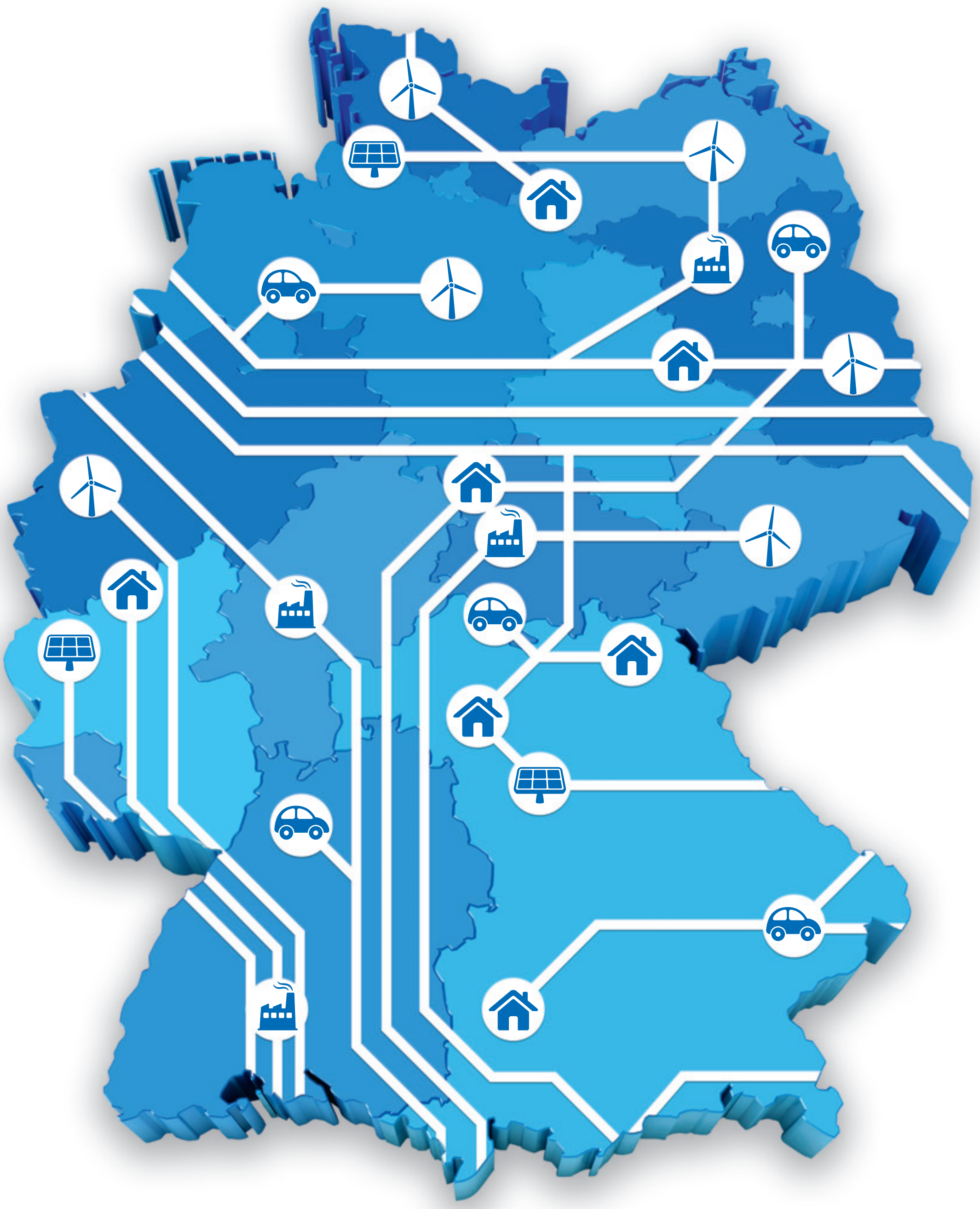
THE GERMAN ROADMAP
E-ENERGY / SMART GRID



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Foreword

Dear readers

New technologies create new opportunities. We are facing enormous challenges, especially in energy supply. New technology can help us there. In the light of a growing share of electricity from volatile, renewable energy sources, the generation and consumption of electricity will have to be more effectively balanced in future. Furthermore, distributed power generation will have to be effectively integrated in the electricity system. Finally, the currently passive electricity consumers will have to evolve into “prosumers”, who take part actively in the energy system.

Solutions to these and other issues of energy and environmental policy are being developed in the E-Energy technology programme, which is promoted by the Federal Ministry of Economics and Technology in cooperation with the Federal Ministry for the Environment, Nature Conservation and Nuclear Safety. In six German model regions, we are conducting trials on the energy system of the future.

The E-Energy Expertise Centre of the DKE, the German Commission for Electrical, Electronic & Information Technologies, is acting as the central contact for all matters of standardization on E-Energy in Germany. I wish to thank the DKE most warmly for that commitment. As a German member of the European Committee for Electrotechnical Standardization (CENELEC) and the International Electrotechnical Commission (IEC), the DKE also functions as an important link to European and international standardization.

This first version of the German E-Energy / Smart Grid Standardization Roadmap, which has been produced in close consultation with the researchers and experts of the E-Energy projects, contains numerous recommendations. The task now is to ascertain the extent to which these approaches can be implemented.

I wish the Roadmap many readers and users.

Rainer Brüderle
Federal Minister of Economics and Technology

Preface

Ladies and Gentlemen

Protection of the atmosphere and climate, and a progressive scarcity of fossil fuels, are leading to increasing use of renewable energy sources, which are fundamentally obtained directly, or as with wind, indirectly, from current sunlight. On account of their immanent volatility (day/night cycle, weather), we will have to come to regard the constant availability of electrical power to the consumer as a persistent national and global optimization problem: The current supply of renewable energy has to be brought in line with the current demand by consumers on a large scale. The means by which such an optimum can be achieved are intelligently controlled electricity networks and storage facilities and the active influencing of consumption, based on a variety of information on the current and expected generation and consumption situations. Replacement of fossil fuels at least in part by electrical energy for traffic (electromobility) will expand the degrees of freedom in the optimization process.

The concept of an "internet for energy" indicates on the one hand that the flexible generation, distribution, storage and use of renewable energies will be based on an information structure similar to the internet. On the other hand, the term evokes associations with questions of information security and the protection of privacy, questions which reach into the areas of regulation, legislation and acceptance by society.

The decentralization of power generation leads to new market structures, which require considerable investments in the networks and in collection of the necessary information for optimum control of the overall system with its generators and loads.

Standards are essential if the market-related optimization problem, the issues of networking energy and information and of securing investments are to be solved. This Roadmap indicates which standards already exist in this regard, and provides concrete, prioritized recommendations to close the gaps. The DKE is to play an active part in the implementation of these recommendations, and has established an "E-Energy Expertise Centre" to coordinate the standardization work in cooperation with the E-Energy projects promoted by the Federal Ministry of Economics and Technology.

The aim of these efforts is to contribute the existing and now extended knowledge available in Germany on the optimum availability and use of sustainably generated electric power to the European and international standardization process in such a way that a supra-regional market is created, providing attractive conditions for the producers and consumers of electrical energy and security of investment for the manufacturers and operators of the corresponding systems and networks. This Roadmap, as a living document, is intended as an incentive to maintain and expand the leading role of German science and industry in the field of energy systems under new environmental and market conditions.

Dietmar Harting
President of the DKE

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1. Executive Summary

Energy supplies to customers and the use of energy in general are undergoing radical change. Triggered by political objectives such as limiting climate change and securing energy supplies, increasing energy efficiency, extending distributed power generation and significantly increasing the share of renewables are regarded as fundamental ways towards a solution. The linking of new technologies in power engineering and ICT[1] to solve the coming challenges in the energy sector is referred to as the Smart Grid. This entails further developments to our energy system in the short, medium and long terms, and, as is the consensus, enormous investments.

In order to achieve the desired objective of reshaping our energy system, the corresponding preconditions must be established both on the technical side (interoperability) and on the commercial side (security of investment and development of new markets). Both these aspects can be served nationally, regionally and internationally by means of standardization.

Standardization in the field of Smart Grids is however characterized by a number of features which distinguish it from standardization as pursued to date. Here, standardization activities are marked by the large number of players, a lot of regional and international activities, the enormous speed and huge economic effects of the various standardization activities. Smart grid standardization is by no means business as usual. The focus must therefore be on the following activities:

- **Political support**
  Close interrelation between research and development, regulation and the legal framework with standardization is necessary.

- **Speed**
  There is at present competition between

1 ICT Information and Communication Technologies

different national and regional standardization concepts. Rapid implementation of the results achieved in Germany in standards is therefore essential.

- **International orientation**
  Rapid embedding in international standards at ISO and IEC is important for the contribution of German interests, technologies and research (such as E-Energy) to international activities.

- **Coordination and focus**
  The Smart Grid is characterized by a large number of players and disciplines. Inter-domain cooperation and coordination by the establishment of a steering group and groups dealing with focal and interdisciplinary topics are necessary if duplication of effort is to be avoided.

- **Support innovation**
  In order to promote innovation, standardization should focus on interoperability and avoid specification of regard to technical solutions.

- **Use and marketing of existing standards**
  Many of the necessary standards already exist. There are internationally recognized standards in the fields of power, industrial and building automation. These will have to be used and promoted accordingly. Information on this standardization work and its status is an integral part of this roadmap.

- **Further development of standards**
  The fundamental need for action consists in linking the established domains. New standardization projects must focus on this topic.

- **Involvement in standardization**
  Increased participation in standardization activities on national, regional and international levels is necessary for achievement of the objectives. German companies should therefore make greater contributions to German, European and international standardization.

A series of actions have already been taken on the basis of these requirements. Those which stand out are the establishment of an E-Energy Expertise Centre within the DKE and the compilation of this standardization roadmap. Chapter 3 of this standardization roadmap deals with reasons for the establishment of a Smart Grid, and discusses various definitions. Chapter 4 describes the existing standards which already point the way to the future, and studies on standardization work in the field of Smart Grids. Finally, Chapter 5 presents recommendations for the further procedure in the various areas under discussion.

In Germany, we are faced with an enormous challenge, but also discern a variety of opportunities in an intelligent redesign of the present systems. The necessary steps have been identified and described. It is now up to all of us to play an active part in their implementation by our own commitment in society and politics, research, industry and standardization. We will also need energetic assistance on the national and international levels to achieve our ambitious objectives for the benefit of society.

Now let's get to work!

2. Starting point for the German standardization roadmap on E-Energy / Smart Grids

There are various roadmaps and frameworks for the Smart Grid which is being discussed intensively in professional circles, some of which have been compiled by national committees and stakeholders, industrial consortiums and international standardization committees. They all have one thing in common, namely the demand to meet the increased complexity and technology convergence involved in the transformation of the electricity grid and the integration of new generation and storage options, and also the involvement of customers as an active part of the electricity grids, with standardized ICT and automation technology. The core of the frequent demand for linking of the new distributed system components with the existing infrastructure is the technical and semantic[2] interoperability of components from various manufacturers in different sectors of industry. This can only be achieved by standards.

The aim of this document is to draft a strategic, and nevertheless technically orientated roadmap which represents the standardization requirements for the German vision of the Smart Grid, taking especial account of the BMWi (Federal Ministry of Economics and Technology) and BMU (Federal Ministry for the Environment, Nature Conservation and Nuclear Safety) funding programme "E-Energy" [BMWi]. In addition, it provides an overview of standards in that context, and of current activities, necessary fields of action, international cooperation and strategic recommendations.

German standardization strategy [DIN1, 2, 3] distinguishes between de jure standardization as the fully consensual compilation of rules, guidelines and characteristics of activities for general or repeated application by a recognized organization and standardization in general as the process of compiling specifications. The latter may result in various documents such as the VDE Rules of Application, PASs (Publicly Available Specifications), ITAs (Industry Technical Agreements) or TRs (Technical Reports).

This roadmap is not intended as a compilation of and reference to the previous approaches, but as a targeted strategic plan of German activities in the context of European and global developments. In the spirit of an integrated German Smart Grid roadmap, this document focuses on standardization aspects in the fields of power system management, electricity storage, distributed generation, safety and security, automation technology, smart meters and home automation. This draft of a national standardization roadmap describes the core standards of a future electrical power supply system, states their importance and areas of application, and presents the resulting opportunities, challenges and effects.

The concept of the Smart Grid is receiving attention in many professional groups and research projects above and beyond the E-Energy projects. For this reason, the draft of the roadmap [DKENR] was presented to a professional audience for comment during a symposium on 02 February 2010 and then in the internet. The opportunity to comment has been actively used by the experts.

