,5,6,8,9,11,12
EN 62056-46+am1	Electricity metering – Data exchange for meter reading, tariff and load control – Part 46: Data link layer using HDLC protocol	2,3,4,5,6,8,9,11,12
EN 62056-47	Electricity metering – Data exchange for meter reading, tariff and load control – Part 47: COSEM transport layers for IPv4 networks	2,3,4,5,6,8,9,11,12
EN 62056-53	Electricity metering – Data exchange for meter reading, tariff and load control – Part 53: COSEM application layer	2,3,4,5,6,8,9,11,12
FprEN 61968-9:2008	Application integration at electric utilities - System interfaces for distribution management -- Part 9: Interface standard for meter reading and control	5,6,7,10
Communications		
EN 13757-1:2003 Part 1	Developed by CEN. Communication system for meters and remote reading of meters. Include such communication systems as M-Bus and PLC. Part 1: Data exchange includes Obis and DLMS/COSEM)	1
EN 13757-2:2004 Part 2	Developed by CEN. Communication system for meters and remote reading of meters. Include such communication systems as M-Bus and PLC. Part2: Physical and link layer.	1
EN 13757-3:2004 Part 3	Developed by CEN. Communication system for meters and remote reading of meters. Include such communication systems as M-Bus and PLC. Part 3: Dedicated application layer.	1
EN 13757-4:2005 Part 4	Developed by CEN. Communication system for meters and remote reading of meters. Include such communication systems as M-Bus and PLC. Part 4: Wireless meter read-out (electricity meters are not covered by this standard, as the standardization of remote readout of electricity meters is a task for IEC/CENELEC.	1
EN 13757-5:2008 Part 5	Developed by CEN. Communication system for meters and remote reading of meters. Include such communication systems as M-Bus and PLC. Part 5: Wireless relay.	1
EN 13757-6 Part 6	Developed by CEN. Communication system for meters and remote reading of meters. Include such communication systems as M-Bus and PLC. Part 6: Local Bus.	1

	Description	Interface Reference
EN 50090-4-1:2004	Home and Building Electronic Systems (HBES) -- Part 4-1: Media independent layers - Application layer for HBES Class 1	1
EN 50090-4-3:2007	Home and Building Electronic Systems (HBES) -- Part 4-3: Media independent layers - Communication over IP	1,2 ?
EN 50090-5-1:2005	Home and Building Electronic Systems (HBES) -- Part 5-1: Media and media dependent layers - Power line for HBES Class 1	1,2 ?
EN 50090-5-2:2004	Home and Building Electronic Systems (HBES) -- Part 5-2: Media and media dependent layers - Network based on HBES Class 1, Twisted Pair	1,2, ?
EN 50090-5-3:2006	Home and Building Electronic Systems (HBES) -- Part 5-3: Media and media dependent layers - Radio frequency	1,2, ?
CLC/prTS 50090-6-4	Home and Building Electronic Systems (HBES) -- Part 6-4: Interfaces - Residential gateway model for a home and building electronic system	3,4 ?
EN 60870-5-1:1993	Telecontrol equipment and systems -- Part 5: Transmission protocols - Section 1: Transmission frame formats	3, 4 ?
EN 60870-5-2:1993	Telecontrol equipment and systems -- Part 5: Transmission protocols - Section 2: Link transmission procedures	3, 4 ?
EN 60870-5-3:1992	Telecontrol equipment and systems -- Part 5: Transmission protocols - Section 3: General structure of application data	??
EN 61850	Communication networks and systems in substations -- Part 3: General requirements	3,6
EN 61850-4:2002	Communication networks and systems in substations -- Part 4: System and project management	3,6
EN 61850-5:2003	Communication networks and systems in substations -- Part 5: Communication requirements for functions and device models	3,6
EN 61850-6:2004	Communication networks and systems in substations -- Part 6: Configuration description language for communication in electrical substations related to IEDs	3,6
FprEN 61850-7-3:2008	Communication networks and systems for power utility automation -- Part 7-3: Basic communication structure - Common data classes	3,6
EN 61850-7-3:2003	Communication networks and systems in substations -- Part 7-3: Basic communication structure for substation and feeder equipment - Common data classes	3,6
FprEN 61850-7-4:2008	Communication networks and systems for power utility automation -- Part 7-4: Basic communication structure - Compatible logical node classes and data classes	3,6
EN 61850-7-4:2003	Communication networks and systems in substations -- Part 7-4: Basic communication structure for substation and feeder equipment - Compatible logical node classes and data classes	3,6
CLC/prTS 61850-80-1	Communication networks and systems for power utility automation - Part 80-1: Guideline to exchanging information from a CDC-based data model using IEC 60870-5-101 or IEC 60870-5-104	3,6
Interface		
EN 61970-403:2008	Energy management system application program interface (EMS-API) Part 403: Generic data access	3,6

	Description	Interface Reference
EN 61970-404:2007	Energy management system application program interface (EMS-API) Part 404: High speed data access (HSDA)	3,6
EN 61970-407:2007	Energy management system application program interface (EMS-API) Part 407: Time series data access (TSDA)	3,6
EN 61968-1:2004	Application integration at electric utilities - system interfaces for distribution management Part 1: Interface architecture and general requirements	6, 11 ?
EN 300 220	Electromagnetic Compatibility and Radio Spectrum Matters; Short Range Devices (SRD)	2
EN 300 228	Electromagnetic Compatibility and Radio Spectrum Matters; Wideband Transmission Systems	2
EN 300 356-1	Integrated Services Digital Network (ISDN); Signaling System no. 7 (SS7)	
EN 300 403-1	Integrated Services Digital Network (ISDN); Digital Subscriber Signaling System no. 1 (DSS1) protocol	
EN 300 440-2	Electromagnetic Compatibility and Radio Spectrum Matters; Short Range Devices; Radio Equipments to be used in the 1GHz to 40 GHz frequency range	2
EN 300 328	Electromagnetic Compatibility and Radio Spectrum Matters; Wideband Transmission Systems; Data transmission equipments operating in the 2.4GHz ISM band and using Wide Band Modulation techniques	2
EN 302 065	Electromagnetic Compatibility and Radio Spectrum Matters; Ultra Wide Band (UWB) technologies for communication purposes	2
EN 302 500	Electromagnetic Compatibility and Radio Spectrum Matters; Short Range Devices (SRD) using UWB technology; Location tracking equipment in the frequency range from 6GHz to 8.5GHz	2
ES 202 630	SRD Technical Characteristics and Test methods	

International

IEC/TR 61334-1-4 (1995-11)	Distribution automation using distribution line carrier systems - Part 1: General considerations - Section 4: Identification of data transmission parameters concerning medium and low-voltage distribution mains	
IEC 61334-4-32 (1996-09)	Distribution automation using distribution line carrier systems - Part 4: Data communication protocols - Section 32: Data link layer - Logical link control (LLC)	
IEC 61334-4-33 (1998-07)	Distribution automation using distribution line carrier systems - Part 4-33: Data communication protocols - Data link layer - Connection oriented protocol	
IEC 62056-21	Electricity metering – Data exchange for meter reading, tariff and load control – Part 21: Direct local data exchange	
IEC/TS 62056-41	Electricity metering – Data exchange for meter reading, tariff and load control – Part 41: Data exchange using wide area networks: Public switched telephone network (PSTN) with LINK + protocol	

IEC 62056-42	Electricity metering – Data exchange for meter reading, tariff and load control – Part 42: Physical layer services and procedures for connection-oriented asynchronous data exchange	
IEC 62056-46+am1	Electricity metering – Data exchange for meter reading, tariff and load control – Part 46: Data link layer using HDLC protocol	
IEEE 802	Standards for Local Area Network and Metropolitan Area Network. The most widely used standards are: Ethernet, Token Ring, Wireless LAN, Wireless PAN (Personal Area Network), Wireless MAN, Bridging and Virtual Bridged LANs.	
IEC 61850-6 Ed. 1.0	Communication networks and systems in substations - Part 6: Configuration description language for communication in electrical substations related to IEDs	
IEC 61850-7-3 Ed. 1.0	Communication networks and systems in substations - Part 7-3: Basic communication structure for substation and feeder equipment - Common data classes	
IEC 61850-7-4 Ed. 1.0	Communication networks and systems in substations - Part 7-4: Basic communication structure for substation and feeder equipment - Compatible logical node classes and data classes	
IEC/TS 61850-80-1 Ed. 1.0	Communication networks and systems for power utility automation - Part 80-1: Guideline to exchanging information from a CDC-based data model using IEC 60870-5-101 or IEC 60870-5-104	3,6
Interface		
IEC 61970-407	Energy management system application program interface (EMS-API) Part 407: Time series data access (TSDA)	3,6
ETSI TS 102 887-1	Smart Metering wireless access protocol; part 1: Physical layer	2
ETSI TS 102 887-2	Smart Metering wireless access protocol; part 2: Data Link Layer (MAC)	2
ETSI TR 102 886	Performance requirements for Smart Metering Wireless Access Protocol	2
Data exchange security		
IEC/TS 62351-1:2007	Power systems management and associated information exchange - Data and communications security - Part 1: Communication network and system security - Introduction to security issues	3,6
IEC/TS 62351-2	Application integration at electric utilities - System interfaces for distribution management - Part 2: Glossary	3,6
IEC/TS 62351-3:2007	Power systems management and associated information exchange - Data and communications security - Part 3: Communication network and system security - Profiles including TCP/IP	3,6
IEC/TS 62351-4:2007	Power systems management and associated information exchange - Data and communications security - Part 4: Profiles including MMS	3,6
IEC/TS 62351-6:2007	Power systems management and associated information exchange - Data and communications security - Part 6: Security for IEC 61850	3,6
ETSI TS 102 689	M2M Service requirements	
ETSI TS 102 221	Smart Cards; UICC-Terminal Interface; Physical and Logical characteristics	1
ETSI TS 102 671	Smart Cards; Machine to Machine UICC; Physical and Logical characteristics	1, 2

ETSI TS 102 223	Smart Cards; Card Application Toolkit (CAT)	1, 2
ETSI TS 102 225	Smart Cards; Secured Packet structure for UICC based applications	2, 7
ETSI TS 102 226	Smart Cards; Remote APDU structure for UICC based applications	2, 7
ETSI TS 102 484	Smart Cards; Secure channel between a UICC and an endpoint terminal	1, 2
ETSI TS 184 002	Identifiers (IDs) for Next Generation Networks (NGN)	2, 7
ETSI TR 187 010	Telecommunications and Internet converged Services and Protocols for Advanced Networking (TISPAN); NGN Security; Report on issues related to security in identity management and their resolution in the NGN	2, 7
ETSI TS 185 005	Services Requirements and Capabilities for customer networks connected to TISPAN NGN	2, 7
Draft ETSI TS 185 003	TISPAN Customer Network Gateway (CNG) Architecture and Reference Points	2
ETSI TS 185 006	TISPAN Customer Devices Architecture and Reference Points	1, 2
ETSI TS 181 005	TISPAN Service and Capability Requirements	
ETSI TS 122 228	IMS Service Requirements for the Internet Protocol (IP) multimedia core network subsystem (IMS); Stage 1	
ETSI TS 122 173	IMS Multimedia Telephony Service and Supplementary Services; Stage 1	
ETSI TR 187 002	TISPAN NGN Security (NGN SEC); Threat Vulnerability and Risk Analysis	
ETSI TS 187 001	TISPAN NGN Security (NGN SEC); Security Requirements	
ETSI TS 187 003	TISPAN NGN Security (NGN SEC); Security Architecture	

Other Defacto standards, TRs, FDIS, CDs

Standard	**Description**	**Interface Reference**
ZigBee Smart Energy Profile	HAN protocol based on IEEE 802.15.4 MAC and PHY.	1
PCI – DSS	Code of practice for payment card Industry for the holding of Credit and Debit Card details and persona data.	4,5,6,7,10,11

EU Commission Task Force for Smart Grids

Expert Group 3: Roles and Responsibilities of Actors involved in the Smart Grids Deployment

EG3 Final Deliverable
22. June 2010

Table of Contents

1 Introduction, Tasks and Scope of Work of Expert Group 3

The tasks and scope of work of the Expert Group 3 (EG3) of the EC Task Force for Smart Grids (TF) are defined on the basis of the Mission Statement of the TF [6] and specified in detail in the Vision document [7], which was presented at the 2nd meeting of the TF Steering Committee on 16. December 2009.

