DSO PRIORITIES FOR SMART GRID STANDARDISATION

A EURELECTRIC position paper

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DSO PRIORITIES FOR SMART GRID STANDARDISATION

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I. Executive Summary

Smart grids will not be rolled out in a single swoop. Instead, their implementation is an incremental and continuous step-by-step learning process, characterised by different starting points throughout Europe. In this context, standardisation is an indispensable step to ensure smart grid deployment. A multitude of standards in different areas are required to ensure new functions and interoperability.

Distribution system operators (DSOs) will play a key role in the smart grid deployment. The table below summarises the DSO priorities for standards along the different smart grid functionalities and services. Recommendations for action on each of these standards are highlighted in boxes throughout the text.

	Smart Grid Functionality & Service	**List of Standards**
Smart Network Management	- Electromagnetic compatibility & power quality - Advanced network operation and control (e.g. faster fault identification and self-healing capabilities, advanced network automation, volt var/watt control) - Smart metering and power line communication	IEC 61000 series IEC 61968/61970/62325 (CIM) IEC 61850 series, IEC 60870 series IEC 62689 series IEC 62351 series IEC 60255 series
Smart Integration of Distributed Generation and e-mobility	- Integration of distributed generation - Integration of electric vehicles - Integration of new usages such as storage, heating & cooling, etc.	EN 50438 IEC 61850 series TS 50549-1 & 2 ISO/IEC 15118 IEC 62786 IEC 61851
Smart Markets and Active Customers	- Enable DSO to act as market facilitator and grid optimiser - Develop demand response and demand side management programmes - Aggregate distributed energy resources and e-mobility - Balance the power grid	IEC 61968/61970/62325 (CIM) IEC 62056 (DLM/COSEM) IEC 61850 series SEP 2.0, Open ADR, ...

Table 1: Standards for smart grid functionalities and services for DSOs[1]

Timely availability of these standards will be important, especially because DSOs already have to cope with challenges that require smart grid functionalities and services. The proliferation of intermittent decentralised renewables in the distribution grid is but one example.

If the final standards are to reflect DSO standardisation needs, DSOs must act rapidly to ensure that their views are heard. To this end, EURELECTRIC will publish a DSO standardisation roadmap for smart grids in the course of 2013.

Meanwhile, smart grid standards are not being developed in a regulatory vacuum. On-going discussions on the smart grid market model within the European Commission's Task Force Smart Grids have to be taken into account, as must the development of network codes by ENTSO-E.

[1] *Source: EURELECTRIC 10 Steps to Smart Grids*

II. Introduction

1. Standardisation at the fore

Standards play a key role in the development and deployment of technology in society, providing an indispensable basis for widespread market penetration and customer convenience. Agreed standards tend to encourage innovation, boost productivity and shape market structures, enhancing economic efficiency by reducing or eliminating technical barriers that can create market distortions. Standardised smart grid technology is a prerequisite for a secure investment climate, especially taking into account the long lead times of the distribution business. Moreover, agreed standards will benefit all stakeholders involved.

In a meeting on energy issues in February 2011, the 27 EU Heads of State and Government concluded that the internal energy market should be completed by 2014 so as to allow gas and electricity to flow freely. To reach this challenging target, they asked Member States, in liaison with standardisation bodies and industry, to "accelerate work with a view to adopting technical standards for electric vehicle charging systems by mid-2011 and for smart grids and meters by the end of 2012."

The electricity industry welcomes this political recognition of the importance of standardising smart grid technology. We are already collaborating with European and international standardisation bodies to ensure the development of secure, cost-effective standards. Although the restrictive timeframe may ultimately prove unfeasible, standards are not an end in themselves but a means to achieve smooth system operation and interaction between relevant actors as well as cost-effective deployment. To this end, both the regulatory framework – which may, for the distribution business, diverge significantly across different Member States – and the market model will also greatly influence the functioning and operation of smart grids in practice.

2. DSO priorities for deploying smart grids

Based on the recommendations for smart grid standardisation in Europe, as developed by the European standardisation organisations, the distribution companies represented by EURELECTRIC and EDSO for Smart Grids have identified the major standardisation priorities for the distribution business.

EURELECTRIC and EDSO for Smart Grids' work concentrates on the following main application areas:

- Peak Demand Management
- DER integration and management
- EV integration and management
- Flexible load integration and management
- Power Quality management
- Grid Optimisation (operation, maintenance and loss reduction)

In future, storage systems will become an additional component to integrate and manage.

The standards related to the abovementioned areas should be further supported by market mechanisms and regulation. The ENTSO-E network codes, for example, could make clear reference to CIM and Role Model eBIX standards, and provide guidelines for national grid connection codes.

Meanwhile, DSOs are already facing challenges related to an increasing share of intermittent and decentralised renewable generation. Given the impact this will have on the distribution network, technical standards related to connection and installation are of utmost importance for the distribution business.

Furthermore, smart grids will require a more advanced level of automation compared to the grids today, leading to an increased introduction of ICT in the grids. Respective standards are therefore a must. Tomorrow's smart grid differs from the existing distribution network in that it will be equipped with extensive telecommunication capabilities. First, information models CIM and IEC 61850 need to be extended to replace old application protocols (identified in the standardisation gap Gen-1 and Dis-2). Second, there is a need to allocate a specific portion of the radio spectrum to smart grids to enable advanced bidirectional communication and data collection. This will improve network operation and open up possibilities for new services on the demand side, for instance through smart meters and electric vehicles.

Telecommunication for smart grids should not be limited to the access segments (for both mobile and fixed networks). Indeed all parts of the telecommunication infrastructure should be equally considered, i.e. backbone, carrier, access, and service provision/delivery. DSOs do not recommend any predefined dominant telecommunication technology: all wired (fiber-optics, copper, power line), radio links (Very High Frequency, Ultra High Frequency, microwave), satellite links, access wired and wireless technologies, and others have to be considered in terms of their performance and cyber security issues.

The following sections highlight and explain the priorities for smart grid standards from the perspective of the distribution business. They have been grouped into three main categories:

- Smart network management
- Smart integration of distributed generation and electric vehicles
- Smart market and customers

III. DSO Standardisation Priority Clustering

Within M/490 – the Smart Grid Standardisation Mandate issued by the European Commission – a stakeholder-based ranking has identified the broad priorities for smart grid standardisation. For the purpose of this document, EURELECTRIC and EDSO for Smart Grids have carried out a specific DSO priority clustering for smart grid standardisation.

The DSO priority clustering intends to cover, first, the improvement from "business as usual" to "grid optimisation" (DG connection rules, EMC power quality, advanced automation, Volt Var control and distribution network dispatching) including the right level of cyber security. In a second step, the possibility is developed to use flexibilities connected to the distribution grid for further grid optimisation and for the market (Active Demand Management). In this second step the DSO acts as a "market facilitator".