The Strategy Group has taken up many suggestions in the present version 1.0 and recommended others, in the light of the highly detailed comments received in some cases, for further

2 Semantic interoperability is taken here above all to mean congruence of term and signification, i.e. identical interpretation of the data exchanged by several parties or systems

detail work in the implementation stage which is now to follow (see also Chapter 6).

The standardization roadmap is to be regularly revised and developed on the basis of new findings – for example from the research projects and the work in the standardization committees. The opportunity for involvement in this process by commenting and assisting in standardization therefore remains open, even after publication.

The E-Energy / Smart Grid Standardization Roadmap Strategy Group

3. Introduction

3.1. Reasons and boundary conditions for the compilation of a Standardization Roadmap

An efficient and above all reliably functioning energy supply infrastructure is the basis for sustainable, growth-orientated development of the German economy and of society as a whole.

Various objectives are defined both nationally and internationally to permit the sustainable operation of this infrastructure in the light of the demands imposed by climate change. In Europe, the 20/20/20 targets, aimed at a further expansion of renewable energy sources and the most efficient use of energy possible, have been set down in the Third Energy Package. This requires the future integration in the existing system both of further large-scale facilities on the basis of renewable energy sources and of distributed generation facilities, also partly based on renewables. Opportunities for flexibilization of load are to be exploited for cost-effective integration of these volatile sources. This requires correspondingly optimized network system operations and grid expansion, and increased use of new technologies such as information and communication technologies (ICT) and modern power electronics.

Corresponding visions and transition processes have been described both on the European level and in the USA. The Smart Grid is regarded as the core aspect in the achievement of this agenda. As early as 2006, the European Technology Platform "Smart Grids" set out the challenges and solutions for future electricity networks in its groundbreaking document "Vision and Strategy for Europe's Electricity Networks of the Future" [ETPEU][3].

The National Institute of Standards and Technology (NIST, USA) [EPRI] defines the Smart Grid as the transition process from today's energy supply to a modernized, better protected, optimized and self-healing infrastructure with dedicated bidirectional communication between the individual components involved in the system. In the Smart Grid concept, the existing electrical networks and communications technologies are linked in the distributed infrastructure to form a new intelligent system in which a large number of producers, consumers and storage facilities act on the market with an optimized portfolio in the field of tension between deregulation, lower dependence on imports, growth in consumption, influence on the environment, network expansion, grid capacities and competition.

3 Square brackets indicate a reference to the bibliography at the end of the document

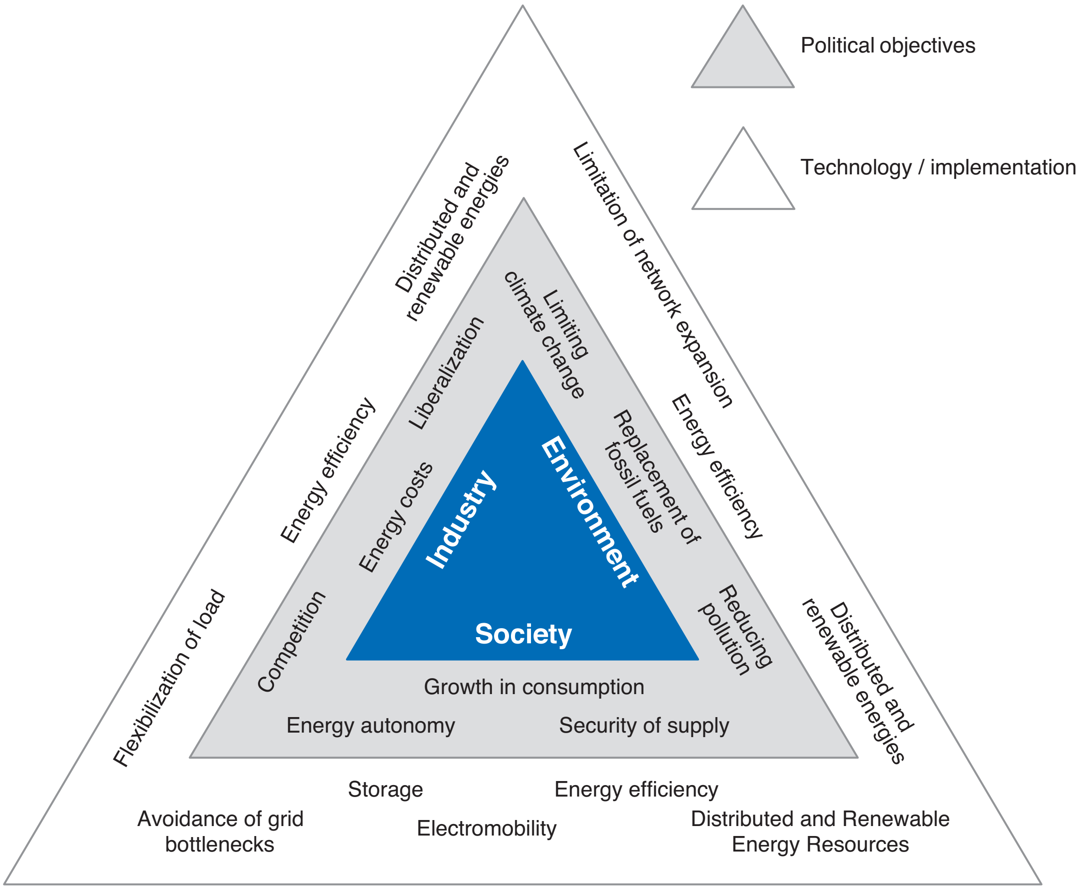

Figure 1: Motivation for a Smart Grid on the basis of the energy management triangle – political objectives and technical implementation

Together with ICT, power electronics, active distribution networks, protection technology, safety and security, and the prediction and optimization technologies, standardization as a cross-cutting topic is a central aspect of a Smart Grid strategy and roadmap. It not only provides for interoperability in the technology portfolio described, but also, together with political support, changes to the legislative and regulatory framework, new technologies and protection of investment, decisively promotes the international development towards a Smart Grid.

3.2. Terms and definitions: Smart Grid

In order to establish a common basis for discussion of the standardization environment of Smart Grids, the term *Smart Grid* is defined in this section.

The definition used in the DKE SMART.GRID [DKESG] mirror committee to IEC SMB/SG 3 „Smart Grid“[4] is to serve as the basis here:

The term "Smart Grid" (an intelligent energy supply system) comprises the networking and control of intelligent generators, storage facilities, loads and network operating equipment in power transmission and distribution networks with the aid of Information and Communication Technologies (ICT). The objective is to ensure sustainable and environmentally sound power supply by means of transparent, energy- and cost-efficient, safe and reliable system operation.

There is no single type of Smart Grid, not even in an interconnected network grid such as the UCTE network[5]. The different power generation structures in Europe, resulting from natural resources and also from regulation, lead to different requirements for the Smart Grid in the individual countries. In addition, the consumer structures have different characteristics, for instance in terms of energy prices, urban population density or habits in electricity use. This has direct effects on the fundamental aspect of the Smart Grid, namely the coordinated balance between power generation and consumption, and thus also on the Smart Grid landscape to be standardized. A definition of the term Smart Grid therefore encompasses properties which can apply to all Smart Grids. Central aspects in the present international and German definitions are as follows:

- The integration of more and more volatile generation with a simultaneously rising proportion of distributed generators and storage facilities, and a flexibilization of consumption.

- Smart Grid is a holistic, intelligent energy supply system, not just an "intelligent network". It comprises the operation of active power distribution and power transmission networks with new, ICT-based technologies for network automation, and the incorporation of centralized and distributed power generation and storage facilities reaching right up to consumers, so as to achieve better networking and control of the system as a whole.

- The aim is the efficient supply of sustainable, economical and safe electricity, even under the changed boundary conditions of the future.

- A Smart Grid is based on an existing infrastructure. A transition process is envisaged to a new overall system which will provide greater opportunities for active and flexible adaptation of generation, network management, storage and consumption to the constantly changing requirements of the energy markets.

- The Smart Grid facilitates new, distributed and decentralized network management technologies for automation in the active distribution network.

- Involvement of the customers in their role as consumers and possibly producers (prosumers[6]) in a smart building, smart home or with an electric vehicle with intelligent charging management,
  - communicating bidirectionally with the utility as an active participant in the energy sys-

4 IEC International Electrotechnical Commission Standardization Management Board (SMB) Strategic Group (SG) 3

5 UCTE – Union for the Coordination of the Transmission of Electricity, the European interconnected network grid, integrated since July 2009 in ENTSO-E (European Network of Transmission System Operators)

6 The term "prosumer" denotes a combination of electricity consumer and electricity producer, i.e. mostly households which not only consume power but also feed power into the grid, for instance with equipment subsidized under the provisions of the Renewable Energies Act

tem by means of communications technologies (e.g. via smart meter technologies or active distribution networks),

- receiving higher resolution information on their consumption than previously,
- making decentralized decisions on the basis of external incentives in support of a stable overall energy system, or
- allowing themselves to be guided directly or indirectly by external market partners of the energy system, and
- wishing to lend active support to objectives of environmental policy such as the 20/20/20 targets.

In this way, this networked energy management becomes a further driving force behind the use of building automation – especially in existing buildings. Energy management systems have been in use for several years now, for building or industrial automation in the more professional environment. The new approaches increase the number and expand the functionality of the previous schemes by involving private households and commerce, and also with regard to increased communication between energy suppliers (network system operators, retailers and meter operators) and the customers.

- Intelligent use of new equipment such as electronic meters, energy management systems, energy management gateways, consumer electronics, electric vehicles, thermal storage facilities (e.g. refrigeration systems, heat pumps and combined heat and power systems with heat storage facilities) and interoperable incorporation of these components in the grid.

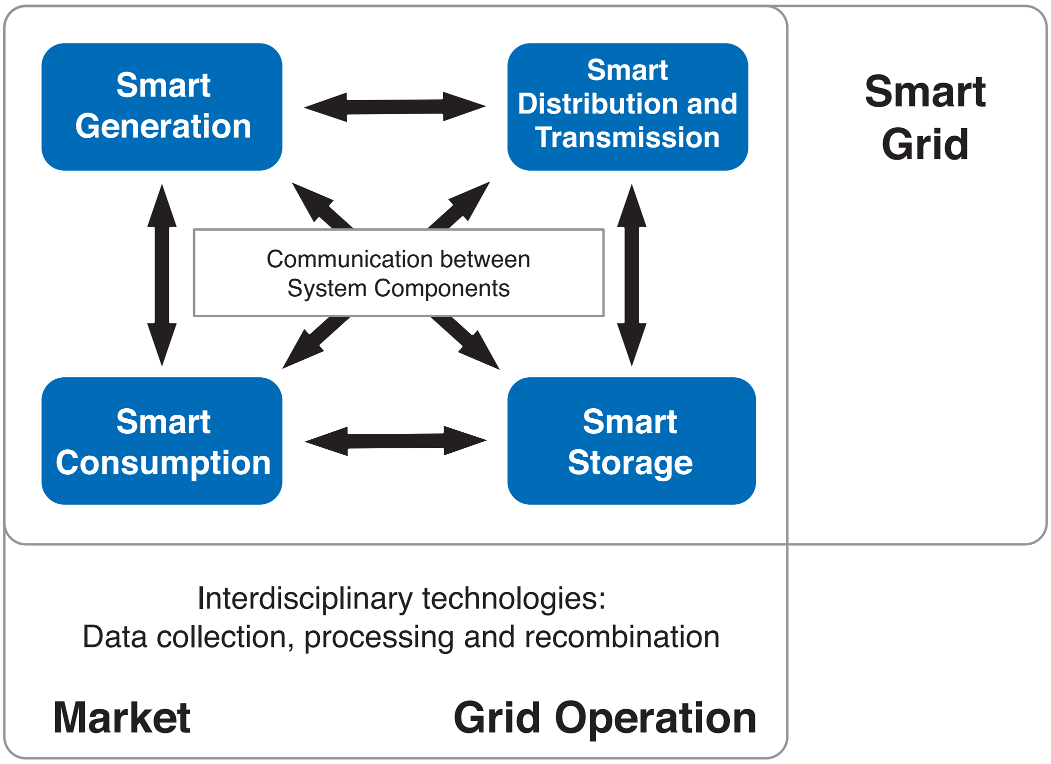

Figure 2: Action matrix of the Smart Grids

- New products and services in the energy marketplace, particularly to increase energy efficiency and to save energy, but also to link energy management and building automation, are facilitated by the Smart Grid, which may create entirely new market opportunities for services and products.

