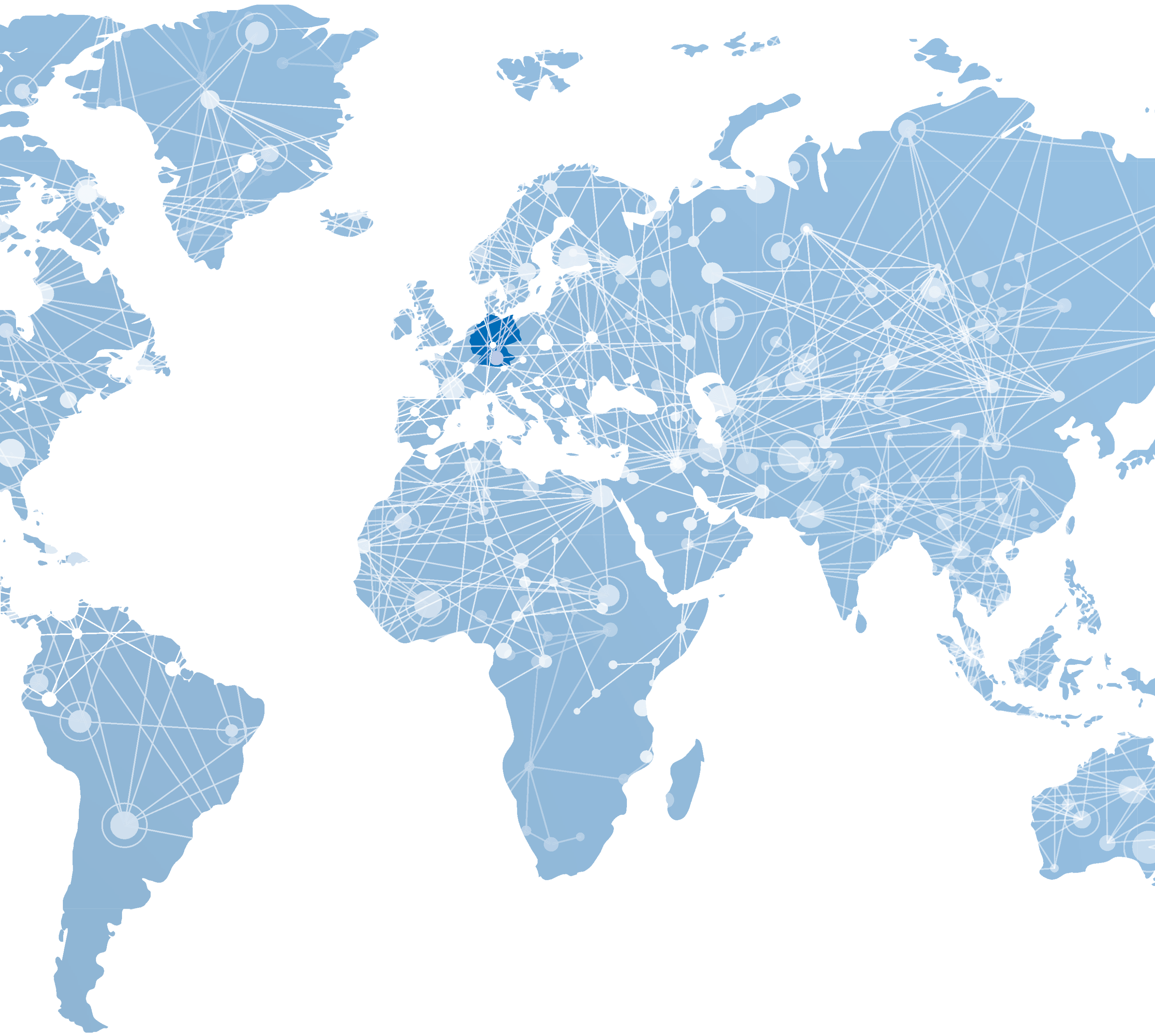
THE GERMAN ROADMAP E-ENERGY / SMART GRIDS 2.0

SMART GRID STANDARDIZATION STATUS, TRENDS AND PROSPECTS



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Foreword

by Dr. Philipp Rösler
Federal Minister of Economics and Technology
Germany's E-Energy/Smart Grids Standardization Roadmap 2.0

The restructuring of Germany's energy supply has significantly accelerated in recent times, with rapid expansion taking place in photovoltaic and wind power facilities in particular. The electricity generated in this way is primarily fed into the grid at local level, leading to completely new load flows and creating major challenges for the electricity network operators concerned. Intelligent, ICT-based control of local networks can make an important contribution to tackling this important issue. It is therefore of special importance to me that we resolutely press ahead with fundamental research in this field. Sponsored by the Federal Ministry of Economics and Technology, and in co-operation with the Federal Ministry for the Environment, Nature Conservation and Nuclear Safety, this research has been conducted across several model regions, in which corresponding methods have been tested under real conditions. Such investigation allows both the integration of technology as well as acceptance by the public to be put to the test. I eagerly await the results, which are anticipated by my experts in early 2013.

The Expertise Centre for E-Energy/Smart Grid Standardization demonstrates exactly how the findings from projects like these can be sustainably exploited and translated into technological advantage. The Centre acts as the bridge between research and practical application, whereby the findings are converted into standards and commercialized. New business models can then be developed on the basis of these standards. The process comes full circle when it serves as a catalyst for further ideas and innovations which increase our economic and technological competitiveness.

The second version of the German E-Energy/Smart Grids Standardization Roadmap not only presents the developments in the field of intelligent networks, but also illustrates potential next steps. I am especially pleased that it has been possible to incorporate contributions from accompanying research, the e-energy projects, and also the Expertise Centre for E-Energy/Smart Grid Standardization. All the ideas will now flow into the network platform at the Federal Ministry of Economics and Technology. The Ministry will come together with representatives from the energy industry, the ICT sector and consumer interests to flesh out the future timetable for the establishment and expansion of smart grids in 2013. Standardization can also make a fundamental contribution in this regard. This E-Energy/Smart Grids Standardization Roadmap will provide an excellent basis for this.

Sincerely yours,

Preface

"Power just comes out of the socket" with practically infinite availability, constant quality and a reliable level of safety. These properties of electrical energy have to date been undisputed requirements which have been followed in the design and operation of electrical systems. The energy turnaround, as voices in the media, politics and science warn, will fundamentally change that scenario. The (so-called) renewables, wind and solar radiation are volatile, while the efficient storage facilities required to meet demand are only likely to be technologically and commercially feasible in the medium term. Biomass, used as a source of energy, can of course be easily stored, but is part of the field of tension between "tables, troughs and tanks". The current global failure of the maize crop and the growing use of biofuel are already being seen to have the effect of worldwide price increases for grain of all kinds, and even affecting the food situation in Africa.

The increasing loss of sufficiently efficient and rapidly deployable storage facilities in the electricity grid, caused among other factors by the deactivation of nuclear power plants, has a significant effect on grid stability. The flywheel masses of the large conventional power plant units with capacities of around 1,000 MW provide ideal energy storage to compensate for short-term network disturbances or peak loads. Such flywheel masses can prospectively only be replaced by new technologies on the generation side and by Smart Grid applications. The energy turnaround, and in its wake the Smart Grid, constitute a departure from the conventional one-way street of electrical energy between a few producers and a host of consumers through the strictly hierarchical network structure linking them. If the use of electrical energy to date has been decentralized, but fundamentally structured as a distribution tree, then the present energy turnaround is bringing about a graphene structure with the additional decentralization of generation (e.g. photovoltaics and wind) and the alternative of local use of the locally generated electrical power. It is evident that the management of such a densely meshed graphene will be much more complex than the management of a traditional distribution tree. In other words, people have been familiar with hierarchies since prehistoric times. Mastering flat, meshed structures is more difficult for them. The systematic influencing of energy users provided for in the Smart Grid leads to an indispensable, system-critical role of information processing as a means of system management. Producers and users of the electrical energy in a Smart Grid must be able to communicate with one another, and that, if possible, via a public network such as the internet. The questions this raises, of the interfaces, data protection or reaction in real time, have to be resolved. However, a change on the consumer side is looming, as shown by improved methods of construction, sophisticated systems and alternative energy sources in buildings and households. Less overdimensioned, more energy-efficient installations reduce the opportunity to make flexibilities such as load reductions or load shifts available without sacrificing convenience. Against this background in particular, the experts in the E-Energy projects* see a necessity to connect automated energy management on the user side indirectly with the energy market. Cumulative flexibilities can then be exploited for the benefit of the customers and the energy market, and also for network management.

Standardization plays a major role in the planning, construction and operation of such new energy and information structures. Existing standards and specifications from a range of highly divergent fields of technology have to be brought together, examined for compatibility and applied in an interdisciplinary manner. New market requirements are creating new functionalities and interfaces, which will lead to new standards and specifications. This applies not least to the field of ergonomics, which has to provide professionals and laymen equally as system users, with access to the optimization functions. In this Roadmap, the Use Cases method plays an important role in the human task of specifying functions and interfaces. Together with various description templates for the standardization committees, structured filing and search functions for Use Cases are provided in an online database. This method has already passed initial trials in the international exchange of information between the standardization committees and assists in achieving the objective of creating a sound basis for the establishment and expansion of Smart Grids by international standardization. This is also a substantial European concern, as the European energy network links highly different energy markets and energy laws. International standardization of Smart Grids across the board ensures uniform and broadly based procedures, products and interfaces.

I should like to thank all the technical experts involved within and outside the standardization committees most sincerely for their commitment, and hope that their active support will continue. Cooperation between professionals from different industries and disciplines – especially in connection with science and research, and in the E-Energy projects – is extraordinarily important, particularly in the context of this complex and wide-ranging issue.

Yours,
Wolfgang Hofheinz
Chairman of DKE

* E-Energy Project, Link: http://www.e-energy.de/

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Preface to the English Edition

This second edition of the German Standardization Roadmap on E-Energy / Smart Grids was published on the occasion of the VDE "Smart Grid" Congress on 5 and 6 November 2012.

This new edition has several objectives:

- Chapter 1 presents an overview of current developments. This serves to provide the various national committees with information on the work of the others, and also to describe and link up with the European and international standardization activities. In addition, it is intended to provide outsiders with an insight into the various evolutionary developments.
- The further chapters explore topics initially addressed in the first Standardization Roadmap and are fundamentally based on the work of the European Smart Grid Coordination Group (SG-CG), which is supported and followed with great interest by the national committees. The reports from SG-CG have in the meantime been published on the CEN-CENELEC website[1].
- Chapter 2 of this document in particular can be regarded as an introduction to the work of SG-CG. It presents the topics of Use Cases, the Use Case Management Repository, smart grid reference architecture and the links with standardization.
- Proceeding from the work performed by SG-CG, chapter 3 examines the further steps to be taken on the way towards comprehensive interoperability. Standardization profiles, which could become necessary on the national level in particular, are proposed as one possibility here. This topic is however now also on the agenda for iteration by SG-CG on the European level.
- Chapter 4 deals with information security in smart grids, and, similarly to chapter 2, summarizes the work of SG-CG.
- Chapter 5 presents a number of example Use Cases which are currently under discussion or describe visions of the future to illustrate possible implementations of the methods previously described.
- In chapter 6, "Prospects", attention is drawn to the desired increasing importance of international standardization in the field of smart grids and the significance of the jointly developed methodology, and the next steps in development are outlined.

[1] http://www.cencenelec.eu/standards/HotTopics/SmartGrids/Pages/default.aspx

Executive Summary

Supply of energy to customers continues to be a major topic on the political agenda. The transition to a new energy era now initiated in Germany is intended to achieve a wide range of objectives, such as cost-effectiveness, security of supply, climate protection and the switchover to renewable energy sources, at the same time. In that context, the Smart Grid, the combination of power engineering with information and communications technology (ICT), plays a decisive role. Standardization, in turn, is a necessary condition for its technical implementation, and for the security of investments in this area. The Standardization Roadmap 1.0 not only described the status quo in the relevant fields, but also clearly pointed out the special aspects of smart grid standardization.[2] These include the large number of actors and of regional and international activities, and the enormous speed of development. Many of these special issues have in the meantime been addressed by the work of the E-Energy/Smart Grid Expertise Centre for Standardization within DKE, the German Commission for Electrical, Electronic & Information Technologies of DIN and VDE. The fundamental results and progress made are to be presented in this Standardization Roadmap 2.0. It must be emphasized that, in connection with the standardization activities in the field of smart grids in recent years, a new approach to standardization itself has been established, taking account of the variety of challenges in complex systems. An essential characteristic of this new approach is the integration of extremely divergent fields and the corresponding professional groups. This is achieved by orienting the activities towards the desired or required services which the smart grid as a complex system is to provide. On the basis of these services or functions, the opportunities for implementation are examined with the aid of a generic model (Smart Grid Architecture Model – SGAM). By describing the services and adding details in Use Cases on the levels of function, information, communication and components, conditions are established for the various standardization committees involved to work together on a common objective – the implementation of the desired services and functions. This procedure not only ensures that standardization work is coherent, but also provides the necessary basis for common understanding and the achievement of consensus between all the parties. In addition, it has been possible to extend collection of the basic services and functions well beyond the established group of participants in standardization. All interested parties can take part and assist in the fundamentals of standardization through publicly accessible Web 2.0 portals.[3]

A View of the Future

This Roadmap 2.0 focuses on the description of the methodology outlined above in Section 2, and of the most important Use Cases in Section 3.

[2] Link to the English version of the Standardization Roadmap E-Energy/Smart Grid 1.0: http://www.vde.com/en/dke/InfoCenter/Pages/InfoCenter-Details.aspx?eslShopItemID=57c0fd81-98e6-4db9-9414-aa279dd218fa

[3] UCMR Use Case Management Repository, Read-only access to the UCMR: https://usecases.dke.de/sandbox/, Access: LookatMe, Password: LookatMe

The standardization activities are explicitly prioritized by the stipulation of these Use Cases. In this sense, the list of Use Cases represents a roadmap for standardization work in the coming years, and will be supplemented and updated repeatedly in the further process.

The methods developed here are already being used today in relatively complex problems. These always concern the joint processing of issues such as the definition of requirements for uses, the reduction of complexity, the achievement of a common understanding and the reaching of consensus, i.e. the foundations of standardization itself. There have been initial implementations, for example, in the fields of e-mobility, ambient assisted living (AAL) and the smart home. On the European and international levels, too, the German work has met with a great response. Consequently, both the activities on implementation of the EU Commission's smart grid standardization mandate M/490 and the activities on the IEC level are following the methodology described above.

The efforts towards regulation taking place on both national and regional levels represent a special challenge. In contrast to the tried and tested, so-called New Approach[4], these are not limited to the fundamental definition of essential requirements, but instead go into detail. The proven approach of leaving the formulation of technical details to the established standardization committees is recommended here. The procedure described above can ensure that there is a basis for consensus even among extremely different stakeholders.

The results presented in this Roadmap 2.0 bear witness to an enormous success of the German activities, which have successfully contributed a number of ideas to the European and international work. In return, the national committee work has been enriched by the discussions and exchange of ideas on those levels. But especially today, the parties involved are increasingly dependent on cooperation from industry, politicians and the public at large. The work which has commenced has to go into greater detail, and be implemented in existing committees. It is still the case that a great many of the necessary standards already exist. There are internationally recognized standards in the fields of power, industrial and building automation. These have to be observed, used and publicized accordingly. For the implementation of the remaining objectives, increased cooperation on the national and international levels is required. German companies should therefore make a more intensive contribution to German, European and international standardization.

At the start of this Roadmap, current developments in connection with smart grids are summarized in the form of a report: background conditions, the national, European and international committee work and, in brief, the tie-in with related issues. Reporting can only take the form of an overview in this document. More extensive interest will require consultation of the referenced documents and the committees themselves. As the activities performed have been many and various, it was considered helpful to provide that overview, which however makes no claim to completeness.

4 On the European level, the New Approach has established a successful interplay between standardization and legislation, with the legislature setting down requirements in Directives which are implemented by means of European standards. The New Approach was modified by the New Legislative Framework (NLF).

1. Background Conditions, Status of Committee Work and Networks

The new issue 2.0 of the German Standardization Roadmap for “E-Energy / Smart Grids” from DKE, with its new structure, reflects the changes and the variety of developments which have taken place in recent times. Increasing complexity is only part of the changes. The fields in which actions were previously totally individual and cooperation is now in place are more clearly defined. The players on this newly defined pitch have not only reflected on their roles and their possible interactions, but have also developed rules and tools ranging up to architectural models which have sufficient flexibility to remain up to date even for several years. It became clear in the development of the Roadmap 2.0 that mere updating would not be sufficient. This new version of the Roadmap does not, therefore, replace the old version, but rather builds upon it and develops its subject matter. Closely following the work on the European level, the focus is on the description of processes, using Use Cases and reference architectures as tools for modelling of complex relationships.

Attention was already drawn to the importance of Use Cases and their methodological classification in version 1.0. A variety of activities picked up on the experts’ requirements: Standardization Mandate M/490 demanded work on Use Case management, which was implemented by the Smart Grid Coordination Group, building upon previous work in the DKE committees. DKE, together with partners in a project, developed an online tool for description of Use Cases in standardization committees. The classification of Use Cases to describe applications and requirements has already been successfully used by the Smart Meter Coordination Group[5] in the extensively completed standardization mandate M/441.

The importance attached by the experts to Use Cases, not only for the topic of the smart grid, is correspondingly reflected in this version 2.0 of the Roadmap. In that context, the new edition is oriented towards the current developments relevant to standardization on the national and international levels, and also touches upon peripheral areas, for instance the influence of legislative regulation on standardization.

The recommendations of Standardization Roadmap 1.0 and the Status Report which has in the meantime been published have been subjected to a critical review by the Steering Committee of the Expertise Centre. The recommendations were prioritized there according to opportunities and risks in standardization and according to their influence on the business processes. As the recommendations are continuously updated, the present status can be seen in detail in the internet (see Appendix).

The synoptical table of standards and studies in the Appendix has also been taken from the first version of the Roadmap and updated. The Appendix also lists studies and research projects in the field of smart grids with relevance to standardization.

5 Smart Meter Coordination Group, M/441, Link: http://www.cen.eu/cen/Sectors/Sectors/Smartmetering/Pages/default.aspx

1.1 Political Background Conditions

Over two years have now passed since the compilation of the first German Standardization Roadmap on "E-Energy / Smart Grid" in the spring of 2010. In that time, not only has progress been made with the E-Energy projects in six model regions as part of a large-scale sponsorship programme by the Federal Ministry of Economics and Technology in cooperation with the Federal Ministry for the Environment, Nature Conservation and Nuclear Safety, but the external conditions imposed by national and European regulations have also changed. Not least the effects of the incident at the Fukushima nuclear power plant in Japan are also of significance in Germany. They led, as recommended in the moratorium, to the immediate shutdown of eight of the 17 German nuclear power plants, and thus to a loss of generating capacity in Germany. The important changes and additional requirements are briefly considered below.

The resolved phasing-out of nuclear energy within the next just under ten years, which is already in progress, and the further foreseeable extensive construction of generation facilities using renewable and for the most part volatile energy sources, and increasingly widespread electricity trading, are leading to growing demands on the transmission networks and, to an increasing extent, on the distribution networks. The resolved energy turnaround will therefore also have significant effects on the electricity networks; smart grid solutions thus gain in importance.

One particular challenge results from the fact that the energy networks are by nature capacity-critical resources, whose costs, then, are determined by the capacity made available. The earnings models and price structures in place today, however, predominantly provide for volume-based fees. Passing on of the costs of the energy turnaround on the basis of simple kWh prices then reaches its limits. Politicians are talking of a "smart market", which has to be made possible by intelligent functions of the technology on which it is based, represented in "smart Use Cases". This is intended to bring about a flexibilization of the energy market and create new opportunities for network management. Furthermore, coordination between the two areas of the market and the grid is to become possible.

European Initiatives

1. Third Package for Electricity and Gas Markets

The 3rd package on the internal market for energy, which has been implemented in legislation by the member states, stipulated a number of fundamental changes in energy policy. The main measures to be taken are as follows:

- Smooth functioning of the market to create a competitive internal energy market.
- Harmonization of powers and strengthening the independence of the national regulatory authorities.
- Promotion of coordinated planning for network expansion throughout Europe (security of supply).
- Separation of supply and generation from operation of the networks (Unbundling).
- Establishment of a European Agency (ACER).
- Formalizing cooperation between network operators: Creation of greater transparency on the energy market (ENTSO-E, ENTSO-G).
- Opportunity to issue legally binding network codes and guidelines for cross-border network issues.
- Strengthening of consumer rights.

2. EU Commission's Smart Grids Task Force[6]

In addition to Standardization Mandate M/490, the European Commission has commissioned further work on the subject of smart grids.[7] Under a high level Steering Committee, four Expert Groups (EGs), have been formed:

- EG 1: Reference Group for Smart Grid Standards
- EG 2: Regulatory Recommendations for Data Privacy and Data Protection in the Smart Grid Environment
- EG 3: Regulatory Recommendations for Smart Grids Deployment
- EG 4: Smart Grid Infrastructure Deployment
  The aim is to compile coordinated regulatory recommendations and identify projects with which uniform, cost-effective, efficient and fair implementation of smart grids throughout the European Union can be ensured. The reference group for standardization (EG 1) also tracks the work of the Smart Grid Coordination Group responsible for M/490.

3. ENTSO-E[8]

In the context of the European Union's Directives in the third legislative package on the gas and electricity markets, there is provision for the development of EU-wide, uniform and binding regulations, so-called "network codes" for the internal electricity market. Accordingly, various network codes are to be compiled by 2014, with the aim of ensuring safe and efficient network operation for the establishment of a single European electricity market. Those codes are to be declared binding upon all EU member states by the EU Commission, and present uniform requirements for issues such as network security, bottleneck management, uniform transparency rules and harmonized transmission fee structures.

The two European institutions ACER and ENTSO-E are the major players involved in compilation of the network codes. ENTSO-E is the European Network of Transmission System Operators for Electricity, and ACER is the Agency for the Cooperation of Energy Regulators in Europe. ENTSO-E is responsible for compilation of the relevant network codes on the basis of the Framework Guidelines issued by ACER and defined for various areas by the European Commission. It is important for the requirements compiled by ENTSO-E on the European level and anchored in the work of the European Commission to harmonize well with established standards and the national regulations, both existing and in progress, in Germany.

The process of establishing and adopting the European network codes[9] is a long, drawn-out one. Amendments to individual technical stipulations in the network code currently tantamount to a European legislative process. There is as yet no provision for a process which permits short-term adjustment or modification of the stipulations.

Recommendation:

From the point of view of standardization, therefore, attention is drawn as above to the established and proven methods of the New Approach. Accordingly, only fundamental requirements should be defined in legislative documents and their details specified by the professional groups involved in the form of standards.

[6] EU Commission's Smart Grids Task Force, Link: http://ec.europa.eu/energy/gas_electricity/smartgrids/taskforce_en.htm/

[7] Smart Grid Coordination Group, M/490, Link: http://www.cen.eu/cen/Sectors/Sectors/UtilitiesAndEnergy/SmartGrids/Pages/default.aspx/

[8] ENTSO-E, Link: http://www.entsoe.eu/

[9] European network codes: www.vde.com/de/fnn/arbeitsgebiete/seiten/netzcodes.aspx/

German Initiatives

4. Energy Industry Act (EnWG), 2012 Amendment[10]

The current revision of the Energy Industry Act stems from the mandatory requirements of the third legislative package on the internal energy market. National implementation in Germany took place with the Act to Amend the Energy Industry Act, which was announced in the Federal Law Gazette on 03 August 2011 and has been in force since 04 August 2011. The amendment to the Act focuses on the following:

- Certification and nomination of transmission system operators.
- Extensive unbundling of the network operator function from other functions of an integrated energy supplier.
- Unbundling of storage facility operators and access to storage facilities.
- Separate branding of distribution system operators.
- Establishment of network development plans and approval by the regulatory authority.
- Obligatory installation of smart metering systems for defined end customers.
- Recording of actual energy consumption and actual time of use of electrical energy.
- Deregulation of metering: Optional installation and operation of metering points by third parties.
- Metering systems must comply with the calibration regulations and the BSI protection profile.
- Consumer protection.
- Reduced bureaucracy.

[10] Law on Electricity and Gas Supply (Energy Industry Act EnWG), Link: http://www.gesetze-im-internet.de/enwg_2005/

5. Renewable Energies Act (EEG)[11]

In June 2011, the German Parliament passed a reorganization of the legal framework for promotion of electricity generation from renewable energy sources. The Renewable Energies Act is oriented towards the following guidelines:

- Dynamically pressing ahead with the expansion of renewables.
- Increasing cost-effectiveness.
- Promoting market, network and system integration.
- Adhering to the established basic principles of the Renewable Energies Act (especially priority feed-in for renewables and statutory feed-in remuneration).

In detail, the following premises, among others, were adopted in the amendment to the Renewable Energies Act:

- With an optional market premium, operators of renewables facilities are provided with an incentive to operate their systems in a market-oriented manner.
- A “flexibility bonus” systematically promotes investments in the ability of biogas plants to generate electricity in response to market demands.
- Development of storage is assisted by the exemption of storage facilities from network fees and an inter-agency research programme into storage, including demonstration systems.
- The integration of photovoltaic (PV) systems in the grid is a further priority:
  - ➢ With a view to the 50.2 Hz problem (risk of large-scale blackouts caused by automatic shutdown of PV systems if the network frequency rises to 50.2 Hz), authority to legislate for retrofitting of existing systems has been incorporated in the Energy Industry Act.