With its emphasis on the seamless functioning of the network, the prioritisation of DSOs obviously differs from the one developed under the M/490 within the WG First Set of Standards, which takes all stakeholder interests into account. The coloured list below provides an overview of the level of urgency in standardisation priorities.

	ID	Gap summary	Justification
DSO Primary Priority cluster	Dis-1 Dis-7	Feeder and advance distribution automation	Significant importance for DSOs to ensure increased automation of the MV network. Enhancement of efficiency in day-to-day grid operation and the ensuring network security, system control and quality of supply are essential items. Main scope of this work is to create a technical report IEC 61850-90-6 for feeder Automation communication and an international standard IEC 62689 for fault detectors for medium voltage lines. The new standard IEC 62689 for fault detectors may result in higher investment costs, but the financial impact in general seems to be low as fault detectors as "state of the art" are important for a secure grid operation. Otherwise, intelligent fault detectors will enhance grid operation and can help to reduce shutdown times. It may have a high impact on operation, complexity, reliability and upgradeability of concerned systems.
	Gen-4 Gen-5	Connecting DER to the grid	The aim is to support harmonizing the electrical connection installation, and operation rules within Europe down to all levels of connection of DER. But too strict connection requirements may have financial impact and slow down the implementation of DER. This gap will also need to adapt to the future European Network Code requirements.
	EMC-1	Review existing EMC standards	Main scope of this work is a review of existing standards regarding EMC taking into account new developments in the grid (DER, e-mobility). Further work is planned on electromagnetic interference between electrical equipment/systems in the frequency range below 150 kHz.
	Dis-3	Seamless communication between control centre and substation	Main scope of this work is to create technical reports IEC 61850-90-2 and -11 for communication between substation and control centre and WAN technology guidelines for IEC 61850 series. IEC 61850 has been identified as a core standard for smart grids by IEC with high impact on operation, complexity, reliability and upgradeability of concerned systems.
	Gen-1 Dis-2	Harmonized glossary, semantic & modelling between back-office applications (CIM) and field applications (IEC 61850)	The missing alignment of glossaries and data modelling between control centres and field application may cause additional complexity and reduce reliability and upgradeability of concerned systems. Main scope of this work is to harmonize IEC 61968/61970 and IEC 61850 series. They have a high impact on operation, complexity, reliability and upgradeability of concerned systems.
DSO Secondary Priority cluster	Gen-2 SM-1 Ind-1	Harmonisation between IEC 62056 series (DLMS/COSEM) data model and IEC 61850/CIM	The exchange of metering data and tariff information is fundamental to the implementation of smart grids. The further development of different and competing standards for the same purpose leads to unnecessary costs and complexity. Main scope of this work is to revise IEC 61968-9 "*Application integration at electric utilities - System interfaces for distribution management - Part 9: Interface for meter reading and control*" and to create IEC 62056-62 "*Electricity metering data exchange - The DSML/COSEM suite - Part 6-2: COSEM interface classes*" (draft published in 2010-11) as international standards. Both standard series have an impact on DSO's further metering infrastructure concerning system interface for meter reading and control.
	Other-1	Smart Grid communication standards relying on the Internet based standard Web Services & harmonisation with CIM and IEC 61850	IEC 61850 has been identified as a core standard for smart grids by IEC with high impact on operation, complexity, reliability and upgradeability of concerned systems. As the communication technology used within back-office systems (such as monitoring & control centres) or on field level (such as feeder automation or integration of DER or active consumer) may have financial impact and also on operation performance, the specific impact also depends on the current applied communication technology at DSO level
	Gen-3 Ind-2 HB-2	Extended field data modelling standard (part of IEC 61850) to support demand response, DER, VPP and home/building/industry automation	The normative definition of logical nodes for DER is necessary for new smart grid appliances because process devices have to be described in such logical nodes for information exchange. Therefore it is important that currently valid logical nodes in process protocols are not subject to change in the further standardisation process. Main scope of this work is to revise IEC 61850-7-420 "Communication networks and systems for power utility automation - Part 7-420: Basic communication structure - Distributed energy resources logical nodes".
	SM-3	From Smart metering to Smart Grid, and e-mobility	It is necessary to ensure harmonization with existing metering models and other relevant standardization initiatives related to smart grids. There is a considerable relevance for all e-mobility topics where smart services are provided as possible market model.

	ID	Gap summary	Justification
	Com-2	Harmonize activities on data transport technologies	Main scope is to extend the frequency range on the low frequency equipment impedances according to EN 50065-1 and to define supported protocols based on ITU G.9960 and G.9961 for Smart Grid applications. It is to notice that EN 50065-1 is a harmonized standard to the low voltage directive 2006/95/EC and the EMC directive 2004/108/EC. Harmonised standards generally are important for the market because they have to be applied by manufacturers and operators due to their presumption of conformity to European guidelines and so also to national legislation.
	Dis-4	Develop cyber security around IEC 62351	The information processing systems at the process control level are consequently exposed to an increasing number of threats and vulnerabilities. It is therefore essential that, in the area of process and business control as used by the energy utility industry, adequate information security is achieved. IEC 62351 standard series has been identified as core relevance for smart grids by IEC. But in fact that IEC 62351 addresses security and specifies technical requirements on protocol level, it mainly addresses vendors and telecom operators when they develop products according to IEC 61850, IEC 60870, IEC 61970 and IEC 61968.
DSO Tertiary Priority cluster	Ind-3	Smart metering data to building system interface	Main scope of this work is to ensure coordination between IEC PC118, TC205, TC57 and CEN TC 294 / CENELEC TC13. As there is a close coordination within the ESOs, there is no specific impact on DSOs.
	Ind-5	Electrical installation allowing DER installation	Main scope of this work is to support the development of a dedicated part within the HD (IEC) 60364 to cover new safety and protection issues for the electrical installation of DER to the grid. Safety issues will concern all kind of operation and plant technology.
	EMC-2	Review EMC and Power Quality levels	Main scope of this work is a review of EMC and power quality levels and measurement methods. A draft of IEC 61000-4-30 Ed. 3 was distributed, including an informative annex for measurement method for conducted disturbances in the range of 2 - 150 KHz. Further actions are the addition of annexes to TR 50422 regarding the impact of DER on supply voltage and the impact of disturbance in frequency range above 2 kHz on supply voltage.
	EMC-3	Consider distorting current emissions from DER equipment	Main scope of this work is to standardize how to give a limitation to the distorting current emission by DER equipment and to fairly allocate the ability of networks to absorb distorting current emissions. With publication of IEC 61000-3-15 in September 2011, the main activity of EMC-3 is closed. Further actions are to revise standards impacted by IEC 61000-3-15 (revision of IEC 61000-2-2 and 61000-2-12, second priority is for IEC 61000-3-14, then for IEC 61000-3-6, 61000-3-7 and 61000-3-13). According to IEC, the 61000 series has only low relevance for Smart Grid application.

1. STANDARDS FOR SMART NETWORK MANAGEMENT

Standards enabling "Smart Network Management" will significantly improve the traditional business of DSOs by addressing key issues such as Power Quality Management and Grid Optimisation, by integrating a high level of cyber security.