The key elements of the EG3 final deliverable are:

- The **recommendations on the roles and responsibilities** of all involved actors in the implementation of Smart Grids;
- The **definition of criteria and recommendations for the funding** of Smart Grids deployment;
- The **recommendations to the EU Commission regarding the needs for any additional legal framework at the EU level**, in support of the Smart Grids deployment.

The work of EG3 has been organized along the following lines:

i. A questionnaire addressing the issues below was elaborated by the EG3 members and compiled together in a summary document [8]:
    a. Expected benefits from Smart Grids for their own organisation;
    b. Smart Grids features provided by their own organisation;
    c. Smart Grids features needed from other actors[1];
    d. Defined decision criteria for the deployment of specific Smart Grids features;
    e. Roles & responsibilities within their organisation relating to Smart Grids deployment;
    f. Anticipated (or already identified from current/previous Smart Grid deployment) interfaces and interaction with other actors in the electric power supply chain required for Smart Grids deployment.

    The information collected via this questionnaire has been the initial source of information in the development of this EG3 deliverable. In addition, other sources such as the findings and results of the EU TP Smart Grids [1], ERGEG position paper on Smart Grids and related public consultation [2] and the BEUC non-paper on Smart Grids and Smart Metering [3] have also been used.

    An additional questionnaire has been used in elaborating the needs for additional legal framework in support of Smart Grids deployment (Annex I).

ii. A synthesis of the detailed information from (i) above was created and used as a working document in the follow-up discussions of the EG3.

iii. This document contains the final deliverable of the EG3, with elaboration of the three key elements mentioned above, submitted now to the EU Commission and TF for Smart Grids

2 Roles and Responsibilities – Current Status

For each actor in the electricity supply chain, its role and responsibilities are defined, structuring them according to their functions and responsibilities into 'groups', which are then used in the

[1] Coordinated with the other Expert Groups, including in particular the relation of Smart Grids and Smart Meterings

elaborations of the remainder of this document. Moreover, an overview of current roles and responsibilities within the electric power supply chain is contained also in [4]. Changes to the current roles and responsibilities that will occur as the deployment of Smart Grids proceeds are addressed in Chapter 5 of this document.

2.1 Grid Operators

The term „Grid Operators“, refers to the undertakings of operating, building, maintaining and planning of the electric power transmission and distribution networks.

Transmission System Operator (TSO): according to the Article 2.4 of the Electricity Directive 2009/72/EC (Directive): “*a natural or legal person responsible for operating, ensuring the maintenance of and, if necessary, developing the transmission system in a given area and, where applicable, its interconnections with other systems, and for ensuring the long-term ability of the system to meet reasonable demands for the transmission of electricity*“. Moreover, the TSO is responsible for connnection of all grid users at the transmission level and connection of the DSOs within the TSO control area.

Distribution System Operator (DSO): according to the Article 2.6 of the Directive: “*a natural or legal person responsible for operating, ensuring the maintenance of and, if necessary, developing the distribution system in a given area and, where applicable, its interconnections with other systems and for ensuring the long-term ability of the system to meet reasonable demands for the distribution of electricity*“. Moreover, the DSO is responsible for regional grid access and grid stability, integration of renewables at the distribution level and regional load balancing[2].

2.2 Grid Users / Customers[3]

Generator: Generating electricity, contributing actively to voltage and reactive power control, required to provide the relevant data (information on outages, forecast, actual production) to the energy marketplace (see also the Articles 2.1 and 2.2 of the Directive).

Customer / consumer: Depending on their characteristics, consumers could be classified into one or more of the following categories:

> **Industrial customer:** A large consumer of electricity in an industrial / manufacturing industry. May be involved in contract based Demand/Response.
>
> **Transportation customer:** A consumer of electricity providing transport systems. May be involved in contract based Demand/Response.
>
> **Buildings**: A consumer of electricity which is a private or business building, may also be involved in contract-based Demand/Response.
>
> **Home customer:** A residential consumer of electricity (including also agriculture users) may also be involved in contract-based Demand/Response.

Supplier: A grid user who has a grid connection and access contract with the TSO or DSO (see also the complementary description of supplier in section 2.3). Moreover, suppliers are those actors which will provide new services, real-time information, energy efficiency services and dynamic energy pricing concepts with Time-of-Use (ToU). The suppliers also provide local aggregation of demand and supply, in order to increase the effectiveness and efficiency of the electricity supply at

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[2] In some countries this is done by a Balance Responsible Party.

[3] Please refer also to the Articles 2.7 – 2.11 of the Directive.

all voltage levels (including low / medium voltage levels).

Retailer: Entity selling electrical energy to consumers – could also be a grid user who has a grid connection and access contract with the TSO or DSO.

In addition, multiple combinations of different grid user groups (e.g. those grid users that do both consume and produce electricity) exist. In the remainder of this document, the terms customer/consumer and grid user are used interchangeably where appropriate.

2.3 Energy Market Place

Power Exchange: Provides a market place for trading physical and financial (capacity/energy and derivates) contracts for capacity allocation by implicit auctions within the defined country, region or cross border.

Balance Responsible Party: Ensures that the supply of electricity corresponds to the anticipated consumption of electricity during a given time period and financially regulates for any imbalance that arises.

Clearing & Settlement agent: Assumes liability for clearing and/or settlement of contracts and provides contractual counterparty within a Power Exchange and for Over the Counter (OTC) contracts.

Trader: A person or entity that buys and sells energy goods and services in an organized electricity market (Power Exchange) or Over the Counter.

Supplier: Has a contractual agreement with end customer relating to the supply of electricity**.**

Aggregator: Entiry which offers services to aggregate energy production from different sources (generators) and acts towards the grid as one entity. Maintains a contract with the supplier.

2.4 Providers of Technologies, Products and Services

The actors listed below provide technology, products and services to the actors mentioned above. They have been classified into the following categories:

- **Electric Power Grid Equipment vendors;**
- **Ancilliary Services providers;**
- **Metering Point Service Providers:** Entities responsible for meter reading and providing additional services for the customer. This service may be provided by an independent company, retailer or DSO;
- **Metering Point Service Operators:** Entities providing and maintaining metering equipment installation and services on a contractual basis. The contract may be with the customer, the supplier or the DSO. The meter may be rented or owned by the customer;
- **Information & Communication Technology (ICT) service providers;**
- **Grid communications network providers** Plan, build and maintain the communications systems that enable the data communication required to maintain grid stability, load balancing and

fault protection systems by a TSO or DSO. This function may be performed by an independent actor, by the TSO or DSO. The overall responsibility and ownership of information[4] remains with TSO and DSO. Grid communications network provider ensures compliance with the agreed service levels (Service Level Agreements including quality of service, data security and privacy) and compliance with any national and/or international regulations as necessary;

- **Home Appliances vendors;**
- **Building Automation / Energy Management providers;**
- **Electric Transportation / Vehicle Solutions providers;**

2.5 Influencers

Grid User / Customer / Consumer: Entity or person being delivered electricity. How a customer perceives the value received from other actors in the electricity supply chain has a substantial influence on the economic viability of the grid in general and on the overall acceptance of how the electricity supply chain performs.

Regulator: Independent body responsible for the definition of framework (market rules), for setting up of system charges (tariffs), monitoring of the functioning and performance of energy markets and undertaking any necessary measures to ensure effective and efficient market, non-discriminative treatment of all actors and transparency and involvement of all affected stakeholders.

Standardization Bodies: Responsible for standardization of all relevant elements and components within the electricity supply chain, which in turn leads to harmonization of relevant services, support towards removing barriers to trade, creating new market opportunities and reducing manufacturing costs.

EU and national legislation authorities: Entities are in charge of defining legislation and metrics for areas such as environmental policy, social policy, energy policy and economic policy. They are also responsible for the authorisation needed to develop the electricity grid infrastructure.

Financial Sector undertakings: Provide capital to other actors or invest themselves into the projects within the electricity supply chain (grid, generation, etc.).

3 Interfaces and Interaction

The present structure of electricity supply chain in Europe is the result of over 100 years of development. The European market liberalization and evolution of the Internal Electricity Market (IEM) is the outcome of implemented policy goals by the EU, but their implementation varies across the Member States. The liberalization process has changed the roles and responsibilities in the electricity supply chain, but many national and regional markets still exist instead of one single European Internal Electricity Market.

The EU 20/20/20 targets aim at further changing the electricity sector and market towards more sustainability and energy efficiency. As a result of political decisions, a large share of variable distributed generation capacities will be installed and connected to the transmission and distribution grids in the years to come. Smart Grids will offer many new opportunities and possible solutions to cope with related challenges.

[4] An exception is the customers' data which are managed by the grid operator but belong to the customer.

One key aspect of the Smart Grids concepts is a stronger integration ("convergence") between players that used to operate on more or less distinct markets. The overarching condition for Smart Grids to meet a plethora of expectations is to ensure an overarching effective and efficient deployment. A comparison with other industries shows that this aspect of "building of community of supporters" is not the least challenging among the environments and populations that have different technical and business cultures, different development cycles and often different standardization cultures. Therefore, a pre-requisite for the Smart Grids deployment is that **all the actors in the electricity supply chain are aware of and commit to their future roles and responsibilities**.

3.1 Electricity Supply Chain

Generally, Smart Grids lead to more interaction between the actors in the energy supply chain. In the context of a liberalised market, additional energy can be traded on different platforms such as markets for energy, capacity, or ancillary services. Subsequently this energy can be physically or virtually exchanged between market players. Along with these additional activities, new opportunities and challenges (risks) are introduced into the system operation. The opportunities apply to those who actually make use of the additional functionalities and processes (such as retailers, consumers and/or renewable and conventional generators – grid users in general). The challenges (risks) in the grids are relevant to all participants, need to be managed accordingly by the grid operators, with the support and commitment of other participants.

Large scale **intermittent generation** from renewable sources (primarily wind) will be connected to the transmission and distribution grids in the future[5]. The three key challenges for the TSOs are (i) to maximize interconnection capacities, (ii) to support the integration of the large wind generation plants and (iii) to keep the grid stable and balanced in cooperation with the DSO´s.

The three key challenges for the DSOs are (i) connecting additional generation from renewables, (ii) enabling active demand/customer side participation in the market (this is also a key challenge for TSOs) and (iii) keeping the distribution grid stable and balanced by handling electric power flows in both directions.

To ensure economically efficient and stable operation taking into account the **importance of the interaction between TSOs and DSOs**, the tasks of economically efficient continuous balancing, monitoring and reporting must be clearly defined and agreed upon by the relevant parties and accordingly implemented by the TSOs and DSOs[6].

In **distribution**, with massive deployment of "conventional" distributed generation and future "in house" micro generation, the DSO role will gradually shift from distributing power on a top-down basis, to a role in which maintaining voltage quality and balance is central while electricity flows in both directions. It follows that the DSO in the future will be **interacting more frequently than today with TSOs, consumers and generators.** The future interfaces required to accomplish this will need to be specified in further detail.

Storage of generated electricity is a subject of intensive R&D and industry effort over many years, including both conventional methods like pumped-hydro-storage and the less conventional ones like compressed air. Future possibilities could possibly extend to batteries of electrical cars connected to the grid. It is therefore possible that electrical cars will play a substantial role in storage in the future, but the realization might be extended until and beyond 2020. The interfaces required between the "storage owners" and the DSOs will require further analysis.

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[5] As a consequence of the adoption of the 2009 RES (Renewable Energy Sources) Directive, the European Wind Energy Association (EWEA), in March 2009, increased its 2020 target from 180 GW to 230 GW of which 40 GW would be offshore.

[6] In some countries also a separate Balance Responsible Party

In addition, more detailed work will be needed on the future down stream **interfaces and interaction in relation to Smart Metering** as following the 3rd Electricity Directive, most European customers will be equipped with Smart Metering by 2020. Moreover, interactions of the electricity supply chain with other forms of energy like heating from gas in relation to the use of Smart Metering will further help to increase efficiency and save energy across the EU.