[11] Renewable Energies Act (EEG), Link: http://bundesrecht.juris.de/eeg_2009/index.html/

- PV systems are included in feed-in management, and will therefore in future be able to have their output reduced in the case of network overload, as with all other renewables facilities, with compensation paid. A simplified feed-in management system is introduced for systems with a capacity of up to 100 kW, providing for technical facilities to reduce output but without any obligation to transmit data. Existing systems with an installed capacity of over 30 kW, taken into service on or after 01 January 2009, must be retrofitted with technical facilities for reducing output within two years.
- As an alternative for small PV systems, the feed-in power at the network connection point can be limited to 70 % so as to "cap" the very rare power peaks. As a rule, this only reduces the amount of electricity by around 2 %, but significantly reduces the stress on the network and reduces the need for network expansion.

6. "Future-Oriented Grids" Platform and "Smart Grids and Meters" Working Group

Important topics on the development of the electricity networks are addressed together with the various stakeholders in the platform established by the Federal Ministry of Economics and Technology (BMWi)[12]. The technical aspects of this wide-ranging issue are dealt with in various working groups. In connection with smart grids, the working group on "Smart Grids and Meters" is worthy of special mention.

7. Smart Meter Gateway[13]

For the introduction of so-called smart meters, the Federal Office for Information Security (BSI) is developing a technical directive on the basis of protection profiles according to common criteria for the use of secure smart meter gateways. Amendments to the legal framework have already been incorporated in the Energy Industry Act, and further adjustments are to follow in an Ordinance to that Act.

1.2 "E-Energy – ICT-based Energy System of the Future" Funding Project

With regard to protection of the climate and the environment, Germany has taken the fundamental political decision to cover its energy demand increasingly from renewable energy sources in future. The associated distribution and volatility of power generation presents a great challenge to network stability. In order to preserve a high degree of security of supply in future, the use of information and communications technology (ICT) will play a key role in the further conversion work leading to a smart grid.

Together with the legislative initiatives described above, the German Federal Government launched the "E-Energy – ICT-based energy system of the future" funding programme as early as 2008. Up to 2013, industrial and scientific consortiums will examine and test the fundamental elements of an intelligent power supply system using renewable energy sources in various scenarios in six model regions. In the holistic research approach consciously selected by E-Energy, which, in contrast to many other projects takes account of all areas of power supply (generation, transmission, storage and consumption), the model projects with accompanying research covering all of them are to clarify what is currently technically feasible with ICT, and what appears commercially

[12] Federal Ministry of Economics and Technology, Link: http://www.bmwi.de/DE/Themen/Energie/Stromnetze/plattform-zukunftsfaehige-energienetze.html/

[13] Link zur BSI: https://www.bsi.bund.de/DE/Themen/SmartMeter/Schutzprofil_Gateway/schutzprofil_smart_meter_gateway_node.html/

appropriate in a preferably deregulated market environment. All six E-Energy projects focus on the ICT-optimized operation of the distribution networks (distribution network automation):

- Networking of end-users in their future role as "prosumers", i.e. as flexible consumers and increasingly also as distributed producers.
- Development of new electronic marketplaces and trading platforms.
- Development of new use scenarios, business models and strategies to gain customer acceptance.

In the E-DeMa research project[14], practical ICT solutions for intelligent generation and consumption management are being developed on the basis of a regional energy marketplace in the form of a data hub. In this field test, around 1,500 households and business establishments are connected via ICT gateways to the electronic E-DeMa marketplace. In this way, it is possible to implement business models which facilitate, on the one hand, the combination of small, distributed generating facilities on the basis of micro-CHP units, deployed in response to costs, with postponable loads such as household appliances (each aggregated into flexible units) and, on the other hand, decentralized distribution networks with optimum network management.

In the Cuxhaven area, a complex closed loop control system is being developed in the eTelligence project to balance out the fluctuations in wind energy by smart feed-in to the networks and integration in a regional marketplace. With the cold storage houses warehouses and combined heat and power plants connected to the marketplace, eTelligence has demonstrated in field tests that thermo-electric power systems are well suited for energy storage and can be operated economically even with a large proportion of renewables energy at a corresponding forecast quality (volatility).

In the MeRegio project, 1,000 electricity customers are testing the "smart home", in which the focus is on efficient energy use by the consumer, taking account of in-house generation and available potential for local load shifting in the form of smart household appliances and stationary batteries. With the use of control boxes, control and price signals from a regional market platform are evaluated. Together with cost optimization for in-house consumption, this also facilitates automatic demand side management, so as to prevent critical network conditions from occurring. A certification strategy developed by MeRegio for a "minimum emission" region is also to make the effectiveness of regional climate protection and energy efficiency measures visible to the population and comparable with other regions.

In the form of the "Energy Butler", the Model City of Mannheim (moma) project has also developed an energy management gateway and used it in field tests. Via the link to a market platform, this enables customers to have generation facilities and appliances in the household automatically controlled in accordance with their instructions so as to optimize costs. Network requirements are also included in the optimization process. In the moma project, an innovative overall architecture for a cell-type energy system has been developed, and implemented as a model in the E-Energy funding programme. With a focus on "security by design", it is ensured that a failure in one object or network cell does not necessarily impair the system as a whole. A CORE platform conditions the status information from the individual object and network cells for network management, and transmits the data to the network control centre. In

[14] E-DeMa stands for Development and Demonstration of Locally Networked Energy Systems to the E-Energy Marketplace of the Future, Link: http://www.e-dema.de/en/

addition, the CORE platform links the local market mechanisms with the higher level energy markets. This architectural approach to a service-oriented ICT solution and the examination in the E-Energy programme of its suitability for use in normal operation are meeting with increasing recognition in professional circles in connection with ensuring future security of supply and reducing complexity in the control of the system as a whole.

In the RegModHarz (Renewables Model Region Harz) project, the question is being pursued of how renewables generation and flexibility from a rural region grouped together to form a virtual power plant can be marketed in bundled form on various markets. An addition to the IEC 61850 series of standards has been developed for the simple and safe connection of distributed facilities. The use of an innovative tariff for regional electricity generated from renewable energy sources only, aimed at minimizing the residual load within the region, is to enable customer households fitted with a BEMI controller to take an active part with optimized costs in the balancing of generation and consumption.

The Smart Watts project develops ICT solutions and strategies for intelligent supply management. The aim is to develop existing smart metering solutions leading towards a modular, interoperable energy meter system. The Smart Watts concept is supported by incentive-based load and generation management using a smart meter gateway in conjunction with smart home gateways as the interface in the customers' households. For networking of the household, the open EEBus specification[15] was developed, permitting non-proprietary control of household appliances for load management. EEBus is based on existing communications standards and provides a technologically neutral interface. A first draft of the open interface standard is prospectively to be published at the end of 2012 as prEN 50491-12. Together with Smart Watts, other model regions have also contributed to the EEBus interface. With involvement by DKE, the EEBus Initiative in the form of a nonprofit association started in early 2012 to define the standardization requirements for the interfaces on the basis of the E-Energy field tests and the work of the STD_1911 focus groups. Joint initiatives with the existing communications protocol organizations (e.g. KNX Consortium, BacNet and ZigBee) increase sustainability. EEBus is now being discussed in IEC committees, and has good prospects of achieving its objective.

In the context of E-Energy, the open software platform OGEMA[16] has also been developed for use in energy management gateways, as a widespread software specification based on Java and OSGi supporting uniform applications development independently of the hardware and accordingly providing a modular implementation environment for the integration of a wide range of protocols and ensurance of device interoperability. OGEMA permits the incorporation of various communications systems, including for example EEBus. In the ICT gateways used in the moma and RegModHarz projects, OGEMA is used as the "operating system for energy management", and is currently being evaluated in field tests. For dissemination and propagation of the idea, the OGEMA Framework originally developed by Fraunhofer IWES was spun off in 2010 to the eponymous Open Gateway Energy Management Alliance, where the further development is being coordinated.

A broad range of communications standards and specifications, such as DSL, Ethernet cable, glass fibre, M-bus, broadband Powerline

[15] EEBus, Link: http://www.eebus.de/

[16] OGEMA, Link: http://www.ogema.org/

(BPL/PLC), GPRS/GSM and WLAN, is in use in the E-Energy projects. The dominant form of transmission for the connection of private households is DSL via the telephone network, on account of its widespread availability. Further frequently used transmission alternatives which use existing communications infrastructure and promise better applicability of the E-Energy concept to other countries, are BPL/PLC via the electricity network and GPRS/GSM for wireless transmission.

Among the communications protocols used in E-Energy, TCP/IP dominates as the network protocol, facilitating the interoperable connection of smart grid components with networkable household and telecommunications technology. Communication with distributed systems is based on standards of the IEC 61850 series. Different technology mappings are used under the umbrella of IEC 61850-7-420, such as the Manufacturing Message Specification (MMS) in the eTelligence project, and web services to IEC 61400-25 in RegModHarz. In the field of building automation in the E-Energy projects, international standardized protocols (such as BACnet, LON and KNX) are given preference, and, together with other established standards, are to undergo harmonization by the Smart Watts EEBus Initiative. The data formats on the application level in E-Energy are fundamentally based on the standards and specifications for CIM, EDIFACT and XML. It has become apparent in simulations and practical tests that the EDIFACT standard, currently established within the framework of GPKE processes, may require further development for future smart grid applications with regard to data protection, definition of access rights and authentication, etc. These findings, and in general all questions on cross-cutting topics such as overall architectures, business models, legal conditions, data protection and security and also standardization, are addressed across all the projects by the E-Energy partners with support from a specially appointed research team. In that context, the early establishment of the E-Energy specialist groups on the individual topics of “Law”, “System Architecture”, “Market Development” and “Interoperability” has proven to be of great assistance in promoting the exchange and transfer of knowledge, both between the projects and externally in contacts with other committees with similar interests on the national and international levels, and with decision-makers in industry and politics. In the implementation of models in E-Energy, for example, regulatory and legal obstacles to development arose, which the specialist group on “Law” then referred to the responsible agencies and ministries (e.g. BNetzA, BSI, BMWi and BMU). In some cases, corresponding regulations have already been revised (ENWG, EEG, calibration law, data protection and security, etc.). A document compiled by the experts in the E-Energy model regions and the accompanying research team and published as a book[17] summarizes the impending challenges and approaches to solutions in the field of data protection. With support from the E-Energy/Smart Grid Expertise Centre for Standardization within DKE, with which the E-Energy specialist group on “Interoperability” has worked closely together since its foundation in 2009, major contributions are being made to the current discussion on standardization on the European and international levels, particularly with reports from the E-Energy project, especially for instance in the work on the European standardization mandates M/441 and M/490. The holistic view first brought into the smart grid discussion by E-Energy and a terminology coordinated between the model

[17] „Datenschutz in Smart Grids“, Raabe, Pallas, Weis, Lorenz, Boesche (Hrsg.), Liber, ISBN 978-1-907150-01-4

regions are now being comprehensively used and developed.

Even if there will only be a complete evaluation of the field tests, some of which are still in progress, in early January 2013, the E-Energy project is already able to point to important findings and solutions of a fundamental nature for a smart grid with increasing distributed feed-in from volatile renewable energy sources[18], for example the following:

- The use of variable tariffs demonstrably brings about changes in consumption behaviour, which however only appear sustainable by the use of automatic systems.
- There are potential savings of up to 20 % for commercial customers, and between 5 % and 10 % for private customers.
- Network stability can be maintained by automated, market-based negotiation systems, even with highly volatile feed-in from distributed energy resources.
- Cellular approaches on an ICT basis can help to achieve a high level of security of supply in the system as a whole. Furthermore, it can be assumed – anticipating the final results of the E-Energy project – that only systematic, ICT-managed linking will ensure the desired convergence of the electricity grid with other energy systems, in particular the gas network and local district heating networks, but also the mobility networks (electromobility and gas filling stations) in the long term.

[18] „Smart Energy made in Germany“, B.A.U.M Consult GmbH (Hrsg.), 2012

1.3 The DKE Expertise Centre for E-Energy / Smart Grid Standardization[19]

As reported above, the E-Energy projects sought to cooperate with standardization bodies, and, at their suggestion, the Expertise Centre for E-Energy / Smart Grid Standardization within DKE was initiated. Thereafter, the first Standardization Roadmap was jointly compiled and, on the basis of the experts' recommendation, the E-Energy / Smart Grid Standardization Steering Group was formed. The DKE Expertise Centre and the Steering Group with its Focus Groups have become established entities on the national level: Their aim is to coordinate the standardization issues raised by smart grids in cooperation with the technical committees of DKE and DIN and with various stakeholders, involving the E-Energy projects. This therefore not only includes established standardization committees, but also associations, governmental institutions and committees in the VDE technical societies which have a connection with smart grids. As a result, the VDE societies of ITG on information technology and ETG on power engineering, and the VDE Forum on Network Technology/Network Operation (FNN)[20] are represented within the DKE Expertise Centre and contribute to the standardization work with their analyses. The DKE Expertise Centre mirrors and observes international and European standardization activities on smart grids. Over and beyond that, it also launches its own projects such as the first version of the German Standardization Roadmap on E-Energy / Smart Grids. The standardization work proper still remains the preserve of the DKE/DIN standardization

[19] Expertise Centre for E-Energy/Smart Grids, Link: http://www.vde.com/en/dke/std/KoEn/Pages/ExpertiseCentreforE-Energy.aspx

[20] Forum network Technology/network operation in VDE (FNN), Link: http://www.vde.com/de/fnn/Seiten/default.aspx/

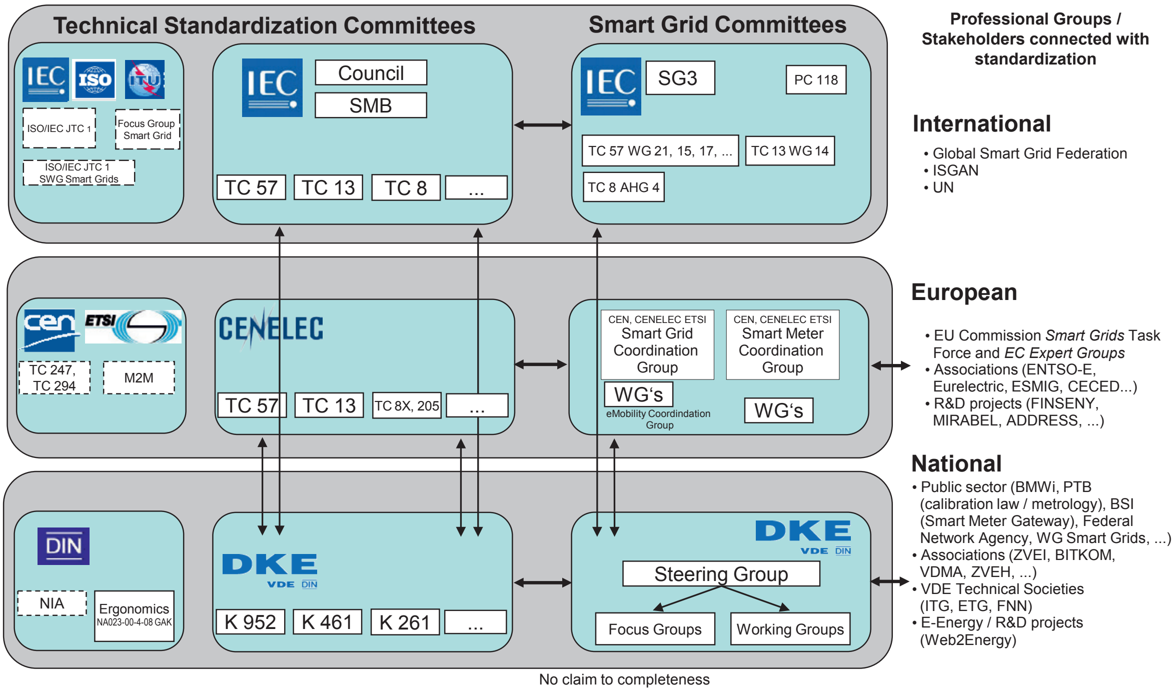

Figure 1: Example overview of the active committees in the smart grids environment (source: DKE)

committees, which do however receive suggestions and support from the Expertise Centre. With the work of the Expertise Centre which spans the topics dealt with by various committees, standardization is provided with a new "communications tool". In all these activities, the Centre benefits from its broad membership base, including representatives of the technical standardization committees and VDE technical societies, associations and the public sector. In this way, the smart grid issues relevant to standardization are pressed ahead in a technically neutral manner in discussions with politicians, the public and industry.

Figure 1 above presents a general overview of how the Expertise Centre is embedded in the smart grids networks, of the connections between the various standardization committees and of the connections to the external professional groups. It is intended to provide orientation in classifying the committees and standardization activities mentioned below. Examples are shown of the usual mirroring of IEC and European committees by the national committees. IEC/TC 13, for example, is mirrored in DKE/K 461, TC 8 in DKE/K 261 and TC 57 in DKE/K 952. Numerous further committees could be listed in addition. The committees of the Steering Group STD_1911 for E-Energy / Smart Grid Standardization and their work are presented in greater detail below.

The Focus Groups

STD_1911.1 "Network Integration, Load Management and Distributed Power Generation"

What all Focus Groups have in common is their strong links to the CEN/CENELEC and IEC committees and to the national committees and their function as a contact for politicians.

STD_1911.1 "Network Integration, Load Management and Distributed Power Generation" has therefore been especially involved in the collection of Use Cases under the terms of Mandate M/490, and has supported the collection with workshops. The committee also sup-

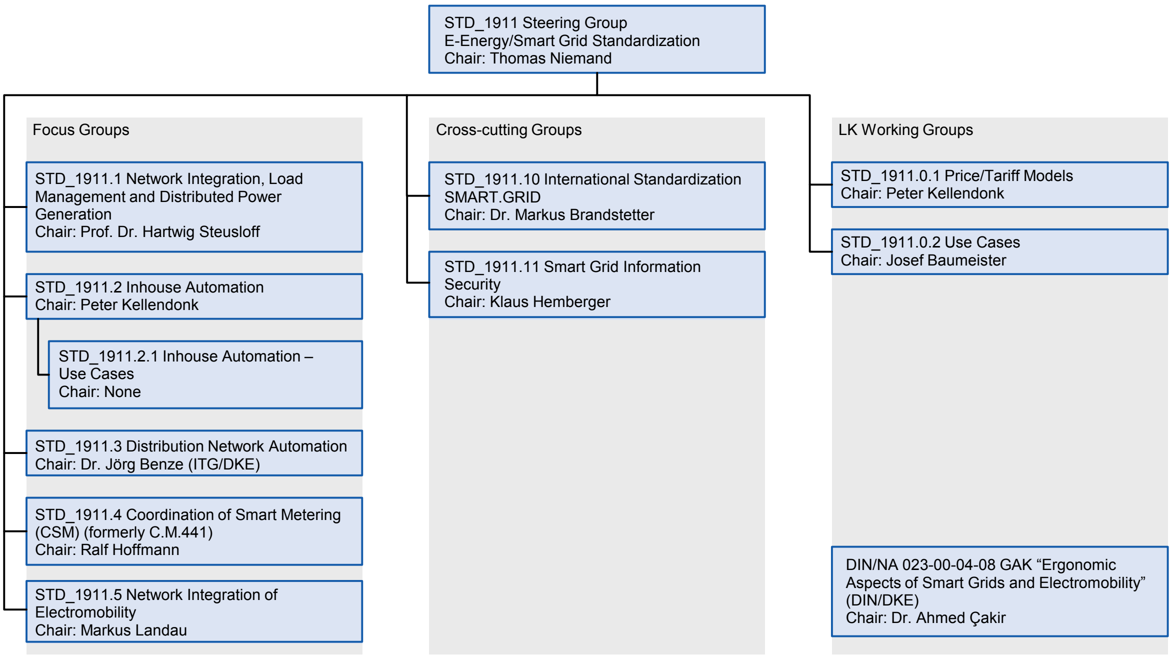

Figure 2: Structure of the DKE Expertise Centre for E-Energy / Smart Grid Standardization (source: DKE)

ports the Use Case methodology and the links with standardization by collaboration with the national standardization committee DKE / AK 952.0.17 "Information Models and Communication for Distributed Energy Supply Systems in Networks". The relevant Use Cases are consolidated and methods for profiling are developed there.

STD_1911.2 „Inhouse Automation"

STD_1911.2 "Inhouse Automation" has the task of expanding Mandate M/490 to cover property, which it does not as yet include, and ensuring a functional network-house connection. These approaches and Use Cases are reconciled with the generic Use Cases of SG-CG. Furthermore, STD_1911.2 collaborates with EEBus e.V. on the description of a neutral abstraction layer, and also with CLC/TC 205/WG 18. Together with STD_1911.4, the committee is also working on a technologically neutral description of XML data models for exchange between the domains of metering and home/building automation. STD_1911.2 supports the logical and functional separation of these domains, with an interface required between the two to coordinate the billing modalities of the incentive-based demand-response mechanisms. On a national level, STD_1911.2, together with DKE/K 716 initiated the Working Group 716.0.1, in which an energy management gateway is being developed, drawing on experience with the smart meter gateway. Only recently, activities started in CLC/TC 205 WG 16 on standardization of the functional requirements for in-home displays. In that context, the focus is initially on the H1 interface designed by SM-CG for the display of meter data (TC 13/TC 294). In the next stage, the display of data from the home automation interfaces (SM-CG H2/H3) is to be revised together with CLC/TC 205 WG18, and the results are to flow into the work of EN 50491-11.

STD_1911.3 "Distribution Network Automation"

In the joint ITG/DKE committee STD_1911.3, the topic of distribution network automation has been addressed by a joint working group with the ITG Focus Group on "Energy Information Networks and Systems". The topics of smart grids and smart metering occupy a large part of the public discussion on the intelligent energy supply system of the future. The focus is mostly on individual technical aspects such as the voltage range problem resulting from increased feed-in from distributed generation facilities, or the development of suitable standards and specifications. In that context it is easily overlooked that the successful implementation of a smart energy supply can only be achieved on the basis of a thorough automation of the distribution networks and the other energy supply systems which interact with them. It is not sufficient merely to consider the individual technologies and standards. On the contrary, a systemic view of the interacting control systems has to be established if the reliability of supply is to be ensured in spite of the increasingly complex interrelationships. In the joint ITG/DKE committee STD_1911.3, with involvement by experts from the fields of power supply, telecommunications and automation, a systematization of the various aspects of distribution network automation has been established and recommendations for action deduced. The results to date are summarized in Part A, "Distribution network automation" of the 2nd position paper on "Energy Information Networks and Systems"[21], which assesses the present status from the point of view of the distribution network operator and presents the requirements for establishment of intelligent network control and the corresponding business models.

[21] ITG Energy Information Networks, Link: http://www.vde.com/de/fg/ITG/Arbeitsgebiete/Fachbereich%201/Seiten/Fokusprojekt%201.5%20Energieinformationsnetze.aspx/

STD_1911.4 "Coordination of Smart Metering"

STD_1911.4 "Coordination of Smart Metering" has been reconstituted to pursue international standardization and the national requirements such as the smart meter security profile. With the stipulations of the Energy Industry Act of 2011 in conjunction with the requirements established by the 3rd EU internal market package of 2009, the installation of smart meters in Germany will no longer be a voluntary option for the market participants from 01 January 2013 onwards, but rather a mandatory obligation for the Use Cases stated in the legislation. In consequence, it is necessary for the legislature on the one hand to define the technical requirements for such systems, taking into account the provisions of the Information Directive 98/34/EC. On the other hand, the privacy of users requires legal protection, and the misuse of personal data has to be prevented. Over and above this, the topic of data security is of national interest with regard to hardening the smart grids against cyber attack. A protection profile for smart meters based on the common criteria and a technical directive TR 3109 determining the minimum functionality and interoperability of such devices are being developed in Germany to master this challenge. The main player in this respect is the Federal Office for Information Security (BSI), which commenced work on this issue on behalf of the Ministry of Economics and Technology.

As far as the higher level political instructions permit, the work by BSI on this topic is dovetailed with that of the private sector. The responsible department head at BSI is also a member of the STD_1911 Steering Group, and in that position coordinates the work of his members in the standardization committees of DKE. Members of BSI are, for example, members or guests on the following committees: 1911.2, 1911.3, DKE/AK 461.0.142 (Data Models for Smart Meter Gateways), DKE/AK 461.0.143 (Smart Meter Gateway Webservices) and the high level DKE/AK 461.0.14 (Gateways and Data Transmission). The renaming of AK 461.0.14 from "Data Transmission" to "Gateways and Data Transmission" was decided by DKE/K 461 not least for the purpose of demonstrating solidarity between standardization and governmental action.

Under the terms of European Mandate M/441, the Smart Meter Coordination Group (SM-CG) has staked out the conditions for the use and application of smart meters in Europe. The SM-CG is compiling extensive analyses of possible Use Cases for measuring systems, a complete list of available communications standards, a work programme on the extension of existing standards and specifications, and a recommendation on the use of the COSEM object model as the topmost layer of the data processed by the measuring systems. DKE is assisting via CENELEC and CEN in the compilation and extension of the standards and specifications for measuring systems. CENELEC TC13 is responsible for the standards relating to electricity meters, CEN TC 294 for volume measuring equipment, and CENELEC TC 205 for home automation.

The EU member states are now called upon to draw on recommendations from this mandate for their national stipulations, in order to ensure that the requirements of Directive 98/34/EC are fulfilled. Juridification of the technical requirements in Germany is effected by revision of the Metering Access Ordinance and by expiry of the applicable notification period. Coordination of the results of statutory requirements, of standardization and of the definition of Use Cases and implementation, not only for electricity but wherever possible for all media, is performed by STD_1911.4.