1.1. Review EMC and Power Quality levels

Electromagnetic Compatibility is a prerequisite for products and is therefore not limited and not unique to a Smart Grid. Nonetheless, to ensure proper functioning of the Smart Grid, coexisting with other electrical and electronic systems, **the Smart Gird must be designed with careful consideration for electromagnetic emissions and immunity for various electromagnetic phenomena**. It is therefore of utmost importance that EMC is addressed effectively if the Smart Grid is to achieve its potential and providing benefits when deployed.

For a number of "smart" applications (e.g. DER, Electric Vehicles or Power Line Transmissions (PLT) in the metering domain), EMC will be a major issue.

Currently, there are some gaps in the field of EMC standardization: e.g. for immunity and emission in the frequency range from 2 kHz to 150 kHz[2]. To ensure proper functioning of electronic equipment and of PLT services these standardisation gaps have to be closed (PLT emission levels are covered by IEC 61000-3-8 and 61334-3-1). Additionally, revised standards are needed so that power quality standards are met in the changing environment of distribution grids and ensuring long term possibility to use PLT under good economic and technical conditions.
Within current standards the requirements for emission and immunity are set for single equipment on a clean grid. In future the interaction of two or more equipment's on the same grid must be covered.

DSO Recommendation:
Support EMC Committees (IEC SC 77A and other CISPR where appropriate), as well as those Product Committees defining EMC requirements in their product standards (TC 22, TC 13, TC57 …), in their effort in view of reviewing the existing standards and covering the abovementioned gap in EMC standardisation. Especially:

- **IEC 61000-2-2**: Compatibility Levels for Low-Frequency Conducted Disturbances and Signalling in Public Low-Voltage Power Supply Systems (Maintenance of an existing standard. Investigation has started in view of addressing the 2-150 kHz frequency range : 77A/773/RR (2011/10))
- **IEC 61000-2-12**: Compatibility Levels for Low-Frequency Conducted Disturbances and Signalling in Public Medium-Voltage Power Supply Systems (Maintenance of an existing standard. Investigation has started in view of addressing the 2-150 kHz frequency range: 77A/774/RR (2011/10))
- **IEC 61000-4-19**: Immunity to conducted, differential mode disturbances in the frequency 2 – 150 kHz at a.c. ports (New Project : 77A/783/CD (2012/01))
- **Emission requirement** in the range of 2-150 kHz (establishment of a Joint Task Force SC77A/CISPR agreed in principle) but in accordance with the existing standard (CEI EN 50065 series.
- EMC and EMC standards, respectively, have to be matched with criteria to power quality

[2] See also the detailed EURELECTRIC position paper: EURELECTRIC position regarding emission levels at frequencies below 150 khz of equipment connected to low and medium voltage electricity networks of November 2012. Available on: http://www.eurelectric.org/media/68009/1128_eurelectric_postion_on_emissions_final-2012-030-1004-01-e.pdf

1.2. Feeder automation and advanced distribution automation

Advanced Distribution Automation is a mandatory function of the Smart Grid. Advanced Distribution Automation will facilitate to improve the management and operation of the distribution network: it will evolve from a semi-automated approach towards a fully automated one. It will not only take into consideration fault detection, also fault clearing, supply restore and network configuration and the effect of these processes of a large amount of distributed generation (especially from RER along MV and LV feeders).

DSO Recommendation:

- Support the development of Advanced Distribution Automation standards, covering V and I sensors, switching equipment and fault detectors (definition, modelling) for medium voltage (overhead and underground) such as IEC 61850-90-6
- Support the development of a proper "real-time" communication network to properly deal with Distributed Generation in the context of advanced network automation and appropriate standards such as IEC 61850-90-2/12, IEC 61850-80-2/3

SCADA systems, advanced sensors, and electronic controllers are integrated into the Distribution Automation system in order to achieve the desired performance and reliability at the distribution network. Interoperability of all components participating in the Advanced Distribution Automation system requires communication standards covering not only the devices of the substation, but all the components from the substation to the point of interface with the end consumer (Smart Grid Connection Point) and to the Distribution Network Control Centre. Traditionally, proprietary protocols have been used to model and transport the data and the applications. Today, some of them such as old protocols (e.g. non-IP protocols like Sprint/X25) do not support the new needs of Smart Grid applications and need to be replaced by more appropriate and advanced protocols.

Nevertheless, further improvements are necessary both on the "basic" level as for a system completely performing on communication. The protocol to be adopted, not only for intra substation communication, but also, and especially, for extra substation communication, shall be IEC 61850 (2nd edition), which has to be completed in most of its parts. In addition, as a real interoperability is a mandatory target, DSOs should avoid accepting IEC 61850 data model and profiles defined from one or another manufacturer, as this will not allow any real interoperability.

1.3. Seamless communication between control centre and substation based on IEC 61850

Old protocols have to be replaced because they do not support the new needs of monitoring and controlling the equipment as primary substations and feeder RTU's.

DSO Recommendation:

- Support IEC/61850-90-2 (Guideline for using IEC 61850 to control centres)
- Support IEC/61850-8-2 and IEC 61850-8-3 (Mapping of web services technology)

1.4. Further develop power/distribution line communication

The use of Power Line Communication (PLC) or Distribution Line Communication (DLC) represents a "natural" solution of M2M communication for DSOs. From the point of view of many distribution system operators, PLC should also be seen as a requirement by default for some smart grid purposes, though its application for mission-critical functions may be precluded.

Currently, due to the low cost, the power line technology is the most beneficial and least invasive for the integration of smart meters. PLC is the only technology which gives real network (grid) topology and provides remote meters reading in locations where there is no radio coverage, for example in basements. However, so that the PLC can become an acceptable ICT infrastructure (and a secure communication backbone), robust protocols have to be created so that the fragilities of PLC can be overcome.

Moreover, given that PLC proves to be a viable technological solution for Advanced Metering Infrastructure (AMI), applications of PLC communication for mission-critical applications has to be investigated, particularly when PLC is considered on MV/LV lines.
PLC used in MV/LV segments could be narrowband or broadband. A deep investigation and standardization effort is required in order to improve all coupling systems, EMC/EMI issues and channelling to take into account the different requirements in terms of reliability, latency, throughput, coexistence and interface physical and logical in order to assure the correct data transport and systems interoperability.

It should be noted in case of high reliable and fast communication i.e. teleprotection systems path have to be implemented in order to fulfil the requirements using the right level of redundancy. The secondary path should use a technology radio or wired fulfilling the same performance requirement.

DSO Recommendation:

- The possibility of using PLC on the MV and LV networks must be protected in the long term through standardisation (e.g. EMC) and regulation (dedicated bandwidth).
- Extending the performance of the PLC communication is important for DSOs to offer a robust and quick communication infrastructure for Smart Metering and Network Automation. An extension should be obtained for the use of PLC on frequencies between 150 kHz and 499 kHz, a solution which is already used in the USA (e.g. FCC).