Smart Metering and related "Smart Communication", when implemented in a right way can provide information to different actors (DSOs, Balance Responsible Parties, Retailers, End users, Service-providers and/or Aggregators) – which all should ensure improved service to the customers. This data can be used not only for classical metering & billing but also for introducing new services on the competitive market.

Demand Side Response will gain importance on household level, not only for retailers but also for the grid operators to "get in contact" with customers in times of scarce capacity. Home applications enabling Demand Side Response have to be developed. However, the "smartness" of metering to inform the customers, will only be achieved if relevant add-on information will be distributed for other energy management purposes like e.g.: peak load management, enhanced customer switching, enhanced alarm and fault management by grid operators, etc. Smart Metering will hence be used differently by different actors and might also be of no use at all for some Smart Grids applications and/or services.

Today Smart Metering roll-outs[7] are being implemented in different ways in different Member States and different actors are responsible for Smart Metering. Thus a standardized set of services and architecture defined by the EU would be highly beneficial for an efficient implementation throughout Europe.

More flexible products will be needed in the electricity market to support system **balancing**; in this context **intraday trading** will become an important instrument. More transparent and adjusted balancing & reserve power rules agreed between TSOs will be required, also in order to facilitate the development of cross border intraday, balancing and reserve markets. Moreover, all players, including DSOs, generators, Balance Responsible Parties, but also regulators will have to establish an appropriate forecasting framework and system to cope with **higher flexibility and volatility in the electricity supply chain**. In this regards, the application of state-of-the-art forecast tools together with larger balancing areas is the key to integrate large amounts of variable RE generation, e.g. from wind power in a cost-efficient way.

3.2 Summary and Recommendations on Interfaces and Interactions

3.2.1 Enhanced cooperation of TSOs and DSOs with Focus on Bi-directional Electricity Flows

Massive deployment of distributed generation will not only contribute to displacing local demand but might also result in "injection" towards the transmission grid, influencing the transmission infrastructure. Connection of distributed and micro generation will provide more options for the DSOs[8] to balance their grid areas on the medium and low voltage level, thereby reducing stress on TSO level. At the same time, this will place new requirements on TSOs and DSOs in terms of operational security. The increased efficiency benefits of local generation, in reduction of distribution and network losses should be recognised in planning the local physical network. From an overall energy efficiency respect the more local the balancing of the network the less losses are incurred in overall flow. Hence local balancing is preferable.

[7] On the contrary to the continuous process of deployment of Smart Grids, Smart Metering as the new metering & billing technology which will enable additional smart services if implemented in an effective and efficient way, will indeed be deployed within a project and rollout plan.

[8] and/or Balance Responsible Parties, where applicable.

Interfaces Recommendation #1: EG3 recommends that DSOs and TSOs implement a two-fold strategy in a coordinated way, including **supply management** and **capacity expansion in regions with high generation potential.**

Growing Distributed Generation also poses operational and control challenges for the traditionally designed and operated distribution grids and is one of the key drivers for Smart Grids. Those challenges include among others voltage and reactive power management, maintaining system stability and operational security. The existing best practices from Member States where considerable distributed generation already exists should be benchmarked in developing new approaches. Therefore **DSOs will have to become much more involved in relation to innovative voltage control, power flow management, dynamic circuit ratings** etc.

Interfaces Recommendation #2: EG3 recommends that the appropriate framework and incentives are introduced for **Distributed Generation (DG) to provide a range of ancillary services** (e.g. voltage-reactive power control, etc).

Interfaces Recommendation #3: EG3 considers that the TSOs and DSOs must significantly enhance the exchange of information and coordination, embracing activities such as **power flow management**, **voltage control, alarm surveillance & fault management,** in order to be able to maintain a reliable and stable system.

It is further necessary to ensure that network operators have a good visibility of real time operational limits and the dynamic stability of the interconnected transmission systems.

Interfaces Recommendation #4: **WAMS (wide area monitoring system)** are already being used by TSOs to get a view of wide-area phasor oscillations and detect dynamic instabilities. Similar systems adapted to the properties of LV and MV networks could be a benefit for the operation of DSOs in the future[9].

Interfaces Recommendation #5: EG3 recommends that the future cooperation between different TSOs and between TSOs and DSOs will include reporting of actual power and energy values for all participants in the new market places down to distribution level for settlement but also for data analysis for planning (active or automatised). The frequency, handling time and duration for this reporting will depend of the purpose and products being offered on a given market place.

3.2.2 Interfaces between the DSOs, TSOs, Aggregators, Consumers and Generators

The DSOs' responsibility in the future electricity market with massive DG and micro DG is multifold and resembles that of the TSOs in the transmission grid of today. These include (i) keeping operational security and quality of supply, (ii) enabling the new operations at the distribution level (including non-discriminatory and effective real-time grid capacity monitoring and management of injections / withdrawals), (iii) market based congestion management, (iv) support energy efficiency and integration of renewables at the producer side by setting harmonized and non-discriminatory rules and codes[10].

[9] The effectiveness of WAMS is conditional on the area covered and this needs to be considered accordingly.

[10] Depending of the national structure parts of this can be handled by the BRPs

Interfaces Recommendation #6: EG3 recommends that consumers, generators and those who do both, cooperate with traders and suppliers (possibly via aggregators) and establish their participation in any kind of market places under **contractual arrangements** pre-defined with the related DSOs. This will resemble the way how the "large" market participants and generators participate in the wholesale market and cooperate with the TSOs today. They will have to deliver information on their planned market activities to the DSO and the TSO, depending on their kind of participation.

Some exemptions to the "standard" contractual arrangements might be necessary for the on-site self generation e.g. industrial plants who own generators at their own premises and produce only for their own consumption purposes, thereby not delivering any energy back to the grid.

3.2.3 Interfaces between DSOs, aggregators, BRP and the Storage Owners

Storage refers here to all forms of energy storage (chemical, potential, kinetic, thermal). The energy stored can either be transformed into electricity or be used in the form in which it was originally stored (i.e. as pressure or steam).

Depending on the model chosen for the future electro-mobility and electrical cars deployment within a country or grid area and depending on technical capability of the batteries for the vehicle to grid (V2G), the electrical cars can also be contractually integrated in the future contracts with Storage Owners. Due to the many different models possible, the actual integration of electro-mobility and electrical car owners is left out from the detailed consideration here.

3.2.4 Interfaces of DSOs, Customers, Suppliers and other actors concerned with smart meters (Interfaces around the Meter)

In relation to the data from Smart Metering, some of the data will be necessary to suppliers for services around the supply of energy e.g. the provision of detailed consumption information and billing. Other data may be required, with explicit consent to provide additional services. Some data will be only of interest to grid operators and other data will be necessary for meter operators (who – depending on the national market model – may be distribution companies, suppliers or meter companies).

Certain data may be relevant to more than one party. The deployment of smart meters thus prompts decisions at national level about the requirements of the various market participants, the nature of data (individual or aggregated) and how data flows should be managed. Decisions in this area will reflect national market structures and industry systems, but they will also affect the commercial and customer services that smart meters will enable. Data privacy rules and regulations must also be adhered to. **DSOs are responsible for managing some customer and consumption information, DSOs should act as enablers of demand side participation in the form of information hubs.** DSOs should be responsible for gathering consumption data (through meter readings) and dispatch it in a swift, reliable and non-discriminatory way to licensed service providers (suppliers, aggregators, etc.) thereby safeguarding confidentiality of information by restricting the ability of third parties to access confidential information. They should provide historic energy consumption information to customers for free in a format that allows them to make like for like comparisons with tariffs and deals available in the market. The responsibility for administration of verified and validated master data currently lies with the DSO in most European countries. In several countries however, this responsibility is handed over to other actors. National differences in market models and responsibilities of DSOs, TSOs and retailers are likely to persist in the future, with metering operators or even new entities potentially providing additional services through communication tools to customers.

Some general principles should apply to improve the interface between DSOs and other actors when it comes to metered data provision. It is essential that market actors are able to use a common and standardised communication and data management system. For this purpose, information requirements should be the same and a minimum level of information requirements should be

Deleted: relevant

Deleted: and their services to customers

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Comment [A1]: Some data – not exclusive rights to manage

Comment [A2]: This approach may not be appropriate for all countries, e.g. the UK which is proceeding of the basis of supplier roll-out and a central data and communications provider. Not comfortable with this statement. In countries where the DSO does take on such a role could this act as a barrier to competition prevent new entrants to the energy services market?

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Comment [A3]: Reiterating point which is made later specific: the database format for example should be open and standardized and facilitate data exchange as well as data aggregation. Aggregators, for example, will need ICT with standard interfaces for interacting with customer meters, displays (information) and customer equipment (for automated demand response). Policy makers should assist in promoting harmonisation and standardisation of data exchanges and customer processes at the European Union level as this would facilitate supplier switches and allow economies of scale. DSOs should move towards a unique identification of metering points to facilitate data exchanges.

A strong and coordinated European effort is recommended to develop a new architecture and new standards in the field of security and privacy protection. The market model "around the Smart Meter" will develop differently in different European countries.

Interfaces Recommendation #7: EG3 recommends interfaces to be specified between communication service providers and the following actors:TSO, DSO, Agregators, Grid Users, BRP, Storage Owners. Theses interfaces are typical user to network interfaces and specify the agreed service level agreements which have a legal and technical part (QoS, security level, privacy, etc.).

Interfaces Recommendation #8: EG3 recommends regulatory authorities to promote maximum standardisation and interoperability and establish level playing fields that encourage the market to work efficiently and to secure customer participation and market integrity. Regarding the interfaces among the actors, EG3 further emphasizes further the need to clarify the role of DSOs as enablers of demand-side participation in the form of neutral and transparent "information hubs".

3.2.5 Flexible Energy Pricing and Grid Tariffs' Systems

One of the most important preconditions to establish a market for higher generation and load flexibility is the optimal price signal in energy. As flexibility - both in supply and in demand - often necessitates costly investments, the tariff system has to provide long-term price relations to legitimate the financial expectations of the investors. The energy market itself will support these efforts, this might require further support. An assessment of the actual grid tariff systems reflecting grid load by demand charge on a metered basis and by offering special discounts for interruptible loads could help to find the essential framework to be designed. Considering one of the important aims of Smart Grids is to enable Demand Side Participation, a system of communication, metering, standardised access and interaction between the grid and the consumer (or the retailer) is necessary.

Interfaces Recommendation #9: The manifold components of such a system are expected to give incentives for a wide variety of innovation and products for flexible demand or generation, under the condition that there exists an **economic incentive for generators, consumers and those that do both in terms of flexible energy prices**. Moreover, this might extend towards the flexible grid tariffs with Time of Use (ToU) payments. Regulators must ensure that there are adequate safeguards in place to enable consumers to effectively engage in this evolving energy services and smart market in order to make well-informed purchasing decisions. Particular consideration must be given to the impact on low income and vulnerable consumers.

In relation to Demand Side Participation and to the growing importance of the grid users who are both, producing and consuming electricity, adequate tariff structures will need to be elaborated taking into account energy (kWh), load (kW) and time of use, so as to ensure fairness towards all grid users and adhering to the principle of causality.

The goal is to achieve optimized use of all generated electricity combined with the optimal use of grid capacity, while limiting financial and environmental impacts. The RES support schemes should be adjusted to take proper account of the financial impact of RES DG, but also other aspects (e.g. overall investment at TSOs vs. DSOs, new services offered as a result of locally connected DG, etc.). The flexibility of generators, consumers and those that do both fostered this way will create liquidity in local market segments at the distribution level.

Comment [A4]: Query this role for DSOs – what about other market players?

Comment [A5]: For example, the underlying assumption is that smart grids will improve the energy retail market and customer service. In practice the consumer experience may be very different. Smart grids are likely to facilitate the introduction of a range of new tariffs – multiple rate time of use, critical peak pricing, remote demand management, along side energy services deals. While this increased choice is welcome, it is also likely to make the market more complex and confusing for many consumers, making it hard to identify the best deal. In GB a third of customers already switch to a worse deal. When it comes to doorstep sales the figure is even higher. We have relatively few tariffs compared to what will happen in a smart world. Similarly we are seeing GB companies starting to offer longer term contracts in exchange for a smart display, as with the mobile phone contracts. Not a problem as long as consumers are aware of the long term implications if they change jobs, have families etc of locking themselves into longer contracts. In Victoria in Australia they introduced a moratorium on the introduction of time of use tariffs following concerns about the impact on low income and vulnerable consumers. In parts of the States mandatory roll out of time of use tariffs and poor roll out strategies have resulted in legal action. Consumers will need to have free access their historic consumption information in a format that allows them to make like for like comparisons with other tariffs available. We need to ensure that consumers have a choice in whether to adopt new deals as not everyone will benefit.