STD_1911.5 "Network Integration of Electromobility"

STD_1911.5 "Network Integration of Electromobility", at the interface between smart grids and electric vehicles, is a typical example of a committee spanning two areas of interest. STD_1911.5 is therefore also in contact with the EMOBILITY Steering Group in DKE. It not only pursues the standardization activities on ISO/IEC 15118, which focuses on "Vehicle to Grid", but also the work of the new CEN/CENELEC "eMobility Coordination Group (EM-CG)" and in particular the Ad-hoc Group "Smart Charging" as a joint committee of EM-CG and the Smart Grid Coordination Group (SG-CG). STD_1911.5 is also compiling a position paper which sheds light on the problems of network integration of vehicles with different levels of intelligence, and also on the detailed needs for standardization and application rules.

The Crosscutting Groups

STD_1911.10 "International Standardization SMART.GRID“

STD_1911.10 "International Standardization SMART.GRID" had set itself the task of identifying and assessing international activities and, where appropriate, recommending that they be pursued by the individual STD committees. Attention was naturally paid to the SG-CG (see section 1.4), but also to activities in Asia. The committee passed on details of the international activities to the responsible committees in the Steering Group and thus created direct links between those committees and the international activities, for instance in the SG-CG Working Group. As this newly established network is now acting independently, STD_1911.10 "International Standardization SMART.GRID" has completed its work and is now suspended. Individual international topics are being pursued by the Steering Group.

STD_1911.11 "Smart Grid Information Security"

STD_1911.11 "Smart Grid Information Security" (DE-SGIS) acts as a national mirror committee to the European working group on Smart Grid Information Security (EU-SGIS) and works together with other corresponding groups at the Expertise Centre, with experts in IT security in network automation and information technology, and also with standardization committees in DKE, such as AK 952.0.15 for example, and in DIN. Initial proposals on information security discussed here have already been adopted as part of the work on the IEC 62351 standard. In addition, DIN SPEC 27009, developed on the basis of the BDEW White Paper, has been successfully positioned on the European level, as has the international standard proposal (ISO/IEC DTR 27019) on the international level in the smart grid environment. One of the central questions in future will be how the requirements and recommendations of Mandate M/490 are to be implemented in the various domains so as to ensure sufficient end-to-end security. To this extent, the Working Group will focus on application and further development in Germany in order to implement the various security levels, SGIS-SL 1-5, and the classification of information assets worthy of protection in relevant SGIS standards (requirements, implementation options and interoperability profiles). Active attention will also be paid to Use Cases such as "Flexibility Management" and "Generic SGIS Use Cases".

The Working Groups

STD_1911.0.1 "Price/Tariff Models"

STD_1911.0.1 "Price/Tariff Models" deals with the establishment of a concept for standardized formats for the demands of definitive calculation factors. The standardized terms, definitions and formats required by Section 40 of the German Energy Industry Act are being defined on a broad basis by the relevant professional circles in this Project Group.

STD_1911.0.2 "Use Cases"

STD_1911.0.2 "Use Cases" not only mirrors the activities of the "Working Group Sustainable Processes", but has also set itself the target of developing Use Case processes, propagating the Use Case philosophy and making the application of Use Case processes a matter of course. For this purpose, the Working Group has conducted a public workshop on the topic of Use Cases and the status of standardization. Furthermore, the committee has presented its topic in the "Smart Grids and Meters" Working Group initiated and managed by the Federal Ministry of Economics and Technology. The idea of Use Cases was adopted as a tool for the analysis of legislative background conditions. In workshops within the committee, work is being performed on terminology for the Use Case method, the required degree of detail in Use Cases, and the derivation of generic Use Cases from highly detailed Use Cases in properties and at the interface to properties.

In order to promote their use and dissemination, the Use Cases and processes compiled have, jointly with STD_1911.2 "Inhouse Automation", been forwarded as a basis for work in the international committees IEC TC 57 "Power Systems Management and Associated Information Exchange", CLC TC 205 "Home and Building Electronic Systems (HBES)" and CLC TC 59 "Performance of Household and Similar Electrical Appliances". They are used there for reconciliation of the corresponding data models and structures.

NA 023-00-04-08 GAK "Ergonomic Aspects of E-Energy and Smart Grids" (DIN/DKE)

The involvement of end customers plays an important role in the success of the smart grid approach. Only if these end customers react to the incentives for energy use as is intended by the political ideas of constant increases in energy efficiency and integration of renewables will the new network structures be future-proof. The interaction interfaces available to the end customers are essentially smart meters and the "smart household appliances" in the domestic environment which are incorporated in the communications network. Consequently, in the light of this role of a proactive market participant which consumers are increasingly expected to adopt, there is correspondingly growing interest on the part of the consumer organizations in a user-friendly design of smart grid technologies. Against this background, the DIN Consumers' Council established the Joint Working Group DIN/NA 023-00-04-08 GAK "Ergonomic Aspects of E-Energy and Smart Grids". With involvement by professional IT ergonomists, this group compiled the preliminary standard DIN SPEC 33440 entitled "Interaction interfaces and products for smart grids and electromobility – Fundamental aspects and principles for ergonomic design", which is to be published by the end of 2012.

DIN SPEC 33440 pursues the aim of disseminating the basic principles and mechanisms of user-friendly design of smart grid devices, in particular to those developers who, following demand, are now starting to familiarize themselves with the human-centred aspects of sociotechnical infrastructures such as smart grids. In this sense, DIN SPEC 33440 is a selection of tools from ergonomics and information psychology which are of special relevance in the area of smart grid interaction.

Under the leadership of the Technical University of Braunschweig's "Efficient Consumer Involvement" project, an appendix intended for publication in 2013 is to illustrate the basic rules using the example of the user-friendly design of an in-home display. A further consequence of the standardization work performed in NA 023-00-04-08 GAK is the commencement of work at DKE on the development of standardized pictograms for use in smart grids and electromobility. In addition, development work is also commencing on a standardized smart grid terminology, specially tailored to the needs of end customers, using the IGLOS terminology management system. Cooperation between the Technical Universities of Bielefeld and Braunschweig and the Physikalisch-Technische Bundesanstalt (PTB) is planned for this project. Further work on collection of the terms is taking place in the standardization committee DKE/K 111.0.5 "Terms for Smart Grids".

Further Committees with Links to Smart Grids

The topic of smart grids is reaching the established standardization committees more and more, partly through collaboration in the Steering Group, and partly through mirroring of the international standardization activities. A list with current projects from these committees is available in the Appendix.

All in all, the DKE Expertise Centre Expertise Centre for E-Energy / Smart Grid Standardization with its Steering Group and the Focus Committees has developed into a new multifunctional tool in the world of standardization which avoids duplication of activities and committees, addresses new topics in standardization and in this way complements and supports the existing committees. In that context, the DKE Expertise Centre not only combines national and international standardization activities, such as the work of DKE/K 261 "System Aspects of Electrical Power Supply", DKE/K 461 "Electricity Meters" and DKE/K 952 "Power System Control" with the activities of the Smart Grid Coordination Group (SG-CG) and the Smart Metering Coordination Group (SM-CG). Over and above that, it also functions as a neutral contact for politicians.

FNN Forum Network Technology / Network Operation

Attention is to be drawn here to the work of FNN in the course of the implementation of new requirements for the networks. In 2011, for example, against the background of integration of energy from renewables in the grid, the VDE Application Rule VDE-AR-N 4105: 2011-08 "Power generation systems connected to the low-voltage distribution network – Technical minimum requirements for the connection to and parallel operation with low-voltage distribution networks" was published.

Further Working Groups with Links to Smart Metering

The activities of the DKE Expertise Centre on the topic of smart metering are being complemented more and more by the work of further groups, for example DKE/AK 461.0.143 and the Forum Network Technology / Network Operation of the VDE (FNN):

DKE/AK 461.0.143 "Web Services Smart Meter Gateway"

DKE/AK 461.0.143 has been appointed by the Federal Office for Information Security (BSI) to draft stipulations for a web service-based WAN interface according to the requirements of the Protection Profile and TR-03109. As the requirements of the Gateway Protection Profile make it impossible to adopt the M2M specification from the European Telecommunications Standards Institute (ETSI) in full, DKE/AK 461.0.143 feeds its findings back into ETSI TC M2M. The usable concepts from ETSI M2M Release 1 are taken into account by Working Group AK 461.0.143 in the WAN interface. Together with Working Group AK 461.0.142, AK 461.0.143 takes account of the recommendation by SM-CG (TR50572) to model the metering data by means of COSEM classes.

Connections and Interfaces to DKE Standardization Committees for General Smart Grid Standardization Topics:

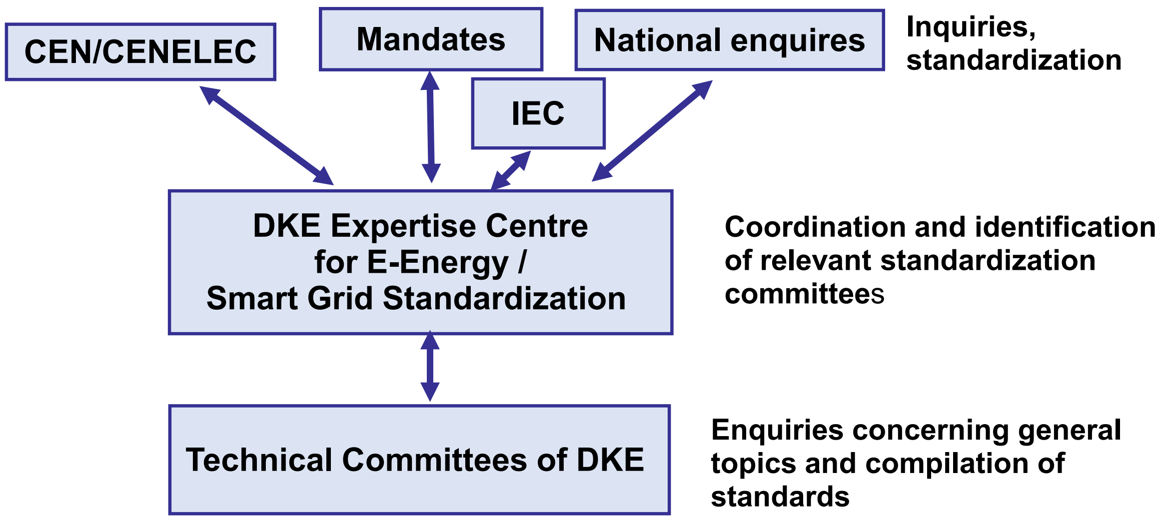

Figure 3: Role of the DKE Expertise Centre for E-Energy / Smart Grid Standardization (source: DKE)

VDE (FNN)[22] – "MessSystem 2020"

Over and above this, DKE coordinates its standardization activities on the topic of smart metering with the Forum Network Technology / Network Operation of the VDE (FNN). In this connection, above all the VDE (FNN) project "MessSystem 2020" (Metering System 2020) is of importance. For in the course of that project, specifications for future metering systems (smart meters) are compiled, bringing together the interests of users and manufacturers in the development of the new metering systems. The project is part of the work of VDE (FNN) on the establishment of specifications for a future smart metering system. This will be structured around a base meter with a smart meter gateway. The initial work is to be essentially complete by the end of 2012, and will have to be revised and finalized when the technical requirements have been put into law by the Federal Government and BSI. The aim is a system of conformity testing in which various energy metering systems function together across industry boundaries (interoperability) and in which the interchangeability of devices from different manufacturers is ensured, insofar as this is technically possible. Defined test cases for implementation in test machines are to form the basis of this work. Accordingly, a definition of corresponding test cases is to take place in parallel with the definition of the requirements.

One of the main functions of the Expertise Centre is that of networking the various standardization committees on a national and international level. The following **table** provides an overview of the activities in the various committees. Further details can be found on the following pages and at the sources cited, and, as regards subject matter, also in the descriptions in Sections 2 to 5.

Note: The following descriptions and further details on the standardization committees can be found at the internet link in footnote 49).

Framework for the Development of New Measuring Systems

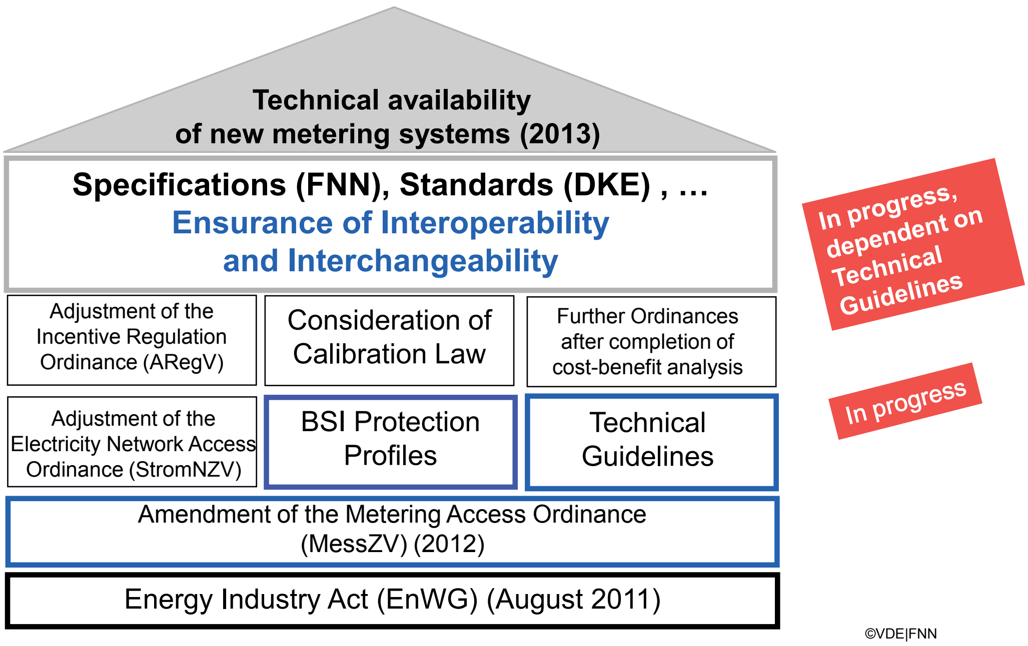

Figure 4: Background conditions for development of new metering systems (source: FNN)

[22] Link to MessSystem 2020: www.vde.com/de/fnn/arbeitsgebiete/messwesen/Seiten/messwesen.aspx/

Committee	What has been achieved?	Current activities
What is planned?	Roadmap 2.0 (this document) Monitoring of European / international standardization activities, coordination with the BSI Protection Profile.	Monitoring of European / international standardization activities, coordination.
DKE/1911.1 Network Integration, Load Management and Distributed Power Generation	Support to SG-CG in the analysis of Use Cases, functional architecture, control concept.	Use Cases and profiling.
DKE/1911.2 Inhouse Automation	Use Case methodology -> 1911.0.1 initiated, Use Cases for energy management and smart homes, in this case mirroring and close coordination with SG-CG/SP, new standardization project initiated on energy management (AK 716.0.1), discussion of tariff models and energy management -> 1911.0.1 initiated.	Tariff models, cooperation with AK 716.0.1, tracking / own developments on the SG-CG flexibility concept. EN 50491-11/12
ITG/1911.3 Distribution Network Automation	Compilation and publication of two position papers, work in SG-CG/RA.	Deduction of requirement for standardization from the position papers.
DKE/1911.4 Coordination of Smart Metering	Mirroring of SM-CG (Mandate M/441), tracking of BSI activities.	Intercommittee coordination on smart metering in connection with legal requirements.
DKE/1911.5 Network Integration of Electromobility		Position paper on system services in connection with smart charging, monitoring of ISO/IEC 15118, mirroring of European AHG Smart Charging.
DKE/1911.10 International Standardization SMART.GRID	Mirroring of various international smart grids committees, with statements and comments. Function transferred to specialist committees.	Committee suspended.
DKE/1911.11 Smart Grid Information Security	Mirror committee of SG-CG/SGIS, support of DIN SPEC 27009 standardization project, additions to IEC 62351.	Mirror committee of SG-CG/ SGIS and implementation of SGIS Use Cases down to the property level, international standard proposal (ISO/IEC DTR 27019), cooperation with DIN NIA and AK 952.0.15.
DKE/1911.0.1 Price and Tariff Models		Compilation of standardized tariff and price models.
DKE/1911.0.2 Use Cases	Workshop on Use Cases in January 2012, mirroring of methodological development by SG-CG/SP and IEC/TC 8 AHG 4.	Further development of Use Case methodology, generic Use Cases concept.

Table: Overview of standardization activities

Committee	What has been achieved?	Current activities
DIN/NA 023-00-04-08 GAK "Ergonomic Aspects of E-Energy and Smart Grids" (DIN/DKE)	The basis is the DIN Consumer Council's study on ergonomics in the smart grid.	Preliminary standard DIN SPEC 33440, "Interaction interfaces and products for smart grids and electromobility – Fundamental aspects and principles for ergonomic design", smart grid / electromobility pictograms, smart grid terminology.
DKE/K 261 System Aspects of Electrical Power Supply	Cooperation with TC 8 to anchor the product-specific requirements of VDE-AR-N 4105 in the future IEC standard on harmonization of network connection conditions.	See project list and link in the Appendix, "Standardization projects".
DKE/K 461 Electricity Meters DKE/AK 461.0.143 Web Services Smart Meter Gateway, DKE/AK 461.0.142 Data Structures for Smart Meter Gateway	Stipulations on the use of web services made and coordinated with BSI in the form of an updated working paper. Definition of functions Use Cases for the IF_GW_ WAN interface started (accommodating SM-CG as far as possible).	Stipulations for a web service based WAN interface for the BSI smart meter gateway in accordance with the BSI protection profile (TR).
DKE/UK 543.1 Consumer Distribution Boards and Meter Panels	E DIN VDE 0603-5-100 (VDE 0603-5-100):2012-05 Consumer distribution boards and meter panels AC 400 V – Part 5-100: Adaptation of standards for eHZ meter panels to integrate required future measuring systems	Stipulations for installation of the smart meter gateway in the vicinity of meter panels (new and existing installations).
UK 767.1 Conducted Low Frequency Disturbances	EN 50160 (Voltage Quality)	IEC/EN 61000-4-19 (Immunity to conducted, differential mode low frequency disturbances)
DKE/K 952 Power system control	Mirror committee of IEC and CLC TC 57 and tracking of the activities in IEC PC 118 together with DKE / AK 716. Focal points of further work: Data communication, mainly protocols to ensure compatibility, planning and network management, etc. – DIN EN 61850, Communication networks and systems for power utility automation – DIN EN 61968 Application integration at electric utilities, and compilation of explanatory documents for the international level.	See project list and link in the Appendix, "Standardization projects".
FNN-MessSystem 2020		Description / specifications for interoperable metering systems on the basis of the technical requirements of BSI and the Federal Government.

Table: Overview of standardization activities (continued)

Committee	What has been achieved?	Current activities
IEC/TC 59/WG 15 Connection of household appliances to smart grids and appliances interaction		Compilation of a collection of common terms, concepts and criteria to support TC 59 and its sub-committees in the technical analysis of interaction between properties and the smart grid.
Smart Grid Coordination Group (SG-CG) of CEN, CENELEC and ETSI	Work under Standardization Mandate M/490, publication of JWG report on smart grids in 2011.	Final report at end of 2012, prolongation of the mandate. Work programmes and new focal areas (flexibility concept, storage facilities, incorporation of DERs, profiling and tests, interoperability).
SG-CG/RA Working Group Reference Architecture	Draft reports, SGAM	Final report
SG-CG/SP Working Group Sustainable Processes	Draft report, Use Cases Management Repository (DKE, OFFIS, IBM), collection of 450 Use Cases, development, concept and examples of generic Use Cases.	Final report, further work on generic Use Cases, handover to TCs.
SG-CG/SGIS Working Group Smart Grid Information Security	Draft report, analysis of the standardization environment, SGIS Toolbox	Final report
SG-CG/FSS Working Group First Set of Standards	Prioritisation and work programme, draft report on systems mapped to architecture and standards.	Final report
Smart Meter Coordination Group of CEN, CENELEC and ETSI	Work under Standardization Mandate M/441, Use Cases, further development of the COSEM model, CEN/CLC/ETSI/TR 50572, "Functional Reference Architecture for Communications in Smart Metering Systems".	Final report end 2012
Electro Mobility Coordination Group	Work under Standardization Mandate M/468	Analysis of the standardization environment, connection opportunities, charging processes, etc.
IEC/SMB SG3 Strategic Group Smart Grids	Roadmap, concept mapping tool and Use Cases, networks with TCs within IEC and in other organizations.	Roadmap 2.0
IEC/TC 8 AHG 4 "Smart Grid Requirements" WG 5 "Methodology and Tools", WG 6 "Generic Smart Grid Requirements", 11 Domain Core Teams (DCT)	Standard project 8/1307/NP initiated on Use Case template workshops for Use Cases.	Collection of Use Cases and development of generic Use Cases.

Table: Overview of standardization activities (continued)

1.4 European and International Standardization Activities

1.4.1 European Standardization Activities

M/490 – Smart Grid Coordination Group (SG-CG)

As a reaction to mandate M/490 (Smart Grid) awarded by the EU Commission, the European standardization organizations CEN, CENELEC and ETSI founded the Smart Grid Coordination Group (SG-CG). The ambitious timetable and the thematic scope of the mandate require a lean, target-oriented project organization:

In spring 2012, the draft of a technical report from the Smart Grid Coordination Group on the "Reference Architecture for the Smart Grid" was published. The reference architecture uses a five layer model to describe the interoperability of processes, and is applicable to both existing networks and future Smart Grids. At the same time, the "Sustainable Processes" Working Group submitted a draft of a technical report. The fundamental result of the work is the collection of Use Cases and their uniform presentation in a corresponding template. The Use Cases are grouped by focal topics and so-called "generic Use Cases" established, grouping together the most important ideas from the individual Use Cases. On the basis of the generic Use Cases, gaps can now be identified in the standards and systematic standardization work embarked upon with all the stakeholders involved. The (draft) technical report from the Smart Grid Information Security Group builds upon the results from the other working groups as described, and uses both the five layer model and the Use Case system in order on the one hand to deduce requirements for information security, and on the other hand to identify loopholes in the stipulations.

The Smart Grid Coordination Group is planning to complete work on methodology by the end of 2012. Then, a report will also be available with a list of standards which already exist for the implementation of Smart Grids in Europe. The mandate is prospectively to be extended so that current projects in the established work programme can be completed and the methods developed further expanded, established and applied to focal topics.

M/441 – Smart Metering Coordination Group (SM-CG)

Under the terms of Standardization Mandate M/441 (Smart Metering) of 2009, the European Commission appointed the European standardization bodies CEN, CENELEC and ETSI to develop European standards for smart meter functionalities and communications interfaces for the electricity, gas, heating and water industries. The aim is an open architecture, using communications protocols which facilitate interoperability. Coordination and implementation are performed by the Smart Metering Coordination Group. Apart from increasing general consciousness of consumption at any particular time, such smart meters are also intended to provide for flexibilization of tariff models.

Organizationally, the Smart Metering Coordination Group (SM-CG) passed on the responsibility for processing the standards and the leadership of the standardization process to the coordinating Technical Committees CEN/TC 294, CLC/TC 13, CLC/TC 205 and ETSI/TC M2M. The detailed results have been presented in the technical report CEN/CLC/ETSI/TR 50572 "Functional Reference Architecture for Communications in Smart Metering Systems". This report places smart metering in the context of smart grids, and describes the functional reference architecture for communications to support the extended smart metering functionalities. Bidirectional communication for the ex-

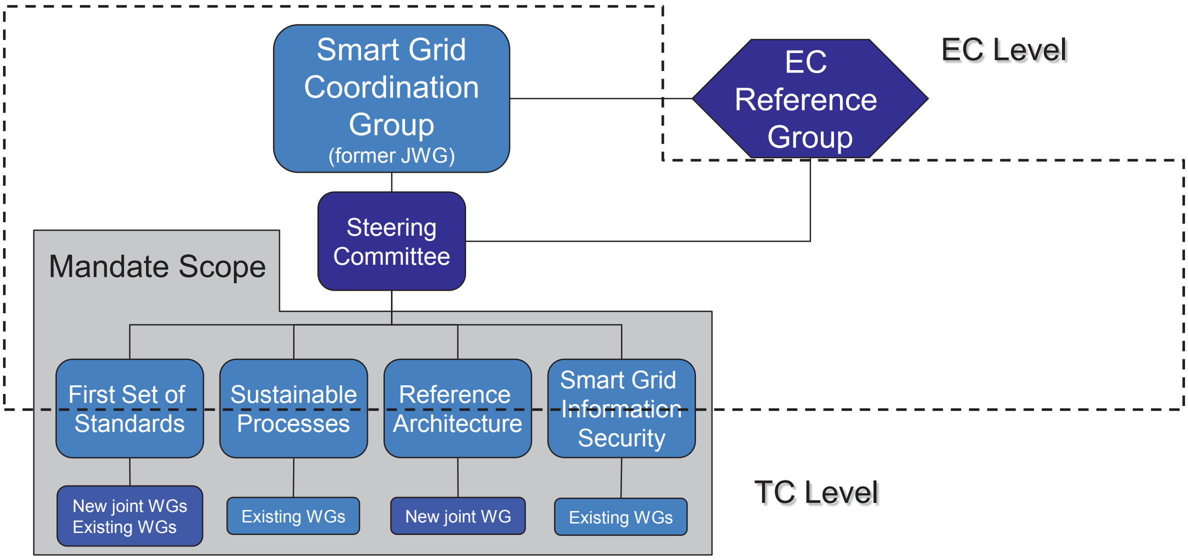

Figure 5: Structure of the Smart Grid Coordination Group (source: SC-CG)

change of information, management functions and control functions is provided for, and the requirements for interoperability are taken into account. Special attention is devoted to data security and data protection. The COSEM object model and OBIS identification to IEC 62056-6-2 and IEC 62056-6-1 have been selected as the uniform object layer for smart metering in Europe. Nevertheless, individual national procedures are permitted for the operation of smart meters and for measurement data communication. Mappers of the individual object layer to the COSEM model have been created or required by standards (e.g. IEC 61850 -> COSEM, ISO/IEC 14908 -> COSEM, etc.) for all the processes used for acquisition and transmission of energy data.