But an extended frequency range may lead to following problems which need to be handled by DSO:

- Electrical distortions of current applied electrical devices and signalling systems,
- Low-voltage power supply networks do not have characteristic wave impedance, as this is common for other communication media. This leads to disturbances and mutual interferences,
- The attenuation and impedance of the low-voltage power supply networks varies considerably over the whole frequency range. This leads to a deterioration in the quality and to an increase of the mutual interference of signals,
- The attenuation and impedance depend on the devices connected with the low-voltage power supply network; for the DSO it is difficult to have impedance which covers the whole frequency range.

Special attention must be paid to these problems with the extension of the frequency range on the low frequency equipment impedances according to EN 50065-7 and the definition of supported protocols based on ITU G.9960 and G.9961 for Smart Grid applications that the resilience of a network could not be harmed. So ESOs need to make sure that standards are developed which enable additional smart services, e.g. via a PLC 'plug and play' approach using current telecommunication structures over the network which also ensure network stability.

It is also to notice that some parts of EN 50065 (part 7 currently not) are harmonized standards to the low voltage directive 2006/95/EC and the EMC directive 2004/108/EC with high impact on the market due to their presumption of conformity to European guidelines and so also to national legislation.

1.5. Electronic data models

This gap also handles the identification of objects and classification of objects in a smart grid environment, mainly based on RDS (Reference Designation System) according to EN 81346 and ISO/TS 16952 series which determines structuring principles and reference designations for all types of industrial systems, installations and equipment and industrial products.

Identification of objects and classification of objects are the minimal essential working areas, influencing the full scope of business activities, from procurement, engineering, maintenance, service and phasing out of operation.

From a DSO perspective the most important features are:

- Unambiguous identification of the objects (e.g. from HV breaker to metering equipment in a household) within the grid considered; this requires the use of a common identification system for the objects including all grids participating in the smart grid
- Classification of the objects used in the grid
- If the relevant object is clearly identified, the technical data associated with the object need to be computer-interpretable
- Unique designation scheme reduces planning and operational costs significantly
- Fault analysis across several grids, identification of equipment prone to faults
- Identification and allocation of status messages in communication networks (e.g.
- SCADA, metering protocols)

These items are absolute prerequisites, for example, for any asset management application, which must be able to include different vendor equipment. For this equipment the same technical properties must be made available by the supplier of the products. As the basic standards only describe the overall RDS structuring principles, current supplier object designations and documentation are very different which makes the administration in asset management systems very complicated or nearly impossible in case of different data positions, so it is in the natural interest of DSOs to have harmonized object designations for administration. Another issue is documentation. In order to support consistency and common understanding, general guidelines and electronic product descriptions must be present.

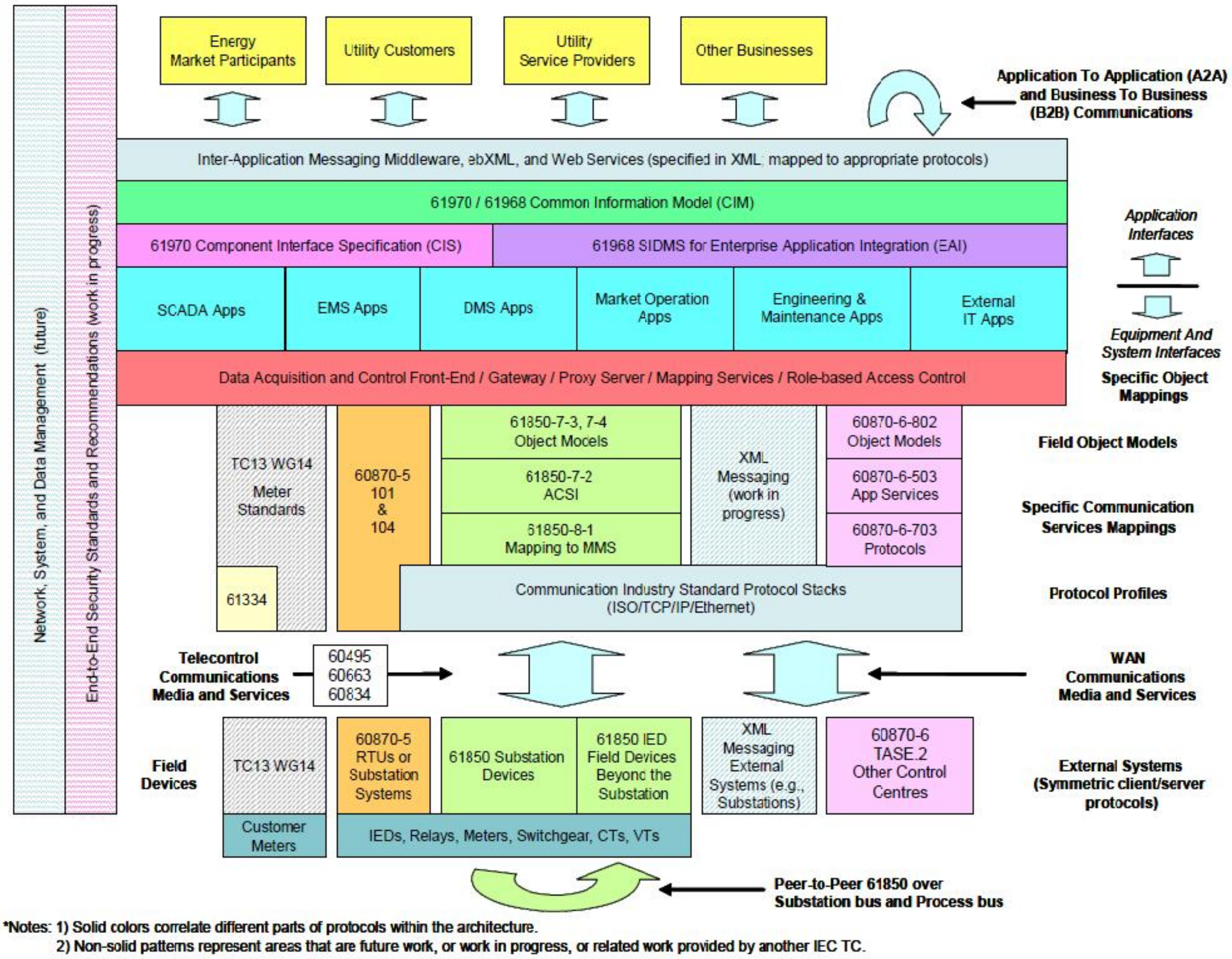
1.6. Harmonize Common Information Model (CIM): structure and semantics to integrate variety of back office applications

The requirements in the energy market are changing. Modern network control systems have to be optimised to meet these requirements. The high degree of scalability with regard to hardware configuration and software functionality allows flexible matching to changing requirements over the entire life cycle of the system and beyond. The aim is to make the system architecture modular and component-based so that a flexible configuration and IT integration can be implemented in a cost-efficient manner.