The services to create a market for load flexibility should follow the assumed **characteristics of such respective demand response products**. This could be load and energy amount, handling time, frequency, duration, etc. Additionally the actual remaining potential of flexibility would be important information to the market. These parameters could also describe standardized and tradable products if the suitable communication tools and information can be provided by the grid operators. If data protection does not allow permanent analysis of grid load, the required data may be collected on an aggregated level. For some devices providing flexibility it may be necessary to monitor the remaining capacity on an individual basis. It will be necessary to define the procedure and formats on how the grid operators will have to present the information in a 'competition neutral' way and how any incurred costs are recovered.

3.2.6 Further Analysis

Interfaces Recommendation #10: EG3 recommends that the elements requiring further analysis in terms of interfaces and interactions in Smart Grids deployment include:

- The interfaces required between the "storage owners" and the DSOs will require further analysis. (From section 3.1 above)
- Future down stream interfaces and interaction in relation to Smart (From section 3.1 above)
- Flexible energy prices, flexible grid tariffs and their impact on the interfaces between consumers and producers, TSOs, DSOs and suppliers/traders/aggregators
- Clearing & settlement systems interfaces and interaction with data collection, data exchange, and electricity flows
- Products and features fostering producers and consumers' flexibility and their relation to capacity management, communication needs, etc.
- Overview and comparison between flexibility demand and potential on different grid / voltage levels (internal, national market, regional/TSO and local/DSO, medium / low voltage)
- Experiences from existing intraday markets: organisation, triggers for activity, volume, framework, obstacles, etc.
- Study of efficient ways to communicate with customers, such as e-mail, SMS, signals to the meter, In-Home display, digital TV etc.
- A higher contribution of DG to the system stability and operational security.

4 Benefits, Criteria and Recommendation for Funding of Smart Grids Deployment

The three complementary objectives of Smart Grids; 1)Economic efficiency, 2)Technology evolution and 3) Environmental policy goals) are summarized in the Annex II, with a specific focus on the trade-offs that may be required between these objectives in order to achieve the 'optimum' Smart Grid deployment. It is against this background that the benefits, criteria and recommendations in this chapter are elaborated.

4.1 Rationale

This section presents **expected benefits**, **criteria** and **recommendations for funding** of Smart Grids deployment. Based on that, a **template for evaluation of the merit for deployment** of the specific features is elaborated.

The main driver for Smart Grids deployment are **the European environmental policy goals** aiming at CO2 reduction, deployment of renewable energy sources, energy efficiency and the resulting **requirements and needs of grid users**. Moreover, an increased demand for flexibility emerges both in the transmission and in the distribution grids due to the massive deployment of variable generation. Part of the needed flexibility can be offered by Demand Side Response, which will be facilitated by Smart Grids. A key challenge here is to identify and implement first those features that **most efficiently meet grid users' needs resulting from policy goals.**

The related definitions, technology issues and specific Smart Grids features are discussed in the deliverables of EG1 and EG2. It is important to emphasise here, that Smart Grids deployment is about **evolution** (not revolution) of the way how electricity grids should be planned, built, operated and maintained, in order to efficiently support achieving the European 2020 targets and policy goals.

In the future, electric power will be transported and distributed over „copper and iron“, with Smart Grids not changing the key principles of physics but instead improving effectiveness, cost- and energy-efficiency. It follows that **there cannot be any "roll-out"** of Smart Grids because "smartening" electricity grids is a continuous process.

Considering the different characteristics and level of "smartness" in the transmission and distribution grids of the EU Member States, it follows that Smart Grids deployment cannot cover 100% of all grids in all Member States at the same time and that **roadmaps for Smart Grids deployment will differ** in the different Member States. The level and need of "smartness" for the grids will also depend on the development of the power generation mix in the different Member States, the regional / national structure of the electricity market and the existing electricity grids' structure.

Finally, while **bi-directionality** – both, of electricity flows in the electricity grid and of exchange of information controlling the grid – is a key feature for Smart Grids deployment, it is not an extra challenge per se. The challenge lies primarily in the interfaces to the grid users' equipment and products, which fall into a wider perception of Smart Grids, the one including grid and grid users. One could also say that "smartening electricity grids" is about achieving "**smart power systems**".

4.2 Benefits and Criteria

A good scheme for promoting enhanced "smartness" of electricity grids requires the quantification through appropriate **criteria and indicators**, of the effects and benefits of this "smartness". These indicators must be identified based on the benefits they deliver and have corresponding metrics defined in order to measure success.

The concept behind defining the criteria to measure the benefits from Smart Grids deployment relies on the following:

- The first and the foremost step is the identification and appropriate elaboration of the **grid user needs and requirements** – this task requires an in-depth discussion and detailed mutual understanding among all relevant stakeholders;
- Definition of **performance targets and measurable output parameters**, as well as the respective "threshold values" which when achieved and / or maintained will ensure the achievement of the needed "smart" grid functionality and features needed to fulfil the requirements above;
- Development and implementation of such a **regulatory framework, that will incentivize TSOs, DSOs and other actors towards achieving the above defined targets**;
- Combining the above elements into a well agreed, committed and transparent **set of rules and measures.**

An initial set of criteria and related indicators, from which a measure of smartness can be extracted and adopted for practical assessment is proposed below, based on [2].

Benefit	Potential key performance indicators[11]
(1) Increased sustainability	Quantified reduction of carbon emissions Environmental impact of electricity grid infrastructure Quantified reduction of accidents and risk associated to generation technologies (during mining, production, installations, etc.)
(2) Adequate capacity of transmission and distribution grids for "collecting" and bringing electricity to the consumers	Hosting capacity for distributed energy resources in distribution grids Allowable maximum injection of power without congestion risks in transmission networks Energy not withdrawn from renewable sources due to congestion and/or security risks An optimized use of capital and assets
(3) Adequate grid connection and access for all kind of grid users	Benefit (3) could be partly assessed by: - first connection charges for generators, consumers and those that do both - grid tariffs for generators, consumers and those that do both - methods adopted to calculate charges and tariffs - time to connect a new user - optimization of new equipment design resulting in best cost/benefit - faster speed of successful innovation against clear standards
(4) Satisfactory levels of security and quality of supply	Ratio of reliably available generation capacity and peak demand Share of electrical energy produced by renewable sources Measured satisfaction of grid users with the "grid" services they receive Power system stability Duration and frequency of interruptions per customer Voltage quality performance of electricity grids (e.g. voltage dips, voltage and frequency deviations)
(5) Enhanced efficiency and better service in electricity supply and grid operation	Level of losses in transmission and in distribution networks (absolute or percentage)[12]. Storage induces losses too, but also active flow control increases losses. Ratio between minimum and maximum electricity demand within a defined time period (e.g. one day, one week)[13] Percentage utilisation (i.e. average loading) of electricity grid elements Demand side participation in electricity markets and in energy efficiency measures Availability of network components (related to planned and unplanned maintenance) and its impact on network performances Actual availability of network capacity with respect to its standard value (e.g. net transfer capacity in transmission grids, DER hosting capacity in distribution grids)
(6) Effective support of transnational electricity markets by load-flow control to alleviate loop-flows and increased interconnection capacities	Ratio between interconnection capacity of one country/region and its electricity demand Exploitation of interconnection capacities (ratio between mono-directional energy transfers and net transfer capacity), particularly related to maximisation of capacities according to the Regulation of electricity cross-border exchanges and the congestion management guidelines Congestion rents across interconnections
(7) Coordinated grid develop-	Benefit (7) could be partly assessed by:

[11] Some of these indicators are already used today in different EU Member States.

[12] In case of comparison, the level of losses should be corrected by structural parameters (e.g. by the presence of distributed generation in distribution grids and its production pattern).

[13] In case of comparison, a structural difference in the indicator should be taken into account due e.g. to electrical heating and weather conditions, shares of industrial and domestic loads.

Benefit	Potential key performance indicators[11]
ment through common European, regional and local grid planning to optimize transmission grid infrastructure	- impact of congestion on outcomes and prices of national/regional markets - societal benefit/cost ratio of a proposed infrastructure investment - overall welfare increase, i.e. running always the cheapest generators to supply the actual demand) → this is also an indicator for the benefit (6) above - Time for licensing/authorisation of a new electricity transmission infrastructure. - Time for construction (i.e. after authorisation) of a new electricity transmission infrastructure.
(8) Enhanced consumer awareness and participation in the market by new players	Demand side participation in electricity markets and in energy efficiency measures Percentage of consumers on (opt-in) time-of-use / critical peak / real time dynamic pricing Measured modifications of electricity consumption patterns after new (opt-in) pricing schemes. Percentage of users available to behave as interruptible load. Percentage of load demand participating in market-like schemes for demand flexibility. Percentage participation of users connected to lower voltage levels to ancillary services

The table above is not in a static one that applies to all grids in all Member States – it should rather to be regarded as the summary of most important and wide elements which are applied according to the specific grid and/or country. In addition to the criteria above, EG3 recognizes the following additional benefits and related criteria for Smart Grids deployment:

(8) Benefit: Enable consumers to make **informed decisions related to their energy** to meet the EU Energy Efficiency targets

Criteria:
- Base to peak load ratio
- Relation between power demand and market price for electricity
- Consumers can comprehend their actual energy consumption and receive, understand and act on free information that they need/ask for
- Consumers are able to access their historic energy consumption information for free in a format that enables them to make like for like comparisons with deals available on the market
- Ability to participate in relevant energy market to purchase and/or sell electricity
- Coherent link is established between the energy prices and consumer behaviour

(9) Benefit: Create a **market mechanism for new energy services** such as energy efficiency or energy consulting for customers

Criteria:
- 'Simple' and/or automated changes to consumers' energy consumption in reply to demand/response signals, are enabled
- Data ownership is clearly defined and data processes in place to allow for service providers to be active with customer consent
- Physical grid related data are available in an accessible form
- Transparency of physical connection authorisation, requirements and charges
- Effective consumer complaint handling and redress. This includes clear lines of responsibility should things go wrong

(10) Benefit: Consumer **bills are either** reduced or upward pressure on them is mitigated

Criteria:
- Transparent, robust processes to assess whether the benefits of implementation exceed the costs in each area where roll-out is considered are in place, and a commitment to act on the findings is ensured by all involved parties

Comment [k6]: This benefit could fit the new proposed benefit (8) in the ERGEG table in the conclusions paper. (8) Enhanced consumer awareness and participation in the market by new players".

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tion they need / ask for

Comment [A7]: For example, we have heard anecdotally about a smart grid trial in Scotland. A consumer did not receive the signal that it was critical peak pricing and therefore did not turn down appliances. They received a huge bill. The energy supplier said it was not their fault but the display manufacturer. The display manufacturer said it was not their fault but the suppliers or networks – possibly a problem with the communications system. The consumer was caught in the middle with debt collectors pressing for payment.

- Regulatory mechanisms exist, that ensure that these benefits are appropriately reflected in consumer bills and do not simply result in windfall profits for the industry
- New smart tariffs (energy prices) deliver tangible benefits to consumers or society in a progressive way
- Market design is compatible with the way the consumers use the grid

While selecting and applying the criteria and indicators, it is important to ensure on one hand that they can be impacted by the TSOs and DSOs and on the other hand that they do not create an incentive for the grid operators' involvement in competitive market, what is neither necessary nor possible according to the existing legal framework. Moreover, mutual dependence (and possible exclusivity for some) of the benefits and criteria is an important factor to be taken into account.

A **practical selection of indicators will vary from country to country**, depending on the starting point (the status of the development and "smartness" of the grids) and on the most urgently required and/or the most appropriate features and functionalities for the specific grid(s) under consideration.

The **significance of the indicators will further change over time**. E.g. the maintenance downtimes will be an indicator in the beginning but as the grid becomes more flexible and predictable, planned downtimes can be longer but would influence the grid to a lesser degree. This means that the evaluation of the Smart Grids benefits and its deployment will remain an evolving process.