- Advanced, ICT-aided management functions are to make more efficient, more flexible and lower emissions operation possible.

- The dynamic integration of a variety of distributed and renewable energies and the necessary load management in many households means increased complexity, which necessitates the Smart Grid with new ICT-based solutions to secure supply at the present high level.

As early as 2006, the European Technology Platform "Smart Grids" [ETPEU] defined a strategic vision based on various driving forces for a transition to the Smart Grid. One of the EU's core demands in that context is the establishment of common technical standards and protocols to achieve open access, interoperability and vendor independence of the Smart Grid components used. The Smart Grid should above all serve sustainable development. The EU defines one of the core features in that connection as bidirectionalism both of communications and of energy flows. Taking account of numerous stakeholders, the transition from the existing energy system with its large producers, centralized control, limited multinational transfer points, local optimization and various national regulatory conditions to a new system is being pushed ahead. In that context, the seven core aspects of the future energy system are the following:

- Coordinated local energy management with integration of distributed generation and renewables and the existing centralized major producers

- Expansion of small, distributed producers with close local links to consumers

- Harmonized legal conditions to facilitate cross-border European trading

- Flexible demand-side management and new, customer-driven added value services

- Various services to increase energy efficiency

- Flexible, optimized and strategic grid expansion, operation and maintenance

- Application-related quality, reliability and security of supply for the digital age.

In the *Strategic Deployment Document* from the ETP Smart Grids [ETPSDD], a Smart Grid is therefore defined as follows:

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

The European regulators use and support the approach of the ETP Smart Grids, but emphasize that development must be a means to an end and investments in smarter networks must result in user value and direct benefits to all network users. ERGEG[7] is pressing the national regulators to make a clear distinction between the costs and benefits for network users and costs and benefits which are not relevant to network use [ERGEG].

7 ERGEG European Regulators' Group for Electricity and Gas

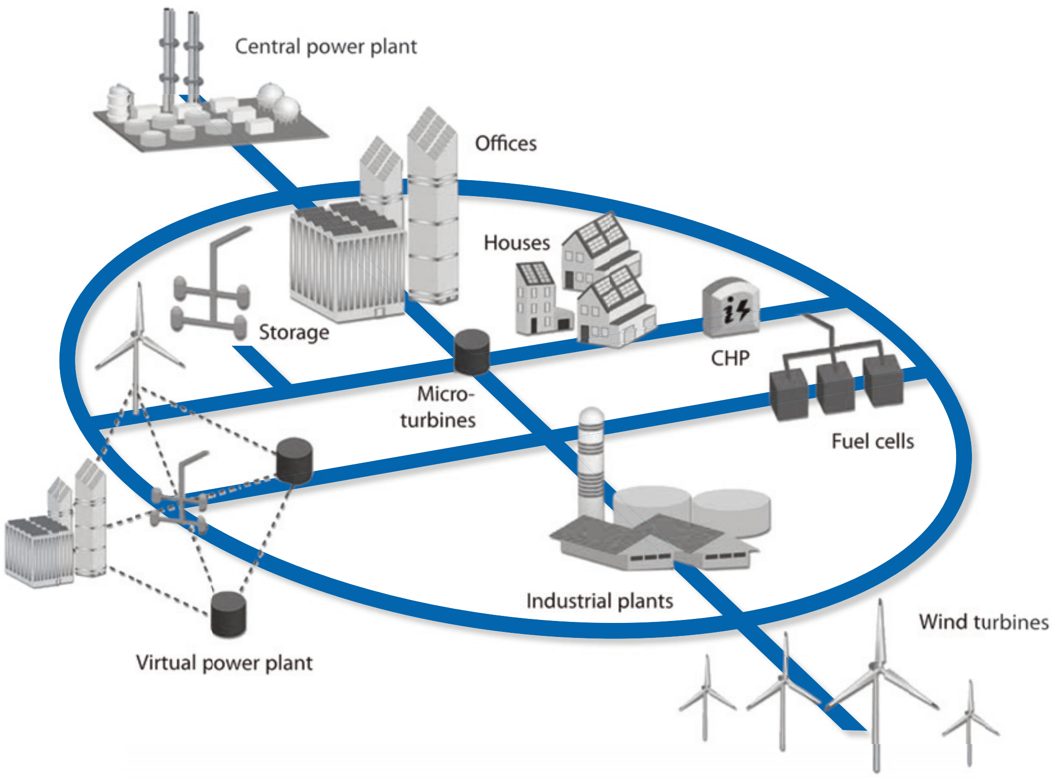

Figure 3: The European Union's Smart Grid vision – grid operation[8]

NIST in the USA summarizes the Smart Grid aspects similarly with the following core characteristics [EPRI]:

"The term "Smart Grid" refers to a modernization of the electricity delivery system so it monitors, protects and automatically optimizes the operation of its interconnected elements – from the central and distributed generator through the high-voltage transmission network and the distribution system, to industrial users and building automation systems, to energy storage installations and to end-use consumers and their thermostats, electric vehicles, appliances and other household devices."

In the American view, therefore, the Smart Grid is analogous to modernization of the current electricity distribution system in the direction of a holistically controlled system on the basis of new ICT technologies by linking of transmission and distribution networks, centralized and distributed power generation, energy storage facilities, industrial customers and building automation systems down to the energy installations of the final customers with their sensor systems, their vehicles and the appliances in their households. Informed customers should thus be put in a position to use new electricity products, services and markets. In order to ensure the consistently high electricity quality which is required, operation of the energy system has to be optimized in terms of efficiency and be robust in withstanding disturbances, attacks and environmental influences.

Every Smart Grid definition comprises technical and economic areas of application, so-called domains, and organizational elements

8 Source: ETP Smart Grids [ETPEU]

such as system participants (actors and market roles). Within domains, in the area of responsibility of market roles, use cases act via actors upon objects. For the field of standardization, the theoretical definitions and descriptions of the interrelationships between system participants, semantic object models, the syntax of the interfaces of use cases and the relationships between objects (ontologies) – only hinted at here and dealt with in somewhat greater detail in the following chapter – are of importance.

The regulatory, organizational and economic aspects of a market are not directly located within the sphere of influence of standardization. Standards can however have the effect of reducing costs, making many a business model possible in the first place. On the other hand, standards are applied within the existing legal and regulatory framework. This roadmap therefore also makes tentative recommendations on these political and regulatory aspects, as they affect standardization and a corresponding need for action was identified both by the Strategy Group and in the subsequent public comments. The organizational and economic aspects are not within the ambit of this roadmap, but exert a mutual influence together with the technical focal points. Standardization is therefore directly located in the field of tension between legal framework conditions, market requirements, expectations of the energy consumers/customers and above all technical development.

3.3. Various perspectives on the Smart Grid / E-Energy topic and development of focal topics

3.3.1. Various perspectives

In the description of solutions or approaches to a Smart Grid – also for example for the detailed further development of certain parts of this roadmap – the following different perspectives are regarded as helpful in outlining the initial development of a comprehensive and uniform approach. Some of these important topics can only be sketched out here: On the one hand, an in-depth description of definitions and relationships would be too complex, and on the other hand this work is still in progress. For further updated details, attention is drawn to the website[9] of the DKE-**Ko**mpetenzzentrums E-**En**ergy (Expertise Centre E-Energy).

- Roles / Market roles

  Roles are used to assign activities in the Smart Grid. They represent legally competent, fine-grain instances in the added value network of the E-Energy market.

  Roles are in part defined and characterized nationally or regionally by different regulatory or legal provisions. With an as extensive a classification of theoretical, granular roles as possible, an attempt can be made to describe solutions, functionalities, modules or interface specifications based on an understanding of the various roles extensively in such a way that fundamental results remain applicable on the international or European levels. This means that many market roles coincide in practice, and that many market participants play several market roles.

  The following market roles exist and have been identified on the basis of responsibilities

9 www.dke.de/KoEn

previously in existence or newly created with the development of the Smart Grid:

- Producer (power or heat generator)
- Energy user (power consumer or connection user)
- Transmission system operator (TSO)
- Distribution system operator (DSO)
- Energy supplier (in the multi-utility sense: electricity, heating, gas and water)
- Balancing group manager
- Balancing group coordinator
- Energy trader
- Energy exchange (EEX)
- Metering point operator (MPO), metering service provider (MSP)
- Energy marketplace operator (collection/negotiation of offers, for example, energy supplies, system services such as balancing power by demand response management or storage, and provision of reactive power)
- Further energy service providers (such as energy consultants and contracting companies)
- Communication network operator

These market roles, directly involved in the processes, are to be supplemented conceptually by further stakeholders, such as the manufacturers of equipment with Smart Grid capabilities.

Bundle role

This defines legally competent instances grouping granular market roles in the added value network of the E-Energy market

Examples of such bundling include prosumers, bundling the market roles of producers and consumer (energy users), and the utilities as enterprises with a fully integrated added value chain comprising power generation, transmission, distribution, energy trading, supply, metering point operation, metering point services and energy services.

Actor

Actor designates an active element in a domain of action – e.g. a physical device, a logical device, a person or a corporate entity.

Domains

Domains of action are used to define system areas with definite boundaries, in which the activities of use cases take place and a rough division of the overall energy system can be established on the basis of the physical flow of electricity and/or the IT connections – such as presented in the NIST or IEC roadmaps. In the sources referred to, the areas of centralized generation, transmission, distribution, customers, markets, operation and services are named. A bundling of use cases can however be appropriate to establish a further subdivision of the overall system, e.g.:

- generation as a domain can be subdivided into centralized generation in large-scale power plants and distributed generation in customer properties (e.g. photovoltaics or unit-type district heating power stations),
- the "customer" domain can be subdivided into sub-domains of domestic customers, commercial customers and industrial customers,
- the "market" domain is for example implemented in the electronic regional market with a virtual balancing group or virtual power plant, energy wholesaling or trading in balancing power

Use Cases / Functions / Interfaces

A use case is a structure for bundling of activities on the bottom level of classification. Use cases are therefore to represent detailed functional descriptions independent of the business model or system architecture within a domain. The description of use cases with object models and service interfaces is regarded as the basis of standardization in the Smart Grid, as the use cases are to be designed to encompass various actors. The system under observation and its system boundaries are always to be stipulated in defining use cases, in which context the use cases are viewed from the outside and the internal flow of the activities is not detailed.

Example: Switching a generation system or a load device on and off.

- Activity in a use case
An activity in a use case is an activity within a domain of action in the energy market, with definition of an input via a sender as a logical node and output via a receiver as a logical node.

Example: Use case "provision of reactive power", activity "information to wind farm", sender "balancing group coordinator", receiver "wind farm", actors "balancing group coordinator" and "energy generator and system service provider wind farm".

The activities of a role are bundled in use cases.

- Semantics, syntax of service interfaces, semantic object models, relationships between objects (ontologies)
The use cases as building blocks in processes communicate via interfaces and require a uniform semantics of objects, definition of the relationships between objects (ontologies) and a defined syntax if they are to be able to ensure the flow of information across a wide range of interfaces, communication models and market roles. This field in particular is regarded as an important task for standardization.

- High level functions
Bundling of use cases with various actors, so as to describe complex business cases appropriately, irrespective of roles and systems, and to systematize the multitude of conceivable, detailed use cases.

Example: Energy metering/billing or demand response management by means of incentive-orientated information.

- Processes and products
Use cases are lined up by market roles to form processes, and linked to products. Products define a service from a supplier to a demand entity. If products are to be offered in an electronic marketplace for energy by machine to machine communication, service interfaces and a data model for products must also be defined.

Example: Electricity supply in connection with a particular, possibly dynamic, tariff; machine to machine communication may in this case mean the provision of information on a new tariff by the electricity supplier's IT system to the energy management system in the household, which automatically uses that information to optimize the in-house load management, i.e. switches devices on or off.

- Business cases
Business cases, as economic services or use models, arise from the linking of processes with their component use cases and the products in the case of a role or bundle role. For example, a business case Grid Load Balancing can be defined with the roles of the Distribution System Operator and Metering Point Operator as a bundle role in connection with the roles of Storage Supplier and System Services Provider as the bundle role Prosumer. Business cases are subject to free market conditions and are therefore not to be standardized. What is

however relevant to standardization is the interaction between the modules in the form of use cases or generic product models to define offers by the market participants against the background of possible changes of supplier. See figure 4.

New, practicable business models have to result for the active market participants. New functions, technologies or challenges are not in themselves sufficient when market participants cannot expect any commercial success in return for their investments. The final customer as a market participant must also be informed and perceive the new functions as beneficial.