The crucial step here is to combine the large number of autonomous IT systems into one homogeneous IT landscape. However, conventional network control systems can only be integrated with considerable effort. Additionally, the missing alignment of data modelling between control centre and field application may cause additional complexity and reduce reliability and upgradeability of concerned systems.

In the area of communications, there must always be clarification as to “WHAT” is being exchanged and “HOW” it is exchanged. The “WHAT” is to be defined by long-lived object models, which need then to be mapped to the communication layers by means of abstraction layers.

The IEC architecture for the Smart Grid is detailed in the IEC 62357 - Seamless Integration Reference Architecture - which is based on the established standards from IEC/TC57 and IEC/TC13 and sets these in relation to each other.



Current IEC TC 57 Reference Architecture

Open systems through the use of standards

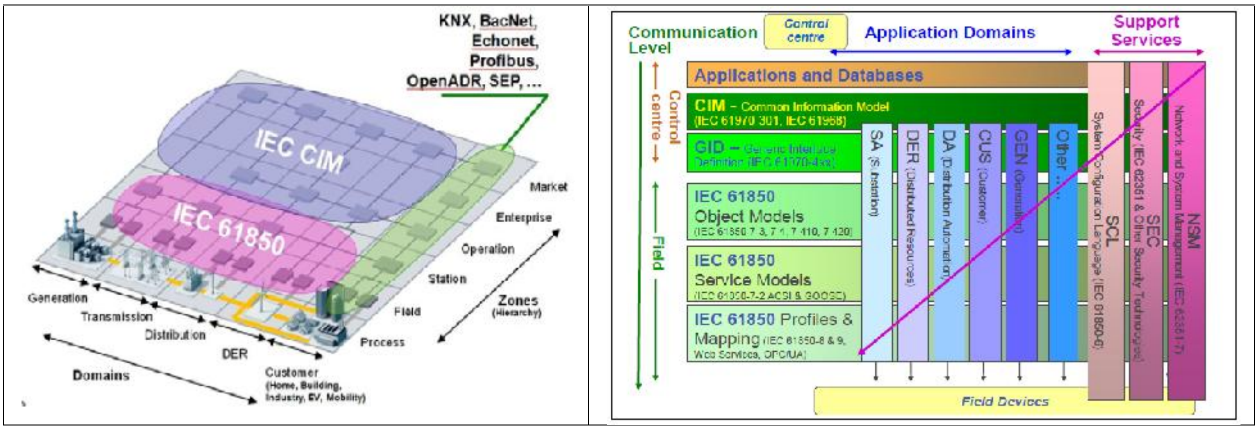
A modern network control system provides the basis for integration of an energy management system in the existing system landscape of the power supply company through the use of standards and de facto standards.

- IEC 61970, IEC 61968 and IEC 62325 – Common Information Model (CIM) – defines the standard for data models in electrical networks. It supports the import and export of formats which are based on the XML standard
- Client/server configuration based on standard LANs and protocols (TCP/IP)
- Open interfaces (ODBC, OLE, OPC, etc.)
- Internationally standardized transmission protocols (IEC 60870-5, IEC 60870- 6)

Service-oriented architecture

A modern network control system provides a service-oriented architecture (see Figure) with standardized process, interface and communication specifications based on standards IEC 61968 for Distribution and IEC 61970 for Transport or IEC 62541 OPC-UA. They form the basis for integrating the network control system in the enterprise service environment of the DSOs.

Standards such as IEC 61968/61970/62325 (Common Information Model, CIM) ensure that topology data, for instance, can be exchanged between the DSOs and among their internal Information Systems, leading to a common semantic model, improved load flow calculation and operational reliability.



Vision of the future standards mapped on SGAM

The CIM defines a common language and data modelling with the object of simplifying the exchange of information between the participating systems and applications via direct interfaces. The CIM was adopted by IEC TC 57 and fast-tracked for international standardization. In Europe, ENTSO-E has decided to adopt CIM and develop it on a regular basis (see IEC 62351-451-2/3).

All functions described above require an increase in information exchanges and therefore a syntactic and semantic understanding of a variety of different domains including AMI, Transmission, Market and "Prosumer" is required.

Connections to Home Area Networks (HAN) is important as a means to enable new services beyond the meters (incorporate smart thermostat, direct load control appliances, smart appliances and in-home energy displays into utility systems, as well as enabling demand-response (DR) and energy efficiency programmes).

Further development of market application and cost reduction of IT development and integration by DSOs need to be based on an evolving and flexible data model and inter-application exchange standard.

In the implementation of Smart Grids, change is to be taken into account in order to achieve sustainability of information and technical solutions, as has already been the case with IEC 61968/61970 and IEC 61850, so that basic communication technologies can be replaced in response to technical progress without any effects on the higher logical function and data layers. This is a relevant issue for users with regards to security of investment, and also of importance with regard to the migration and integration of existing communications technologies.

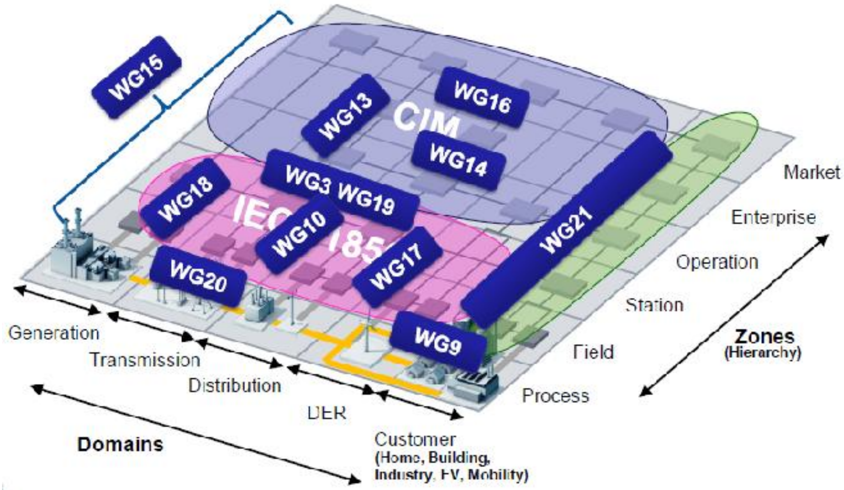
The CIM forms the basis for the definition of important standard interfaces to other IT systems. The working group in IEC TC 57 plays a leading role in the further development and international standardization of IEC 61970 and the Common Information Model. Working group WG 14 (IEC 61968 standards) in the TC 57 is responsible for standardization of interfaces between systems, especially for the power distribution area. Standardization in the outstation area is defined in IEC 61850.