While practical selection of indicators will vary from country to country (depending on the different maturity level of the national grids) and where significance of the indicators will further change over time, the most important aspect in assessing the benefits (and applying the defined criteria for that), is the **initial evaluation whether and what needs to be done in a different way than it is done today**. This is required because a large number of existing features and functions in the electricity grid today are already supportive of distributed generation, renewables integration, etc. It follows that an appropriate scrutiny and objectivity will be required from grid operators in cooperation with grid users, in assessing the necessity and needs for all "smart" investments and developments in the grids. The key benefit to be achieved is that the economic efficiency of Smart Grids must improve considering overall benefits for the grid users and society when compared with continuing with a "business as usual" approach of today.

Within the context of discussing the criteria above, it is worthwhile recalling the elements which are (by large) already today widely used in the electricity transmission and distribution grids:

- Replacement/refurbishment of power components;
- Increased use of WAMS/WACS;
- Upgrading protection and control devices for communication;
- Installation of power quality devices;
- Increased use of compensation devices;
- Adoption of new technologies and systems for power transmission (all types of HVDC).

4.3 Legal Framework

The new Electricity Directive 2009/72/EC defines a number of general tasks and provisions for the organization of the electricity sector in Articles 3.1, 3.2 and 3.10, which are also relevant for Smart Grids. Moreover, even the "old" Directive 2003/54/EC dealt with issues of importance for Smart Grids in the Articles 3.1, 3.2 and 3.10.

More specific tasks in relation to Smart Grids are defined in the new Electricity Directive, in the Article 12 (a) – (e) for the TSOs and in the Article 25 1-7 for the DSOs. The "old" Directive was also addressing the tasks of TSOs (Article 9) and DSOs (Article 14), related to Smart Grids.

4.4 Regulation

A key principle of good regulation – not just in the electricity sector but also in other regulated businesses – is to **concentrate on outputs of the regulated entity** and effects of a given activity or service, influencing the processes and activities by appropriate regulatory measures, but not directly interfering in management and operations of the grid undertakings / regulated companies.

The **incentive mechanisms** currently adopted to promote other aspects of grid business, like **the quality of supply in electricity distribution** can be used for the promotion of smart grid deployment. In case of incentive regulation, regulated entities can be either rewarded if they improve their performance in the interest of the customers or penalised if they underperform with respect to such targets. This incentives' approach corresponds well to the provisions in the Electricity Directive 2009/72/EC and applies to a number of topics. A complementary approach is the use of a **direct set of minimum requirements** to be fulfilled in the evolution towards Smart Grids, or a **hybrid solution relying on both approaches**. It is in any case of paramount importance that no regulatory scheme or requirement represents a barrier for the development in technology or application of necessary (new and "smart") solutions in the grid.

In that context, a "**grid-user centric approach**" (in a broader sense) should always be used, so that all players (grid users, suppliers, generators, TSOs and DSOs, system/equipment manufacturers, energy market providers and influences) are involved in the most appropriate way in the deployment process. Making the deployment process economically attractive and efficient will ensure the needed commitment by the participants, while recognizing their different needs.

In order to achieve these important objectives, a well balanced consideration of Smart Grids from the perspective of market, regulation and grid development & innovation is required, where the **interests and needs of all – but most notably grid users and customers** – are taken into account.

Some aspects of the way the interfaces need to function are likely to be covered by regulatory actions, either at national or at European (for cross-border) level. Careful action needs to be taken to ensure clarity of the boundary lines in order to make sure that **the "market platform" can function effectively on the basis of a level playing-field.** Standardization must further provide a clear technical framework for interoperability in conjunction with these regulatory requirements and European level standardization.

Grid codes for example are the fundament of generation product innovation. Unless these are clearly and uniformly defined across Europe, manufacturers cannot develop products which are able to meet a range of proposed standards at minimal costs. Grid codes are also an example for an area where substantial improvements will be achieved through the implementation of the Third Legislative Package.

Besides the incentives and direct regulatory measures for ensuring "smartness" in the grids, another key task for regulation is to **support smooth communication by defining data collection requests, standardised data formats and communication protocols and the access to relevant market information.**

A set of recommendations on regulation is elaborated in [2] based on the initial Position Paper on Smart Grids by the European Energy Regulators and on the results from public consultation:

(1) Ensure, as appropriate, a long-term stable regulatory framework and reasonable rate of return for cost-efficient grid investments;

(2) Consider and further analyse decoupling between grid operators' profits and volumes of elec-

tricity they deliver taking into account the introduction of performance indicators and performance-based incentive regulation;

(3) Pursue regulation of outputs as a mechanism to ensure value for money paid by network users and to investigate metrics for the quantification of the most important output effects and benefits ;

(4) Promote mechanisms favouring an improved consumer awareness of their electricity use and market opportunities through actions of suppliers and other market participants and an improved engagement of network operators with their network users;

Comment [A8]: Would also welcome this being a responsibility for government later

(5) Encourage the deployment of Smart Grid solutions, where they are a cost-efficient alternative for existing solutions, and as a first step in this direction, to find ways of incentivizing network companies to pursue innovative solutions where this can be considered beneficial from the viewpoint of the society;

(6) Evaluate the breakdown of costs and benefits of possible demonstration projects for each stakeholder and to take decisions or give advice to decision-makers based on societal cost-benefit assessment which takes into account costs and benefits for each stakeholder and for the society as a whole;

(7) Ensure dissemination of the results and lessons learned from the demonstration projects in case they are (co-)financed by additional grid tariffs or from public funds to all interested parties, including other network operators, market participants, etc.;

(8) Participate in Smart Grids discussions and cooperation activities among stakeholders and especially to consider an active cooperation with European and national standardisation organisations, grid operators and manufacturers, for example on open protocols and standards for information management and data exchange, in order to achieve interoperability of smart grid devices and systems;

(9) Clarify the difference between regulated grid activities and market opportunities for new services under a competitive regime (e.g. aggregation of resources, Electric Vehicle (EV) recharging) and to carefully monitor and prevent the possible presence of cross-subsidies between network activities by TSOs or DSOs and market-based activities;

(10) Continue the exchange of expertise at European level, in order to learn as soon as possible from best regulatory practices.

The principles and recommendations above are the basis for the following considerations and the definition of the template for funding of Smart Grids deployment.

4.5 Recommendations for Funding

In different situations, different funding options for Smart Grids deployment are possible. In general, the investment costs in the electricity grids are covered by grid tariffs. These include among others the use of system charges, access charges, connection charges, metering charges, etc. A precondition for recognition of costs within the grid tariffs is, that the costs relate directly to a real and specific purpose and to a specific solution or service which is deployed in the grid.

This also means that imposing a non-specific tariff component on grid users in an unselective way for grid development, while it can broadly fit into the overall scope of innovation but without a specified goal, service or solution being defined it is not feasible, and is not in line with legal provisions, technical and economic principles.

It follows that the costs in the grid need to be as far as possible attributed to those incurring them and that transparent cost structures on both transmission and distribution level would foster development of Smart Grids. As part of this, . It follows that regardless of a specific grid cost and tariffs structure, it is essential that grid users understand the system which must be transparent, cost reflective, justifiable and non-discriminatory.

Deleted: analysis of the distributional impact of the benefits of smart grids must be carried out to ensure that low income and vulnerable consumers are not unfairly carrying the burden of costs and to put in place safeguards. Positive discrimination should be considered to ensure a fair and equitable cost allocation

The costs emerging from the introduction of new services or solutions in the grids (e.g. introduction of new bi-directional protection for massive integration of distributed generation, optimized grid expansion in support of new gird users' needs, etc.) are today mainly[14] paid by the actor which requires those new services and which is the main beneficiary of them, like new generators, new kinds of consumers, energy management service providers, etc. Therefore particular attention needs to be paid to avoiding that the costs incurred once are charged to the grid users twice or more times, or that the first mover is burdened with the total cost of a change which further users will then access for free. The payment of costs must at any time – today and in the future – remain **fair according to the actual originator of these costs, adhering to the principle of causality.**

Regulation of outputs, by incentives, by minimum requirements or by a combination of both, requires **predefined performance targets and indicators**. Clear and transparent measurement rules are important to make it possible to observe, quantify and verify such targets. Performance targets must be strictly related to the pursued objectives and should therefore be designed so as to avoid external effects which are out of control by the grid operators. Indicators could be benchmarked whenever possible at national or international level before their adoption in order to define the expected performance targets (comparability must be ensured).

Defining **metrics for quantification of the effects and benefits** of Smart Grids – with specific emphasis on the evaluation of efficiency, effectiveness and comparative cost analysis in relation to a conventional "non-smart" approach – is a challenging but necessary task in order to be able to perform the cost / benefit analysis, before cost recovery and possible introduction of incentives for the deployment of Smart Grids. This is a complex and high priority issue which needs to be addressed accordingly by the regulators in close cooperation and coordination with grid users, owners and operators.

In the European context a number of different public funding options are in place ranging from EU funding, national governments funding, both as the sole option or in combination with public-private partnerships. The level of scrutiny given to publicly funded options should be higher than that given to privately funded options to reflect the reduced incentives on the energy industry to make optimal investment decisions where it does not directly bear the risk of these. Public subsidy should only be used where it is clear that industry will not invest otherwise and – most important – where the benefit to society clearly justifies such an approach. In summary, the following funding options / possibilities for deployment of Smart Grids features exist:

1. Private funding by industry, private investors, etc.

2. Public funding and tax incentives at the national and EU (FP's) level,

3. Private-public partnerships,

4. Funding by the European Investment Bank

5. Investment incentives coupled with obligations and reward / penalties in regulation (i.e. incentive & quality regulation) and the grid tariffs.

[14] Examples exist with some costs being also socialized among all the grid users.

The type of funding to be used will also depend on the stage when it is needed, e.g. initial R&D phase, pilot demonstration projects, transition phase from first market introduction to a fully-fledged deployment.

The process and model for elaboration of recommendations are schematically presented in the Figure 1 below, whereas from an economic point of view the "smart" features of the electricity grid need **to be considered as a whole** and need to match the relevant benefits and criteria elaborated in Chapter 4.2.

With respect to all relevant grid features, a categorization into three subgroups appears useful. Furthermore, certain features and functions (described subsequently in 4.5.2 – 4.5.4) will be of different relevance for users according to their needs and requirements and according to the actual situation in the different transmission and distribution grids.

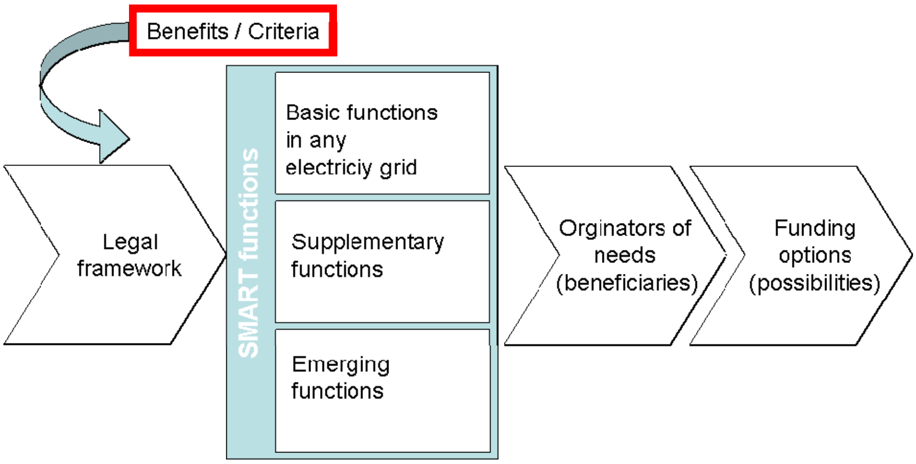

Figure 1: Proposed process for elaboration of recommendations for funding

Furthermore, an underlying common factor in the process above is the need for appropriate **standardization** quid link with title? in all necessary aspects of Smart Grids deployment.