Automation

Whereas business processes can often be represented statically along a linear chain with branches, and static interface descriptions are therefore sufficient, complex automation processes with feedback loops are dynamic. If, in order to reduce complexity decentralized and distributed automation technologies are used in place of purely centralized control technologies, interoperability in a heterogeneous system environment with a broad range of suppliers requires the standardization of condition and function descriptions. This especially affects the domains of distribution networks and buildings.

Cross-cutting issues

There are repeated topics relevant to standardization spread horizontally across all domains which cannot be assigned to any particular area but pervade all the areas of a future Smart Grid. These include for example the architecture definition, safety and security topics, stipulation of a common terminology or a uniform semantics for data transfer across several interfaces and stages of added value.

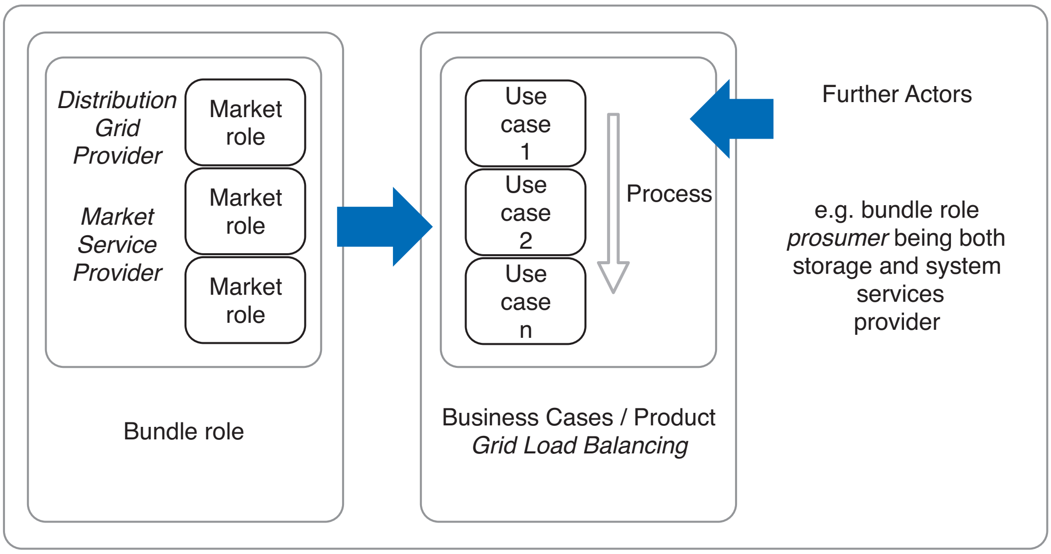

Figure 4: Explanation and examples of the terms business case, actor, market role and use case

- Privacy
  Example: Protection of energy meter data (Smart Meters)
- Security
  Example: Protection of information from hacker attacks or falsification
- Safety of products and systems
  Example: Safety of projects with new Smart-Grid capabilities
- Critical infrastructure
  Preservation of the security of supply and thus in particular maintenance of the indispensable core functions of energy supply, even in crises.
- ICT architecture
  Whereas an ICT architecture develops on the market and is subject to rapid changes, the systematics of architecture definition and the development of a generic reference architecture should however be pursued.

  The generic reference architecture for the Smart Grid should form the basis of sustainability, flexibility, efficiency and cost-effectiveness, and also satisfy special requirements such as robustness and resilience of the future energy supply system.

Interest groups / stakeholders

Together with the market roles, a variety of further stakeholders are active in the environment of Smart Grids and can also make a contribution to the implementation of Smart Grids or exert influence on their design and implementation. These comprise associations, universities and research institutes, consumer and conservation organizations, and also politicians in that they establish the legal framework conditions, and authorities such as the Federal Network Agency with its regulatory stipulations, etc.

Challenges, motivation and obstacles

As a rule, the new developments in this area are motivated by the new challenges, such as climate change in general, a new energy mix or the necessary modernization of the networks. In general, as a consequence, increased use of renewable energy sources or improvements in energy efficiency are stipulated as political objectives. These points are addressed in brief in the introduction and in section 3.4, and described in detail in much of the source literature.

Standards

Existing standards, and standards to be developed or modified, must be taken into account in the developments. The benefits of standards to the individual market participants is dealt with in section 3.4.

3.3.2. Focal topics

For the coming implementation in Germany, the following focal topics have been identified from the discussion on the various perspectives for priority treatment in standardization. It is planned, and has already in part been organized, for focus groups to deal with these topics for standardization and thus establish a link between the general discussion on the Smart Grid and the detailed work in the standardization committees – i.e. the focus groups will bring committees and stakeholders together with regard to the following topics (see also Chapter 6 – *Prospects for continuation of the standardization roadmap*).

- Information security, privacy and data protection as a cross-cutting issue (see above)
  Uniform recommendations on information security, privacy and data protection, assessment procedures for security systems in various areas and with changing threat scenarios.

- Communication
  Data models and semantics/syntax of services interfaces, semantic object models, relationships between objects (ontologies)
  Development of a uniform semantic model to describe objects and the relationships between objects, the syntax for the interfaces of use cases in processes across the various added value stages and interfaces, and between different market roles. Here, for example, additions to the CIM[10] models are considered necessary. This work is to serve as the basis for the development of new market models for generation and load management.

- Smart Meters
  Digital energy consumption meters with standardized communication interfaces for local and remote communications, and object models for new types of equipment (see also In-house automation).

- Distributed generation and load management
  Connection conditions and incorporation in communications technology of distributed generation facilities such as wind, photovoltaic or combined heat and power systems and loads, also including storage facilities and electric vehicles, generation management / load management, for instance via price signals / dynamic tariffs.

- In-house automation
  Energy management in buildings or in industry, taking account of the load management of equipment, local generators or storage facilities. In-house communication with various devices, systems, and smart appliances or heating systems.

- Distribution system automation
  Automation in the distribution system, especially by extending network management to the low voltage range by distributed and decentralized network management technologies.

These focal topics are congruent with the estimation that there are extremely good conditions and a high level of expertise in these fields in Germany, both on the basis of the already large share of wind and solar power and the political will to expand the use of renewable energy sources further, making this a sustainable driving force behind the E-Energy ideas, and on the basis of the subsidized E-Energy projects themselves and further projects on electromobility.

The transmission system, for example, is discerned as one of the topics to be dealt with in further stages.

10 CIM Common Information Model (see Chapter 4)

3.4. Benefits of Smart Grids and their standardization

Various stakeholders benefit in different ways from Smart Grids and from standardization in that field. The following section describes general advantages for various stakeholder groups and sets them in relation to the aspect of standardization. Both the advantages of Smart Grids[11] and those of standardization[12] are described in the literature. It is not the intention to repeat those arguments in the following description, but merely to draw attention to special aspects between these two fields.

3.4.1. Benefits for the state and the economy – general description

A variety of advantages are associated with a Smart Grid, an intelligent energy supply system, and these are to be outlined here in the following list which is by no means to be considered complete:

Environmental policy advantages

- Establishment of conditions for climate protection and the 20/20/20 Agenda by:
  - Integration of renewable and distributed power generation.
  - Future integration of further renewable energy sources in the existing systems will only be possible with Smart Grids.

    With coordinated connection and disconnection of generators and loads, more systems will be integrated in the grid and integration of renewable energy sources will be supported by concepts such as that of the "virtual power plant"[13]. The aim is to support local optimization and load shifts, in conjunction with local storage units. Not only the supply of active power into the grid, but also the contribution to the generation of reactive power is to be considered in this context.

- Energy efficiency
  - Smart Grids / Smart Metering create incentives for energy efficiency.
  - Avoidance/reduction of balancing power – direct use of renewable energy by load management.

Economic policy advantages

- Sustainable and economic ensurance of energy supplies
  - Increased energy autonomy, diversification of primary energy sources and replacement of fossil fuels by intelligent use of wind and solar energy.
  - Contribution to grid stability

- Securing and increasing the expertise of national manufacturers
  - German industry benefits from its strong ICT background, but above all from the global demand for new technologies by expertise in engineering disciplines such as mechanical engineering, plant construction and automation.
  - In addition, German medium sized businesses are strongly engaged in the fields of renewables and special technologies.

Standardization policy advantages

- Facilitation of exports and securing of markets with extensive standardization of the components of a Smart Grid
  German experts are already highly involved in many international fields, e.g. in the internatio-

11 See for example [BDI, BMWi2, 3, ETPEU] and also sections 3.1 and 3.2

12 See the German standardization strategy [DIN1, 2, 3] and source literature on the relationship between standardization and innovation [Footnote 25, CENELEC2]

13 In the context of Smart Grids, mainly in connection with distribution systems, the clustering of small power plant units, especially those using renewable energy sources and feeding in on the medium/low voltage side, to form larger controllable units, is referred to as "virtual power plants".

nal working group on the IEC 61850-7-420 standard[14]. In this way, the interests of German manufacturers of distributed generation facilities can also be contributed to the discussion.

- Lower implementation costs – connection costs and engineering work for connection of de-centralized plants or load management systems – in the national implementation of the Smart Grid as a result of interoperability standards.

- Support in securing knowledge from the results of governmentally sponsored research projects (such as the BMWi and BMU E-Energy projects) by stakeholder involvement in the DKE-Kompetenzzentrum (Expertise Centre) E-Energy and the corresponding DKE and DIN committees.

- A direct cost-reduction effect for the state, as standards are drawn upon in the stipulation of legal and regulatory framework conditions.

- Complexity
  Standards make the complexity which necessarily increases in the course of technological convergence of the ICT, automation, electrical engineering, automotive engineering and power supply disciplines manageable.

- Market penetration of innovations
  Innovations which result from Smart Grid developments are able to establish themselves on the market more easily with standards, and in particular with standardized interoperability. The confidence of users in a new, complex technology is increased. Time-to-market of the new solutions is thus reduced.

- Support from standards in the safe application of new devices and systems with Smart Grid capability.

- Standardization and interoperability standards facilitate market communications
  The further liberalization of the existing energy markets and the creation of new forms of energy markets and services for the Smart Grid require standards.

- Standards facilitate the reuse of software solutions.

These general effects are considered in greater detail below.

3.4.2. Benefits for the energy customers

Benefits of the Smart Grid

Both domestic and industrial customers will no longer perceive energy as a commodity procured for annual or monthly payments, but will actively influence and optimize their energy consumption on the basis of new markets, energy services and products – for instance by Demand Side Management, Demand Response Management or new tariff models. It will be possible to sell potential load transfers, and the previously passive consumer will become an active player.

Smart Meter systems are to represent consumption with high time resolution and make users aware of the emissions caused. Energy efficiency thus becomes tangible and practicable for the consumer. The use of corresponding tariffs can be an incentive to change consumption behaviour and may possibly lead to cost savings for the customer.

14 EN 61850-7-420:2009, "Communication networks and systems for power utility automation. Basic communication structure. Distributed energy resources logical nodes" (IEC 61850-7-420:2009)

Benefits of standards

This scenario requires standards for home automation, Smart Meter systems and the corresponding interfaces. Standards are especially necessary in the field of future electromobility, sensibly integrating a household's vehicles in the Smart Grid. In relation to the connection costs for intelligent charging management, such standards can reduce the costs for the customer. A further relevant point for domestic customers is the security of their personal data (privacy). In that context, standards can define procedures which both make security verifiable and transparent and strengthen the confidence of the customers in a Smart Grid (customer acceptance). Furthermore, against the background of far-reaching changes, the further development of the standards in the field of consumer protection is also to be discussed, for example with regard to grid and supply quality.

3.4.3. Benefits for the distribution system operators

Benefits of the Smart Grid

The further development of the distribution network is an integral part of the Smart Grid. Against the background of increasing decentralized infeed, particularly on this grid level, distribution system operators can plan an optimized network taking into account the reserves revealed in the first place by the Smart Grid, thus possibly avoiding network expansion which would otherwise be necessary [BMWi3][15]. Furthermore, the Smart Grid enables coupling of the distributed generators for the purpose of local optimization and facilitates the better balancing of concepts such as electromobility in the local network. With increased use of actuator systems and metering facilities in the distribution network, bottlenecks, overloads and voltage range deviations can be detected and overcome, and the integration of electromobility and distributed generation further optimized.

Benefits of standards

Standards for communication for the measuring systems in the network and uniform modelling of measurements and control commands for distributed generators contribute to the prompt provision of information to distribution system operators on loads, generation capacities and thus the system loading.

3.4.4. Benefits for the transmission system operators

Benefits of the Smart Grid

The Smart Grid allows transmission system operators to involve distributed energy producers and virtual power plants in system services such as the provision of balancing power. Components such as FACTS[16] facilitate load flow control and monitoring.