As with the smart grid mandate M/490, the Use Case method is used to determine the system requirements and the resulting need for standardization. The Use Cases describe how the different users, components and market roles interact with the system to perform particular functions. The method is widely used in system engineering for determination of the requirements for software and system solutions.

SM-CG is currently working on a final report which is to be published by the end of 2012. This report will document the status of the work to date and the standards developed, and describe the tasks which are still outstanding.

M/468 – Electro Mobility Coordination Group (eM-CG)

Under the terms of Standardization Mandate M/468 (Electromobility), the Electro Mobility Coordination Group (EM-CG) is dealing with standards for charging of electrically powered vehicles. In a similar manner to other mandates, the existing standards are examined there for applicability and gaps. The review covers the areas of logistics, infrastructure, flexibility, interoperability, connection facilities and safety. The topic of flexibility, for example, comprises several new charging methods in addition to the customary practice of removing batteries for charging. The connection facilities are to facilitate all combinations and types of charging stations and vehicles. Charging itself is also assessed with a view to improved user-friendliness and potential cost savings. One of the further focal points of the mandate is of course the examination of safety as a basis for the introduction and acceptance of the charging process. Further details of this mandate can be found in the Electromobility Roadmap 2.0 (see section 1.5.2).

ETSI M2M

Under the terms of Standardization Mandates M/441 and M/490, TC M2M of the European Telecommunications Standards Institute ETSI has developed a domain-independent M2M communications architecture (functional architecture) and published it as a technical specification. The technical specifications are based on the Use Cases of SM-CG and SG-CG, and are referenced in their reports. The specifications of "M2M Release 1" were published in February 2012. The functional architecture pursues the aim of specifying the communications service and management interfaces (APIs) independently of the application domain and the technology (type of access network). In order to ensure scalability for a large number of networked devices and interoperability by versioning over a long period of time, ETSI used a resource-based API style with web service protocols (RESTful). This facilitates competition in communications services and decoupling of the ICT infrastructure from the energy network infrastructure. The investment and operating costs of the gateways, head-end systems and public key infrastructure (PKI) can be distributed among several applications.

1.4.2 International Standardization Activities

IEC International Electrotechnical Commission

On the IEC level, work is currently being performed on an updated version of the Smart Grid Roadmap. In contrast to version 1.0, the character of which was more that of a stock-taking of existing standards in the smart grid environment, version 2.0 is also to provide a prospect of future standards. On the one hand, the standards which are to be released within the next five years are included in the Roadmap. On the other hand, there will also be a section describing the future fields of technology which IEC regards as its domain with regard to standardization.

IEC/TC 8 AHG 4[23] "Smart Grid Requirements" is also working on Use Cases for standardization work (see NWIP 8/1307/NP). The use of these standardized documents is expected to provide a better exchange of information between the technical expert groups and better coordination at the boundaries of responsibilities. In addition, it is assumed that with the aid of Use Cases the need for new standards will be recognized more rapidly and that it will be possible to avoid parallel proposals of standards with similar contents.

IEC/SMB[24] SG3 "Smart Grid" is dealing with the development of a framework which contains basic structures, protocols and standards for modelling. In that context, this Strategic Group also provides support for the implementation of ideas and technologies which are developing in the smart grid environment and could be the basis of future IEC standards. SG3 cooperates closely with other smart grid project groups worldwide, such as the National Institute of Standards and Technology (NIST).

In the past, there have been a series of overlapping proposals worldwide at the interface between the smart grid and smart energy management with the end customer. In order to resolve those overlaps and provide the technical expert groups with firm standardization requirements, the Project Committee (PC) 118 Smart Grid was temporarily constituted.

[23] TC Technical Committee, AHG Ad-hoc Group, NP New Project = Proposal for a new standard project.

[24] SMB Standardization Management Board, SG Strategic Group

National standardization activities in other countries

In June 2012, the Smart Grid Coordination Group hosted an international Plenary attended by participants from Brazil, China, Korea, Japan and the USA and representatives of international organizations such as IEC, ITU-T, ISGAN and UNIDO. The aim was to exchange information and discuss a coordinated procedure.

USA

The activities in the USA, headed by the National Institute of Standards and Technology (NIST), have produced not only the "NIST Framework and Roadmap for Smart Grid Interoperability Standards" Version 1.0 (January 2010) and Version 2.0 (February 2012), but also an organization (Smart Grid Interoperability Panel – SGIP). SGIP, with its corresponding sub-groups, currently comprises around 800 companies and organizations. The main function of the organization is currently the work on the Priority Action Plan (PAP) and the Catalog of Standards (CoS). As of June 2012, 28 of the around 100 standards named in the NIST Framework have already been verified and a further 15 are awaiting a decision. The SGIP organization has many similarities to the European SG-CG. There are, for example, not only working groups on architecture, Use Cases and security, but also the corresponding work programme in the form of the PAPs (Priority Action Plans). Both NIST and SGIP signed declarations of intent in 2011 on cooperation with SG-CG, defining the areas of joint work more closely. The corresponding cooperation on the expert level, for instance with SG-CG, is well established. IEEE has submitted specification P2030 on interfaces in the smart grid.

China

In China, smart grids activities are strongly influenced by the State Grid Corporation of China (SGCC). SGCC has established a smart grid standardization system with eight domains. These eight domains are planning, generation, transmission, transformation, distribution, consumption, dispatching and information & communication. Each of the domains is itself divided into fields with the corresponding standards and standardization activities. The 92 series of standards identified are to be completely compiled or revised by 2015.

Japan

In Japan, a total of 26 Focus Areas in which standardization activities are to take place were identified in the course of 2010. For that purpose, the "Subcommittee on Smart Grid International Standardization" was founded in May 2012 within the Japanese Industrial Standards Committee (JISC). That subcommittee maintains close contact with the Japanese Smart Community Alliance (JSCA) and the standardization group there. The aim of the new group is not only to act as a mirror group to IEC/SMB SG3 "Smart Grid", but also to compile a report on the Japanese activities by March 2013. The basis will once again be the 26 Focus Groups. The methods developed in the European group (e.g. SGAM) will be used in the design of the work. Overall, there has already been close dovetailing of the European and Japanese activities since 2010. This is also reflected in the annual meetings of the relevant representatives at the JISC-CEN/CENELEC events.

Korea

In Korea, there has also been a Standardization Roadmap since 2010, and an Interoperability Framework since March 2012. The activities are controlled by the Korean Agency for Technology and Standards (KATS). The relevant fields of standardization are currently being examined under three top-level domains (Smart Service, Smart Power Generation and Smart Consumer). The work is strongly oriented towards the US/NIST model. The second version of the Framework is to be available by the end of 2014, and a third version which concentrates on testing and conformity by the end of 2016.

Others

In addition to the activities mentioned above, further international initiatives on smart grids are on the starting blocks. Smart Grid Standardization Groups have, for example, been established in Brazil and in India, and an even greater number of national standardization initiatives can be expected in future. The IEC activities aimed at bringing these various initiatives in the smart grids field together are therefore becoming more important and enjoying increasing recognition.

1.5 Further National Standardization Roadmaps with References to Smart Grids

In complex systems and in the interplay between widely divergent standards, even the best experts can lose track. An overview is provided not only by this Roadmap, but also by the following further standardization roadmaps with references to smart grids, the aim of which is really to present the current state of affairs and identify initial recommendations for further structured approaches. On the basis of this Roadmap and those cited below, their interdependence and the EU Commission's focal areas of research, it is already becoming apparent today that the topics will be further networked and in some cases merged, under the heading of "smart cities".

1.5.1 Standardization Roadmap on AAL – Ambient Assisted Living[25]

According to DKE, standards and specifications which make cost-effective, non-proprietary interoperability of system components possible in the first place are a necessary condition for the widespread use of smart assistance systems. Ambient Assisted Living system models have up to now predominantly been used for products that are relatively simple both technically and organizationally. In the product environment, too, there are at present only a small number of systems and platforms from various manufacturers in use. In future, however, the applications will become significantly more complex and convergent in response to the requirements of cost-effectiveness. It is therefore correspondingly important to develop the relevant standards and specifications for AAL systems and components and to discuss the background conditions, such as the requirements of data protection legislation and those of the Medical Devices Act. Over and above this, the relevant heterogeneous user requirements and the general demands placed on assistance systems in various areas of AAL are to be clarified. The current AAL standardization roadmap serves above all to coordinate and integrate various activities in the AAL environment and in different domains. It assists manufacturers and designers in the development of products, and promotes both a uniform understanding of the topic and the interoperability and compatibility of AAL components from different vendors. In addition, the roadmap is intended to promote the development of integration profiles for prototype application scenarios. The AAL roadmap thus follows similar principles to those on

[25] German Standardization Roadmap on AAL, Link: http://www.dke.de/de/std/AAL/Seiten/AAL-NR.aspx/

which smart grids focus: Interoperability of solutions is achieved by profiling, driven by a Use Case. The interaction between a wide range of AAL systems and components is being investigated by Working Group STD_1811.0.12 and the results will be presented in a new roadmap on the subject of interoperability. The publication, planned for the first quarter of 2013, will also use Use Cases.
Link to smart grids: A connection is seen between AAL and smart metering, energy management gateways and smart homes, in the use of common infrastructures in the smart home, the use of comparable approaches and the same methods and standards.

1.5.2 German Standardization Roadmap on Electromobility 2.0[26]

The second version of the German Standardization Roadmap on Electromobility is now available. There, additions have been made to version 1 which was presented in 2010, and a number of issues have been addressed in greater depth. A further update (version 3) is in progress. Publication is not expected to be before the second half of 2013. In that version, recommendations are then to be established for standards for all classes of vehicle.
Version 2 of the roadmap is the first to take account of performance and consumption characteristics, in which context particular attention is paid to the consumption of the charging stations themselves. Further relevant points are electrical safety, which is already covered by various standards from the field of electrical installations, and electromagnetic compatibility (EMC), for which requirements for the charging points are defined in the DIN EN 61000-6-2 and DIN EN 61000-6-3 standards. The topic of EMC can only be touched upon here: EMC at the charging points is being addressed by IEC/TC 69 and DKE/K 353 (IEC/EN 61851-1).
GAK 767.13/14.18 is examining the EMC stipulations for electric vehicles themselves. IEC/SC 77A and UK 767.1 are analyzing the limitation of feedback effects on the network. CLC/TC 8X and UK 767.1 are working on stipulations in the field of voltage quality in the public electricity supply networks. Structural and functional safety, and lightning and overvoltage protection are regarded as sufficiently standardized. Work is currently still in progress on a standard for the construction and extension of electrical systems with charging stations. In contrast, experts consider that operational reliability is not yet sufficient for practical use, and demand regular testing of the systems by qualified persons, without however setting out any firm requirements.
All the standardization projects are aimed at a period of the next five to ten years, in which the recommendations are to be put into practice. In addition, new standards will be necessary as soon as more widespread use of electric vehicles has been achieved. These will then contain stipulations on the reusability of batteries, on feedback into the network, on communication between vehicles, on a uniform voltage level (depending on experience from the market launch of electric vehicles) and on inductive charging during journeys.
Link to smart grids: Smart charging is seen as an essential element of the flexibility concept (DR, DSM)[27] in smart grids, irrespectively of whether charging is public or private (see also Use Cases in section 5, in the Standardization Roadmap on Electromobility and the Use Cases of SG-CG / Report by the Working Group on Sustainable Processes).

[26] German Standardization Roadmap on Electromobility, Link: http://www.dke.de/de/std/e-mobility_neu/Seiten/E-Mobility.aspx/

[27] DR Demand Response, DSM Demand Site Management

2. Systematic Standardization Process and Use Cases

The smart grid is a complex system which not only comprises the various domains of electrical power supply, from generation through distribution up to the consumer, with the relevant services and systems, but also interacts with adjacent areas such as home, building and industrial automation and electromobility. This leads to a multitude of functions, actors and components which have to interact if an efficiently and safely functioning system is to be ensured. Interoperability must be ensured in that context, not only in the area of the power generation and distribution processes, but also in the business processes and market communication with the actors involved. This is also reflected in smart grid standardization with the various directly or indirectly involved standardization organizations and technical committees.
A structured and coordinated procedure is therefore required to facilitate the timely compilation of the necessary high quality smart grid standards. Methods of system engineering, such as those used in development processes for complex systems, are therefore deployed in smart grid standardization.
The Use Case methodology was already addressed in the first version of this roadmap. Even if some technical committees (TCs) previously drew on Use Cases internally for their work, this way of working has in the meantime become unexpectedly widespread on both national and international levels. From the very start of work on Mandate M/490, the Use Case methodology of the European Working Group on Sustainable Processes in IEC TC 8 on development of IEC PAS 62559, "IntelliGrid methodology for developing requirements for energy systems" was used. This document already described the function of Use Cases as tools and provided practical notes on their application. In that context, IEC PAS 62559 was based on the methodology developed by the Electric Power Research Institute. As with IEC TC 8, the other working groups of the Smart Grid Coordination Group use or integrate the Use Case method with the aim of defining requirements jointly with applicability in all committees.
One of the main components of the system engineering approach is modelling of the system as a whole on the basis of a functional architecture, i.e. using individual functions which interact with each other to describe the system. Definition of the functional architecture takes place on the basis of the Use Cases which are implemented or supported by the system. Use Cases also constitute the basis for stipulation of the requirements for the system. In addition, it is necessary to identify the actors which are responsible for the various functions of the system, so that these can be defined and assigned accordingly. The functional architecture, Use Cases, actors and requirements form the basis for the standardization of functionality and interfaces.
In complex systems, a simplified model which describes the main functions of a system and their interactions independently of designs and technologies is required for functional modelling. In the course of European smart grid standardization, the Smart Grid Coordination Group defined the Smart Grid Architecture Model (SGAM) for that purpose. The SGAM uses a

multidimensional approach to take account of various aspects of a smart grid.

The dimensions represent interoperability, domains of the energy system and the hierarchical automation zones **(figure 6)**. Interoperability is one of the most important preconditions for the widespread introduction of smart grids, and is ensured by standardization. As a result, interoperability is explicitly taken into account in the SGAM, on the basis of the interoperability criteria defined by the GridWise Architecture Council [GWAC2008][28]. The interoperability categories define interoperability requirements on the various system levels. In the SGAM, the categories are grouped in five interoperability layers:

Business: Represents commercial and operational aspects such as business models, product and service portfolios, business processes and market structures, taking account of political, regulatory and economic stipulations and requirements.

Function: Represents functions and services independently of their specific implementation. The Use Cases, actors and requirements are defined on this level.

Information: Represents the exchange of information between the functions, actors and components. Provides semantic interoperability on the level of data models and objects.

Communication: Defines protocols and communication mechanisms for interoperable data exchange between components.

Components: Shows the physical distribution of the system components. This covers actors, sensors, energy system components,

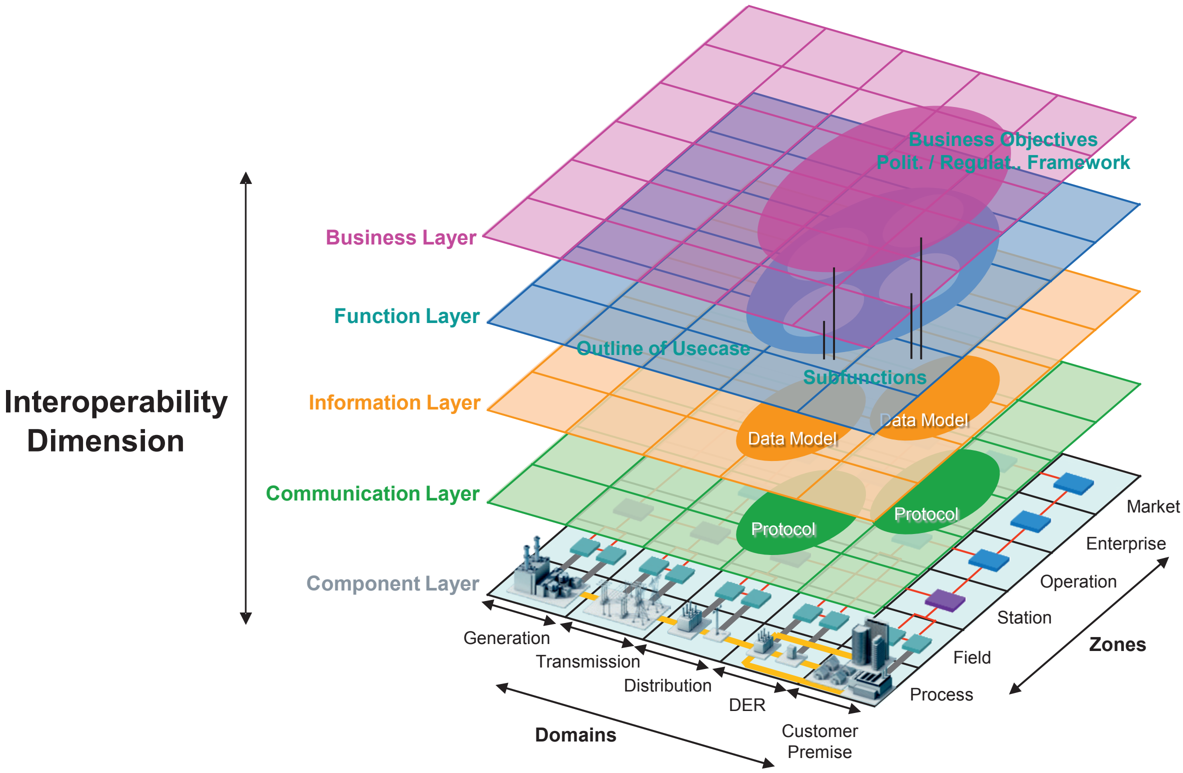

Figure 6: Smart Grid Architecture Model (SGAM) (source: Smart Grid Coordination Group)

[28] [GWAC2008] GridWise Architecture Council; GridWise Interoperability Context-Setting Framework; March 2008; http://www.gridwiseac.org/

communications network infrastructure and control and monitoring components.

The five domains represent a physical grouping of the complete power supply chain in the future energy grid.

Generation: Generation of electrical power on a large scale, for instance using fossil raw materials, nuclear energy and hydro power, offshore wind farms and large-scale solar power plants. Centralized generation facilities are normally directly connected to the transmission network.

Transmission: Organization and infrastructure for the long-distance transmission of electrical power.

Distribution: Organization and infrastructure for distribution of electrical power to the customers.

DER: Distributed, relatively small generators of electrical power (including storage facilities), typically in the range from 3 to 10,000 kW, which can be directly controlled by the distribution network operator.

Customers: Industrial, commercial and private energy consumers and producers.

The hierarchical zones are broken down into the following:

Process: Primary components of a power grid (e.g. transformers, generators, cables, loads and switches).

Field: Process monitoring and control (e.g. sensors, actors and protection relays).

Station: Accumulation of process monitoring and control functions, data concentration.

Operation: System monitoring and control within a domain (e.g. generation, transmission and distribution management).

Enterprise: Commercial and organizational business processes, service and corporate infrastructure (e.g. billing systems, plant management, customer management and purchasing).

Market: Market processes and interactions (e.g. energy trading).

The SGAM model used contributes to the common understanding of all those involved and allows the interactions between the system components to be examined. The interactions in the system are described by Use Cases. A Use Case describes a function of the system with all the actors concerned. If, then a system is to be completely described, it must be ensured that all the relevant Use Cases are considered. In a complex system, this can lead to a very large number of Use Cases, which in some cases differ in details only. A systematic process is therefore necessary to collect, manage, analyze and harmonize the Use Cases.

Use Cases are contributed by an extremely broad range of actors and stakeholders, such as research projects, national standardization committees, industrial associations, manufacturers and users. Legislative and regulatory requirements are also considered. In the case of smart grids, for example, the functionalities of smart grids and smart meters defined by the European Commission's Smart Grid Task Force [SGTF_EG1][29] form a basis for the collection and evaluation. The Use Cases are described on the basis of a Use Case template which takes account of the viewpoints of experts from the various areas of the system (IT experts, system engineers and domain experts). IEC supplies a specific template for the energy sector [IEC62559][30]. For simple management and editing, the Use Cases are stored electronically in a Use Case Management Repository (UCMR). The UCMR further contains a list of actors and requirements. As shown in **figure 7**,

[29] [SGTF_EG1] EU Commission Task Force for Smart Grid: Functionalities of Smart Grids and Smart Meters, Link: http://ec.europa.eu/energy/gas_electricity/smartgrids/doc/expert_group1.pdf/

[30] IEC/PAS 62559; IntelliGrid Methodology for Developing Requirements for Energy Systems; January 2008

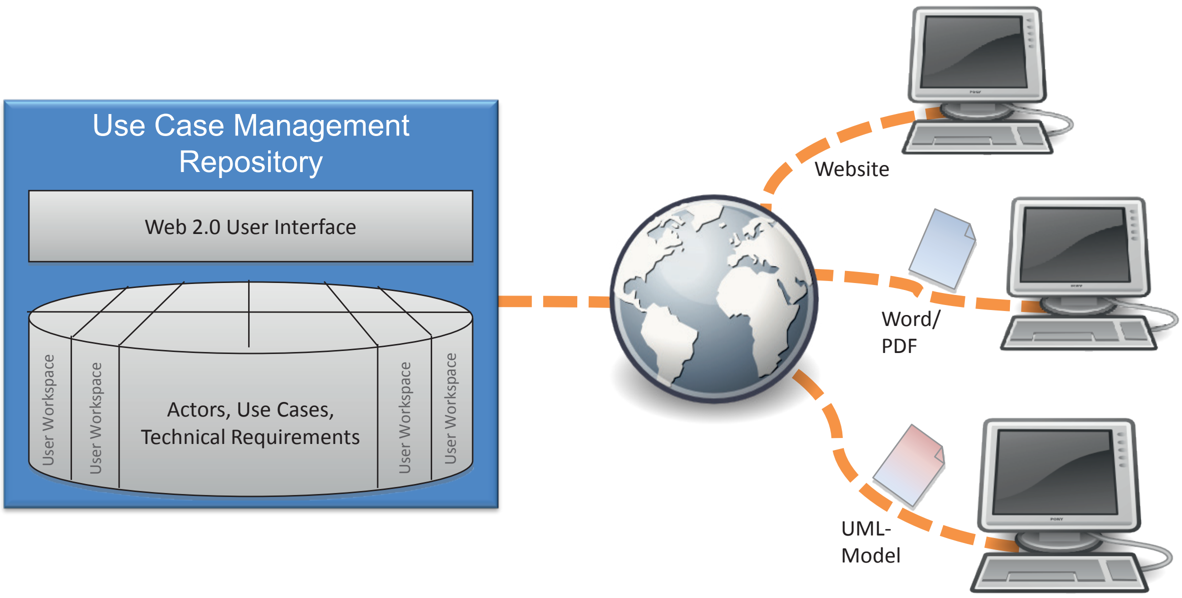

Figure 7: Use Case Management Repository (UCMR) (source: OFFIS / DKE)

the repository supports a wide range of formats for the export of Use Cases, including the software engineering language UML for direct further processing by suitable software tools.
The quality of the Use Cases is checked. Similar Use Cases are grouped together to form generic Use Cases. This is an iterative process, which finally leads to validated generic Use Cases. Generic Use Cases are characterized in that they describe a general concept which meets with broad acceptance and does not represent implementation in any specific project. These then serve together with the SGAM as a basis for the analysis of the necessary standards and specifications. The Use Case concept combines the functional description with actors which interact (data exchange and communication). The term "actor" is consciously broadly defined, encompassing market roles (e.g. distribution network operator, customer or energy supplier – in some cases market roles are or will be defined by law) and system actors which can be functional systems (e.g. a network control system, SCADA or a database) or physical components in an architecture. Especially in standardization on an international level, actors tend to be defined generically by their task or functions. In the national legislative environment, these generic actors can then be assigned to concrete market roles (the task of a measuring service provider is, for example, assigned to various market roles in the member states of the EU), or generic actors can be assigned to components in concrete projects (e.g. communications channel -> broadband connection + router or Power Line / PLC via concentrator, etc.).
IT security and data protection play a special role in the implementation of the future smart grids. They must therefore be taken into account in standardization and in the standardization process right from the start. To achieve this objective, the required security levels (SLs) and data protection classes (DPCs) are stipulated for the generic Use Cases. These, for their part, determine the security requirements which are set down in the standards.
In the form of the partial aspects described above – the model, Use Cases, actors, security and data protection – all the components are

now available for the performance of a systematic study and possible expansion of the smart grid landscape. This interplay is presented schematically in **figure 8.**

The process diagram shows how, with the aid of the partial aspects described above, the requirements for smart grid standards can be stipulated step by step, and how they can be used to identify existing standards and gaps in the standardization system. New standards then have to be compiled or existing standards supplemented to fill those gaps. This leads to new standardization activities with responsible technical committees, work programmes and the expected results. The final step is then the drafting of the standards. It will be explained in the next section that profiling of standardization can, for example, take place on a national level. In that process, generally formulated standards are adapted to reflect certain background conditions such as national legislation or reduced to firmly stipulated alternatives to provide for consistent interoperability, and specific stipulations added where required.