4.5.1 High-Level Smart Grids Services

The EU TP Smart Grids has defined six priorities for the Smart Grids deployment in the Strategic Deployment Document [1]. The EG1 has adopted the key elements of this definition, describing them as the "**high-level Smart Grids services**", including:

A. Enabling the grid to **integrate users with new requirements**

B.Enhancing **efficiency in day-to-day grid operation**

C. Ensuring **grid security, system control and quality of supply**

D. Better **planning of future grid investment**

E. Improving **market functioning and customer service**

F. Enabling and encouraging stronger and more direct **involvement of consumers in their energy usage**

EG1 is conducting detailed analysis of functions, with each of the above high level services being described in terms of different functionalities. Those functions can be conceptually classified in three levels: basic, supplementary and "smart" emerging ones. It's relevant to underline that a practical classification of Smart Grids functions into these three levels can and will vary according to the voltage level (EHV, HV, MV, LV) as well as according to the starting level of grid functionalities that – especially for distribution network – varies from country to country.

4.5.2 Basic Functions in Any Electricity Grid

Basic features of any electricity grid are required in order to ensure correct functioning, supply and service to the grid users and support of the electricity market, in line with the legal framework (Section 3.3). For instance, within high level service "D. Ensuring grid security, system control and quality of supply" a basic functionality is: "Maintain adequate level of voltage quality (supply voltage variations, rapid voltage changes, dips, swells)". The following recommendations apply for this group of basic grid functions:

Funding Recommendation #1: EG3 recommends that basic functions need to be provided by Transmission or Distribution System Operators within the scope of the applicable regulation and tariffs - considering legal provisions (Section 4.3). In the distribution grids of today, this is often one kind of incentive regulation, combined with quality regulation.

Funding Recommendation #2: EG3 emphasises the importance to avoid cross-subsidizing or double financing. If some additional funding beyond the regulated tariffs is used, this needs to be considered in relation to any regulatory incentives, to avoid any cross subsidies.

4.5.3 Supplementary Functions in Any Electricity Grid

A number of supplementary functions exist, the significance of which is increasing with growing penetration of distributed generation, higher volatility and demand side participation requirements.

For instance, within high level service "C. Ensuring grid security, system control and quality of supply" a supplementary function would be: "Promote tailored contracts between the customers and the network operator for enhanced voltage quality".

Funding Recommendation #3: EG3 recommends that funding for the supplementary functions (depending on each individual case) is also within the scope of the applicable regulation and tariffs - under the conditions that the overall benefits are passed to all customers paying those tariffs and that transparent and economically efficient deployment is ensured. Funding mechanisms must not be regressive, impacting low income households and the fuel poor unfairly.

Comment [A9]: We would welcome a recommendation around assessing the distributional impact of smart grids on different social groups. E.g. Victoria in Australia halted the roll out of TOU because of concerns around the impact of new tariffs on low income and vulnerable households. We have concerns that low income households are going to end up footing the bill for smart when they are the least likely to be able to benefit from it.

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4.5.4 Emerging Functions in Transmission and Distribution

On top of the basic and supplementary features, a number of new and emerging ones are more and more widely required and deployed in the electricity grids of today – a trend set to continue even stronger in the next years.

For instance, within high level service "D. Ensuring grid security, system control and quality of supply", emerging "smart" functionality can include: "Foster proactive system stability assessment and management at distribution level (including future load and feeder state assessment, exceptional weather events, etc, also by increasingly intelligent post-fault actions)".

It follows that also for these emerging features, the costs can be clearly attributed to the related grid users / beneficiaries within the foreseen tariffication components.

The recommendations #1 to #3 above apply therefore to the funding recommendations in this section too.

Funding Recommendation #4: In relation to the listed (and possible new, or presently yet unknown) emerging features in combination with the supplementary and basic ones, EG3 recommends to establish a multi-dimensional mapping where the area "spanned" as illustrated in Figure 2 is maximized in terms of Smart Grids benefits and criteria elaborated in Section 4.2.

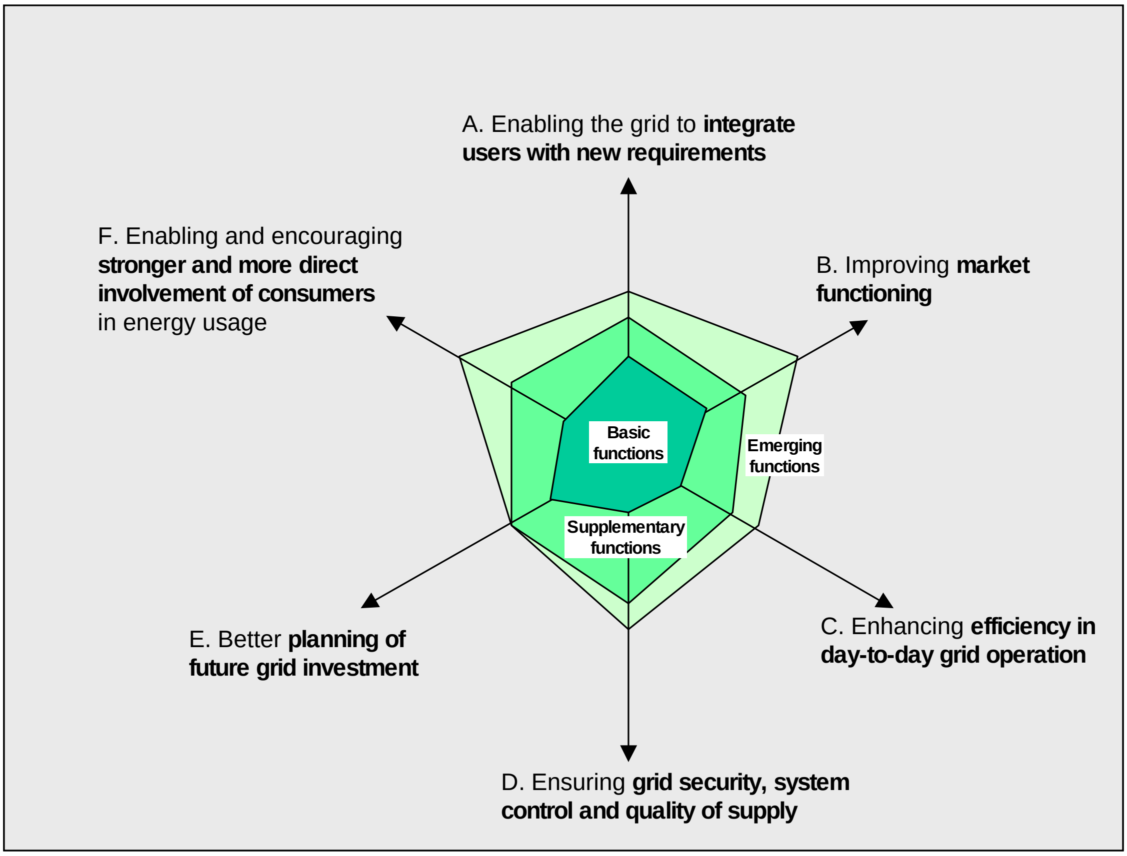

Figure 2: Mapping between the three levels of grid features, the grid users / beneficiaries and the funding options

Funding Recommendation #5: EG3 is of the opinion that in terms of benefits from section 4.2 the key criteria in deciding on possible funding through the additional socialization within grid tariffs, shall be based on the optimized (maximized) area in the Figure 2

Funding Recommendation #6: EG3 recommends that the evaluation of applicable and recommended funding options for the given features in Smart Grids deployment shall be based on completing the template for evaluation of which is described in the following Section 4.6

4.6 Template for Evaluation of the Merit for the Deployment

The grid users' needs could develop the needed dynamics if all the relevant players are involved in an appropriate way: including consumers, generators, TSOs and DSOs, equipment vendors etc.. An important condition for this is an adequate legal and regulatory environment, ensuring attractiveness and economic efficiency of Smart Grids deployment.

Based on the expected benefits and criteria in Section 4.2, taking into account the legal provisions and tasks of the DSOs and TSOs and with mapping between the grid functions in Sections 4.5, a **template for evaluation of the merit for the deployment** is proposed in the spreadsheet below – it is intended to ensure consideration of all the different interests in evaluation of the merit for the deployment of specific Smart Grids functions (defined by EG1).

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The way to use this template is a rather simple and straight forward one:

- First the different benefits and related criteria should be evaluated in terms of their contribution to the specific grid features; a proposed metric is to use 0 for no contribution, 1 for the highest contribution and a value between 0 and 1 for some degree of contribution; this way a weighted sum of contributions for a given feature, in terms of the applicable benefits / criteria can be obtained.

- Second, the weighted sums should be calculated for the specific grid features (only an example is listed in the spreadsheet above) and for the benefits / criteria.

- Third and final step would be to elaborate on those grid functions to be deployed, which have the highest contribution to delivering the desired benefits and meeting the most criteria.

The process and template here are the initial tool for evaluation and consideration for the deployment, the next step should be a cost/benefit analysis as the basis for the concrete business plan with all the necessary elements to justify the selected Smart Grids function for the deployment – this however needs to be done on a case-by-case basis and will have to involve, besides the grid operator, all the relevant and affected grid users and stakeholders.

The primary users of this template should therefore be the DSOs and TSOs in cooperation with grid users who should be consulted and sufficiently involved in elaborating the specific relations in the template.

Thus, the funding should then be recommended only for those functions / features, where highest benefits for all grid users are ensured – in line with the optimization approach from Figure 2 above.

5 Roles and Responsibilities – Recommendations on Scope, Policy and Regulatory Directions

In Chapter 2, the current roles and responsibilities of the actors in the electricity supply chain were presented. In this chapter the changes in current actors' roles and responsibilities and the new roles of the new actors are presented, along with the proposed policy and regulatory changes that may be required or may evolve in the coming years.

The political goal to reduce greenhouse gas emissions and to increase generation from decentralized and/or renewable energy sources has already changed and in the future will further change the energy mix in Europe. This development will continue due to the improved economics of distributed and renewable generation. To exploit the full potential of the increasing output from centralized and decentralized renewables, network structures and operations will become more sophisticated, "intelligent". This will require changes in the planning, operation, maintenance and expansion of the transmission and distribution grids. This can further lead to a shortening of investment cycles of grid operators due to the massive integration of ICT (Information and Communication Technology) components. All actors will ultimately benefit from this development as the increased smartness should result in potentially overall lower costs, higher quality of supply, enhanced competition and more flexible tariff options compared to situation where no Smart Grids deployment is made.

That said, for the successful deployment of Smart Gird, a number of challenges that need to be resolved include:

- **Technical issues,** including standardization activities, where ways to make the transmission and distribution grids smarter and stronger are proven at appropriate scales for replication in Europe
- **Market design issues,** where variable energy sources and active demand side management are integrated into new market rules, incentivizing consumers and (small) producers to actively participate in the energy market
- **Necessary changes** that allow grid operators, retailers, small generators and customers to make use of state-of-the-art communication technologies to improve data transparency and actively participate at the energy market
- **Regulatory measures allowing** the development of smarter grids and more active participation of small players by e.g. giving proper incentives to grid and energy providers and users to contribute to an efficient system
- **Customer engagement with Smart Grid issues,** especially focusing on public acceptance of and engagement with smart metering and reassuring consumers on privacy and/or security, and other issues that may arise. In order to build consumer trust there needs to be a systematic review of consumer protections and a strategy to deliver tangible benefits to consumers.
- **Societal issues,** such as acceptance and engagement with technological changes, ensuring that all consumers including vulnerable and low income consumers can access the benefits of Smart Grids. The way forward is to inform grid users, especially households, which in turn is a responsibility for all actors: "watchdogs" services, regulators, suppliers, distribution networks and manufactures. At the same time, national communication campaigns must acknowledge that it is not possible to engage all audiences on the same level: consideration must be given on how best to segment and approach the respective consumer groups. Furthermore, educational messages do not deliver behavioural shifts. To achieve the desired outcomes campaigns must comprise a call(s) for action that is fun, easy and popular.

In addition, another key aspect is the **position and needs of consumers** which must be addressed appropriately and contained in any strategy for overcoming the challenges above. These include;

- The national economic assessments must address the potential social benefits and risks;
- Consumers must be protected from financial risks and from unfair, new and confusing tariffs;
- Low income and/or vulnerable consumers must be protected.