There is also a need to:

- Integrate DER profiling and device discovery in future IEC 61968 network extension models. In synchronization with IEC 61850-7-420.
- Incorporate AMI and HAN models to allow for Demand Response capabilities and interfaces to these domains. Financial incentives and direct intervention cannot by themselves guarantee a successful demand response. Modelling of load behaviour at end-user level seems to be necessary for implementing a successful Demand Side Management and Demand Response.
-

DSO Recommendation:

- Speed up the development of the IEC 61968/61970/62325 standards including the DSO needs to facilitate the Smart Grid information exchange



IEC TC 57 – Overview of the relevant Working Groups

1.7. Smart Grid communication standards relying on the Internet based standard Web Services & harmonisation with CIM and IEC 61850

Standard communication technology to be used either within back office systems (such as monitoring & control centres) and fields systems (such as feeder automation or integration of distributed Energy Resources or active consumer) play an important role. Main scope of this work is to create new international standards IEC 61850-8-2/3 for mapping of IEC 61850 SCSM over the Web Services and probably to enhance IEC 62056 according to this.

As communication via Web Services and available infrastructure shows an effective way to connect systems, potential threats posed to data security as a result of the protocol not aligning to existing protocols in place for other sectors and to avoid large scale substitution of current infrastructure devices/solutions to new 'protocol compliance' must be considered.

ESOs should focus on new standards/protocols to enhance the operational efficiency and performance of existing asset bases through reducing both complexity and costs of compliance associated with complying with a variety of different standards.

DSO Recommendation:

- Support TC57 in further developing IEC 61850-80-3

1.8. Develop cyber-security around IEC 62351

The field of cyber-security should be analysed with reference to the specific environment of electrical power supply (i.e. availability, security of supply and critical infrastructures) and a system should be developed for assessing the comparability and applicability of security systems.

These risks predominantly concern the IT and telecommunication infrastructure. In order to achieve an adequate level of protection, classical security objectives such as confidentiality, integrity, availability, non-repudiation and privacy must be assured by the implementation of security controls.

Due to the nature of the Smart Grid, as a huge network of interconnected sub-networks and its inherent complexity, the aforementioned risks could quickly be increased. Additionally, there are vast numbers of systems, interfaces, operational modes and policies implemented by stakeholders which is rending the system more vulnerable and with an increased probability that these risks will be exploited. In addition, new functionalities like smart metering and electric vehicles introduce stronger requirements for data protection and privacy. The subsequent bullets state the risks more precisely:

- The architecture of the Smart Grid will be complex with a very high number of endpoints, participants, interfaces and communication channels and with different levels of protection in the underlying systems. In general, it is always a challenge and requires effort to achieve an adequate level of protection for such a complex system.

- The introduction of Smart Metering systems and processes will increase the number of endpoints dramatically and will move them to private households. Physical security is hard to achieve in these scenarios and time and motivation to penetrate the systems are in plentiful supply.

- Many components of the Smart Grid can be characterized as legacy where security has never been an important requirement.

- The majority of network connections and communications paths in the scope of the Smart Grid will be based on Internet-technologies / IP-networks. This infrastructure comes along with high flexibility and many existing systems but also introduces a higher vulnerability because of the mal-ware (e.g.: worms, viruses) which already exists in this ecosystem and the potential risk of this spreading quickly, which could have fatal consequences.
  A higher number of attack scenarios based on very different objectives, ranking from industrial espionage and terrorism to privacy breaches should be anticipated.

Fortunately, a lot of work and attention is already given to these topics. The existing solutions for the Smart Grid core architecture such as IEC 62351 and European works (M/490 – WGIS, ENISA) or "national" White Paper (German BDEW, French National Agency for Information Security ANSSI, NIST, ...) have be taken into account in this context.

DSO Recommendation:

- The security of information systems should be regarded as a core topic in the development of the architecture for Smart Grids, but also in view of user acceptance: the protective objectives of availability, reliability, integrity and confidentiality should be taken into account in the technical concepts and operation.
- Resolve possible conflicts between objectives of data protection on the one hand and the Smart Grid approach on the other. The standardisation process is the appropriate approach to cope with these challenges.
- Support TC57 in the development of IEC 62351 with a global vision of the international work on cyber security and associated risk analysis.

2. SMART INTEGRATION OF DISTRIBUTED GENERATION & E-MOBILITY

2.1. Connecting Decentralised Generation

The deployment of distributed generation will increase further and probably at a rapid pace. A non-linear growth within the next few years is expected. Technical requirements have to be specified for the connection interface of DER including its protection functions, designed for operation in parallel with distribution networks.

ENTSO-E has received mandate from the European Commission to develop Network Codes. The so called "Requirements for Generators (RfG) Code" are currently under development. Flexibility and maintainability of the technical requirements are crucial. Standardisation is the best way to deal with the technical details, especially at the LV and MV levels, because of necessary adaptation to local particularities and fast move. Standardisation includes grid connection and operation rules as well as product specifying requirements.

The priority is to specify constructive capacities of equipment, some flexibility being left to the relevant Network Operators and/or to contract between network operator and network users (settings …).

DSO Recommendation:

Develop appropriate European standards:

- EN 50438: Requirements for connection of micro-generators to the LV grid (second edition is being prepared in CLC TC8X)
- prTS 50549-1: Requirements for connection of DER to the LV grid (being prepared in CLC TC8X)
- prTS 50549-2: Requirements for connection of DER to the MV grid (being prepared in CLC TC8X)
- Care should be taken of future IEC 62786-2: Smart Grid User Interface, Part 2: Domain Side Energy Source Interconnection with the Grid (accepted NP in IEC TC8)
- Product standards for conformity assessment purposes (expected new projects)
- Future CENELEC/TC95: e.g. "Protective functions and equipment for DER connection to the Grid"
- CENELEC TC82: e.g. "Test procedures for grid-code compliance of utility-interconnected photovoltaic inverters"

Apart from the grid issues, standardization has to cope with aspects like DER modelling (IEC 61850-7-420) and its various communication mappings for the ACSI to deal at SCADA/EMS/DMS level with DER. Profiling of existing solutions for proper testing and interoperability is needed.

Large amount of decentralised generation connected to the distribution networks also impact the operation of transmission networks. To that extent, ENTSO-E is currently working on three network codes that are relevant to network operation which will require significant information exchanges, even in real time, between the DSOs and the TSOs. The three codes are: 1) Operational Security, 2) Operational Planning & Scheduling, and 3) Load Frequency Control & Reserves. The standardisation process has to take into account the impact of these European Network Codes and propose standardised profiles for this information exchange.

2.2. Electrical installation allowing DER installation and protections issues

New safety and protection issues arise due to using distributed energy resources (DER), as part of electrical installations and part of micro grids for industry. The multisource aspect is not fully covered by current installation rules, and TC64 should develop a dedicated part within the HD 60364 to cover this need, keeping in mind that all national wiring rules through European countries are based on the HD 60364. In the light of DSO's global HSE strategies, a provision of international well accepted, high level technical protection measures for DER installations and humans are necessary. Nevertheless, these measures must be financially reasonable.