It is to be assumed that a large number of smart grid standardization projects will be necessary. As these cannot all be processed at the same time, continuous prioritization is to be applied. The relevance of the Use Cases at a particular point in time, the expected market developments, technological developments and also the available standardization resources are to be taken into account. In the course of time, new market models with new actors will also arise, and new Use Cases will be defined. These will be fed into the standardization process and can themselves lead to new standardization projects. In this systematic and iterative process, the necessary smart grid standards will be compiled in high quality and within the required time frame. The process allows the gaps in the standardization system to be identified and the standardization activities to be targeted at the necessary functionalities. Within the European smart grid standardization body, the Smart Grid Coordination Group, this process has been implemented with the energetic support of DKE and German industry, and it is also

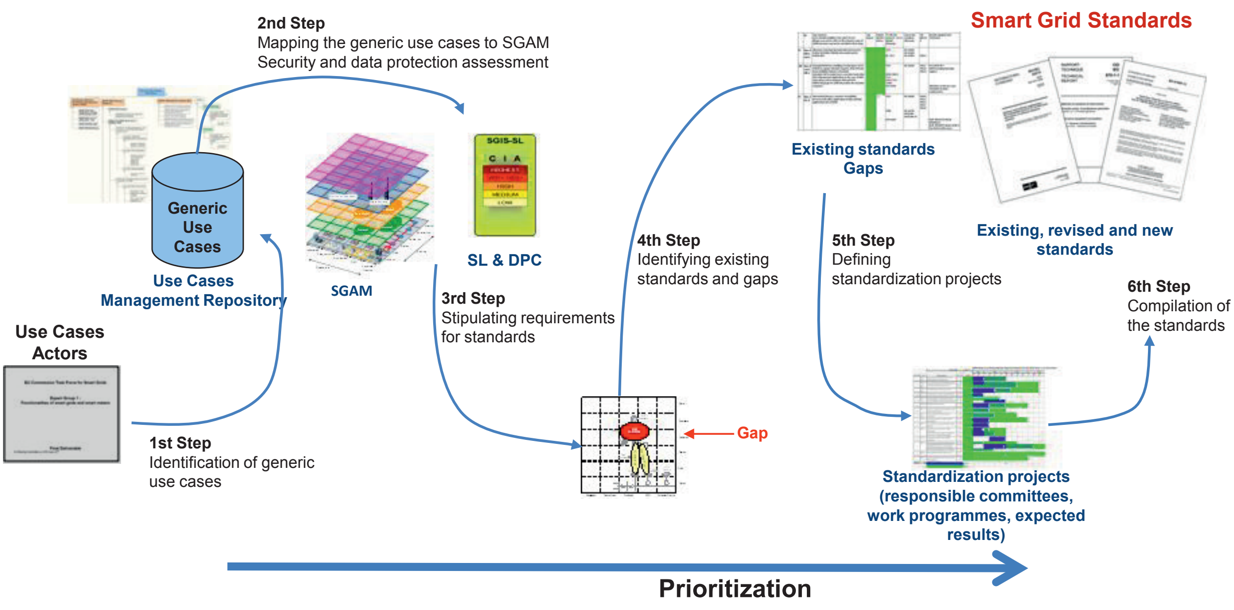

Figure 8: Sustainable process for Smart Grid standardization (source: SG-CG)

reflected in the corresponding national activities of DKE. The Use Case Management Repository was developed by DKE for Use Case collection and made available to the Smart Grid Coordination Group.

Conclusion

It is important to emphasize once again that this systematic process provides an opportunity to bring standardization work in line with the basic functionalities involved in complex issues, and thus to provide a common objective for the technical committees. In this respect, the methodology presented is not only of interest in Smart Grid standardization, but can also be applied to many other innovative and complex topics with intensive networking within the standardization scene.

3. Profiling

The basis for the successful development

- of an intelligent energy system with interconnected centralized and distributed generation, higher demands for the energy efficiency of the system as a whole, bidirectional energy flows, high volatility of renewables, challenges ranging from grid management to low voltage, and incorporation of the end customer

is

- achieving the necessary high degree of flexibility along the added value chain in the energy industry with control of consumption and generation, energy storage, joint system management and import/export mechanisms between customer objects, regions and higher level interconnected network grids.

3.1 Use Cases and Processes

The process of standardization in smart grids on the basis of a uniform Use Case specification has already been described. In that process, gaps in the standards are identified and new standardization projects established to create new or extended standards.

The machine-to-machine interaction described by Use Cases in the environment of a variety of market and network actors on the deregulated and unbundled energy market and different regulations from the various states in the European interconnected network grid requires a Use Case methodology as the agreed means of description with

- agreed terms (e.g. for domains, actors, functions, components, data models, communications, security and energy flows) and ontologies as the basis of formalized descriptions of systems, functions and workflows[31],
- a reference architecture on the basis of terms for common understanding of the mapping of functions to domains, components, actors, etc.,
- an agreed form of description for Use Cases which are used by actors, act on certain components in domains and reliably communicate with each other,
- ergonomic requirements in the interaction between human beings and system components to influence functions,
- assignment of requirements to ensure information security, and
- use of software tools for formalized acquisition, storage, display and use of Use Cases

The process of specifying Use Cases on the basis of a uniform methodology is illustrated in **figure 9**.

The standardization process proper, based on the Use Case methodology, ends, as shown in figure 9, with the new or amended standard.

Further profiling of the standards can be necessary, especially on the national level, for application. In that process, generally formulated standards are adapted to take account of particular background conditions such as national legislation. In particular, however, the implementation of standards can also be defined for spe-

[31] See also the work in DKE/AK 111.0.5 "Terms for Smart Grids" and the online glossary created there: https://teamwork.dke.de/specials/7/Wiki-Seiten/Homepage.aspx/

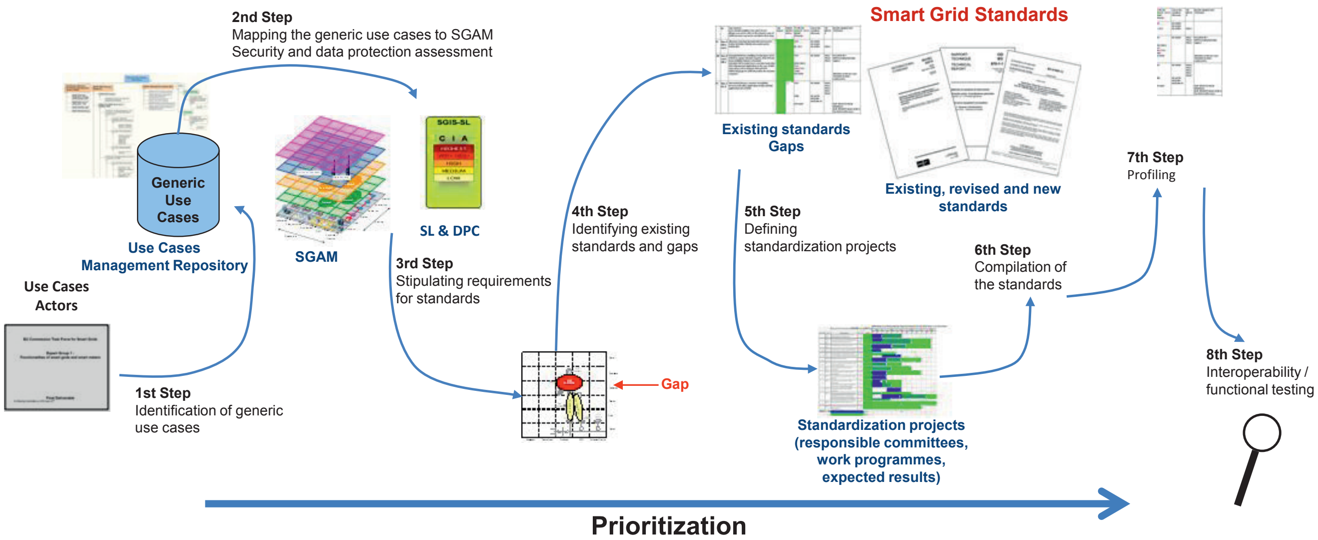

Figure 9: Sustainable process for Smart Grid standardization (source: DKE)

cific applications to ensure consistent interoperability.

On the basis of a standard profile in conjunction with a cluster of Use Cases, a test procedure can be defined, with which for example certain devices or systems which promise interoperability with regard to a particular use cluster can be tested for conformity with the corresponding standard profile. With tested conformity in implementation of the standard profile, the interoperability of different devices and systems used within a use cluster (e.g. incorporation of a CHP system in a virtual power plant with the use cluster "provision of energy and flexibility") can be guaranteed.

A procedure for profiling is proposed in the following section.

3.2 Processes and Profiling of Standards

Prioritizations are to be made in the further detailing of Use Cases and their subsumption in processes, so as to identify the high-priority functionalities in the conversion of the energy system. The aim here is to filter out the differences and innovations between "today's world", with static feed-in processes and minimal consumer communication, and "tomorrow's world" of energy industry processes with market integration of energy from renewable sources, consumer integration and market-network interaction, so as then to set priorities for further processing within the framework of those differences.

It is also necessary on the one hand to specify generic Use Cases only to such an extent that generally valid requirements for standards in the European and global contexts can be identified, while, on the other hand, it is possible in the following process specification to take account of national peculiarities by consolidating them in granular Use Cases, on the basis of which profiling of standards takes place at the interface between the activities of Use Cases.[32]

[32] In this connection, BDEW draws attention to the use of new techniques of process modelling, which have been applied since 2009 in accordance with UMM 2/ UML (to UN/CEFACT specification). Here too, the benefit of standardized, syntax-neutral process modelling with Use Case, sequence, activity and class diagrams is seen in the opportunity for versatile transformation into various communications standards. For modelling, the European harmonized role model ebIX/ENTSO-E/efet, which has also been adopted in the CIM data model at IEC and in the reports of SG-CG, is referenced.

Specification of generic Use Cases down to granular Use Cases is in progress. The specification and standardization process has been described in detail above. Attention is therefore to be devoted in the following to process definition and profiling. The objective is to agree upon defined market communications, market-network communications and end customer communications, in which context of course voluntary market agreements are just as productive as any necessary obligations in the energy industry for communication in the important processes of "tomorrow's world".

A procedure is proposed with a methodology for the use of Use Cases, derivation of functional processes and data objects (e.g. calculation factors which will be decisive in future) and subsequent definition of technical market communication. In today's energy market processes, standards and specifications are in particular used in market-network communication in the context of end customers changing supplier and the exchange of necessary measurement data and master data. This also concerns the transmission of measurement data in the course of balancing and of billing for network use. The corresponding processes for the functions named were defined on the basis of Use Cases in 2005. Then, in the next step, those processes were profiled for the EDIFACT specification[33] and corresponding message types defined. These message types were then introduced and declared mandatory by the Federal Network Agency, for example as UTILMD and MSCONS message types for change of supplier and the exchange of measurement data and operating schedules. Work is currently in progress on a further application, as it has also proved necessary to stipulate corresponding message types for feeders into the grid. On the basis of analogous Use Cases established for market communication in 2005, fundamental processes for feeders are being described for identification of a system, for the start and end of supply and for various processes involving master data and billing.

It can be assumed that these processes will work as long as we are in the conventional scenario with conclusion of a supply contract for a relatively long period of time until termination, and billing performed at monthly or annual intervals with simple static and quantity-based tariffs. Use of the text-based mail messages with EDIFACT files functions in such a context. However, new requirements for future machine-to-machine communication extending down to the end customer, taking account of the political desire for market integration, are to be examined. Quality assurance of the automatically transmitted data is to be ensured.

The research results to date, for instance from the E-Energy projects, and the global development trends, permit the expectation that the application of conventional EDIFACT messages to the processes described under conditions of a market integration of renewables systems with increasing use of dynamic tariffs, with operating schedule and price negotiation processes and with more frequent processes of supplier change, will have to be reconsidered.

→ To this extent, a separation of process description and process stipulation (see the Business and Function layers of the SGAM model[34]) and their use in the profiling of information models (Information layer of SGAM) and communications standards (Communication layer of SGAM) is proposed.

In this context, certain processes relevant to the system could be stipulated as mandatory in the

[33] EDIFACT Electronic Data Interchange For Administration, Commerce and Transport (United Nations), created by CEFACT Centre for Trade Facilitation and Electronic Business.

[34] See section 2, based on the work of SG-CG on the European level.

spirit of the social demand for transformation of the energy system. There should, however, still be an opportunity to develop futuristic, innovative processes. The technical implementation leading to a communications standard should however be interchangeable with various layers, corresponding to the SGAM approach. In this respect, EDIFACT as an information model, for example, could have a shorter life than the superimposed level (Function layer with Use Cases).

Looking forward, therefore, the aim is for "tomorrow's world" of dynamic energy market processes to be describable in that, for example, feed-in at fixed supply rates is increasingly replaced by feed-in on the basis of market integration. This means that although a system will still only have to be registered once in the network for the purposes of integration, market integration will be able to take place through suppliers, virtual power plant operators or directly via dealers and aggregators, and, with dynamic generation prices, a daily change of market partner in the marketing of the energy quantities will be possible on the basis of operating schedule and price negotiation processes. Similarly, it should also be possible to market flexibilities (e.g. yellow interaction between the market and network in the BDEW traffic light model) through market partners in the sense of redispatching[35] to compensate for volatility in certain market and network situations. To that extent, there is also a need here to describe the processes more extensively, and on that basis to stipulate and profile the information model and communications standards for particular Use Cases or Use Case clusters.

Communication in "tomorrow's world" is currently being described on the European level in the contexts of EU Mandates M/441 (Smart Metering), M/490 (Smart Grid) and M/468 (Electromobility). It is to be assumed that this will be secure communication over the Internet Protocol using modern web technologies such as XML and web services. If these stipulations are made nationally, account has to be taken of the security mechanisms required for communications networking of a critical infrastructure. Initial trials are therefore being conducted with the definition of security and communications mechanisms within the framework of the BSI smart meter gateway, and at the same time XML and web services and extensive security mechanisms are being used.

→ It is therefore to be recommended that, on the one hand, the current work on market communication for static feed-in for "today's world" be completed with separation between processes and the information model and communications standards, but that on the other hand work should commence without delay on market/network/end customer communication for "tomorrow's world" on the basis of prioritized Use Cases.

For separation of the functional process definitions and the technical market communication, the procedure described below can be adopted.

The basis of the new process definitions are Use Cases, each of which maps a functionality in its context in the use cluster in conjunction with various actors in the energy sector. These Use Cases can be contributed by various professional groups, but then require harmonization to ensure general acceptance. In this way, for example, Use Cases have been collected in E-Energy, and then further in the DKE Expertise Centre for E-Energy / Smart Grid Standardization, and finally in the Smart Grid Coordination Group and the Smart Metering Coordination Group (Mandates M/490 and M/441) on the Eu-

[35] Redispatching – Changes to an agreed operating schedule, traditionally used in power plant deployment planning.

ropean level, and then consolidated to form the generic Use Cases.
This shows that Use Cases are available above all for network automation, market integration, demand side management with variable tariffs, smart metering and the integration of electromobility. On the aggregating level, Use Cases are currently also being collected in the Working Group "Smart Grids and Meters" of the BMWi Platform on "Future-Oriented Grids". In the next step, functional process definitions are to be derived from the Use Cases as sequences of individual activities and used as a basis for profiling of the required information models and communications.

→ The following steps are proposed to establish the connection between currently pressing topics of "today's world" and the topics of "tomorrow's world" that will become relevant in future:

a) *Functional process definitions and stipulations* for initial processes in "today's world" concerning system registration and identification, termination, master data polling and editing, and billing.[36]
b) *Stipulation of separate information model and communications standards for the functional process definitions,* so as to obtain profiled data types, defined interface messages and short-term market communication for feed-in with fixed supply fees.

The following steps can then be performed in accordance with the process presented in section 2:

c) Step 1 as in figure 9: *Extension of the functional process definitions and the security definitions to cover "tomorrow's world" using the Use Case descriptions*, for example on the market and network integration of renewables facilities and electric vehicles, on dynamic tariffs for end customers and on daily negotiation of prices and operating schedules in energy quantity and flexibility products as a basis for future market/network/end customer communications. These Use Cases serve as the basis for the further standardization process.
d) Step 2: *Mapping to the reference architecture* (steps 2 and 3), stipulation of the fundamental standards for the information models (information layer) and communications / protocols (communication layer).
e) Steps 4 to 6: Definition of the need for further development in standardization and processing.
f) Step 7: Profiling on the basis of step 1 and step 2
   a. *Stipulation of extended data models[37] for the corresponding use clusters:*
   --> e.g. data descriptions at the use interface of profiled data types derived from standards for the relevant use cluster for tariffs, operating schedules, systems, etc. (e.g. in CIM and IEC 61850).
   b. Definition of the technical market communications in technical standardization committees (DKE) with involvement of the energy industry committees. In that process, profiling of the communications and security standards to be applied to the relevant use cluster with assigned Use Cases, information models and processes should also take place:
   --> Communications stacks on the basis of the Internet Protocol
   --> Technologies for message presentation (web services and XML notation method)

[36] Already in preparation. See BDEW proposals

[37] Stipulation of data modelling: For instance, the decisive calculation factors ranging from today's static tariffs to dynamic price models with electricity identification or identification marking of the origin and type of the energy supplied.

--> Messages derived from the profiled data types for the process interfaces between various actors, taking account of profiles from security standards to ensure information security during the transmission of messages (involving BSI to achieve end-to-end process security).
These stipulations may have to be backed up politically by mandatory stipulation by the Federal Network Agency of functional process definitions and technical market communication with different durations.

g) Testing of interoperability
With this procedure of separation into different layers and process steps, stipulations which are currently necessary for “today’s world” may be used successfully and appropriately for the transformation of the system into a new “tomorrow’s world”.

4. SGIS – Smart Grid Information Security

4.1 SGIS – Introduction

The necessity of incorporating data protection (privacy) and data security (information security) in smart grids became apparent in Germany in the E-Energy projects, and, through the German involvement, also flowed into the reports on European Commission Mandates M/468 and M/490. The importance of Smart Grid Information Security (SGIS) increased significantly in the context of those mandates. Essential contents of this section are therefore attributable to the activities of the SGIS Working Group on Mandate M/490.

The fundamental procedure aims at taking information security into account right from the start in the implementation of functional and commercial Use Cases in standards. This is intended to create a standardization framework which ensures that information security is ensured in all smart grid functions and applications by technical and organizational security measures providing the required level of protection throughout the process, e.g. in the communications channels and in the system components.

It is of great importance to design information security interoperably in the various fields of application of smart grids and to bring the requirements in line with the state of the art in each phase of the service life of the systems.

The innovation cycles in information technology and, by association, the requirements for information security and their implementations, demand a significantly greater amount of work than was previously necessary in the energy sector.

The standards and elements of the SGIS Toolbox, to be presented below, constitute a good basis for the specific information security of smart grid services, but further development of the standards to achieve and preserve end-to-end information security is a continuous process.

4.2 SGIS – Fundamental Requirements

In principle, the fundamental protection goals of information security are also to be considered in the context of smart grids:

- Confidentiality
- Integrity
- Availability

The protection goals stated above are merely listed and do not constitute any order of priority. For the sake of cost-effectiveness and appropriateness of the security measures applied, these protection goals need to be evaluated in the context of each individual Use Case. In the case of of smart meters, for example, significantly greater importance will be attached to confidentiality and the protection of personal data than with the control or automation systems in the smart grid; there, the focus is on integrity and the availability of the information.

In order to achieve the required security level for a particular Use Case the appropriate security controls have to be implemented and applicable standards (or profiles) must be applied.

4.3 SGIS – Standardization Landscape

Based on the relevant standards and documents (e.g. ISO/IEC 27001, ISO/IEC 27002, DIN EN 62351, NERC/CIP, NISTIR-7628 and the reports of the EU Task Force on Data Protection and Data Security in the Smart Grid and of the Joint Working Group of the European standardization organizations) four quadrants have been defined in which a gap analysis has been performed on SGIS standardization requirements. These four quadrants are shown in **figure 10**. The analysis identified gaps and areas for improvement, which were addressed to the relevant standardization committees (national and international). In concrete terms, detailed improvements to the existing standard IEC 62351 were proposed and made available to TC 57 WG 15 via liaison. The improvements result from the advances in the development of cryptographic algorithms and security protocols. Moreover, new Use Cases have led to new security requirements to be addressed.

Figure 11 illustrates the smart grid focus in the SGIS standardization landscape. It was further noted that some relevant standards have different objectives. For this reason, the standards were divided into three types:

1. Requirements standards (technologically neutral)
2. Implementation options (dependent on technology, domain, ...)
3. Interoperability profiles (specific stipulation/ restriction of implementation options

Figure 12 presents the overall consideration for all four quadrants, also with regard to the remainder of the Standardization Roadmap. The focus is on the coming years.

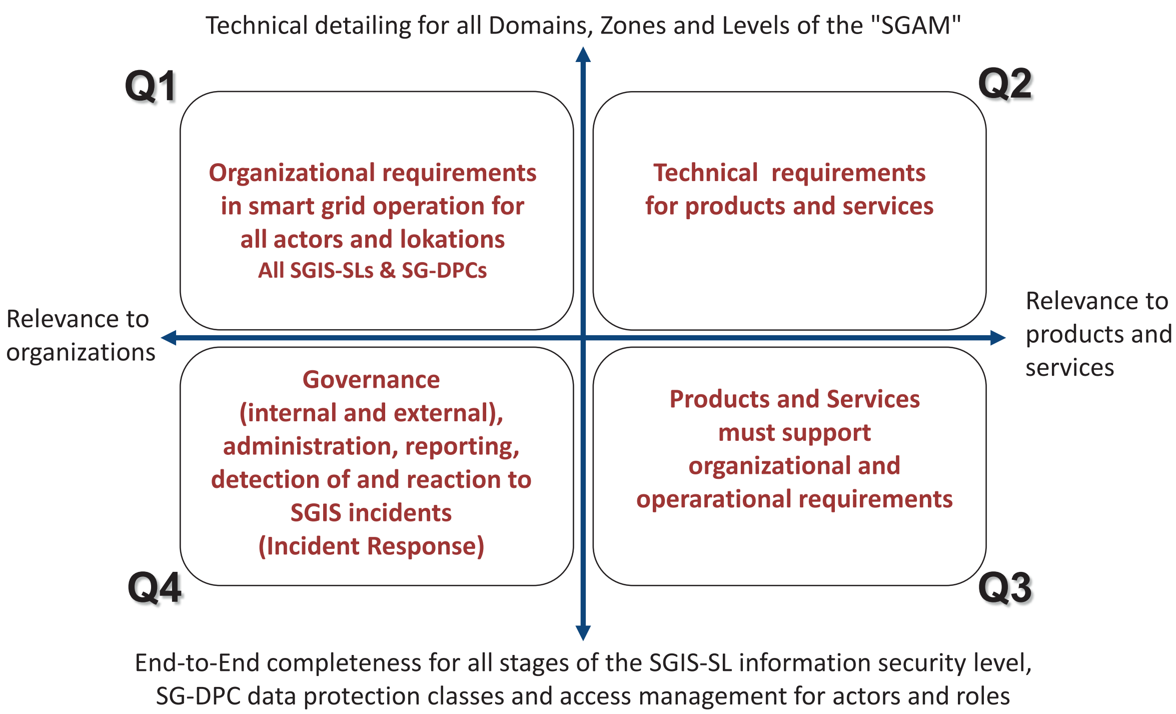

Figure 10: SGIS – Four quadrants with standardization requirements (source: Smart Grid Coordination Group SG-CG/SGIS)

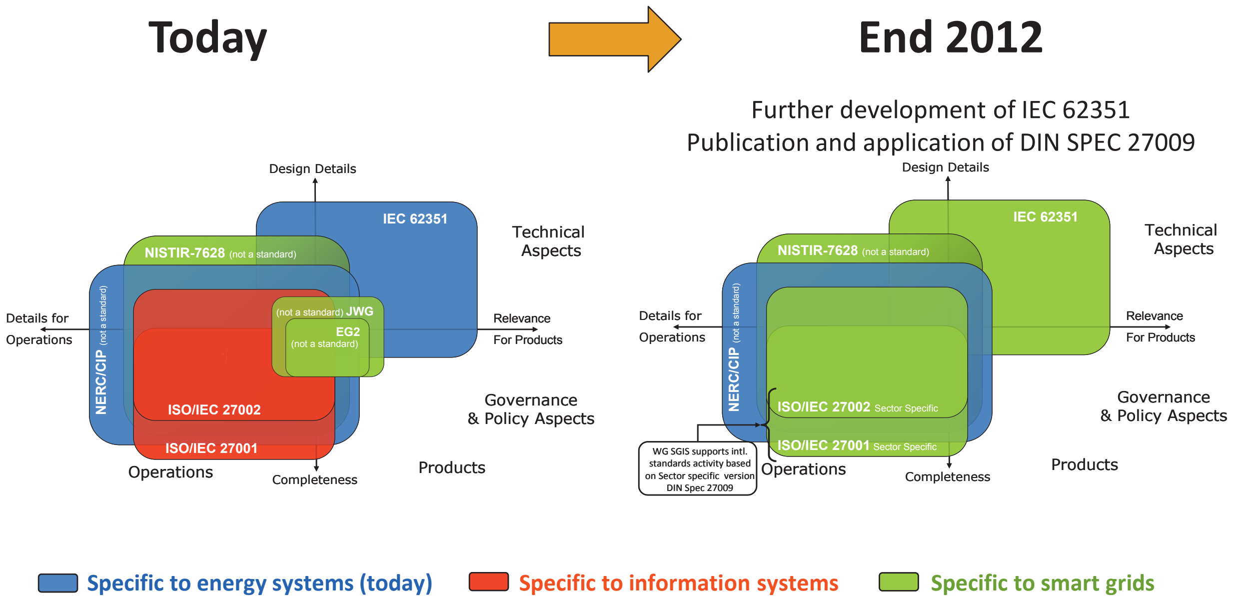

Figure 11: SGIS – Present standardization landscape (source: SG-CG/SGIS)

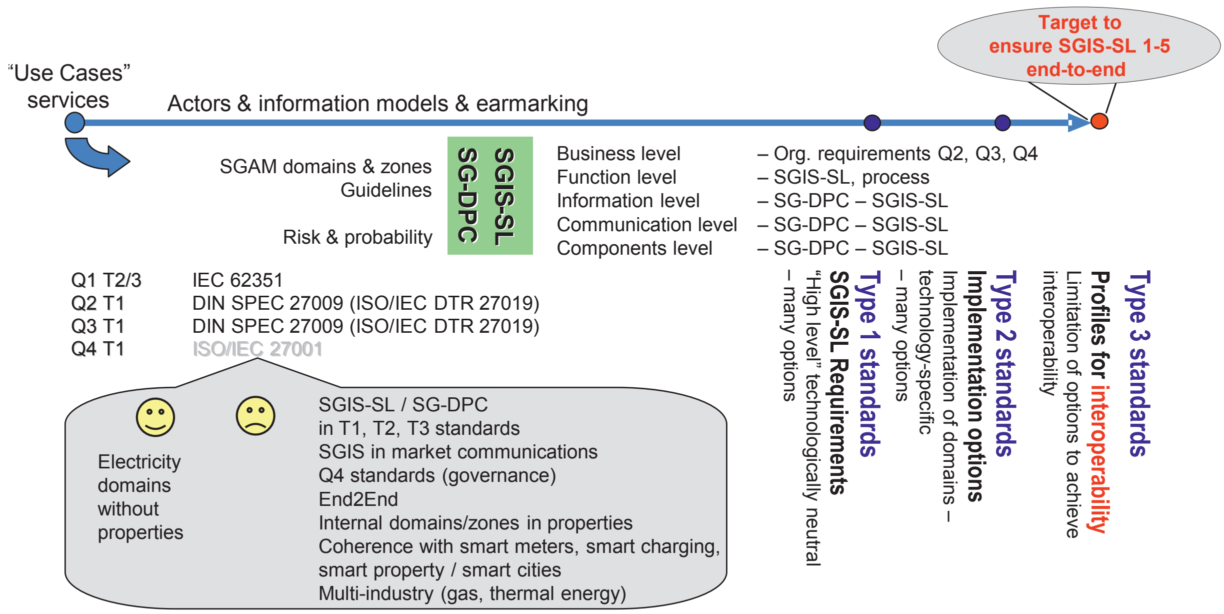

Figure 12: SGIS – Status and focus in SGIS standardization (source: SG-CG/SGIS)

4.4 Key Elements

4.4.1 Smart Grid Architecture Model (SGAM)

Information security is part of the Smart Grid Architecture Model (see section 2 for a detailed description). The fundamental responsibilities in smart grid as a whole are to be considered as technical and organizational requirements. The SGAM, as a universal model, provides a consistent method of assigning information security to the Use Cases.