5.1 Finally, it is essential to assist consumers to understand and value the environmental benefits related to the deployment of Smart Grids. Grid Operators

DSOs' related issues will be treated mostly on national level but will require some elements of harmonization at the European level. Further investment and innovation will be required by both TSOs and DSOs. However, it appears that it is the DSOs who will have to face the biggest challenges so that Smart Grids will become a reality. The reasons include;

- Growing distributed generation, active management of demand, local storage and electric vehicles (EV) will impact the DSO infrastructure. Thus the DSO will have to be an active participant

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in all such projects along with the actors implementing these projects as these projects will fundamentally change today's relatively static distribution system to a much more dynamic distribution system.

- As more fluctuating distributed generation will feed into the distribution system, gathering and handling the data about the state of the distribution system will be one key issue for the DSO.
- Attention will need to be paid to ensure that all privacy and system security recommendations (in line with the provisions defined by EG2) will be adhered to. Ownership of the data, length of time data is stored etc will all need to be addressed in an appropriate way.
- The data collected will enable the DSOs to fulfill their duty in relation to the overall grid stability and operational security, given that more and more distributed generation will be connected to the distribution grid.

In order to resolve the above challenges, the DSOs will have to continue upgrading their grid infrastructure, control centers and educating their employees accordingly.

The TSOs will have to provide more support & communication of data to the DSOs, but will also require more specific information from the DSOs, especially with more distributed generation coming from the distribution grids. In order to achieve this, both TSOs and DSOs need to ensure that the standards they implement for communication and data exchange are compatible. It also follows that the TSOs will have to gradually redesign **power system control** as well as **market information management** relating to forecasting the overall system load in conjunction with the DSOs. At the same time, the DSOs will have to strengthen their role in providing the required data relating to the distributed generation, local storage and electric vehicles within the distribution grid.

Both TSO and DSO should be able to **execute their active role in Smart Grid management by ensuring more sophisticated legal provisions for system security management under increased uncertainty.** Following the analysis about funding in Chapter 4, these mechanisms should include the ability to interfere with the planned market activities in case of disturbed or emergency operational conditions, without "automatic" socialization of the related costs to other grid users.

Finally, the role of grid communications will significantly increase as much more data will have to be gathered and exchanged frequently, which will be in turn used for different purposes by the grid operators and other service providers. As stated above, **the standardization of communication protocols as well as clear rules for the handling and the security of this data** will have to be developed and enforced. The security of the grid and supply systems as well as the **privacy of customer data** must remain the top priority.

5.2 Grid Users

Generators

Today, large generators are responsible for supplying the major share of the load, for supplying ancillary services and reserve capacity, as well as for contributing to voltage control. This role will not change in general, but with an increasing share of distributed generation, the responsibility of distributed generation in contributing to grid stability and operational security will progressively increase, hand in hand with the technology progress which will enable that in a cost/effective manner.

Consumers

Consumers will become more engaged in Demand Side Response (DSR) and DSR will become increasingly important to enhance the overall system efficiency and effectiveness. DSR has also significant implications for the DSOs as well as equipment suppliers and electricity retailers.

Moreover, based on the increased information on consumption, consumers can make more informed decisions on how & when they can save energy, either by changing their behavior or by engaging with an energy efficiency service provider.

Suppliers

The DSOs and Retailers will have to develop transparent and easy understandable rules for Demand Side Response, such that they are accepted and trusted by all consumers. It is also important that by collecting and communicating such data, all consumers will become more aware of their overall consumption of energy and how they actually use that energy. This will result in equipment suppliers, energy retailers and new actors such as 'aggregators' to offer new energy efficiency services. The ultimate result will be more competitive and market driven products being offered to consumers.

To make Demand Side Responsible possible, standard load profiles used by suppliers for customers will have to be replaced by 'dynamic' load profiles in case of flexible energy prices and / or grid tariffs. Moreover, this information will need to be complemented with the actual information about market activities of consumers, producers and those that do both, to the DSOs/TSOs.

5.3 Energy Market Place

With the deployment of Smart Grids, more and more consumers and new actors such as aggregators will participate in the energy market place. This will result in new opportunities and challenges that will need to be dealt with in a structured manner. Based on the discussions of EG3, the following have been identified as priority areas[15]:

- With the increase in distributed generation, **new energy market places will have to be promoted, contributing to a further optimization of the system**. These market places might require additional rules than the ones which are in place today in the wholesale market. The structures in the markets will start to reflect more and more the increasing decentralized character of the power system and balancing, clearing and settlement will have to react to this development by opening to smaller participants. It can be expected that an increasingly flexible formation of energy prices and ancillary services (both on the time scale and in the spatial extension) as well as increasingly flexible and specific grid tariffs will ultimately be required to deliver the full potential of Smart Grids.

- The trading activities are responsible for the **economic optimization of the European generation "portfolio"** since the first market openings in Europe. In order to best cope with short-term intraday changes in generation patterns and congestion at the same time, it would be helpful to introduce a **central implicit intra-day platform** which allows continuous wholesale power trading across Europe and to incentivise TSOs to further develop and harmonise the capacity calculation systems. Beyond that, the demand side response framework and implementation should be developed, that will allow the best use of the most effective measures at the customers' side also to contribute managing the intermittency of e.g. wind power.

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[15] Whereas the considerations on energy market place are intended to remain as universally applicable as possible, further cost-benefit and demand analysis taking into account local and regional conditions might be advantageous for effectiveness of the Smart Grids deployment.

- The emergence of more dynamic energy pricing being offered by suppliers/retailers to consumers is expected. These products may vary the price offered based on time-of-day or day-of-week related to the cost of electricity on the marketplace at that time. This would bring many benefits, but also a higher complexity for the supply of standard customers both with regard to making an adequate offer for supply and with regard to billing. Retail suppliers will be more and more confronted with **supplying customers that produce some of their electricity as well**. The management of such customers will be a challenge but at the same time an opportunity for retail suppliers or other service providers. As stated above, a change of standard load profiles will be needed for customers that actively manage their demand. These **new load profiles / flexibility measures should help retail suppliers to optimize their procurement from the energy market**.

5.4 Providers of Technologies, Products and Services

Electric Power Grid Equipment supplied to grid users will continue to evolve as suppliers innovate to integrate more and more 'smartness' into their products and solutions. Further technology developments in conjunction with advances in modern ICT will result in more sophisticated and intelligent equipment being used in the Smart Grid. An open **standards based approach** will be key for market development with standards set at the European level, through a transparent process, to create market size and through a process involving the full range of the new and different stakeholders in Smart Grid with distributed generation**.** Moreover, new primary technologies will be able to fulfil functionalities that had not been available in the past (e.g. relying on power electronics).

In particular, as Smart Metering does provide important functionality in support of active demand side participation, whoever is responsible for the roll-out of Smart Metering (i.e. DSOs, retail suppliers, others) it must be ensured that all relevant actors, market participants and stakeholders are be able to use the benefits of Smart Metering. Thus, the actors specifying the requirements for Smart Meters and the manufacturers of such devices must be aware that they are developing products for a regulated market environment in which European integration, consumer privacy, security of supply and regulated returns on investment are important and need to be understood.

Compatibility of in home technology including appliances, communications networks and meters is key for consumers. Consumers should be able to switch energy company without having to change their display or other in-home smart products or services. Failure to address this would result in increased inconvenience to consumers, barriers to competition, additional cost of purchasing new equipment and environmental waste from obsolete technology which is thrown away.

New business models and service offerings will evolve as actors take advantage of the new information that results from the new data sources that become available to them. The ability of actors to better understand their customers' needs, their usage behaviours towards electricity, where efficiencies can be gained within the system etc., will all enable new innovative business models and thus services offerings to be delivered to consumers. These in turn will fuel further development in new technologies, products and services from suppliers to further capitalise on these new opportunities. Consumers must have the choice whether other parties than the DSO should have access to their specific data. In this context both the kind and amount of data shared should be controlled by the consumer. Moreover, the consumers must have free access to their energy consumption data in a format that will help them compare offerings in the market. They must have the choice to share their own energy consumption information with third parties in order to benefit from the choice that competition offers in the market in terms of price, products and services. To that matter, all legal provisions for data protection and privacy must be complied in full.

Examples of new services range from data mining systems for identification of new customer opportunities, infrastructure management products for distribution systems, home automation devices and home energy management class of devices and services, contract based products to consumers based on their individual usage pattern of energy, etc.

The services related to Electric Vehicles will induce further innovation both in terms of technology and business models. While feasible business models are still being formulated, the physical impact of millions of electric vehicles participating both as 'consumers' and 'storage' actors in the grid needs to be fully understood and may further add to the complexity of maintaining overall grid stability and security of supply especially within the distribution system. It is not 100% clear at this time if new grid infrastructure will need to be built to meet electric vehicles needs, and who will actually invest in this build out. It may be the traditional TSO & DSO that do this investment or it may fall to the current 'fuel station' providers to develop this infrastructure. Regardless of who implements this infrastructure, new energy supply models and services will emerge, like e.g. 'mobile' energy consumers, pre-paid energy cards, etc.

In addition, communication service providers will offer services addressing the electricity industry needs. Given the critical role of the electricity supply, those communication services must deliver the necessary quality of service, security of information and privacy. This is particularly important under the disturbed or emergency conditions in the grid.

5.5 Influencers

Consumers and Smart Metering

While the dependencies between Smart Metering and Smart Grids have been explained, Consumers (especially residential) acceptance of Smart Metering, specifically on the perceived benefits and particularly on the perceived implications to the cost of bills, privacy and security will be key.

As outlined in Chapter 2, Smart Metering in itself is not the critical element to ensure Smart Grid deployment, it will play an important part in the success of Smart Grid deployments Thus it is important to bear in mind that consumer acceptance of Smart Metering is a critical element to the successful deployment of Smart Grids in the EU.

Regulators

It is important that national regulatory authorities and European institutions (CEER, ERGEG and ACER in the future) ensure a **long-term-predictable and stable regulatory framework**, including adequate incentives for investments, taking account of: 1) economic and technical efficiency, 2) quality of supply, 3) "smartness" of the electricity grids and 4) energy efficiency. As explained in Chapter 4, the payment of costs must at any time – today and in the future – remain **fair according to the actual originator of these costs, adhering to the principle of causality.** It follows that a well balanced and sustainable approach is needed between the appropriate rate-of return for the regulated grid operators and the respective requirements and benefits for the grid users.

Given that more actors will participate in the marketplace, Regulators will also need to further support designing and implementing the **direct regulatory measures and market rules** required for the market place of the future and for ensuring utilization of all the new services and opportunities to the benefit of all actors.

Regulators have a responsibility for systematically reviewing customer protections to ensure that they are fit for purpose in a smart world. For example, new safeguards will need to be put in place to protect customers from misuse of remote disconnection, remote switching, misselling of complex new tariffs alongside new data protection and privacy rules. They have a particular responsibility to protect the interests of low income and vulnerable consumers to ensure that all customers are able to access the benefits of smart grids.

Finally and as outlined in 5.4, the emergence of electric vehicles is expected to become an important factor in the electricity supply chain, with the emergence of multiple new business models for 'mobile' consumers. This may in turn result in the need for increased regulatory oversight, similar to the recent developments in the telecommunications industry.

Standardization Bodies

An open standards based approach is crucial for the deployment of Smart Grids. The recognised European Standardization Organizations (ESOs), CEN, CENELEC and ETSI are traditionally closely linked to regulation at European level, providing the technical specifications that are needed to implement regulation. These links are explicit in the context of EU Directives including those for EMC (Electro-Magnetic Compatibility), low-voltage and (in relation to Smart Metering) measuring instruments, where the legislation refers to standards as a tool, but standardization should play a role in other areas where technical back-up for market decisions by regulators or private sector actors is needed. Additionally, "soft" standardization covers issues such as personal data protection and privacy or electronic data exchanges.

The ESOs also have formal links with global standardization bodies ISO, IEC and ITU-T (and also with UN-ECE, which is relevant for electronic business process standards. The ESOs are already working on a standards framework for Smart Metering, and have initiated work on electric vehicle standardization (with a focus on cross-border interoperability of connectors and chargers), in each case in relation to European Commission mandates issued towards to the standards bodies.

The ESOs have also established a common working group on EU Smart Grid Standards that will assess the standards' implications of the Smart Grids Task Force recommendations and advise the Task Force on the implications of any future mandate on Smart Grids[16].