Benefits of standards

Standards such as IEC 61970, "Common Information Model" ensure that topology data, for instance, can be exchanged between the UCTE transmission system operators (TSOs), leading to a common semantic model, improved load flow calculation and operational reliability.

3.4.5. Benefits for the German manufacturers

Benefits of the Smart Grid

Promotion of German industry in the field of Smart Grids will not only build up knowledge and expertise, but also develop international

15 „Bytes instead of excavators", in the presentation by the Austrian delegation at the Annual E-Energy Congress, 2009, http://www.e-energie.info/documents/Huebner_Austria_261109.pdf

16 FACTS Flexible Alternating Current Transmission System

markets and, finally, secure jobs for highly qualified employees.

Benefits of standards

Working on standards for the Smart Grid secures international commercial success and a technological lead for the companies involved. As the grids have to be renewed and expanded, countries such as China and India are currently converting their infrastructure to new, open IEC standards such as CIM (IEC 61970/61968[17]) or IEC 61850[18].

3.4.6. Benefits for the research community

Benefits of the Smart Grid

Programmes such as the BMWi and BMU E-Energy programme and many other research projects directly back systematic promotion of major pilot projects and provide support to technology convergence and the ICT industry in particular. Targeted promotion will create platforms which enable researchers better to exchange information and facilitate networking which can lead to further cooperative ventures on the European level. The aim for German researchers must be to address the topic of Smart Grids in a practical manner, with support from industry and the government.

Benefits of standards

The solutions developed and frequently publicly subsidized in the research projects should flow into standardization at an early stage, so as to secure the results of research from the point of view of social policy and put them into practice.

17 IEC 61970 – Energy Management System Application Program Interface (EMS-API); IEC 61968 – Application Integration at Electric Utilities

18 IEC 61850 – Communication Networks and Systems for Power Utility Automation

4. Activities for the development of standards in the field of the Smart Grid

4.1. Introduction

The relevant standards which have been identified in the field of Smart Grids worldwide on the basis of previous roadmaps by the community of manufacturers, users and researchers are named below. In the field covered by the DKE as an important national standardization organization in the IEC (International Electrotechnical Commission), the IEC standards are above all, but not solely, to be identified as relevant. Figure 5 represents the dependencies and organizational structures of the relevant organizations.

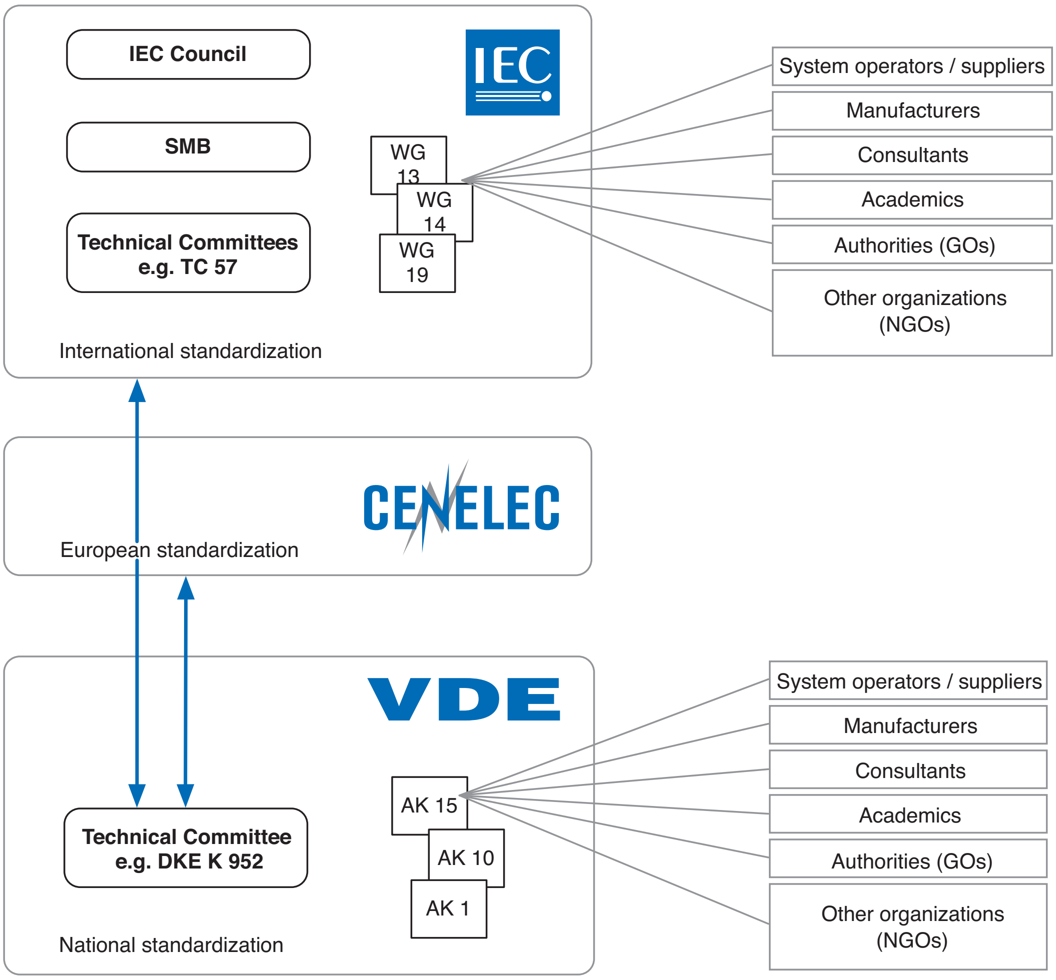

Figure 5: Dependencies between the standardization organizations in the field of electrical engineering

There are of course further standardization organizations which have to interact in the networks of the Smart Grids technologies. DIN on the national level in Germany, CEN and ETSI on the European level, and ISO, ISO / IEC JTC1 and ITU-T on the international level are especially worthy of mention. Cooperation with other organizations has already been extensively formalized. In the course of this roadmap, further dependencies are also documented, especially with a focus on new topics such as digital energy consumption meters or electric vehicles, and new links are proposed.

The following section shows the IEC architecture for the Smart Grid of the future. This architecture is discussed in various national and international studies on the topic of Smart Grid standardization, and is regarded as the core of future automation and power system management for global Smart Grid implementations.

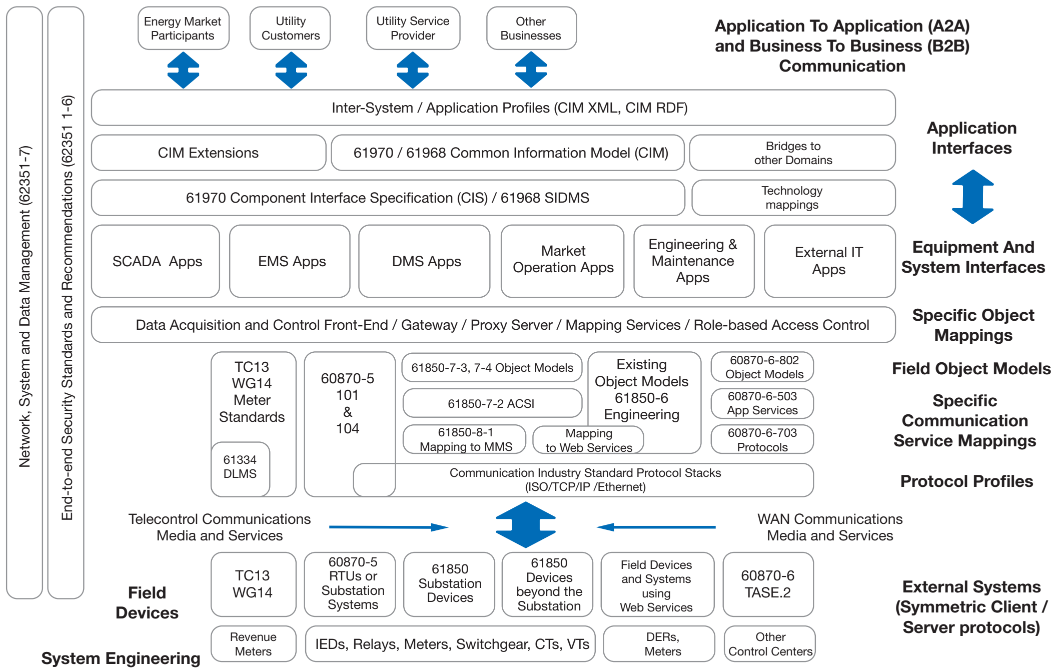

Figure 6: The IEC TR 62357 Seamless Integration Reference Architecture (SIA)

Figure 6 documents the individual layers of the IEC TR 62357 Seamless Integration Reference Architecture [IEC 62357]. It is based on established standards from IEC/TC 57 and IEC/TC 13, and sets these in relation to each other. There are two interfaces to external systems and domains, above all in the areas of market communication (which is mostly regulated on a national level) and digital meters, often referred to as “Smart Meters”. The rest of the architecture under consideration is mostly organized and implemented internally within the relevant market participant (e.g. network operator or supplier). The standards of the IEC Seamless Integration Architecture (SIA) can therefore roughly be assigned to the areas of “integration of applications and business partners”, “integration of energy systems" and "security and data management" (see Figure 6).

The IEC SIA defines the basic data models of a Smart Grid (IEC 61970 and IEC 61968 series: Common Information Model CIM). For the CIM, interfaces to the primary and secondary IT for energy management systems (EMS) and distribution management systems (DMS) are provided. Fundamentally, areas such as market communication and distributed generation are already being taken into account in the current work on the SIA, and interfaces between systems, communication architectures (Service-Oriented Architectures, SOAs), processes and data formats are being standardized. With regard to cross-cutting functions for the Smart Grid, IEC defines the core area of software security in the IEC 62351 series of standards. Communication protocols (IEC 60870) and substation automation, communication with distributed generation (IEC 61850-7-4XX) and coupling with the digital meters are also in the focus of the architecture. Care is taken in that context not to standardize applications and functions too closely, so that proprietary variations and implementations are still possible, leaving room for competition and innovation. All in all, therefore, standards for a number of the core aspects of the Smart Grid have already been defined, and can either be directly applied or above all used as the starting point for further work in the sense of a crystallization point for standardization in the field of Smart Grids. Figure 7 shows the complex system – including interdependencies – of the various standardization organizations which, by virtue of their relevant core topics, are of importance to the Smart Grid.

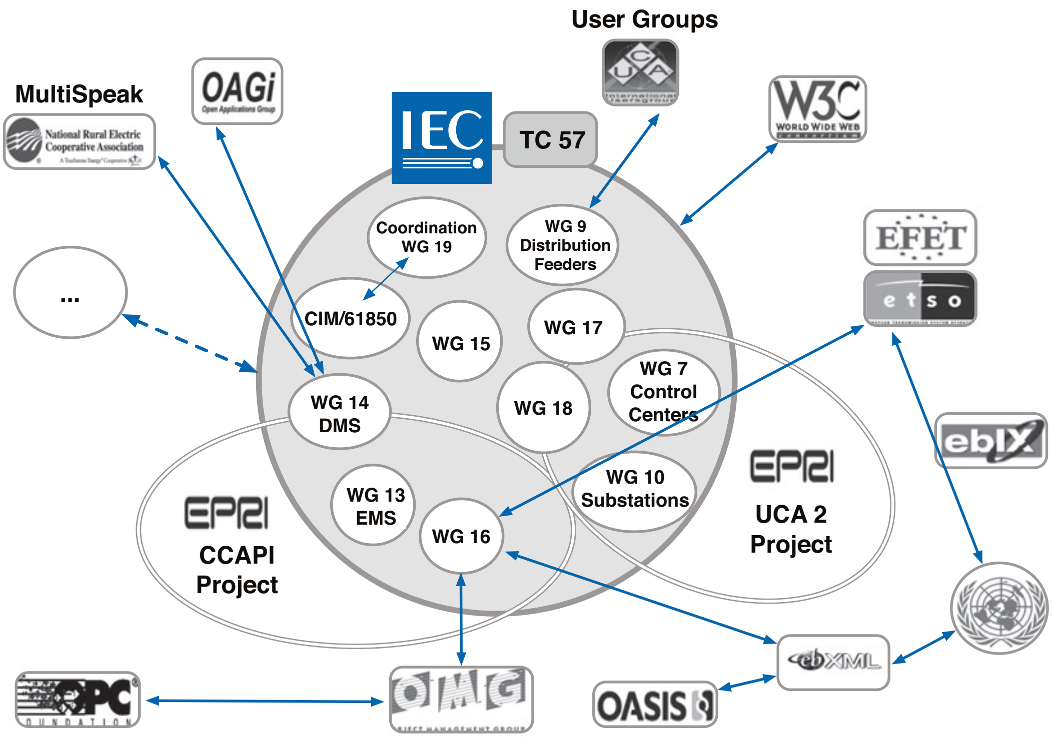

Figure 7: IEC/TC 57 in the context of other committees and organizations

The following sections present three studies in the field of standardization for the Smart Grid, each of which builds upon the work of IEC/TC 57 Seamless Integration Architecture, which is relevant to the DKE, and makes recommendations compiled by numerous experts at home and abroad.