As mentioned above, information security is an integral part of the SGAM. It has effects on all layers, domains and zones, and must therefore be taken into account explicitly in each SGAM cell. This is described in the following sections on the basis of the security levels and the SGIS Toolbox.

4.4.2 Security Levels

In order to facilitate quantification of the need for protection, a five-stage security level system was introduced. The assignment of a Use Case to a security level is dependent on the effects a security incident has on the system and on the probability of its occurrence. A Use Case related threat analysis is therefore necessary to determine the protection requirement and the security level.

An example: The German power system is interconnected with the European power system. It is therefore appropriate to define the highest information security level for impacts which put the European supply system at risk of failure. The European interconnected system grid is however also affected by SGIS events which have an impact on the national power systems. In the risk impact analyses, the highest risk impact stage is therefore assigned to power flows > 10 GWh. As this also has to be avoided for rather seldom events (low probability of occurrence), the highest information security level is required here, too. Further assessment criteria for risk impacts, estimates of probability and the resulting analysis of the necessary stage of information security level are described in the report by the SG-CG/SGIS Working Group.

Initial statements on the three highest stages (as these are relevant to the critical infrastructures of the energy information system) can already be found in IEC 62351 (Part 10). The Business layer (SGIS-B) contains organizational requirements and requirements for the system components, monitoring, analysis and reporting obligations. These are linked in this lay-

SGIS-SL	Security Level Name	Examples of Grid Stability Scenarios
5	Highly Critical	Assets whose disruption could lead to a power loss above 10 GW
4	Critical	Assets whose disruption could lead to a power loss from above 1 GW to 10 GW
3	High	Assets whose disruption could lead to a power loss from above 100 MW to 1 GW
2	Medium	Assets whose disruption could lead to a power loss from 1 MW to 100 MW
1	Low	Assets whose disruption could lead to a power loss under 1 MW

Figure 13: Examples of SGIS Security Levels (source: SG-CG/SGIS)

er with the credentials of actors (technical systems and individuals) and with their roles and their access entitlement information.
The Function layer (SGIS-F) contains functional or commercial applications which define the actual access rights.
The Information layer (SGIS-I) defines the information models with the data protection classes (DPCs).
The information from the data models is transmitted or received via the Communication layer (SGISC). This layer contains the technical requirements for all information security levels which are applied to the communication interaction between the systems and ensure that the relevant SGIS Security Level (SGIS-SL) is maintained.
The Component layer (SGIS-C) contains all the technical requirements for all components in the smart grid information system and their required SGIS-SLs. The access entitlements for actors and roles are implemented on the system component level. As a result, the authorization and access mechanisms and the encryption and decryption mechanisms are included in this layer.
The following example shows that this universal model permits the application of the SGIS standards in the context of specific Use Cases as part of SGAM. This approach is part of the SGIS toolbox.

4.5 The SGIS Toolbox

The SGIS Toolbox provides guidelines for determination of the necessary security levels in relation to domains and zones, and specifically for the two defined data protection classes SG-DPC1 (Personal Data) and other data protection classes (SG-DPC2). Furthermore, it is also possible to determine a Use Case specific protection level and the application of related standards and specifications. This method provides for a detailed analysis of risk impacts, enabling

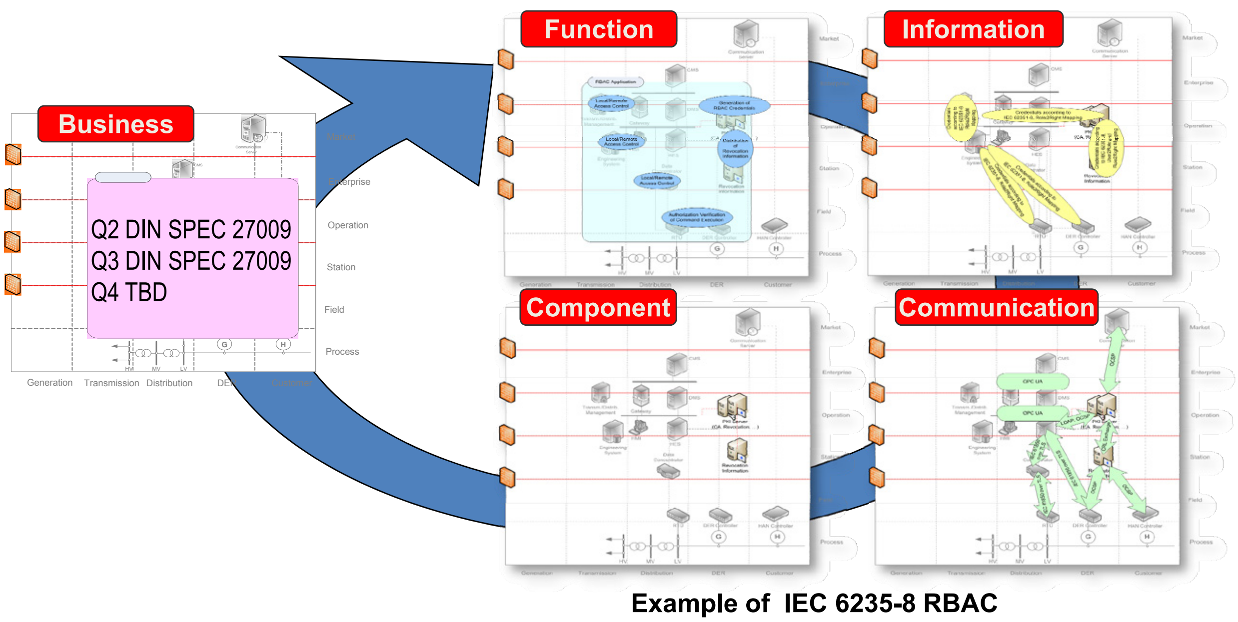

Figure 14: Example of SGIS standard mapping in the SGAM-SGIS layers (source: SG-CG/SGIS)

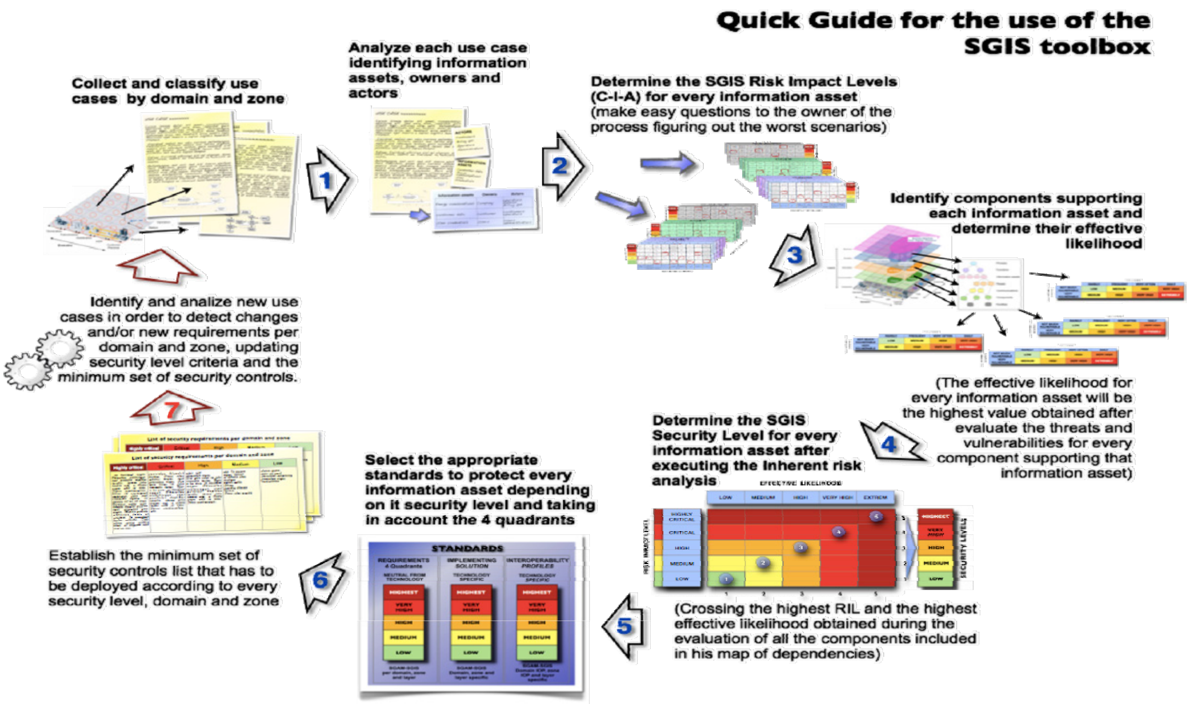

Figure 15: Use of the SGIS Toolbox (source: SG-CG/SGIS)

the discussion of SGIS per SGAM layer as well as the assessment of the associated incident rate. Based on this, the applicable standards for the requirement, implementation and interoperability profiles can be selected. **Figure 15** shows the methodology for use of the SGIS Toolbox.

4.6 Summary of the SGIS Results

The fundamental requirements for information security (confidentiality, integrity and availability) have different importance in the various Use Cases across domains and zones. While availability has the highest priority in critical infrastructures, especially confidentiality with regard to personal data is important to private consumers. Other basic requirements such as authenticity, allocatability, non-disputability and reliability have to be assigned to corresponding data protection classes (SG-DPCs) on creation, processing, storage, transmission or deletion. These are also to be applied for sector specific considerations. The smart grid is a system of interconnected and interacting systems. The SGIS considerations refer exclusively to risk impacts which arise from insufficient information security.

Apart from the Smart Grid Architecture Model (SGAM) and the SGIS levels it contains, the key elements include the five-stage information security levels (SGIS-SLs) and the two smart grid data protection classes (SG-DPCs).

The information in the smart grid must be protected at all times in accordance with the data protection class (personal data = SG-DPC1 and other data = SG-DPC2) and the necessary security level. All actors (technical systems or individuals) must be authorized for access on the relevant level. Corresponding guidelines and recommendations for implementation have been compiled. The standardization landscape is illustrated by the areas of standardization (four quadrants) in which SGIS has to be available as requirements, implementation and interoperability standards. It can be seen that standards relevant to SGIS are already available today. Nevertheless, there is still a need for them to be developed further.

In order to provide a pragmatic procedure for the actors in the smart grid, an SGIS Toolbox has been made available, allowing the identification and application of information security standards for particular Use Cases in a simple way. Moreover, it also helps to reveal gaps in certain areas of standardization.

5. Use Cases in Smart Grids

Following the more theoretical deliberations in the previous sections, a number of Use Cases are now to be briefly outlined as examples. For further details, please consult the descriptions in the Use Case Management Repository (UCMR)[38].

5.1 Example Use Cases from the Working Group on Sustainable Processes

The work on Use Cases in smart grids is currently being performed in several standardization committees. In the following, so-called generic Use Cases (GUCs) compiled in the course of the work on Standardization Mandate M/490 by the Working Group on Sustainable Processes of SG-CG (SG-CG/SP) are to be presented. These generic Use Cases are based on a collection of over 450 Use Cases in which many stakeholders throughout Europe are involved.

The Working Group on Sustainable Processes has not limited its work to the collection and evaluation of the Use Cases, but also developed a methodology: Clustering was developed as a means of grouping the multitude of Use Cases. An overview of a group (cluster) of Use Cases is presented in a conceptual description. A cluster can correspond to a system and be shown in a reference architecture (SGAM) which facilitates description of the actors and relationships in the Use Case. Examples of such a system include the flexibility concept described below in figure 16, or a smart metering system (see the report from the Smart Metering Coordination Group on Mandate M/441).

[38] UCMR Use Case Management Repository, read only access to the UCMR: https://usecases.dke.de/sandbox/, Login: LookatMe, Password: LookatMe

Use Case Cluster

The SG-CG/SP has focused its activities on the following clusters:

- *Flexibility Concept*

  Flexibilities denote opportunities to adjust electrical loads or generators – a process partly also known as demand response or demand side management. Flexibilities such as changes in output, postponing power consumption or providing reactive power are useful for network management and/or optimization on the energy markets.

  A fundamental distinction is made here between the provision of flexibilities and the use of flexibilities by the network or market. For the first area, a general functional reference architecture, a conceptual description and initial Use Cases, some in detail, have been created. For the area of using flexibilities, the conceptual description serves as a basis for further discussion and for the description of further Use Cases. The traffic light concept developed by BDEW in Germany has been drawn upon here and taken up for application with Use Cases. While the first area, "providing flexibilities" can be regarded as quite homogeneous – even in the light of the large number of Use Cases which have been provided – elaboration of the second area is still in progress due to its greater complexity. The EU Commission has also devoted attention to this item in its Smart Grids Task Force to examine the regulatory

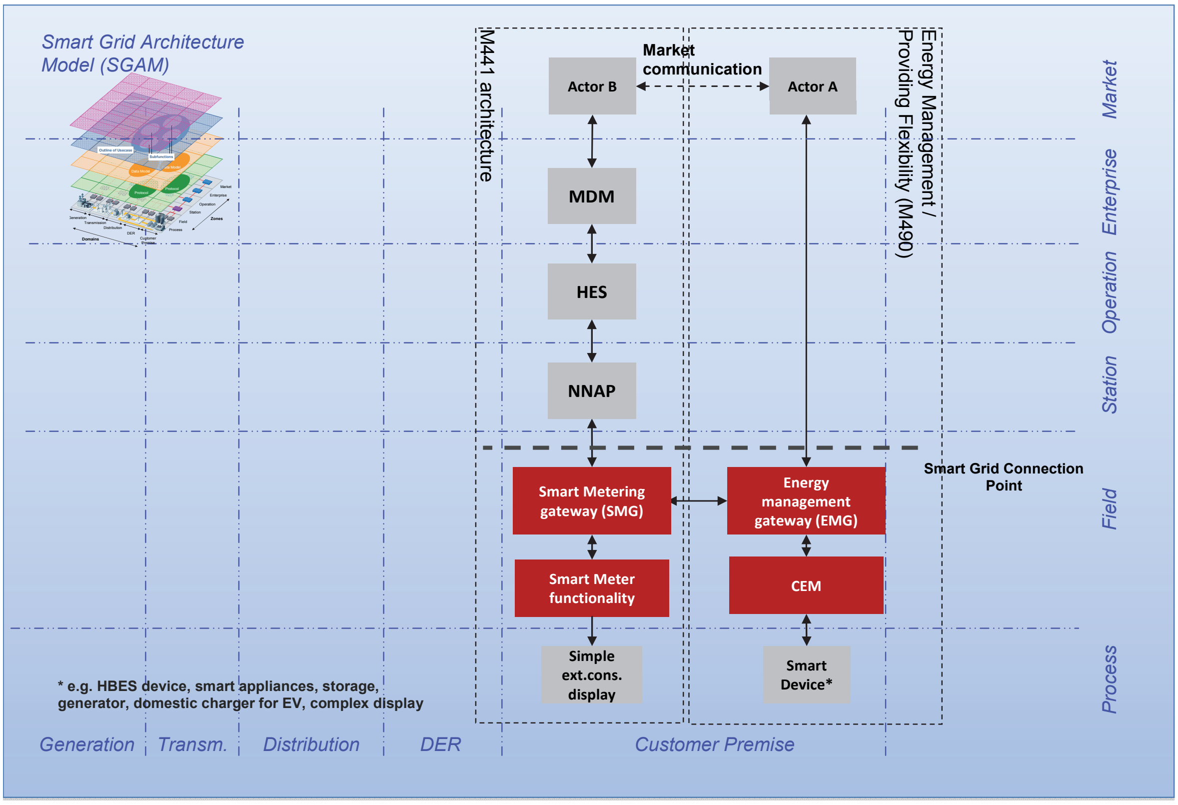

Figure 16: Functional reference architecture of the flexibility concept (source: SG-CG/SP)

conditions for new smart markets. The legislative background, which is still in flux, has a great impact on the description of Use Cases for standardization. In reverse, the discussions and work to date have also influenced the investigations conducted by the EU TF.

- *Smart Charging for Electromobility*
  On the basis of Use Cases submitted and experience gained in research projects in the Netherlands, a concept comprising high level Use Cases for charging and for the charging infrastructure has also been established for this field.

- *Network Management*
  Many Use Cases for network management, grouped together in the following high level Use Cases, have also been named: automatic fault location, isolation and restoration (FLIR), Var Volt Optimization (VVO), load and generation forecasts, microgrids, monitoring in the distribution network, and smart load shedding with emergency signals.

In accordance with the further developed methodology, further GUCs are currently also being compiled in the other working groups of the Smart Grid Coordination Group. In the report by the Working Group on "First Set of Standards" (FSS) in particular, the connections between systems, Use Cases, architectures and standards are being identified and illustrated on the basis of many systems which already exist today and are regarded as the basis of smart grids.

Further information can be found in the official reports of the Smart Grid Coordination Group, created with intensive German assistance and to be published in the near future.[39]

[39] Drafts of the reports have been made available to the relevant DKE and DIN committees for comment. The official reports are to be published in early 2013.

DKE Use Case Management Repository

All Use Cases are or will be deposited in a database application initiated by DKE and created as a prototype by OFFIS. Together with the management and updating of the Use Cases, it is a fundamental aim of this online application to enable the description of Use Cases to be performed jointly by various experts, both within committees and in cross-committee activities. The database thus also serves as a communications platform between various committees and industries. These initial approaches have been received favourably by the standardization experts. On the basis of the DKE tool, an implementation within IEC is currently being reviewed.

5.2 Example Use Cases on Flexibility

The following high level Use Cases have been established in the Working Group on the basis of the Use Cases provided in the collection by stakeholders for the area of "providing flexibility":

1. Receiving consumption, price or environmental information for further action by consumer or a local energy management system.

This Use Case, also referred to as demand response, fundamentally assumes that customers react to information from the network or market themselves (manually) or by means of their energy management systems (automatically). Only information is provided, then, and devices are not controlled directly from outside, with the result that only statistical reactions can be expected to information or warning signals. Where appropriate, feedback from an energy management system preset in its options can determine the effect of an incentive transmitted from the network (see "Information from smart devices" below). Four detailed Use Cases draw upon this high level Use Case:

- Information on consumption / generation
- Price / environment information
- Warning signals

Warning signals can on the one hand be sent by the energy management system to the devices if contractually agreed maximum purchase quantities (power or energy) are exceeded. On the other hand, the information channel can also carry warning signals from the network operator to ensure network stability (e.g. requests to reduce power). In this Use Case, the reaction to this signal is of course left to the customer, the connected devices or the energy management system.

- Information from smart devices
  Where corresponding contractual terms are in place, an external market role receives information on generation and consumption.

2. Direct Load / Generation Control

This high level Use Case describes the opportunity to specify requirements for consumption and feed-in from outside. In accordance with legal or contractual stipulations, devices (e.g. generation facilities such as PV systems) can be controlled from outside or via the energy management system by one or more external market roles (e.g. energy suppliers, aggregators or network operators). In comparison with the previous Use Case, the decision is not made by the customer, but by the external market role.

If the signal is transmitted to an energy management system it can control the connected devices accordingly to fulfil an external request. A request to reduce feed-in to the network can, for example, be sent. In that case, the energy management system could decide not to switch off the PV system but instead to store the energy in a local battery or in an electric vehicle, or to increase in-house consumption by bringing forward the time at which certain devices are switched on. This Use Case is used, for example, by network operators for network stabilization or by aggregators to optimize energy trading and purchasing (participation in energy and balancing energy markets).

The following Use Cases add details to this high level Use Case:

- Control of consumption, generation and/or storage

  A request to reduce or increase consumption or feed-in is sent by an external source. The energy management system converts that request into control signals to the connected devices. A distinction is made between two scenarios:

  1. The device (e.g. washing machine, refrigerator, heat pump, etc.) decides itself whether the command can be executed at the present time.
  2. The device follows the control signals without making any decision itself (direct control).

- Emergencies

  Whereas previously a general request was sent, urgency can be emphasized with an emergency signal. The energy management system can directly switch or inform connected devices accordingly.

- Energy management system controls smart devices

This Use Case is the basis of some of the Use Cases listed above.

3. Flexibility Offerings

On the basis of research projects[40], a further high level Use Case proceeding from negotiation between participants in a flexibility market has been established. Enquiries and offers can be exchanged in real time, in order for example

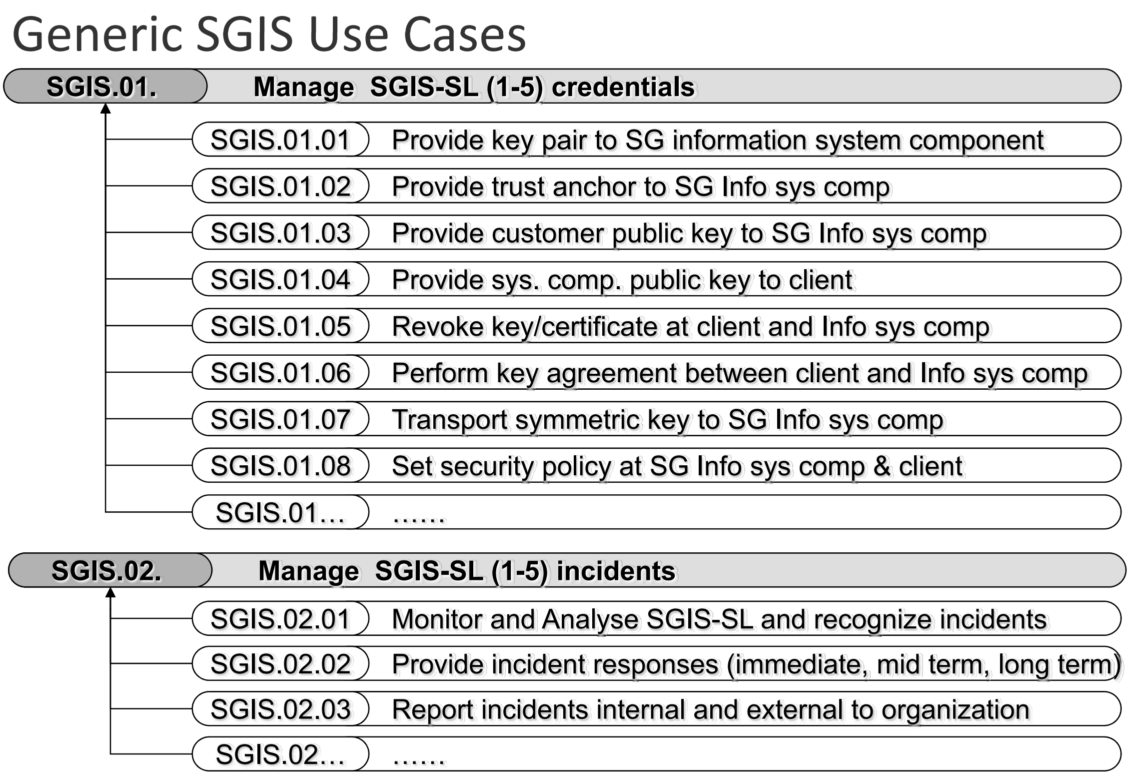

Figure 17: Generic SGIS use cases (source: SG-CG/SGIS)

[40] E.g. E-Energy projects and the EU MIRABEL R&D project

to compensate for deviations from forecasts caused by renewables (PV or wind). The course of negotiations, the acceptance of an offer, activation and billing are described in the Use Case.