Against this background, it will be important to ensure a coherent approach. This is needed to avoid duplication of effort. In many cases the standards will already exist. Although some issues can only be standardized at European level, in other cases the necessary standards should be provided globally but the ESOs should ensure these global standards meet European requirements. In ICT standardization, there is also a plethora of different industry consortia providing sometimes competing standards solutions, and care needs to be taken to avoid resulting interoperability problems or issues related to intellectual property rights.

EU and National Legislation Authorities

Policy makers should ensure active support for market and competitive business activities – including innovative approaches where these benefit their citizens. They must put in place the appropriate regulatory framework to protect consumers and enable them to access the full benefits of smart grids and metering. At the same time, they should avoid interfering where this is not necessary to preserve the competitive environment, ensuring non-discriminatory treatment, unless it is for fairness reasons, and guaranteeing proper functioning of all markets in a sustainable way to the benefit of all actors and society as a whole.

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It should also be recognized that some EU, national or regional initiatives related to energy policy, economic policy, environmental policy etc may actually be counterproductive to meeting all the benefits of Smart Grids but consumer and citizen concerns must be put at the heart of the decision making process. Where such issues arise, then, the framework and template defined in Chapter 4 should be used to assess potential implications, to limit unintended consequences. Work will also need to be done around the accreditation of new technologies, products and services to ensure that customers can have the peace of mind that they deliver their proposed benefits e.g. around micro-generation.

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[16] The working group has had the first meeting on 31. May 2010.

Within the discussions and work of EG3, the following areas have been identified as priority areas to be addressed;

- Given that the marketplace will expand with new actors and services offered, the required legal framework needs to exist and be enforced to ensure all relevant market rules and regulations are in place between TSOs, DSOs and other market participants.

- Policy makers will be required to create a framework and guidance for the Smart Metering roll-out especially to deal with issues relating to customer data privacy, data protection, tariffs, remote management and disconnection. Necessary legislation for imposing cross-industry standardization (energy and ICT) and imposing the Calibration Directive implementation in a uniform way throughout the member states will be required.

- The TEN Guidelines have set clear priorities for the development of transmission grid infrastructure for the EU and it is expected that the Infrastructure Package to be announced by the EU Commission at the end of 2010 will set similar priorities. Policy makers will be required to ensure the required legal framework exists to support this.

- As distributed generation will further grow, DSOs will have to rely on it to contribute to the stability of the overall grid and the associated regulatory framework to both incentivize and enforce these changes will need to be created.

- Defined and enforceable legal provisions for education and certification of DSOs and TSOs staff as well as training of other market participants will need to be developed. (E.g. comparable to provisions in air-traffic control today). The goal will be to ensure an efficient and secure operation of the grids in the highly meshed grids of Europe.

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6 Conclusion

The current roles and responsibilities of the actors in the electricity supply chain have been summarized in Chapter 3.

A number of specific and directly applicable recommendations have been proposed by EG3 in relation to Interfaces (Chapter 3) and Recommendations for Funding (Chapter 4). Chapter 4 also presents the criteria, benefits and a template (tool) for assessment and elaboration of the most useful Smart Grids functions / features.

The future roles and responsibilities for the deployment of Smart Grids, have been elaborated in Chapter 5 for all kinds of actors in the electricity supply chain.

Recalling the tasks and scope of work of EG3, it should be stated at the conclusion of this document that is is not a final and static answer to all questions in relation to the Smart Grids deployment – it should be envisaged as a practical toolset for use by grid operators and grid usersand also as a toolset that will be further developed as the deployment of Smart Grids across the EU become a reality.

7 Glossary and Abbreviations

BRP........................Balance Responsible Party

CEN........................European Committee for Standardization

CENELEC...............European Committee for Electrotechnical Standardization

DER........................Distributed Energy Resources

DG..........................Distributed Generation

DSO........................Distribution System Operator

DSP........................Demand Side Participation

DSR........................Demand Side Response

EC..........................European Community

EHV........................Extra-high voltage, above 230 kV, ref IEC

Comment [k10]: Include extra high voltage (according to definitions from IEC) in order to include all voltage levels at European level. See comment to section 4.5.1

ESO........................European Standardization Organization

ETSI........................European Telecommunications Standards Institute

EV..........................Electric Vehicles

HV..........................High Voltage, above 35 kV up to and including 230 kV, ref IEC

IEC.........................International Electrotechnical Commission

ISO.........................International organization for Standardization

ITU-T......................International Telecommunication Union

LV...........................Low Voltage, up to and including 1 kV, ref IEC

MV..........................Medium Voltage, above 1 kV up to and including 35 kV, ref IEC

MS..........................Member State

RES........................Renewable Energy Sources

SG..........................Smart Grids

SM..........................Smart Metering

TSO........................Transmission System Operator

ToU.........................Time of Use, the way of pricing of energy depending on the time of its usage

UoS.........................Use of System

V2G…………………..Vehicle to Grid

Ancillary services (from FERC order 888-A, April 1996): Those services that are necessary to support the transmission of capacity and energy from resources to loads while maintaining reliable operation of the Transmission Service Provider's transmission system in accordance with good utility practice. FERC Order 888 identified the following six ancillary services to be included in an open access transmission tariff:

- Scheduling, System Control and Dispatch Service;
- Reactive Supply and Voltage Control from Generation Sources Service;
- Regulation and Frequency Response Service;
- Energy Imbalance Service;
- Operating Reserve - Spinning Reserve Service;
- Operating Reserve - Supplemental Reserve Service.

FERC Order 888 does not preclude the transmission provider from offering voluntarily to provide other interconnected operations services to the transmission customer along with the supply of basic transmission service and ancillary services. During the consultation process towards Order 888, NERC proposed interconnected operations services were 12 as follows:

- system control and dispatch services;
- accounting;
- regulation service;
- energy imbalance service;
- frequency response service;
- backup supply service;
- operating reserve service: spinning reserve and supplemental reserve services;
- real power loss service;
- reactive supply (from generation resources) and voltage control service;
- restoration service;
- facilities use;
- reactive supply (from transmission resources).

Demand Side Response (by FERC): Changes in electric usage by end-use customers from their normal consumption patterns in response to changes in the price of electricity over time, or to incentive payments designed to induce lower electricity use at times of high wholesale market prices or when system reliability is jeopardized.

Demand Side Management (from EIA DOE): The planning, implementation, and monitoring of utility activities designed to encourage consumers to modify patterns of electricity usage, including the timing and level of electricity demand. It refers to only energy and load-shape modifying activities that are undertaken in response to utility-administered programs. It does not refer to energy and load-shaped changes arising from the normal operation of the marketplace or from government-mandated energy-efficiency standards. Demand Side Management covers the complete range of load-shape objectives, including strategic conservation and load management, as well as strategic load growth.

8 List of References

[1] Documents, information, results of work and the three General Assembly meetings of the EU Technology Platform Smart Grids 2005-2009, www.smartgrids.eu

[2] ERGEG Position Paper on Smart Grids – Consultation Paper and Conclusions Paper (after public consultation), ERGEG, May 2010, www.energy-regulators.eu

[3] BEUC Non-Paper on Smart Grids and Smart Metering, delivered to the TF and EG3 in Spring 2010

[4] ETSO, EFET, eBix: The Harmonised electric market role model,January 2010

[5] T&D Europe – University of Genoa & others Universities in EU: Study on Criteria for the Quantification of how modern T&D-systems help accomplish the EU 20/20/20 targets, October 2009

[6] Mission Statement of the EU Commission TF for Smart Grids

[7] Vision of the EU Commission TF for Smart Grids

[8] Summary of answers to the EG3 Questionnaire

Annex I: Possible Needs for Additional EU Legislation in Support of the Smart Grids Deployment

The following questions have been answered by the EG3 members, in relation to the need of any new framework for Smart Grids:

1. Do you consider any new EU framework for Smart Grids deployment necessary? Y / N
2. If you answered Yes to the question 1. please explain:
    a. Why there is such a need?
    b. Which specific issues it needs to address?
    c. How those issues shall be addressed?
3. Do you consider any framework for standardization in relation to Smart Grids deployment necessary? Y / N
4. If you answered Yes to the question 2. please explain:
    a. Which issues need to be addressed?
    b. What kind of framework (e.g. EU regulation, standardisation bodies' framework, etc.)

A summary of the answers and recommendations by the EG3 to the EU Commission are presented below:

1. There is a need for standardized, harmonized approach to all issues (technical, privacy / data protection, organisational, cross-issues between energy and ICT, etc); very important: issue is **interoperability**.

2. There is **no need for new Directives or Regulation** but there is a need for a harmonized and effective implementation of the 3rd Package

3. A range of **consumer related issues** need to be addressed, mainly relating to the implementation of the 3rd Package, including appropriate market instruments and easier switching of supplier or energy form, consumer protection, standards, dealing with environmental issues and putting benefits of that to the consumers, etc; a particularly important issue is a principle of privacy by design implemented in the European law (e.g. data minimization[17], deadlines for storage of the data, procedures of deleting the data, anonimization)

4. Strengthen Support for **right and smart** investment and ensure adequate return

5. Need to **legally enable TSOs and DSOs** to fulfil their duties (also relying on the implementation of the 3rd legislative package and, if necessary correcting a national framework).

[17] The use of data you only need for a specific application/usage model.

Annex II: Objectives, Dependencies and Smartening of Grid Operation

Actors, Objectives and Trade-offs

The actors of the electric power supply chain and other actors described in Chapters 2 & 3, aim at fulfilling different objectives: economic, technical and social / environmental. A common, optimized scenario requires a compromise approach and trade-offs between these objectives, in order to achieve the optimum. This is illustrated symbolically in the Figure 3 below.

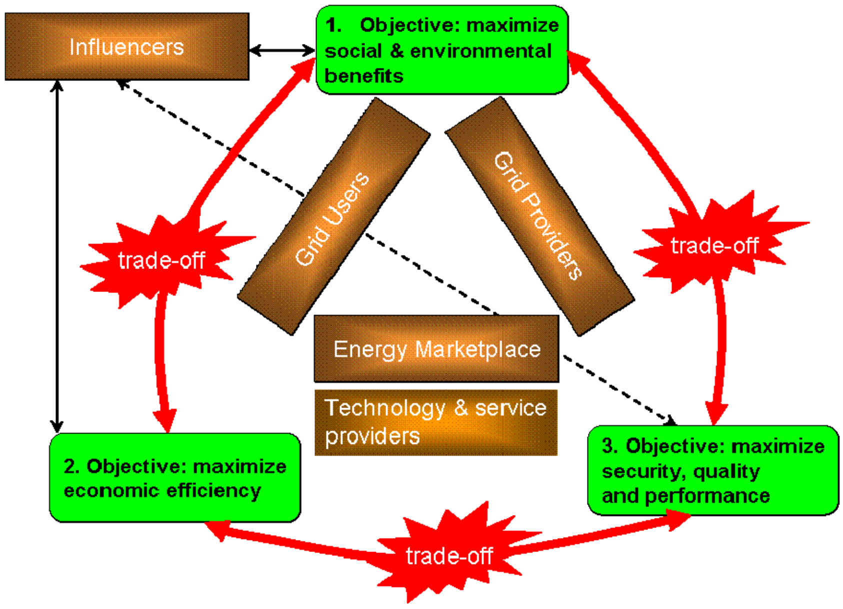

Figure 3: A view on the three different objectives and their interaction

„Smartening" the Grid Operation

While seeking this "optimum" end state and ensuring the sharing of the necessary information required for grid operation, different actors may reconsider their planning and operation schedules in order to improve the overall grid merit. A grid is considered to be operated at its optimum when a predefined and adequate mix of quality of supply, operational security, minimizing impact on the environment and maximizing economic benefits to all actors (most notably users / consumers) metrics are achieved.

It follows that to "smarten" the operation of the grid (both transmission and distribution) it is required to reconsider the actor's behaviour, under the necessary control, in order to meet the three objectives.

In addition, the electric power grids can undergo dynamic changes and volatile "pressure" depending on varying injections and withdrawals at any given time, which could lead to reducing the optimum state outlined above. With increased volatility and potential magnitude of this volatility (e.g. by massive wind power deployment), additional interaction and information from the grid users will be required, in conjunction with well structured control loops that will be deployed both at transmission and distribution level.

ANNEX 3