DSO Recommendation:

- Support TC64 in further developing IEC 60364, a dedicated part for installation rules

2.1. Integration of Electric Vehicles

Electric vehicles will become an integrated part the smart grid: they will act both as mobile consumers and electrical storage possibilities. Hence the charging infrastructure for electric vehicles will have to comply with certain technical requirements. Indeed, an intelligent connection between the grid and the car is necessary to smoothly integrate the additional loads into the distribution networks, while coping with an increasing share of intermittent and decentralised renewable energy sources. Grid stability is an indispensable aspect that needs to be carefully addressed.

DSO Recommendation:

- Support the work of TC8/WG6 and particularly the DCT8 Electric Transportation
- Support implementation tests of ISO/IEC 15118

3. THE ROLE OF DSOs IN THE MARKET AND ACTIVE DEMAND

3.1. Ensure smart metering: harmonise data model, exchange of metering data, tariff information

The harmonization between the data model for revenue metering and IEC 61850/CIM is important in order to assure that the full smart metering potential, especially with regards to grid-relevant information collected by the meter (phase-detection, reactive energy, alarms, quality-of-supply information, grid topology, etc.) can be exploited in order to optimize grid operation. The harmonization of IEC 62056 series (DLMS/COSEM) with IEC 61850 and with CIM is already in process, as those protocols are already standardised. For other protocols and data models that have been accepted for standardization but the process of which is still on-going, the gap “other-2” has been introduced by the ESO.

On the other hand, efforts to harmonize the standards in this area may lead to reduced complexity for the rollout of further smart meters and to adopt a multi-vendor strategy, (e.g. by additionally supporting the COSEM object mode). It will help in integrating a range of stakeholders such as customers, business partners, utility companies and smart services/metering providers within the same system. In addition to this, new standards/protocols should support different information channels such as the internet, PLC, GPRS or LANs which could offer required DSOs flexibility when deploying smart solutions to their customers.

3.2. Harmonization of DLMS/COSEM with other standards or on-going standards

The harmonization of DLMS/COSEM with IEC 61850 and with CIM is already in process, as those protocols are already standardised. For other protocols and data models that have been accepted for standardization but the process of which is still on-going, the gap “other-2” has been introduced by the ESO.

DSO Recommendation:

- Support the harmonisation process (IEC TC13/JWG16) for a direct mapping of DLMS/COSEM to CIM

3.3. Extended field data modelling standards (IEC 61850) to support demand response, DER and VPP

While the IEC 61850 standard was originally addressing applications and communications within the substation, recent work is being undertaken for extending its applicability to distribution automation applications integrating field devices located outside the substation fence. With its object oriented structure, IEC 61850 can provide comprehensive and accurate information models for various components of distribution automation systems, as well as an efficient solution for this naturally multi-vendor environment. Some typical applications include: Volt/Var Control (VVC), Fault Localisation, Isolation and Restoration (FLIR), Outage Management System (OMS), Distribution State Estimator, Distributed Generation and Demand response Management, Load Forecast and Modelling (LFM), and other.

IEC 61850 is the only international standard for substation automation which is open for future application. Currently IEC 61850 is extended for use outside substations. The use cases of the different distribution automation concepts need to be considered in the information data models. Therefore the IEC 61850 data models shall cover all distribution automation objects. IEC 61850 allows an open and flexible design and operation of communication networks. IEC 61850 not only provides a protocol for communication but is a whole new concept for naming and configuring substations and power grids.

The normative definition of logical nodes for DER is necessary for new smart grid appliances because process devices have to be described in such logical nodes for information exchange. Therefore it is important that current valid logical nodes in process protocols are not subject to change in the further standardisation process and to enable new devices to seamlessly comply with existing protocols without proprietary vendor solutions.

DSO Recommendation:

- Support IEC/TC57 (WG17 on Communications Systems for Distributed Energy Resources)
- Support IEC/TC38 and TC95 (in their product standards on fault detectors, V and I sensors, relay and protection equipment) and other product TCs involved in T&D equipment in view of developing appropriate interfaces for the smart grid.
- Promote the use of IEC 61850-7-420. This offers a method to describe the communication of DERs with the power system. It is consistent with the IEC 61850 framework (IEC 61400-25 should be used for wind power plants)

3.4. Harmonise smart grid interfaces with smart metering, building/home automation and EVs and demand response information

The information coming from smart metering can be used as input to building/home automation systems, either via a direct interface with the meter or via Internet. Charging poles for electric vehicles require also metering. In both cases, privacy and security issues must be considered.

The closing of those gaps must also handle the specific generic use cases to electric vehicles as:

- Only recharge possibility,
- EV demand response with price signals,
- Smart recharge (e.g. via a mobility service provider),
- New (mobile) billing systems and EV charge infrastructure management system.

DSO Recommendation

- The corresponding gaps for IEC 61851, IEC 61850/CIM and the existing and upcoming standards for revenue metering (IEC 62056 series, CLC/Fpr TS 50568-X, etc.) require further standardisation.
- Support work of IEC TC8/WG6 – Smart Grid requirements in the Distribution Grid Management, Smart Home/Building/Industry, Electric Transportation domains (DCT 2, 6 and 8)

3.5. Introduce the new role of DSOs in the CIM Market Model

DSO recommendation:

- Support extension of IEC 62325-351 – Framework for energy market communications – Part 351: CIM European Market Model Exchange Profile in order to give an active role to the DSO

4. OUTLOOK: FUTURE STANDARDISATION WORK

4.1. Work under M/490

By end 2012, both the European Commission as the CEN/CENELEC/ETSI Smart Grid Coordination Group agreed on the need to iterate the EC Mandate 490. Ideas circulated on further work built on the deliverables so far. Firstly, a further refinement of the methodology used under Mandate 490 is envisaged. Secondly, a set of consistent standards, by end 2014, that should complement the First set of Standards is foreseen. This work will include a prioritization of new gaps and an inclusion in the on-going work programme of M/490 by end of 2013. To complement the existing mandate the work of the Smart Gird Coordination Group will also include:

- A system interoperability testing method including conformance testing, "profiles" and "test use cases", should be provided by the end of 2013;

- A conformance testing map should be provided by the end of 2013. Conformance tests are tests to evaluate the adherence or 'non-adherence' of a candidate implementation to a standard, i.e, which provides to the user a guarantee that the considered implementation is not against the standard. Getting a conformance testing map will ensure that each selected standard (from the 1st set of standard) is provided with conformance testing tools and respective processes;

- An assessment of needed profiles (limiting implementation options given by the standards to achieve interoperability), should be provided by the end of 2014.

4.1.1. System operability testing method

DSOs will have to play a role of active system managers in order to integrate the rising share of distributed generation while maintaining security of supply and quality of service in their networks. When possible DSOs will procure under market-based conditions flexibility services and other services from suppliers who have entered into contracts with customers with the objective to change under commercial terms and via appropriate tools (smart meters, ripple control application, etc.) the off-take of these contracted customers.