5.3 Examples of Generic SGIS Use Cases

Generic SGIS Use Cases are described in Annex 5 to the SGIS report from the Smart Grid Coordination Group. Standardization activities have also commenced on this aspect (see IEC 62351-9) and are available as a Committee Draft (CD). Consequently, only an overview of the Use Cases is presented here.

The operation and administration of system components in smart grids – no matter which domain/zone they are located in – will require a higher security level for administration, irrespectively of whether this takes place locally and physically at the actual location of the system component or by remote access. In both cases, the relevant SGIS-SL, which may be different for local and remote access, must be ensured. The SGIS generic Use Cases described at present deal with management of the credentials for access to such system components and management of SGIS incidents.

Beyond the outline presented above, German work has contributed further Use Cases to the European activities in the field of security. The Use Case "Pre-Communication SGIS Capability Check" is particularly worthy of mention here. This Use Case is in future to provide an opportunity to ensure end-to-end implementation of information security levels at the state of the art at all times, before information worthy of protection is transmitted to other actors in the smart grid information system. This can of course only take place along the communications lines if the information models are marked for identification in accordance with the data protection classes SG-DPC1 and SG-DPC2 (in a similar fashion to the transport of hazardous goods).

Information security also plays a role in the functional / commercial Use Cases. The Use Case "Implement Energy Supply Contract for Customer in Smart Property Sub-Cell", for example, cannot be executed without linking to the above SGIS generic Use Cases.

5.4 Example Use Cases for Network Integration of Electromobility

The following Use Cases are examples illustrating the connection between smart grids and electromobility. They are closely connected with the flexibility Use Cases cited above[41].

Frequency-stabilizing Charging

The charging power of an electric vehicle can be controlled on the basis of the network frequency. The charging process therefore also represents a service similar to primary balancing power. This system service is equivalent to a closed loop control effect which is immediately available and automatically increases the purchase of electricity when the frequency rises, and vice versa. Communication is not necessary in this case; merely local frequency measurement and a resulting setpoint for charging power are required. Any available facility for feedback into the grid doubles the potential. If secondary balancing power is to be offered, extended technical facilities in the form of communications with a control station are required. From the present point of view, electric vehicles are therefore not very suitable to take part in the secondary balancing power market. Tertiary control also requires a connec-

[41] See also the Standardization Roadmap on Electromobility and the report by SG-CG/SP.

tion to a control station, but its requirements for communications are less critical in terms of time. It is conceivable that frequency-stabilizing charging could be included in the connection conditions for electric vehicles.

Tariff-Optimized Charging

In this case, the power supplier has to provide the vehicle with tariff information. On the basis of these data and user preferences (prospective time of departure), an optimization algorithm can determine the lowest cost charging strategy. The permissible charging power at the connection point also has to be taken into account. For implementation, unidirectional communication would be required for transmission of the variable tariff. It is to be ensured that no abrupt change of power flow occurs on change of tariff, so that frequency stability is not put at risk and local overloads of network equipment are avoided.

Two objectives can fundamentally be pursued with variable prices. On the one hand, the energy supplier can set his tariffs to reflect exchange prices and pass on part of the profit to the customers in the form of lower energy costs. On the other hand, network operators can use electricity prices to provide incentives for more even use of the existing capacities, creating a cost advantage in the expansion of the networks, part of which could be passed on as compensation to the end customers.

5.5 From Vision to Practice – Use Cases

Use Cases are also, and above all, intended to describe future developments and visions in terms of concrete functions and requirements. This will be illustrated by the following description of a new cluster with corresponding Use Cases.

5.5.1 Interaction Between the Market and Grid – the "Traffic Light Concept" as a Concept and Use Case

Within the German Association of Energy and Water Industries (BDEW), which represents all market roles defined by law, the "traffic light

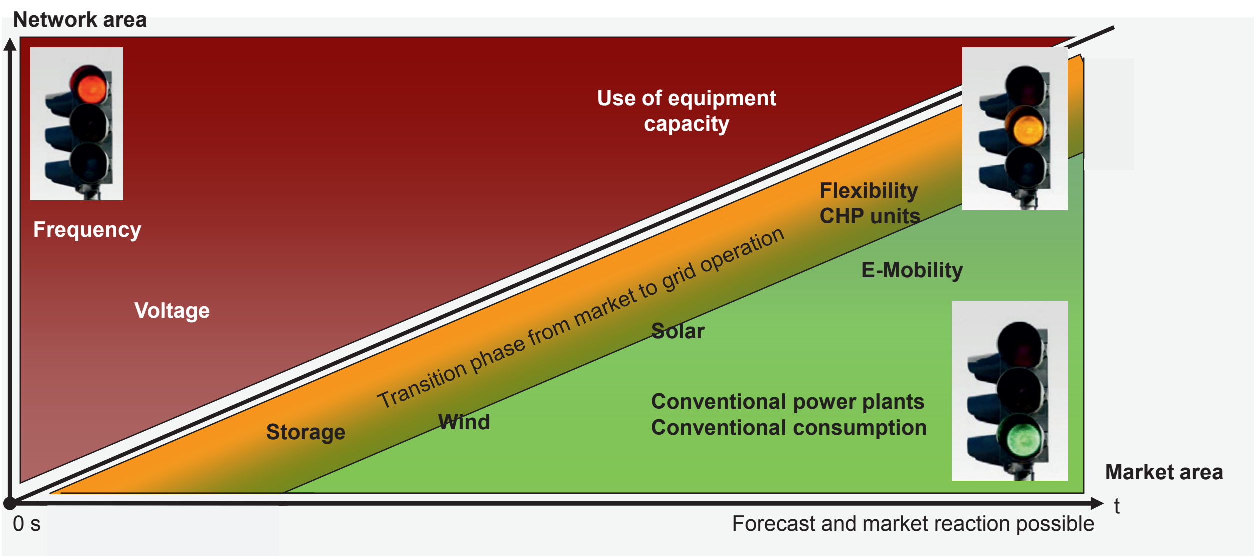

Figure 18: Traffic light concept – a Use Case and concept for the classification of Use Cases (source: SWM Infrastruktur GmbH)

concept" is used to describe the interaction between all market-relevant roles (e.g. suppliers, traders, producers using conventional and renewable energy sources, storage facility operators, etc.) and the roles regulated by law (network operators, metering point operators, etc.). The aims of the traffic light concept are to ensure on the one hand that there is as much of a free market (consumption and feed-in) as possible and on the other hand that system stability (frequency, voltage, etc.) is maintained at all times for all market participants and, finally, for all network users, especially the consumers.
In relation to Use Cases, the traffic light concept can on the one hand assist conceptually to classify Use Cases, so as better to understand the relationships between them, as the traffic light concept provides a simple and easily understood basic pattern for representation of the highly complex and various interactions and dependencies between all the market participants, i.e. the network users and the network operators responsible for the system.
The grading within the traffic light concept provides the network operators responsible for system stability and the market participants / network users with information on the current and forecast condition of the network. The market participants use this information to implement their business models in an optimum manner and to offer new products (Use Cases) within the context of a smart grid. With this function, the traffic light concept is, on the other hand, itself a Use Case.
The "green" traffic light phase indicates that no critical network conditions are forecast or have been noted by the responsible system operators. All entitled market participants are informed or can obtain information on this network condition. (The nature of the information channels or platforms has not yet been a matter for consideration.) All market products are available for supply and demand without restriction. The network operators are monitoring the network but not intervening.
In the "red" traffic light phase, systemic limit infringements are detected or reliably forecast by the responsible network operator. In order to preserve system security, the responsible network operator accesses suitable market participants (statutory or contractual) or his own equipment with setpoints or direct instructions / control commands aimed systematically at maintaining system stability or avoiding network conditions which endanger the system.
These two network conditions have already been defined in detail and are in general underpinned by the Energy Industry Act and the network expansion obligations stipulated by legislation in Germany. This means that if the condition of the network is in the red phase and at risk, the network operator responsible for the system already intervenes directly in the market. The existing mechanisms include for example direct instructions to suitable generation units (e.g. activation of operating reserve), load shedding, and also feed-in management for renewables facilities. The green phase is already defined by the statutory network expansion obligations. The network operator is obliged to dimension the system for the maximum theoretical feed-in capacities and for the maximum load peaks. The market can offer its established products at all times without restriction. These expansion obligations require networks to be designed to the maximum for any extreme situation, and therefore demand investments in the economy which, in the final analysis, have to be borne by all network users in the form of network fees.
In a smart grid, the objective is now to equip the network with so much intelligence that economically unnecessary network expansion is avoided and new products (network uses) be-

come commercially interesting for the market, thus achieving the optimum for the system in economic terms. These are the strengths of a smart grid. This mechanism, and the interaction between the market and the network are described in the BDEW traffic light concept as the "yellow phase". In the yellow phase, the smart grid proper, two mechanisms are fundamentally necessary from the point of view of the network operators responsible for the system.

- When sufficient reaction time is available, the responsible network operator signals the network conditions forecast in the long and medium terms, and informs the market participants of these. The market participants convert that information into suitable price signals or price-based offers. On the basis of experience which will be available in the future and the newly planned and forecast utilization of the network, the responsible network operator can then adjust the forecasts for the network. This process can be repeated as long as deviations persist in the yellow phase and there is sufficient lead time.
- When there is a lack of lead time, the network operator responsible for the system draws upon contractually assured offers, generation units (e.g. control reserve), loads (e.g. DSM, for instance by means of electric vehicles), storage facilities, etc., and controls these directly as provided for by the contractual conditions.

The aim of the actions taken by the network operator responsible for the system is to maintain system stability for the market and the network users at all times. The market participants can develop a new "flexi-market" in the yellow phase and thus make their contribution to the smart grid.

The detailed system limits and control variables, especially those for the yellow phase, are still to be developed.

In order to create rapid functionality, automated wherever possible, it will be necessary to provide this "traffic light concept" with agreed network rules and both global and local control mechanisms. The objective is to be as highly automated a traffic light system as possible, comprising regional control parameters (voltage and network load) and global control parameters (frequency). Apart from the detailed conceptual development, which has been initiated by BDEW, this will require joint development in a research project involving industry, regulators and standardization bodies. The traffic light concept has also been successfully presented on the European level in the Smart Grid Coordination Group and included in the report from the Working Group on Sustainable Processes.

5.5.2 Transmission Network / Hybrid Network

The energy turnaround is associated with ambitious targets for the expansion of generation from renewable energy sources. If these targets are to be reached, it will not be sufficient to replace conventional power plants with renewables facilities and make power from renewable sources cheaper. On the contrary, the move to renewable energy sources will lead to serious challenges with regard to the stability of the energy system.

Hybrid networks represent one answer to these challenges: With the aid of intelligent information and communications technologies (ICT), electricity, gas and district heating networks merge to form a resource-conserving, flexible and secure supply infrastructure which meets the requirements of the energy turnaround.

Such hybrid networks can only be controlled with the use of innovative ICT. There is a need for

a highly interlinked and flexible information, communication and I&C infrastructure throughout the chain of added value. In addition, adequate interfaces and processes between the supply infrastructures which previously existed in parallel have to be created. The process coupling of power-to-gas in combination with electricity generation from gas represents a central technology component, as do hybrid loads with variable energy sources.
In such a hybrid network, hundreds of millions of IT applications will be networked for communications and react to and with each other in an automated manner. Processes are necessary here to implement plug & play or plug & automate functionalities. These require the further development of existing standards and the definition of suitable profiles and tools for their use. Together with the projects on development of standards, projects must therefore also be put in place to focus on the implementation of findings from industry and scientific research in international standardization. Active participation in international standardization with innovative proposals is of especial interest in this context to export-oriented German industry.

Conversion and storage of energy in the gas network in situations of excess electricity supply (Power2Gas)

The Power2Gas Use Case describes the storage and transmission of energy from renewable sources (primarily generated as electricity) in the form of hydrogen or methane. In electrical supply systems with a large proportion of generation from renewables, methods of compensating for the intermittent yield-dependent supply gain in importance. Not only methods of generation and load management and network expansion, but also and above all new methods of medium and long-term storage of large quantities of energy are required to compensate for these fluctuations. In this way, renewable resources can be optimally used in the course of time, despite the fluctuations which occur, and can act as functional substitutes for fossil-fired power generation.
Firstly, hydrogen is produced by electrolysis in low load periods using electrical power from renewables, a process for which industrial electrolyzers of different performance classes already exist. Oxygen is created as a by-product (and can also be used commercially, but falls outside the considerations of this Use Case). The hydrogen can either be stored and used to generate electricity in CHP plants at times of low wind, or fed into the natural gas network as additional gas. Alternatively, hydrogen can be converted together with CO_2 into methane (natural gas). In this catalytic process, not only is water liberated as a by-product, but process heat is also created and has to be channelled off and either stored or fed into appropriate infrastructures (also beyond the scope of the present Use Case).
In this way, electricity from distributed generation facilities based on renewables is transformed into a high-density, CO_2-neutral energy source in the form of hydrogen and methane. The use of both the chemical by-products and the heat from the process improves the overall energy efficiency of the Power2Gas process described here.

Cross-domain load shifting by bivalent industrial consumers

This Use Case is connected to the previous Use Case, “Conversion and storage of energy in the gas network in situations of excess electricity supply (Power2Gas)”. The Use Case describes the coupling of the electricity and gas networks via bivalent industrial consumers (e.g. thermal smelting processes) who can operate their primary processes with different energy sources (in this case electricity and gas). In this way, primarily electricity and at the same time less gas can be used in situations of excess electricity supply (low load), and electricity consumption reduced and more gas used in times of low supply. This cross-domain/energy source load shifting in a hybrid network is significantly more efficient than a material conversion process involving hydrogen synthesis, methanization and subsequent reconversion into electricity (see Power2Gas Use Case).

Cross-domain load shifting by bivalent compressor stations (gas network infrastructure components)

This Use Case is connected with the Use Case "Cross-domain load shifting by bivalent industrial consumers" and represents a special case of cross-domain/energy source load shifting. After conditioning, the gas network infrastructure channels natural gas from the gas fields through pipelines to the consumers. It is fed in at high pressure. As a result of flow losses, the pressure in the pipeline falls, which necessitates the regular compression of the natural gas back to operating pressure in compressor stations. A compressor station, therefore, is a system in a natural gas pipeline (a piece of gas network equipment or infrastructure element) in which a compressor recompresses the natural gas to compensate for pressure losses.

While compressors in compressor stations have to date been of the gas turbine type, electrified gas compressor stations fitted with both electric motors and gas turbines could be operated directly by surplus electricity from renewable energy sources. In this way, primarily electricity and at the same time less gas can be used in situations of excess electricity supply (low load), and electricity consumption reduced and more gas used in times of low supply. This cross-domain/energy source load shifting in a hybrid network is significantly more efficient than a material conversion process involving hydrogen synthesis, methanization and subsequent reconversion into electricity (see Power2Gas Use Case).

A shift in time can thus be combined with the spatial shift in use of the motive gas from the compressor stations to power plants. This shift in time has the same electricity storage effect as the methanization of surplus electricity, which is why electrical compressor drives are to be counted among the Power2Gas technologies[42].

[42] H. Derlien, J. Müller-Kirchenbauer: Elektromobiles Erdgas – Stromspeicherung und Steigerung der Energieeffizienz durch elektrische Verdichterantriebe. In: gwf Das Gas- und Wasserfach, Gas – Erdgas, ISSN: 0016-4909, Jg.: 152, Nr.9, 2011, S. 558-563.

6. Prospects

"Predictions are difficult, especially when they are about the future."[43]

Many of the concepts developed in recent years with the first version of the Standardization Roadmap and the subsequent activities in Germany have been successfully adopted on the European and international levels. In reverse, the work and ideas on the international level enrich the national approaches. The large number of international standardization initiatives itself emphasizes the importance of contributing to the work on the international level. It is therefore to be expected that drafting and editing – as in many other areas of standardization – will increasingly take place in this transnational environment. In the light of the many national and partly overlapping international projects, concentration on a single set of international standards, preferably by continuation of the smart grids activities at IEC, is of essential importance.

This does not however mean that the national work should therefore be stopped, but rather that the focus of the national work will develop in two directions. On the one hand, cooperation on the international level by commenting on proposals and contributing ideas from Germany will continue as before. On the other hand, this Standardization Roadmap shows that in the national context there is a need for more concrete processing of the corresponding national conditions. It is therefore to be expected that profiling for application in Germany will now take place on the basis of international standards and Use Cases. The first examples of such work are the activities of BSI, VDE (FNN) and DKE on the smart meter gateway and the connection of distributed energy resources.

The work on the European level, with the recently published reports from the Smart Grid Coordination Group and the Smart Metering Coordination Group, serves as a blueprint for this development. In a fundamental approach, across committees, architectures and concepts have been established and new projects jointly identified. These new processes and fundamental analyses will be of great importance to both the national and the international standardization work. The analysis performed, for example in the "First Set of Standards" Working Group, provides an overview of the application of existing standards, architectures and systems in the smart grid. The newly developed processes and methods which have been described in detail in this document have the potential to revolutionize standardization work far beyond the application in smart grids. The use of Use Cases above all facilitates access to the body of standards for all parties involved and ensures consistent standardization work.

But all this also means that implementation of the new processes and methods will be an essential aspect of the future work. Furthermore, standardization organizations and committees have to be persuaded of their advantages. For only when the processes performed rather as examples by a small group of experts in the course of their work on the Smart Grid Standardization Mandate are accepted by the professional world as appropriate and are widely put into practice will the objective have been achie-

[43] Variously attributed to Nils Bohr, Mark Twain, Winston Churchill and many others (source: Wikipedia).

ved. Feedback to date on the national, European and international levels gives cause for optimism, but the initiators continue to be reliant on broadly based support. The description of Use Cases, for example, should not merely take place in a small group of experts, but be underpinned by cooperation from the experts in the technical committees, no matter whether existing Use Cases are to be commented upon, added to or detailed, or whether new requirements or functions are to be documented directly by Use Cases, involving further experts from other fields. The online tool used for that purpose is to be further developed.

Another development is already becoming apparent in the establishment of fundamentals and the analysis of the actual situation. In the near future, the fundamental deliberations will be increasingly replaced by concrete standardization work. The work on the European and international levels has already initiated an entire series of standardization projects. If the methodology which has been developed is congruently incorporated in these, one of the basic prerequisites for mastery of the smart grid will have been fulfilled. In that case, the Standardization Roadmap will in future be replaced by an update of the overview with the elements of Use Cases and reference architecture and systems (mapping in the SGAM) and the associated lists of standards based on an international consensus.

Appendix

Smart Grid Research and Best Practice

Some examples of studies and research projects with connections to DKE and standardization are presented below. This list cannot of course completely represent all the research activities on the smart grid, and attention is therefore drawn to the relevant information[44].

acatech (Future Energy Grid[45])

The FEG study by the German National Academy of Science and Engineering (acatech) describes the migration path to be taken towards the "Future Energy Grid" by the year 2030. The possible future scenarios to which that migration path must refer were identified. In order to create those scenarios, the decisive key factors, namely the expansion of the electrical infrastructure, the availability of a system-wide ICT infrastructure, the flexibilization of consumption, an energy mix, new services and products, end consumer costs, standardization and political framework conditions, were defined.

These eight key factors will be combined in various ways in a further step, forming three consistent scenarios for the year 2030:

1. *"20th Century":* The energy supply system is based on centralized, non-fluctuating generation which permits load-dependent operation as in the 20th century. There are only very few new ICT-based services on the market. As a rule, no move is made towards variable tariffs. The legislature has consistently implemented this system and strengthened competition.
2. *„Complexity trap"*: Although there is a strong intention in society and government to effect the energy turnaround, it has not been possible to implement it operationally in a uniform legal framework. The main actors have not been able to agree on a uniform procedure and uniform standards. This leads to problems in the expansion of the electrical infrastructure. The availability of new energy services is limited to a few basic functions. The inconsistency of the developments is reflected in high costs of the energy supply system.
3. *„Sustainable & economical"*: The restructuring of the energy system has been successfully completed by 2030. Smart grids have made an important contribution. With coordination between energy policy, society, utilities and technology suppliers, the restructuring has followed a long-term plan. The supply of electrical power is predominantly based on renewable energy sources. The system-wide ICT infrastructure together with the transmission and distribution networks expanded to meet demand from the backbone for efficient operation of the energy supply system and the platform for a multitude of new services which act as the driving forces for innovative business models. Competition on the energy market has increased.

In the next step, the question of what technological progress is necessary for each scenario

[44] See, for example, the study by the Joint Research Centre (JRC) of the European Commission: http://ses.jrc.ec.europa.eu/

[45] Link: http://www.acatech.de/?id=1389/

has to be answered. The possible development of each field of technology can be divided into a maximum of five stages leading up to the year 2030. For each of the scenarios, the degree to which a field of technology has to develop for the overall system described in that scenario to be implemented is described. One major challenge is the logical interdependence of the technologies in their development. In order to identify a migration path, therefore, all the dependencies between the development stages are determined. In this way, an overview is created for each scenario, allowing a time sequence for the necessary developments to be established on the basis of the dependencies found.

The "sustainable & economical" scenario corresponds most closely to the aims of the energy turnaround and has therefore been analyzed in greater detail. It becomes apparent that the development up to 2030 will cover three phases:

1. During the Concept phase (2012-2015), the course will be set for further development in the closed system layer in particular.
2. The Integration phase (2016-2020) is characterised by the systems in the closed system layer requiring increasing access options to components in the networked system layer. The rapid development of the ICT infrastructure layer is a key trigger in this process.
3. During the Fusion phase (2021-2030), the closed and networked system layers merge, as do the electrotechnical systems and ICT system. The now high mutual dependency between closed and networked system worlds requires, in particular, a high level of development among the cross-cutting technologies and ICT connectivity. Major importance is attached to security.

European Web2Energy project

The Web2Energy project[46] is sponsored by the European Commission in the period from 2010 to 2012 under the call "Energy.2009.7.3.5. Novel ICT solutions for smart electricity distribution networks". 12 partners from Germany, the Netherlands, Austria, Switzerland, Poland and Russia are taking part in the project. In the course of the project, the information and communications technology requirements for the following tasks have been redefined and tested in practice in operation of the HSE AG 20 kV network in Darmstadt:

- Network automation and telecontrol for condition monitoring, closed loop and open loop control in the distribution network – upgrading of nine secondary distribution substations and connection to the communications network
- Smart clustering of distributed generation facilities, storage facilities and controllable loads to form a virtual power plant (VPP) incorporating 15 generation facilities (systems with combined heat and power (CHP), wind, PV and hydro power), 12 battery storage facilities and 10 MW of controllable loads for optimization of market activities and securing the network compatibility of the grid subscribers
- Smart metering and involvement of consumers in the electricity market by means of variable tariffs in six residential areas with 200 pilot customers.

Figure 19 provides an overview of the functions and shows the data traffic required for their implementation between the systems involved (server) and the control centre (client).

The recommendations of the German Standardization Roadmap are consistently implemented in the project. For the first time in the distri-

[46] Link: www.web2energy.com/

Smart Grid Distribution Network Automation	Smart Market Virtual Power Plant	Smart Market Smart Metering

Tasks, Functions and Objectives		
Voltage and load flow monitoring for integration of distributed generation facilities and new loads, voltage control, shifting of sectioning points for fault rectification and overload reduction, improved supply quality	Aggregation of distributed generators, storage facilities and controllable loads for balancing and optimized market participation for energy, system services, CO_2 certificates	Market integration of electricity customers by dynamic tariffs – motivation for energy efficiency by visualizing tariffs, consumption and costs, commercial benefits for traders and customers
Data to be Communicated		
¼ h meter readings, measurements of *I*, *U*, *P*, *Q*, status of switching conditions, switching and tapping commands, status of short-circuit current indicators, resetting of short-circuit current indicators, display of remote/local control	¼ h meter readings, measurements of *I*, *U*, *P*, *Q*, P_{th}, E_{gt}, *P* and *Q* setpoints operating schedules (*P*, *Q*, 96 ¼ h) switching commands status information	1 h meter readings, tariff signals, day ahead and intraday tariff forecasts, current consumption, costs and savings via web or cell phone

I = current, *U* = voltage, *P* = power, *Q* = reactive power, *E* = energy, th = thermal, gt = thermally stored

Figure 19: Functions and data exchange (source: Web2Energy)

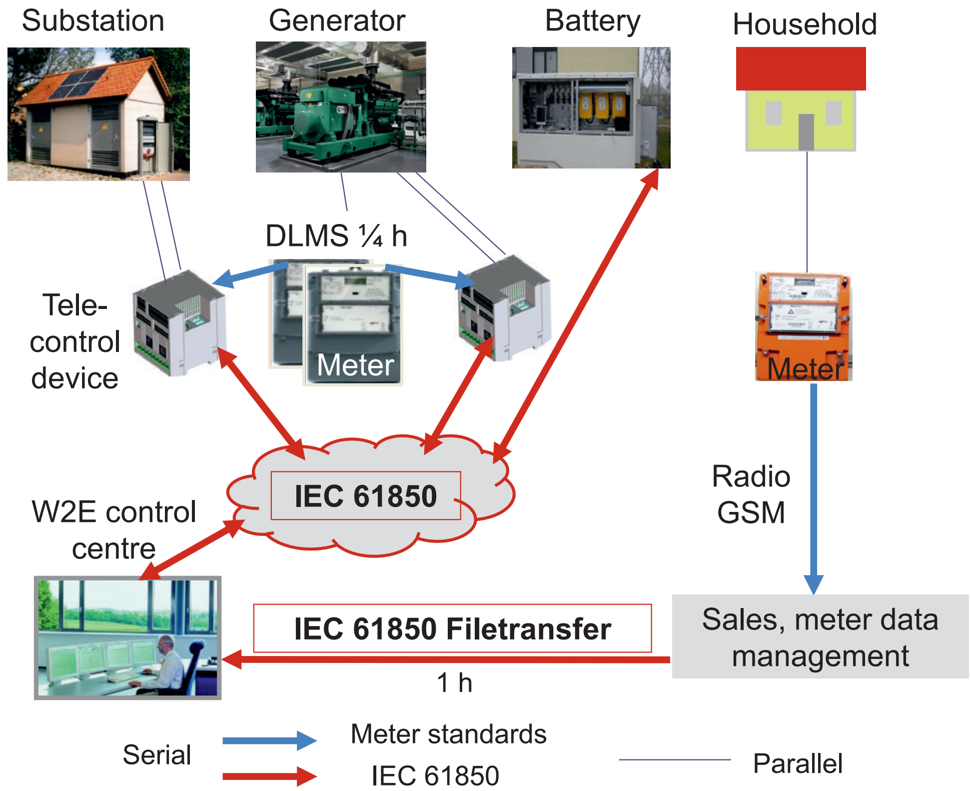

Figure 20: Web2Energy communications system (source: Web2Energy)

bution network, the forward-looking standard IEC 61850 is used for communications in combination with the Common Information Model (CIM) to IEC 61968/70 for data management in the control centre.