4.2. IEC Standardization "Smart Grid" SG 3 – Preliminary Survey Draft

The Standardization Management Board (SMB) of IEC resolved the establishment of a Strategy Group on "Smart Grids" (Strategy Group 3), which submitted an initial roadmap for its own standards and 11 high level recommendations to the SMB in February 2010. At the present time (April 2010), the roadmap is still in the final consultation phase. This work and these recommendations are especially relevant to a national standardization roadmap as pursued by the DKE. The heart of the Smart Grid in the IEC roadmap comprises both improved supervision and the monitoring of all the components located in the grid. This however, in the opinion of the IEC, requires a higher level of syntactic[19] and semantic[20] interoperability for all the components and systems involved. Requirements for this transition to a Smart Grid also result from the integration of existing systems and improved investment security from standards. Existing IEC core standards serve as the basis for further Smart Grid standards to be developed.

IEC identifies the main driving forces as the rising demand for energy, the further spread of distributed generation facilities, sustainability in generation and distribution, competitive market prices, security of supply and the ageing infrastructure. The fields considered in the roadmap are as follows:

- HVDC/FACTS
- Blackout prevention /EMS
- Distribution system management, distribution system automation and intelligent substation automation
- Distributed generation and storage facilities
- AMI, Demand Response Management, load management
- Home and building automation
- Storage, electromobility
- Condition monitoring

Apart from the division of its standards into core standards for the Smart Grid and others with less relevance, the IEC also describes general requirements for a Smart Grid reference architecture. These are presented in brief in the following section.

Smart Grids may occur in various forms, and are based on the existing infrastructure. The IEC aims at further international standardization of existing, tried and tested communications mechanisms and definition of interfaces and requirements without however standardizing applications and business processes, as these are too national in character; a national roadmap can where appropriate provide supplementary recommendations or stipulations adding to the relevant national legal framework. The IEC has already developed numerous suitable standards. Its aim is therefore also to disseminate these further and to draw attention to them. The special focus in that context is on IEC 62357, "Seamless Integration Architecture", as already mentioned. As technical grid connection conditions are subject to national law, the IEC will not standardize them, but only issue general recommendations. In the field of market communications, the IEC aims to harmonize the existing proprietary models in the long term, and is working together with UN/CEFACT and UN/EDIFACT, for example. This cooperation

19 Technical interchangeability

20 Technical and interpretative interchangeability

is intended to lead to harmonization in the field of Smart Grids and promote the seamless integration of the markets in the technical infrastructure. In addition, the IEC wishes to take the work of EPRI and NIST into account, and is seeking close cooperation in order to rectify the weaknesses in standardization identified by the NIST roadmap in future standards.

The IEC/TC 57 standards identified as core standards are the following:

Table 1: Core standards of IEC/TC 57

Core standards	Topic
IEC 62357	IEC 62357 Reference Architecture – SOA Energy Management Systems, Distribution Management Systems
IEC 61970/61968	CIM (Common Information Model) EMS Energy Management, Distribution Management DMS, DA, SA, DER, AMI, DR[21], E-Storage
IEC 61850	Substation Automation, EMS, DMS, DA, SA, DER, AMI
IEC 62351	Security

The IEC Roadmap's assessment also includes the classes of "Low", "Medium" and "High" relevance. The following standards are considered to be of high relevance:

Table 2: Standards of "High" relevance

Standards of "High" relevance	Topic
IEC 60870-5	Telecontrol, EMS, DMS, DA, SA
IEC 60870-6	TASE.2 Inter Control Center Communication EMS, DMS
IEC TR 61334	DLMS, Distribution Line Message Service
IEC 61400-25	Wind Power Communication EMS, DMS, DER
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 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

A total of over 100 IEC standards were identified, described and prioritized by SMB SG 3. Twelve application areas and six general topic blocks were examined by SG 3, and 44 recommendations for a Smart Grid under the aspect of standardization issued. As it says, the IEC accepts the challenge of standardizing the technical infrastructure for the Smart Grid

21 See Chapter 8 for a key to the abbreviations

of the future and wishes to function as a "one-stop shop" for the standards of the future[22]. Close cooperation with the national committees and their experts (e.g. NIST and its Priority Action Plan) are in the focus of interest.

In the course of public commenting, the special importance of the SG3 Roadmap was emphasized and attention was drawn in particular to further recommendations with regard to distribution system automation: Blackout prevention, outage analysis, smart substation automation process bus with time synchronization, protection technology.

Nine of the eleven high level recommendations submitted to the SMB were accepted in early February and are also fundamentally supported by the DKE:

- SG3 DECISION 0: To put in place a formal liaison between NIST SGIP and SMB SG3
- SG3 DECISION 1: TCs will provide practical guidelines to increase current usability of standards
- SG3 DECISION 2: Fast-track new standards to close the gaps
  In order to save time, the adoption of existing standards from other organizations in an IEC framework is to have priority over the development of IEC's own standards, and for example be accelerated by the use of the Publicly Available Specifications (PAS).
- SG3 DECISION 3: Set up a Feedback process for continuous improvement
  Experience gained from the use and application of the standards is to be more rapidly integrated in the existing standards.
- SG3 DECISION 4: Across the IEC Smart Grid Framework, the Application Domain TCs must use the methods delivered by the "horizontal" TCs included in the Framework.
  Horizontal standards and series of standards such as IEC 61850 and CIM are to be defined and applied by all TCs within the IEC for the use of Smart Grids.
- SG3 DECISION 5: The Application Domain TCs must develop their own Data Models and Test Cases
  Based on these horizontal standards, data models and test cases are to be developed in the relevant application domain TCs.
- SG3 DECISION 6: Accelerate the harmonization of IEC 61850 and CIM
  See also recommendation SG-ANLT-2 in section 5.2.5.
- SG3 DECISION 7: Deliver generic Use Cases
  TC8 as the system TC for electrical power supply is to develop use cases in cooperation with the application-related and product-related TCs.
- SG3 DECISION 8: Establish a new TC or SC on "connecting the consumer applications" (decision postponed)
- SG3 DECISION 9: Add a Smart Grid certification process to the IEC System family
  SMB passes on this recommendation to the IEC Conformity Assessment Board (CAB).
- SG3 DECISION 10: Add operational management of the IEC Smart Grid Framework
  Recommendation to implement the High Level Recommendations submitted and the IEC-Roadmap.

22 http://www.iec.ch/zone/smartgrid/

4.3. Study on the standardization environment of the E-Energy funding programme

The study on the standardization environment of the E-Energy projects was commissioned in October 2008 by the BMWi and performed between October 2008 and January 2009 [BMWi]. On the basis of an expert poll in the E-Energy projects, the experience of the consortium compiling the study and bibliographical research, standards were identified and presented in detail. The study covered the topics of software architecture standards, development models, ICT, automation technologies, distributed generation, digital meters, national and international market communication and home automation. The study provides no information on the field of electromobility. The BMWi programme "ICT for Electromobility" was only established after the study started, and will presumably launch its own studies on this aspect. The study's recommendations for action are also applicable to other Smart Grid projects, as the full public report does not include the individual recommendations for the individual projects [ETG, BMWi]. The following table provides an overview of the recommendations issued for Smart Grid standards from the IEC SIA environment, and forms the basis of the development of this roadmap.

Table 3: Recommended standards

Recommended standards	Subject
IEC 62357	IEC 62357 Reference Architecture – service-orientated architecture, EMS, DMS, metering, security
IEC 61970/61968	CIM (Common Information Model), domain ontology, interfaces, data exchange formats, profiles, process blueprints
IEC 61850	Substation automation, distributed generation, wind parks, hydro power plants, electromobility
EDIXML	Market communications with gradual transition from EDIFACT to modern, CIM-capable technologies
IEC 60870	Established communications
IEC 62351	Security
IEC 61334	DLMS
IEC 61499	SPC and automation, profiles for IEC 61850 (planning)
Digital meters / Home gateways	Reference is made here to competitive solutions and EU mandate M/441
IEC 62325	Market communications using CIM
IEC 61851	Electric vehicle conductive charging system (added during comments phase)

Apart from the IEC standards, attention was devoted above all to the technological convergence of ICT and automation technology, and in the area of standards closely connected with IEC a recommendation of CIM for the field of market communications was issued, but the regulatory dimension and the strongly national character of EDIFACT were pointed out.

As a result of the large number of standards on wired and wireless home automation, no dedicated recommendations were issued on this field in the study cited, as the E-Energy projects bring different infrastructures with them. With Mandate M/441 from the EU Commission to CEN, CENELEC and ETSI, consolidation will where necessary also take place here, and an integration of the multi-utility approach will be possible (see next section).

4.4. CEN / CENELEC / ETSI Smart Meters Coordination Group on EU Mandate M/441

The European Union has issued a mandate for the standardization of smart meter functionalities and communications interfaces for use in Europe [CENELEC], [ETPSDD] for the electricity, gas, heat and water sectors to the organizations CEN, CENELEC and ETSI. The results of Mandate M/441 are standards or technical documents. Standards in this context are to be voluntary technical specifications and general technical rules for products or systems on the market. The aims are to secure interoperability, protect the customers and ensure system reliability. Above all, the following six aspects of smart metering are considered and the prevailing standards examined.

- Reading and transmission of measurements
- Two-way communication between the meter and a market participant (biller)
- Support by the meter for various tariff models and payment systems

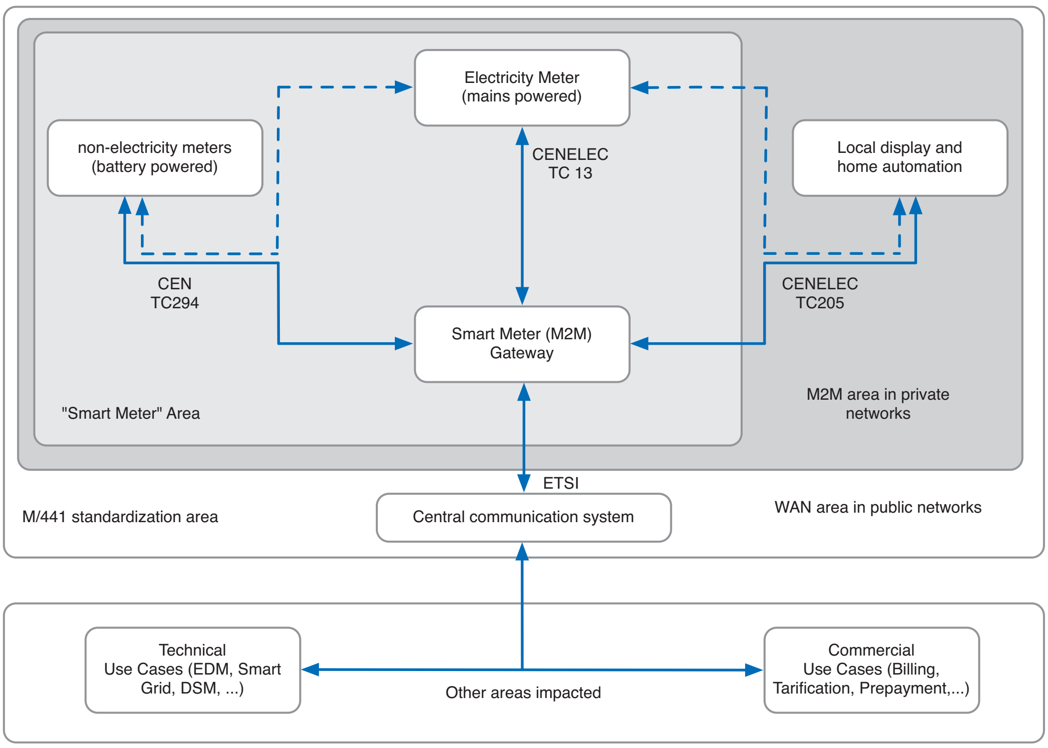

Figure 8: Reference architecture of the SM-CG and cooperation by the relevant European standardization organizations

- Remote meter deactivation and start/finish of supply
- Communication with devices in the household
- Support of a display or interface in the household for display of the meter data in real time

The meters must not always support all the functionalities; this can be arranged from country to country. Within the “Smart Meters Coordination Group” (SM-CG), existing standards are classified in relation to these six functionalities and responsibilities delegated to individual standardization committees.