4.1.2. Conformance testing map

When talking about standardisation, conformance testing is a logical step. Standards generally cover the technical requirements in order to fulfil demands and expectations in different areas like functional requirements, safety, interoperability, etc. The evaluation of the conformity is only possible if these technical requirements are covered with test methods and evaluation criteria. For each of the standards dealt with under Mandate 490, the conformance testing map should identify the gaps in test methods and evaluation criteria needed for a correct evaluation of the conformity. It is clear, that the priorities to fill up the gaps should be aligned with the priorities as identified in the overview table of chapter III. An illustrative example for connecting decentralised generation is developed in Annex I.

4.2. Work under IEC TC8/ WG5 and WG6

In October 2012, the IEC TC8/WG5 “Methodology and Tools” and WG6 “Generic Smart Grid Requirements”, have been created to replace the previous TC8/AHG4 in order to give a clear working structure to establish the methodology to describe the complexity of the Smart Grid and to define the use cases and the associated generic Smart Grid requirements.

The general objective of the work on use cases is to gather requirements of functionalities in a structured way according to the scenarios and technical architectures. Today, the Standards Bodies and the Smart Grid community agreed on the fact that use case methodology (i.e. IEC PAS 62559) is the best candidate for the description of a complex system like the smart grid. Using this method, the DSO ensures a complete compatibility with both normalisation and EU-work in a comprehensive manner.

Based on the collected use cases existing at international level and at European level through the mandate M/490 – Smart Grid (CEN/CENELEC/ETSI), a detailed description and a global consolidation between the different domains must be realised. Then, standards can then be analysed, if they are supporting these functionalities (use cases) or if further developments of standards to close identified gaps have to be initiated.

DSO Recommendation:
- Support work of TC8/WG5 and TC8/WG6
- Nominate DSO experts to the TC8/WG6

IV. Standards List

Standard	Description	Responsible TC
EN 50438	Requirements for the connection of micro-generators in parallel with public low-voltage distribution networks. This European Standard specifies technical requirements for connection and operation of fixed installed micro-generators and their protection devices, irrespective of the micro-generators primary source of energy, in parallel with public low-voltage distribution networks, where micro-generation refers to equipment rated up to and including 16 A per phase, single or multi-phase 230/400 V or multi-phase 230 V (phase-to-phase voltage). This European Standard is intended for installation mainly in the domestic market.	CLC TC8X
IEC 60255	Measuring relays and protection equipment	IEC TC 95
IEC 60870	Telecontrol equipment and systems	IEC TC57
IEC 61000	Electromagnetic compatibility (EMC)	IEC TC77 CISPR
IEC 61334	Distribution automation using distribution line carrier systems	IEC TC57
IEC 61850	Communication networks and systems in substations	IEC TC57
IEC 61851	Electric vehicle conductive charging system	IEC TC 69
IEC 61968	Distribution Management, System Interface for Distribution Management Systems (CIM for distribution)	IEC TC57
IEC 61970	Energy management, application level energy management system interface, Core CIM	IEC TC57
IEC 62056	COSEM	IEC TC13
IEC 62325	Framework for energy market communication	IEC TC57
IEC 62325	Framework for energy market communications	IEC TC57
IEC 62351	Security around IEC 60870-5 series, IEC 60870-6 series, IEC 61850 series, IEC 61970 series & IEC 61968 series. The different security objectives include authentication of data transfer through digital signatures, ensuring only authenticated access, prevention of eavesdropping, prevention of playback and spoofing, and intrusion detection.	IEC TC57
IEC 62357	Power system control and associated communications - Reference architecture for object models, services and protocols	IEC TC57
IEC 62689	Current and Voltage sensors or detectors, to be used for fault passage indication purpose	IEC TC 38
IEC 62786-2	Domain Side Energy Source Interconnection with the Grid. It mainly includes general requirements, power quality issues, power control, voltage regulation, response characteristic of voltage and frequency, maximum current of short circuit, safety and relay protection, communication and information exchange, metering, operation and testing	IEC TC8
ISO/IEC 15118	Road vehicles -- Vehicle to grid communication interface	ISO TC22
prTS 50549-1	Requirements for the connection of generators above 16 A per phase - Part 1: Connection to the LV distribution system	CLC TC8X
prTS 50549-2	Requirements for the connection of generators above 16 A per phase - Part 2: Connection to the MV distribution system	CLC TC8X

V. Glossary

ACSI	Abstract Communication Service Interface" defined in IEC 61850-7-2	IED	Intelligent Electronic Device
AMI	Advanced Metering Infrastructure	OMS	Outage Management System
CIM	Common Information Model	OSGP	Open Smart Grid Protocol
CISPR	Special international committee on radio interference *(Comité International Spécial des Perturbations Radioélectrique)*	PLC	Power Line Communication
CLC	CENELEC – European electrotechnical committee	PLT	Power Line Transmissions
COSEM	Companion Specification for Energy Metering	RfG	Requirements for Generators (ENTSO-E Network Codes)
DER	Distributed Generation and Demand response Management	RTU	Remote Terminal Unit
DES	Distribution State Estimator	SCADA	supervisory control and data acquisition
DLMS	Device Language Message Specification	TC	Technical Committee
DMS	Distribution management systems	VPP	Virtual Power Plant
DSO	Distribution System Operator	VVC	Volt/Var Control
EMC	Electro-Magnetic Compatibility		
EMS	Energy Management Systems		
ENTSO-E	European Network of Transmission System Operators		
EUTC	European Utilities Telcom Council		
EV	Electric Vehicle		
FDIR	Fault Detection, Isolation and Restoration		
HAN	Home Area Networks		
HV	High Voltage		
IEC	International Electro -technical Committee		
LFM	Load Forecast and Modelling		
LV	Low Voltage		
MV	Medium Voltage		

VI. ANNEX I: Illustrative example of conformity testing for connecting decentralised generation.

Connection of decentralised generation" as discussed in chapter 2.1. is being developed.

Functional requirements

Decentralised generation has an important impact on system operation and even, due to their important share, on overall system stability. Therefore, they must behave in well-defined way in certain circumstances which one can call the functional requirements.

Technical requirements

When we translate these functional requirements into exact figures, we get a set of technical requirements generating units have to respect when working in parallel with a distribution grid. Although they are not in a final state yet, these technical requirements are already quite developed considering the evolution of EN50438 and TS50549-1 and -2.

Test methods and evaluation criteria

Actually clear test methods and evaluation criteria for the technical requirements discussed here above are missing. For decentralised generation, a two-step approach is needed. The first step should be the identification of the technical requirements that need to be tested and a general approach how to do so. If needed, the second step should be the translation of this approach into the specific technical domain of the generating unit technology.

Conformance

Conformance evaluation is essential for the good functioning of the distribution system because this is the best (and only) assurance that the generating unit shall behave in line with the functional requirements. This is even more important because of the fact that the DNO has, for most of them, no direct impact on the generating units and that the circumstances for which a specific behaviour is requested might appear very seldom.

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