Figure 20 shows the practical implementation of the communications system with the newly developed components. Generating facilities and secondary distribution substations are equipped with small telecontrol devices and digital meters. The telecontrol devices convert the meter protocol DLMS to IEC 61850. The batteries have their own IEC 61850 interface. The data from the household customers are collected hourly by radio from the meter data system of the sales unit and transmitted to the W2E control centre by means of IEC 61850 file transfer. In this way, two methods of integrating meters in the communications world of IEC 61850 come to be used. In the control centre, all three functions mentioned are managed in a database based on the CIM class model, and monitored and controlled via the interactive VDU workstation.

The household customers are provided with information on the tariffs, their consumption and the costs. An important link in the process – data collection – communication – data management chain is the implementation of the data models of IEC 61850 and IEC 61968/70. The need for extension of both standards for application in the distribution network was identified in the project with 12 new classes and attributes for the CIM structures, 26 logical nodes and data, and improved operating schedule management for IEC 61850.

ITG Focus Group "Energy Information Networks and Systems"

The Focus Group on Energy Information Networks and Systems of the Information Technology Society (ITG) has existed since November 2009 as an interdisciplinary expert platform for the clarification of relevant issues on the topic of smart grids. It compiles recommendations for action from an ICT point of view to promote standardization, and submits them on the EU level via the committees of DKE. For this purpose, several working groups on specific topics have been formed within the Focus Group and publish their results jointly in position papers.

The first position paper from the Focus Group, entitled "Energy information networks and systems – Present status and development trends" was compiled by 14 experts from industry and research, and published in December 2010. The declared aim of that position paper was to create a common understanding of the topics related to smart grids and thus promote cooperation between industries. Over and above that, it was to create the basis for further activities, especially in the areas of distribution network automation and business models.

The second position paper from the Focus Group was published in October 2012 and consists of two parts. In Part A, "Distribution network automation", 17 experts describe the basic characteristics of the intelligent energy supply system of the future from a technological point of view. The focus there is on automation of the distribution network, which is regarded as a decisive condition for the successful implementation of the energy turnaround. In Part B, "Future business models for distribution network operators in the smart grid of the future", 18 experts address the economic and commercial aspects of the future energy supply system. Possible business models for distribution network operators are described, and the necessary regulatory conditions for these are outlined. Both position papers present concrete recommendations for action to government, industry and standardization committees.

ETG Studies[47]

The Power Engineering Society of VDE (ETG) has published a series of studies in connection with the topic of smart grids. These focus on presenting the objectives and challenges on the way towards a flexible, intelligent grid. The studies are characterized not only by the informative presentations of the technical background and prospects, but also by the methods and tools used.

Examples:

The VDE/ETG Study "Storage facilities for the energy turnaround" is a compilation of various scenarios, some of which lead to astounding findings. There is not only a description of the general need for storage facilities, but this need is also systematically described in connection with the shares of renewable energy sources and classical power plants in the system. The study addresses both the necessary dimensioning and the changes in storage requirements at a renewables share of over 40 %. The study is rounded off by a consideration of electricity costs.

The ETG Study "Demand Side Integration" outlines the potential contribution to be made by electricity consumers and the flexibility needed to integrate energy from renewable sources. In the study, theoretical and technical load shift potentials are identified for the areas of households, trade and services, and industry. The study shows what opportunities are offered by corresponding load management in Germany to shift available capacities, minimize fluctuations, reduce load peaks, optimize the utilization of equipment and thus make an important contribution to the energy turnaround.

VDE Projects

The funding programme "ICT for Electromobility II – Smart Car – Smart Grid – Smart Traffic" by the Federal Ministry of Economics and Technology (BMWi), with a total volume of around 77 million euros, comprises a total of twelve projects dealing with the development of inno-

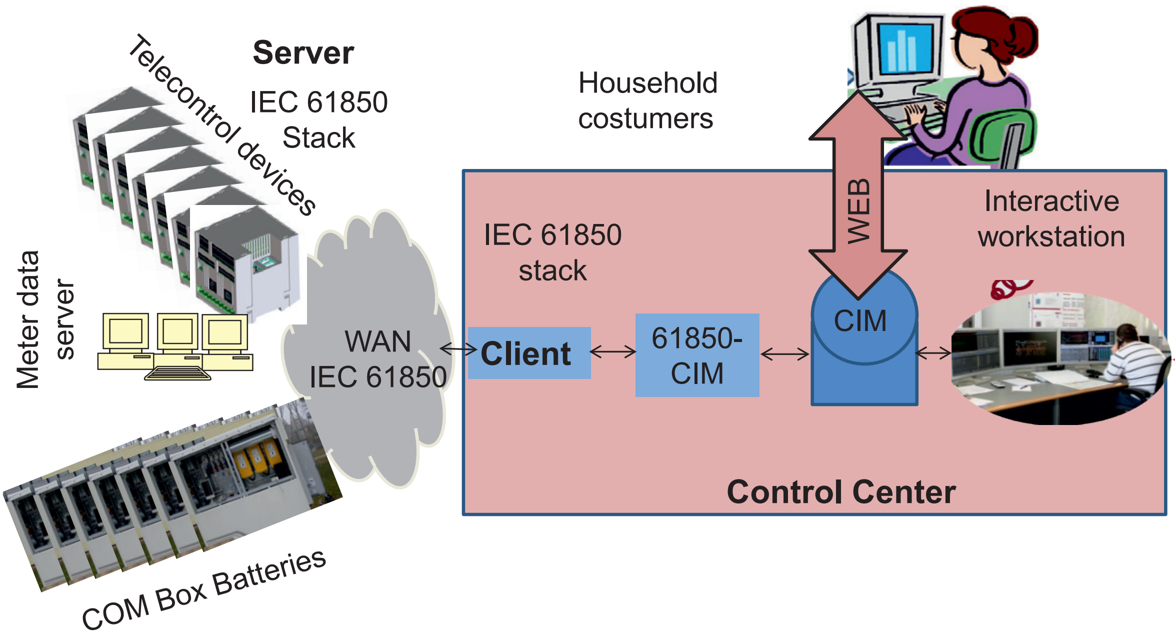

Figure 21: Structure of the control centre and links to the outside (source: Web2Energy)

[47] Link to ETG Studies: https://www.vde.com/de/fg/ETG/Pbl/Seiten/default_0.aspx/

vations in the high tech fields of "smart cars" (intelligent vehicles with a new ICT system architecture), "smart grids" (intelligent incorporation of electric vehicles in the energy supply system) and "smart traffic" (intelligent traffic infrastructure to increase efficiency, range and safety). Around 100 reputable companies from the energy, automotive and ICT industries are involved in the programme.

The funding programme is accompanied by VDE, the German Association for Electrical, Electronic & Information Technologies, and by the Deutsches Dialog Institut in Frankfurt am Main. Both partners support the projects in the identification and overcoming of obstacles to innovation, with cross-project cooperation with other partners, and in marketing the technology. They assist in the exchange of knowledge by establishing specialist groups on the cross-cutting topics of use scenarios and the innovation environment, regulation, and interoperability and standardization. Services like the inter-industry online platform "Electromobility in Dialogue" (https://www.dialog-elektromobilitaet.de/) and dialogue events with experts and decision-makers on electromobility concentrate the German activities at the interface of smart cars, smart grids and smart traffic. That creates not only visibility and acceptance for the project results, but also a common understanding of the measures with which Germany's innovative power can be further strengthened in this field of innovation.

FINSENY[48] – Future Internet For Smart Energy

FINSENY, with its strong connections with standards, is worthy of mention here as an example of the large number of European research projects on smart grids. 35 of the leading energy and ICT companies, research centres and universities from Belgium, Denmark, Germany, Finland, France, Greece, Ireland, Italy, Poland, Spain, Sweden and Switzerland founded the FINSENY consortium. It is part of the Future Internet Public Private Partnership (FI-PPP) initiative, and is sponsored by the European Union.

The research consortium identifies the requirements of a smart grid ICT system, develops reference architectures (in some cases as contributions to a broadly based future internet core platform) and thus contributes to the development of multi-industry standardization. Over and above this, a broad acceptance of smart energy solutions is to be ensured in Europe and beyond. The purpose of a smart grid is seen as guaranteeing a stable and affordable energy supply. A sustainable, modern electricity grid with a large number of independent and widespread generation facilities based on renewable energy sources can only do that if all the participants are optimally coordinated. That, in turn, is only possible when there are suitable communications networks which are reliable, secure and cost-effective, and at the same time flexible enough to provide suitable communications solutions for all the different regional energy networks – even when the energy networks are in a process of development. Real time requests, for example, are necessary to control the low and medium voltage distribution networks which make up an essential part of the smart grid. For this reason, studies have been performed by FINSENY on various scenarios in the smart grid, also as preparation for field trials in Phase 2 of the FI-PPP programme, and initial applications tested under laboratory conditions. The consortium with its working groups has not only studied the interaction between ICT and the power supply system, but also actively contributed to the work on Mandate M/490. In that context, FINSENY is involved in three out of

[48] Link to FINSENY: http://www.fi-ppp-finseny.eu/

four SG-CG working groups and has actively shared its findings with SG-CG. Further details on FINSENY are presented in a White Paper which is available at http://www.fi-ppp-finseny.eu/finseny-white-paper/.

Standardization Projects

A brief overview of the standardization projects in the fields of meters, system aspects of electrical power supply and network control and automation not only illustrates the work in progress, but also reflects the areas of development in the smart grid. As space is limited, only the current national standardization projects are presented, but these also indicate the trends in international standardization activities. With regard to meters, the main focus is on DLMS/COSEM data communication and secure data transmission. Network control and automation also deals with data communications, with the main focus on protocols to ensure compatibility, planning and network management. The system aspects of electrical power supply concern the interfaces to the distributed renewables facilities and how they can best be incorporated in the grid.

The overview[49], which is available in the internet, presents the status as of September 2012. The current standardization projects can be viewed by the DKE mirror committees in the internet (in German) under the individual divisions and subject areas[50].

Recommendations of the German E-Energy / Smart Grid Standardization Roadmap 1.0

Various recommendations were made in the first version of the German E-Energy / Smart Grid Standardization Roadmap 1.0 by the experts who compiled it in 2009/2010. A large proportion of those recommendations have been assessed, prioritized, processed and updated in the Expertise Centre and in the Steering Group on E-Energy / Smart Grid Standardization, which was itself established on the basis of the recommendations[51].

The list of past recommendations, available in the internet for ease of updating, shows for example the status of processing and any changes to relevant background conditions.

In general, it can be noted that the major topics have for the most part remained unchanged in the current work on standardization: Resilience as a core function, information security and data protection remain at the top of the list. Similarly, there is an important focus on cooperation between committees and networking, which certainly plays a major role, not only in standardization. The initial standardization concepts are still often developed in national committees – not only in Germany, but worldwide, with great commitment – while establishment of the standards takes place on the international level. The importance of new market processes in the smart grid also remains a current topic – also not only in standardization. This includes the areas of price and tariff design, market roles and incentive signals, which are regarded as the basis of the design of the market. It is also interesting that this topic is given such a high ranking from the point of view of standardization. That clearly indicates that the markets need a framework which can only be created on the national or European levels in cooperation between standardization bodies, government and regulatory authorities.

[49] Overview of standardization projects: http://www.dke.de/Normungsprojekte/

[50] Committee overview: http://www.dke.de/de/Wirueberuns/DieDKE-Struktur/Organisationsstruktur/Seiten/Organisations-struktur.aspx/

[51] Link to recommendations from the Roadmap 1.0: http://www.dke.de/Empfehlungen1_0/

List of Abbreviations

AAL	Ambient Assisted Living
ACER	Agency for the Cooperation of Energy Regulators
ACSI	Abstract Communication Service Interface
AMI	Advanced Metering Infrastructure
ANSI	American National Standards Institute
ASHRAE	American Society of Heating, Refrigerating and Air-Conditioning Engineers
BACnet	Building Automation and Control Networks
BDEW	Bundesverband der Energie- und Wasserwirtschaft e. V. (German Association of Energy and Water Industries)
BEMI	Bidirectional Energy-Management-Interface
BMU	Bundesministerium für Umwelt, Naturschutz und Reaktorsicherheit (Federal Ministry for the Environment, Nature Conservation and Nuclear Safety)
BMWi	Bundesministerium für Wirtschaft und Technologie (Federal Ministry of Economics and Technology)
BNetzA	Bundesnetzagentur (Federal Network Agency)
BSI	Bundesamt für Sicherheit in der Informationstechnik (Federal Office for Information Security)
CD	Committee Draft
CEN	Comité Européen de Normalisation
CENELEC	Comité Européen de Normalisation Électrotechnique
CHP	Combined Heat and Power
CIM	Common Information Model
CoS	Catalog of Standards
COSEM	Companion Specification for Energy Metering
DIN	Deutsches Institut für Normung e. V.
DKE	Deutsche Kommission Elektrotechnik Elektronik Informationstechnik im DIN und VDE (German Commission for Electrical, Electronic & Information Technologies of DIN and VDE)
DLMS	Device Language Message Specification
DPC	Data Protection Class
DR	Demand Response
EEBUS	E-Energy Bus

[52] EMS or Energy Management System is used in different contexts. Energy management as an automation system or function is meant here. IEC / TC 57 uses EMS in network instrumentation and control as a function for distribution networks (IEC 61970). Variations can be found in HEMS (Home EMS, ISO/IEC/JTC1) or BEMS (Building EMS) or CEMS (Customer EMS, SG-CG/SP). DIN/NAGUS uses the term Energy Management System (EnMS) in DIN EN 50001 rather in the sense of a management systems; there, EMS means Environmental Management System.

EEG	Erneuerbare-Energien-Gesetz (Renewable Energies Act)
EG	Expert Groups
EMC	Electromagnetic Compatibility
EM-CG	eMobility Coordination Group
EMS	Energy Management System
ENTSO-E	European Network of Transmission System Operators for Electricity
ENTSO-G	European Network of Transmission System Operators for Gas
ENWG	Energiewirtschaftsgesetz (Energy Industry Act)
ESHG	Elektrische Systemtechnik für Heim und Gebäude (Electrical System Technology for Homes and Buildings)
ETG	Energietechnische Gesellschaft (Power Engineering Society in VDE)
ETSI	European Telecommunications Standards Institute
EU	European Union
FEG	Future Energy Grid
FINSENY	Future INternet for Smart ENergY
FI-PPP	Future Internet Public Private Partnership
FLIR	Fault Location, Isolation, Restoration
FNN	Forum Netztechnik/Netzbetrieb im VDE (Forum Network Technology / Network Operation in VDE)
FSS	First Set of Standards
GAK	Gemeinschaftsarbeitskreis (Joint Working Group)
GPKE	Geschäftsprozesse zur Kundenbelieferung mit Elektrizität (Business Processes for Supply of Electricity to Customers)
GUC	Generic Use Case
HBES	Home and Building Electronic Systems
ICT	Information and Communications Technology
IEC	International Electrotechnical Commission
IEEE	Institute of Electrical and Electronics Engineers
ISGAN	International Smart Grid Action Network
ISO	International Organization for Standardization
IT	Information Technology
ITG	Informationstechnische Gesellschaft (Information Technology Society in VDE)
ITU-T	Telecommunication Standardization Sector
JISC	Japanese Industrial Standards Committee
JSCA	Japanese Smart Community Alliance
KATS	Korean Agency for Technology and Standards
KNX	Field bus for building automation
LON	Local Operating Network
MMS	Manufacturing Message Specification
moma	Model City of Mannheim
MPG	Medizinproduktegesetz (Medical Devices Act)
NERC	North American Electric Reliability Corporation

NIST	National Institute for Standards and Technology
NWIP	New Work Item Proposal
OGEMA	Open Gateway Energy Management Alliance
OSGi	Open Services Gateway initiative
PAP	Priority Action Plan
PAS	Publicly Available Specifications
PC	Project Committee
PKI	Public Key Infrastructure
PLC	Power Line Carrier
PTB	Physikalisch-Technische Bundesanstalt
PV systems	Photovoltaic systems
RegModHarz	Regenerative Model Region Harz
SCADA	Supervisory Control and Data Acquisition
SG	Strategic Group/Smart Grid
SGAM	Smart Grid Architecture Model
SGCG	Smart Grid Coordination Group
SG-DPC	Smart Grid Data Protection Class
SGIS	Smart Grid Information Security
SGIS-RIL	Smart Grid Risk Impact Level
SGIS-SL	SGIS Security Level
SL	Security Level
SMB	Standardization Management Board
SM-CG	Smart Meter Coordination Group
SP	Sustainable Processes
TC	Technical Committee
TR	Technical Report
UCMR	Use Case Management Repository
UK	Unterkomitee (Subcommittee)
UML	Unified Modeling Language
USA	United States of America
VDA	Verband der Automobilindustrie (German Automotive Industry Association)
VDE	Verband der Elektrotechnik Elektronik Informationstechnik e. V. (Association for Electrical, Electronic & Information Technologies)
VDU	Visual Display Unit
VPP	Virtual Power Plant
VVO	Var Volt Optimization
WAN	Wide Area Network
WG	Working Group
ZVEI	Zentralverband Elektrotechnik- und Elektronikindustrie e. V. (German Electrical and Electronic Manufacturers' Association)

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Dates and Internet Links

17 and 18 January 2013	Final E-Energy Conference, Berlin
24 January 2013	Presentation of Mandates M/441, M/468 and M/490, Brussels, EU Commission
23 and 24 September 2013	Word Smart Grid Forum, Berlin, Organizers: VDE, IEC and State Grid (SGCC)

Updates can be found in the internet
http://www.dke.de/de/std/KompetenzzentrumE-Energy/Seiten/default.aspx/

Internet Links to Standardization

Standardization projects by DKE/K 952 Power system control, DKE/K 461 Electricity meters, DKE/K 261 System aspects of electrical power supply	
http://www.dke.de/Normungsprojekte	
Recommendations from Standardization Roadmap 1.0	
http://www.dke.de/Empfehlungen1_0	
List of committees	
http://www.dke.de/de/Wirueberuns/DieDKE-Struktur/Organisationsstruktur/Seiten/Organisationsstruktur.aspx	
Links and downloads on the subject of standardization for E-Energy/ Smart Grids	
http://www.dke.de/de/std/KompetenzzentrumE-Energy/Seiten/Links.aspx	

Comparison of Various Studies on Smart Grid Standardization

Approaches													Standard	Description
ElectriNet	SGAM, Sustainable Processes and FSS M/490	IT Architecture Development and Recommendations	NIST 2.0 High = Add (ok)	Future Energy Grid	SIA	DKE Standardization Roadmap Smart Grid 1.0	NIST / IOP / Roadmap	SMB SG 3 / IEC	BMWi / E-Energy	BDI – Internet of Energy	Microsoft / SERA	CIGRE / D2.24	Standard	Description
		■					■				■		AMI-SEC System Security Requirements	Advanced metering infrastructure (AMI) and SG end-to-end security
■			■				■				■		ANSI C12 Suit : (C12.1, C12-18, C12-19/MC1219, C12-20, C12-21/IEEE P1702/MC1221, C12.23, C12.24)	Revenue Meter Information Model
■			■				■			■	■		BACnet ANSI ASHRAE 135-2008/ISO 16484-5	Building automation
						■			■				Digital meters / home gateways	Attention is drawn here to competitive solutions and to EU Mandate M/441
■							■				■		DNP3	Substation and feeder device automation
									■				EDIXML	Market communication with a slow transition from EDIFACT to modern, CIM-capable technologies
	■	■	■	■	■	■			■			■	IEC 60870	Established communications
■	■	■		■	■	■		▒				■	IEC 60870-5	Telecontrol, EMS, DMS, DA, SA
■	■	■	■	■	■	■	■	▒			■	■	IEC 60870-6 / TASE.2	„Inter-control center communications TASE.2 Inter Control Center Communication EMS, DMS"
■	■	■		■	■			▒	■	■	■	■	IEC 61334	DLMS
	■	■	■	■		■		▒	■	■		■	IEC 61400-25	„Wind Power Communication EMS, DMS, DER"
									■				IEC 61499	PLC and automation, profiles for IEC 61850
■	■	■	■	■	■	■	■	■	■	■	■	■	IEC 61850 Suite	Substation automation and protection, distributed generation, wind farms, hydro power plants, e-mobility
■	■	■	■	■	■	■		▒				■	IEC 61850-7-410	„Hydro Energy Communication EMS, DMS, DA, SA, DER"
■	■	■	■	■	■	■		▒				■	IEC 61850-7-420	„Distributed Energy Communication DMS, DA, SA, DER, EMS"
			■			■		▒					IEC 61851	„EV-Communication Smart Home, e-Mobility"
■	■	■	■	■	■	■		■		■		■	IEC 61968	Distribution Management, System Interfaces for Distribution Management Systems, DCIM (CIM for Distribution)
■	■	■	■	■	■	■	■	■	■	■	■	■	IEC 61968/61970	Application level energy management system interfaces, CIM (Common Information Model), Domänenontologie, Schnittstellen, Austauschdatenformate, Profile, Prozessblueprints, CIM (Common Information Model) EMS, DMS, DA, SA, DER, AMI, DR, E-Storage
■	■	■	■	■	■	■		■		■		■	IEC 61970	Energy Management, Application level energy management system interfaces, Core CIM
						■		▒					IEC 62051-54/58-59	„Metering Standards – DMS, DER, AMI, DR, Smart Home, E-Storage, E-Mobility"
■	■		■					▒	■	■			IEC 62056	„COSEM – DMS, DER, AMI, DR, Smart Home, E-Storage, E-Mobility"
													IEC 62325	Market communication using CIM
■	■	■	■	■	■	■	■	■	■	■	■	■	IEC 62351	Information security for power system control operations, security profiles
	■	■		■	■	■	■	■	■			■	IEC 62357	IEC 62357 Reference Architecture – Service-orientierte Architektur, EMS, DMS, Metering, Security, Energy Management Systems, Distribution Management Systems
		■	▒							■			IEC 62443 (ISA 99)	Procedure model for establishment of IT security for industrial automation and control systems
				■		■					■	■	IEC 62541	OPC UA (Automation architecture)
■	■	■		■									IEC PAS 62559	Requirements development method covers all applications
■			■				■				■		IEEE 1547	Physical and electrical interconnections between utility and distributed generation (DG)
			■				■				■		IEEE 1686-2007	Security for intelligent electronic devices (IEDs)
■			■				■				■		IEEE C37.118-2005	This standard defines phasor measurement unit (PMU) performance specifications and communications for synchrophasor data
				■						■			ISO / IEC 14543	KNX, BUS
			■										MultiSpeak	A specification for application software integration within the utility operations domain; a candidate for use in an Enterprise Service Bus
		■	■				■				■		NERC CIP 002-009	Cyber security standards for the bulk power system
			■				■				■		NIST Special Publication (SP) 800-53, NIST SP 800-82	Cyber security standards and guidelines for federal information systems, including those for the bulk power system
			■				■				■		Open Automated Demand Response (Open ADR)	Price responsive and direct load control
			■				■				■		OpenHAN	Home Area Network device communications, measurement, and control
	■	■											The Open Group Architecture Framework (TOGAF)	TOGAF is a framework – a detailed method and a set of supporting tools – for developing an enterprise architecture
				■			■				■		ZigBee/HomePlug Smart Energy Profile	Home Area Network (HAN) Device Communications and Information Model
			▒	■									Z-wave	A wireless mesh networking protocol for home area networks

	SGAM domains					Criteria: Added Value Area								Criteria: TC 57 Reference Architecture				
	Bulk Generation	Transmission	Distribution	DER	Customer Premise	Production	Energy Trading	Sales	Transmission	Storage	Distribution	Measurement	Application	Integration of Business Partners	Integration of Applications	Integration of Devices and Plants	Security	Data Management
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