In the discussion of the draft of this roadmap, it was also suggested that the properties of meters should be examined over and above the findings currently discussed with regard to extended “Smart Grid suitability”, e.g. for distribution system operators, also taking account of any regulatory frameworks.

In addition, attention is drawn here to the activities of the EU Commission in relation to Smart Grids. The necessary actions for implementation of a Smart Grid in Europe are being examined by a task force with three subordinate working groups. Even if the work currently appears to be concentrated on the regulatory and legal framework conditions, it will have effects on standardization.

4.5. In-house Automation – Joint working group of DKE and E-Energy research

If distributed load and generation management, the use of distributed energy storage capacities in buildings and industrial properties and the provision of energy efficiency services are to be realized in response to fundamental challenges of the Smart Grid, communication within utilities and down to the equipment in buildings and industrial properties is necessary. A basic distinction is made between two approaches:

- Direct control of devices by market roles in the energy system (e.g. cold storage facility balances out wind peaks)
  This type of control is likely to be expected for relatively large systems in industrial or commercial environments.
- Indirect, incentive-based control for decentralized, autonomous decision-making (example: variable price models, CO_2-free electricity, stipulation of a running schedule)
  Indirect control by incentives such as dynamic price signals from outside is in particular envisaged primarily for households or small businesses. Studies are currently focusing on what an optimum price signal which may contain additional network aspects could look like, or whether direct control is possible (by whom, and to what criteria).

An energy management system will be a central element in this connection, reacting to the incentives from outside in accordance with the wishes of the customer, and passing on information to in-house devices and generation facilities.

Energy management can be implemented in various ways:

- In-house automation is already in place in some buildings. This is to be extended by adding energy management functions.
- A separate energy management system is installed.
  This variant is currently encountered in most cases in the Smart Grid and E-Energy research projects.
- The energy management functions are integrated in future devices in various ways.

- A gateway only transmits information between the market actors (e.g. suppliers or network operators) and the individual devices and systems in the buildings which have distributed intelligence and, for example, react autonomously to price signals.
  Alternatively, reasons of convenience and the opportunity to implement more complex control algorithms speak in favour of centralized building energy management (example: energy management gateway implemented as runtime environment with added communication with the terminal units). The energy management system communicates in the building with sensor and actuator components and the smart metering infrastructure, and has a control interface with the building users. Finally, basic functionalities will as a rule remain independent in the devices for reasons of product liability (e.g. refrigerator restarts when a maximum temperature has been reached).

IIn the course of the public discussion on the draft of the standardization roadmap, attention is drawn to the activities of CENELEC TC 205 and CEN TC 247 WG 4:

- DIN EN ISO 16484 Parts 5 and 6 (BACnet)
- DIN EN 50090 and DIN EN 13321 (KNX)
- DIN EN 14908 (LON)

and to

- CiA[23] 437 for photovoltaic systems, based on EN 50325-4

4.6. Further relevant roadmaps with statements and influence on standards

4.6.1. NIST Framework and Roadmap for Smart Grid Interoperability Standards

Empowered by the Energy Independence and Security Act (EISA) of 2007, the Department of Commerce in the USA devolved the main responsibility for the coordinated development of a framework for the achievement of interoperability of Smart Grid systems and devices, taking especial account of protocol and data model standards for information management, to NIST [EPRI]. Various pieces of equipment, such as Smart Meters for the US Smart Grid, are already being evaluated in field trials. NIST[24] also emphasizes that large investments in a Smart Grid will not be sustainable without standards.

NIST has therefore established a phase plan intended to accelerate identification of the standards required for the Smart Grid. The document [EPRI] is the result of the first phase in compilation of the framework. It describes an abstract reference model of the future Smart Grid and in doing so identifies almost 80 essential standards which directly serve the Smart Grid or are relevant to its development on a meta-plane. In addition, 14 key areas and gaps are identified, in which new or revised standards are needed, especially in the field of security. NIST further establishes plans of action with aggressive timetables and coordinates the standardization organizations to the extent that they support its plans to close the gaps in achieving Smart Grid interoperability in the near future. Table 4 presents an overview of the initially identified 16 standards on which the expert groups in the three major meetings reached consensus; not all the standards listed, however, fulfil German requirements for a standard.

23 CAN in Automation (CiA)

24 NIST National Institute for Standards and Technology

Table 4: Overview of the 16 proposed core standards for the NIST Interoperability Roadmap

Designation	Topic
AMI-SEC System Security Requirements	Advanced metering infrastructure (AMI) and SG end-to-end security
ANSI C12.19/MC1219	Revenue metering information model
BACnet ANSI ASHRAE 135-2008/ISO 16484-5	Building automation
DNP3	Substation and feeder device automation
IEC 60870-6/TASE.2	Inter-control center communications
IEC 61850	Substation automation and protection
IEC 61968/61970	Application level energy management system interfaces
IEC 62351 Parts 1-8	Information security for power system control operations
IEEE C37.118	Phasor measurement unit (PMU) communications
IEEE 1547	Physical and electrical interconnections between utility and distributed generation (DG)
IEEE 1686-2007	Security for intelligent electronic devices (IEDs)
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 communication, measurement, and control
ZigBee/HomePlug Smart Energy Profile	Home Area Network (HAN) Device Communications and Information Model

4.6.2. UCAiug Open Smart Grid subcommittee

In the field of the two series of standards IEC 61850 and IEC 61970, an association of users of those standards has come into being as the “Utility Communications Architecture International Users Group” (UCAiug), whose members supply important input for international standardization on the basis of their experience. As the two standards are regarded as core standards of a future Smart Grid, a sub-group, the Open Smart Grid Group (OpenSG) was founded within the UCAiug. It regards technical Smart Grid standards as a critical factor in greater interoperability, more competition, and simplified implementation. The aim is to carry the new Smart Grid standards into the markets in order that they be used for new energy efficiency applications and products and to secure investments in infrastructure, projects and products. The work focuses on profiles for standards, promotion of their dissemination in applications, improved cooperation between manufacturers and standardization organizations, development of meter systems, and verifiability of implementations by interoperability tests.

4.6.3. Identification of future fields of standardization 2009 – Basic study by DIN Deutsches Institut für Normung e.V.

In the context of the initiative "Promotion of Innovation and Market Capability by Standardization – Innovation with Norms and Standards" (INS)[25] the INS basic study "Identification of future fields of standardization 2009" has identified future challenges for standardization [DININS]. The INS project is sponsored by the BMWi.

The basic study combines the statistical analysis of various indicators with an online Delphi pole, and provides information on the areas in which an increased need for standardization can be expected in future. In 2009, together with the field of optical technologies, E-Mobility and E-Energy were core topics of the study. In the poll, focal topics for E-Energy and E-Mobility were identified and the relevance of standardization, the necessary types of standards, the level of the activities and the time priorities for standardization were assessed.

The results of the study emphasize a medium to high importance of standardization for almost all the topics identified. For the commercial and technological development of E-Energy, standardization is classified as having a high level of importance, and for environmental protection and security the importance is classified as medium to high. The time priority of the standardization work is mainly seen as lying within the coming 5 years. The potentials of standardization are discerned in the solution of specific technical problems, the improvement of cooperation with researchers and developers, and as a basis for future research and development.

As the necessary types of standardization, the experts identified compatibility standards, terminology and classification standards, and quality and safety standards. It is recommended that the standardization activities mainly take place on the national and European levels.

The standardization roadmap addresses the most important requirements identified in the basic study. With regard to the 63 individual topics identified in the fields of decentralization of power generation, system management, energy transmission networks, energy storage and transformation facilities, energy metering systems on the generation level and consumer level, and alternative energy generation, coordination can still take place after the official publication on 20 April 2010.

4.6.4. BDI initiative "Internet for Energy"

The study on "Internet for Energy – ICT for the energy markets of the future" completed by the BDI in December 2008 and published in February 2009 [BDI] deals not only with the three aspects of energy scarcity, the regulatory environment and technical developments with rising energy prices, but also with the German electricity system and its penetration by ICT technologies. Together with substantive roadmaps dealing with technologies and scenarios, the roadmap also provides recommendations for the field of standardization. The BDI above all issues four recommendations: the demand for improved harmonization and integration of existing standards and (communication) protocols, the extending of standardization efforts to cover gas, water and heat, the coordinated promotion of interoperability and the development of open communications standards for

25 www.ins.din.de

new technologies. The domains identified are distributed energy generation, transmission and distribution networks, energy metering and end-user consumption. Standards for the use level, application and transmission level and the transmission and communication media level were assigned to each of these topics.

4.6.5. FutuRed – Spanish Electrical Grid Platform

The Strategic Vision Document from the Spanish Smart Grid platform FutuRed [SGES] issues numerous national recommendations in the areas of regulation, political and legislative support and general technical progress. Furthermore, recommendations are given on the field of standardization, without however explicitly naming established standards. Here too, standards are regarded as the basis for the achievement of interoperability in the complex system of the Smart Grid. Without simplified integration of the various systems, barriers would arise and endanger the technical implementation of Smart Grids. The FutuRed roadmap therefore demands the standardization of communications protocols, grid connection conditions for new producers, safety limits for the grid, and processes to make the Smart Grid become reality.

4.6.6. Smart Grids Roadmap for Austria

The Smart Grid roadmap [SGA] presented for the first time at "Smart Grid Week 2009" in Salzburg makes no explicit statements on standardization, but does define fields of technology in which technical progress is indispensable for a Smart Grid of the future. Above all, generalized information models in the area of SCADA, bandwidth for communication with digital meters, regulation of the frequency bands for PLC, integration of electromobility, integration of existing infrastructures and general interoperability are regarded as important.

4.6.7. Electricity Networks Strategy Group (UK) – A Smart Grid Routemap

In Great Britain, a so-called "Smart Grid Routemap" in the form of a PowerPoint presentation has also been established by ENSG, the Electricity Networks Strategy Group. It examines the extent to which a Smart Grid can help in Great Britain in supporting the government's targets on carbon dioxide emissions and cost reductions for final customers[26]. The strategy groups are to bring together all the relevant stakeholders in the field of electricity grids. The group is managed and supported both by the energy ministry DECC[27] and the regulator Ofgem[28]. The period 2010-2015 is seen as the time horizon for demonstration projects of the Smart Grid. Under three major objectives, namely carbon dioxide reduction, security of supply and competition, twelve different challenges are discussed and documented. With the aim of an integrated, scalable technical design for the Smart Grid, standards are also discussed, without recommending any particular standards as such. As fully integrated end-to-end solutions are at present mostly not scalable from a technical point of view, interoperable solutions and suitable technologies will have to be found and integrated for the future Smart Grid, in both commercial and technical regards. Safety, security and privacy aspects are always to be taken into account.

26 http://www.ensg.gov.uk/

27 Department of Energy and Climate Change

28 Office of Gas and Electricity Markets

4.6.8. Japan's roadmap to international standardization for Smart Grid and collaborations with other countries

The Japanese approach to standardization in the context of Smart Grids is highly similar to the approach of NIST in the USA: Starting with an initiative by the Ministry of Economy, Trade and Industry (METI), a strategy group was founded in August 2009 with the aim of promoting Japanese activities in international standardization in the Smart Grids field. Standards are seen in that context as a fundamental element in the achievement of the required interoperability. The flexibility and expandability of the future Smart Grid can, according to the strategy group, only be achieved with an appropriate degree of standardization. A first report was completed by January 2010, providing for the establishment of a roadmap in close cooperation with other standardization organizations and countries. On the basis of a general picture of the future Smart Grid, seven main fields of business (Wide-Area Awareness in Transmission, Supply-Side Energy Storage, Distribution Grid Management, Demand Response, Demand-Side Energy Storage, Electric Vehicles and AMI Systems) were identified, to which 26 Priority Action Areas are assigned. Special core aspects for the Japanese economy were also identified. The topics are to be addressed in cooperation with IEEE, IEC and CEN/CENELEC. The recommendations are therefore also congruent with the previous recommendations from those organizations.

4.6.9. CIGRE D2.24

CIGRE WG D2.24 deals with the topic of "EMS Architectures for the 21st Century". The aim of the group is, by its own statements, to develop a vision for the architecture of the next energy and market management systems. This architecture is to be applied in practice and its implementation is to rank as a de facto standard. Real time systems are to be coupled with transmission network and market systems, and extended to cover distribution and generation. The working group defines the non-functional requirements of interoperability and reusability. In addition, it develops a set of requirements and describes an architecture and its standard components. The group has agreed on the following ten points as design principles:

- Component-based, service-oriented architecture to facilitate integration and reusability in utilities
- Modularization for breakdown of business processes
- High speed buses for real time messaging
- CIM as the domain data model
- A security level as a cross-cutting function
- Use of industry standards
- Standardized user interfaces
- Abstraction of current transmission protocols for future proofing
- Scalability for future applications
- Standardized tools for data management and display

There is cooperation between CIGRE D2 and IEC/TC 57 in the form of a "Cat A Liaison". CIGRE intends to base the development of its architecture above all on established IEC/TC 57 standards and report its results to IEC.

4.6.10. IEEE P2030

Under the name of IEEE P2030, a project has also been established at the USA's professional association for electrical engineering and information technology dealing with the development of a draft to ensure the interoperability of energy and information technology in the Smart Grid with the special focus on end-user applications. Similarly to that of NIST, this project developed by IEEE is traceable to the US government's Energy Independence Security Act (EISA) from the year 2007. As part of SCC21, Smart Grid Standards, the P2030 working group is compiling the document "IEEE P2030 Draft Guide for Smart Grid Interoperability of Energy Technology and Information Technology with the Electric Power System (EPS), and End-Use Applications and Loads". The aim, according to IEEE, is a knowledge base with coordinated terminology, characteristics, functional descriptions and evaluation criteria, and suitable development measures to achieve interoperability in the Smart Grid. In contrast to IEC, architectural best practice experience and functions are also to be described here. As a result of the close cooperation with NIST, it is to be expected that the recommendations will be highly similar and the recommended standards will be identical.

4.6.11. Automation 2020+ Energy integrated technology roadmap

The Automation 2020+ Energy technology roadmap compiled by the IZT Institute for Future Studies and Technology Assessment on behalf of the Automation Division of ZVEI, the German Electrical and Electronic Manufacturers' Association [ZVEI], regards Smart Grids together with other future topics such as CCS, biomass utilization and hydrogen as an energy store as a fundamental new area for automation technology. Various scenarios are examined with regard to the market potential of the relevant topics for automation technology. Especially in the field of Smart Grids, the importance of standardization is emphasized here too.

4.6.12. Further roadmaps

The further foreign Smart Grid roadmaps are not directly applicable to a German roadmap on account of their characteristics from an industrial or national, rather strategically driven, focus. They do however provide information on certain technical domains which are relevant to the recommendations made in this preliminary study (Smart Metering, broadband communications), or on already accepted standards (e.g. IEC 61970/61968 and IEC 61850).

4.7. Summary

This section of the roadmap presents the previous Smart Grid interoperability and standardization roadmaps relevant to the DKE, briefly sheds light on their contents and origins, and also documents focal points which are relevant to this German standardization roadmap on the topic of Smart Grids.

		Recommendations for Smart Grids				
		IEC Standards Roadmap	NIST Roadmap	ETP Smartgrids	BMWi-Standardization study	BDI – Internet for Energy Initiative
Origin		International	US	EU	DE	DE
Type of committee		Standardization committee	US Institute			Initiative
Document type		Standards Roadmap	Standards Roadmap	Research Agenda	E-Energy Standardization study	Vision
Area of added value	Production	high	covered	covered	high	
	Energy trading	covered	covered	covered	high	high
	Sales	hardly or not at all covered	high	covered	hardly or not at all covered	
	Transmission	covered	high	high	covered	
	Storage	high	high	covered	hardly or not at all covered	
	Distribution	high	high	high	high	
	Metering	high	high	covered	high	high
	Application	high	high	covered	high	high
Integration aspects to the TC 57 Reference Architecture	Integration of business partners	covered	covered	covered	covered	
	Integration of applications	covered	covered	hardly or not at all covered	covered	
	Integration of devices and plants	high	covered	covered	covered	
	Security	high	high	covered	covered	
	Data management	hardly or not at all covered	hardly or not at all covered	covered	hardly or not at all covered	

Degree of Coverage: high covered hardly or not at all covered

Figure 9: Overview of studies and their examination horizons

4.7.1. International studies

In the area of international standardization and interoperability roadmaps, a relevant document for DKE is already available in the form of the draft of the IEC roadmap, from whose contents standards for a German roadmap can be deduced. The standards from IEC/TC 57 Seamless Integration Architecture (IEC TR 62357) are worthy of particular mention in this context. The IEC's provisional roadmap represents a good basis, which can exert influence on standardization in the field of Smart Grids on an international level. The IEC focus however means that areas which may be relevant to Germany are missing and cannot be adopted from the study (e.g. market communication and data exchange with EDIFACT).

4.7.2. National studies

The work of NIST refers in part to North American standards such as those from ASHRAE or IEEE, which are less widespread in the European context. Nevertheless, many of the recommendations from the international IEC roadmap are picked up in the national North American roadmap.

In the area of standardization for the Smart Grid and the E-Energy projects in Germany, especially the study commissioned by the BMWi on the standardization environment of the E-Energy funding programme and the "Internet for Energy" study compiled by the BDI initiative are of significance. While the latter merely summarizes the topic of standards and standardization by means of recommendations on just under two pages, the former describes the recommended standards in detail, with the focus on IEC 62357, and states the advantages and disadvantages of the various technologies for the E-Energy model regions. The recommendations of the two studies extensively agree with each other and are also congruent with the simultaneously, but completely independently compiled NIST/EPRI document. It is therefore to be assumed that certain IEC standards (for example IEC 62357 SIA) will indeed form the core of a future Smart Grid (see also the overview matrix in the appendix). The roadmap documented here also draws on aspects of the national studies [ZVEI, SD2020, DE2020, ESEE].

4.7.3. Existing challenges already identified

The analysis of the previous roadmaps already reveals and suggests difficulties and challenges in the use of standards in the field of Smart Grids. Standards do of course promise advantages such as the avoidance of duplicated work ('reinventing the wheel'), use of best practices, easier recognition of requirements, reduced integration costs, avoidance of vendor lock-ins and greater market acceptance. Nevertheless, there are certain aspects which must be taken into account in standards. The specification must be sufficiently developed, relevant stakeholders involved, revisions regularly performed, implementations present, tools available for use and marketing pursued. There are different motivations and challenges for the various domains and actors in Smart Grids.

In the area of standards for SCADA, there is a culture of manual, labour-intensive integration of systems. There are admittedly already standards for data and object models, but there are also a multitude of serializations of these models (XML, RDF, OWL, OPC). IEC 62357 should be able to provide appropriate structuring in this area.

In the field of automation for distribution and transmission systems, an object-based, increasingly widespread standard already exists in the form of IEC 61850 for switchgear. Automation technologies for transmission systems are already widespread, but for distribution systems models still have to be found for the handling of distribution network automation in the field of tension between regulation, innovation, cost-effectiveness and political directives.

There are numerous, relatively old standards and technologies for the field of WAN communications. Here, suitable migration and integration strategies have to be developed. There are numerous communications standards for access to WANs used to reach switchgear systems, but many of these are not suitable for access to data in households. Other standards therefore have to be adopted there. Most of the technologies in this area are proprietary. Many use IP as the preferred network layer, but there are often problems with the required bandwidth. Broadband is therefore frequently regarded as a core element in communication with the energy customers. In the household itself, account has to be taken of the coexistence of established standards for home automation and ICT, extending to convergence of objects with the internet. These include standards such as Zigbee, KNX, LonWorks, Ethernet, IP over PLC, Wifi, etc.. One of the many challenges in this context, for example, is the integration of communication with electromobility.

Distributed generation is becoming more relevant, and is already controllable by standards and communication technologies such as OPC, BACnet, CiA, Seamless IP or IEC 61400-25 and 61850-7-420; nevertheless, stand-alone solutions result here from different communication technologies.

In conclusion, it can be said that the studies reveal need for uniform, harmonized models in all respects. Standards should stringently define semantics and syntax. The necessary conditions are corresponding bandwidths to the customers and uniformity and standardization in the fields of home automation and smart meters. Security is an all-pervading cross-cutting topic, which is essential not only for the acceptance, but also for the reliable and stable operation of the envisioned Smart Grids – in this respect there are already partial solutions in existence such as IEC 62351 or the NERC CIP. All in all, with the integration of the energy industry, manufacturing industry, ICT, households and distribution networks, standardization is facing a great challenge which requires coordination not only on the national level.

4.7.4. Common factors in approaches to standards

Apart from the challenges with regard to regulation and technological progress documented in the previous section, the roadmaps also point directly to standards, and to critical success factors and a need for harmonization.

In the studies examined, the following standards have been selected on the basis of the frequency with which they are named and identified as an extensive consensus for the Smart Grid. The detailed matrix of the standards examined is to be made available in the internet (www.dke.de/KoEn):

- IEC 61970/61968: Common Information Model CIM , SIDMS, CIS, GID,
- IEC 61850, 61850-7-4XX: SAS, Communications, DER,
- IEC 62351: Security for Smart Grid,
- IEC 62357: Seamless Integration Reference Architecture,
- IEC 60870: Transport protocols,
- IEC 61400: Communications for monitoring and control of wind power plants,
- IEC 61334: DLMS,
- IEC 62056: COSEM,
- IEC 62325: Market Communications using CIM.

In addition, there are general recommendations which appear in all the studies. In the field of Smart Grids, ICT and automation levels are clear; in the area of home automation and Smart Meters, however, there are obviously too many “standards”, making it imperative for the EU to impose its Mandate M/441. For the coupling of the distribution network, meters and households, bandwidth at the domestic connection is often seen as one of the decisive problems, and in this respect the intended national expansion of broadband networks can provide the necessary corrective action. The area of electromobility is not standardized as yet, and requires new standards for the mobile load with batteries and roaming; existing standards could be extended in some cases. The German roadmap will therefore take account of this consensus in the recommendations in Chapter 5 and add specific proposals.

The following standards were named in the field of in-house automation:

- EN 50523 Household appliances interworking; especially for the incorporation of intelligent household appliances
- EN 50090

4.7.5. Expansion stages and imponderables

When one considers the various roadmaps, there are quite clearly a number of points which indicate that the technical conditions, and also the regulatory or legislative frameworks will once again require adaptation after a certain time. The roadmaps examined do not provide for any expansion stages or revisions to strategy from the start. Roadmaps can merely indicate a direction, and the further one looks into the future, the greater the uncertainty attached to the recommendations made. A glance at the past shows that technological progress in fundamental research can bring about changes to requirements: An example worthy of mention here is the change in demands from hydrogen-fuelled vehicles to electric vehicles caused by the developments in electricity storage technologies.

For the present German standardization roadmap, it is therefore advisable, as with the NIST interoperability roadmap, to adopt a prioritized procedure for important standardization activities in the first phase, and then, after initial practical experience, to supplement or revise the roadmap as agreed at the time in the Steering Group (see section 6.1).

5. Recommendations for a Standardization Roadmap – Phase 1

Based on the findings and documented results of the previous sections, this chapter of the roadmap will present recommendations for various aspects of a German standardization strategy for the Smart Grid. The following section documents the domains and actors identified for that purpose, and the cross-cutting topics, so that the relevant recommendations can then be assigned to those areas.

5.1. Areas identified – domains and cross-cutting topics

Cross-cutting topics

- General recommendations
- Regulatory and legislative recommendations
- Recommendations on information security, privacy and data protection
- Recommendations on the area of communications
- Recommendations for the areas of architectures, communication and power system management processes
- Recommendations on the safety, reliability and durability of products (e.g. classical safety studies and functional safety)

Domain-specific areas

- Recommendations for the area of Active Distribution Systems
- Recommendations for the area of Smart Meters
- Recommendations on the area of Electromobility
- Recommendations for the area of Storage
- Recommendations for the area of Load Management /Demand Response
- Recommendations for the area of building and In-house Automation
- Recommendations for the area of Distributed Generation
- Recommendations for the area of Transmission Systems

Those topics and domains can be assigned to national and international studies discussed as well as the IEC Seamless Integration Architecture TR 62357.

The following focal topics resulted from the discussion of this roadmap: information security, data models / semantics, Smart Meters, distributed generation / load management / demand response including the integration of electromobility into the Smart Grid, distribution system automation and in-house automation. In the course of the further work, the following recommendations will be assigned to these focal groups and the target groups will be defined.

5.2. Recommendations for a German Roadmap

As the analysis of strengths and weaknesses in connection with national expertise in the various fields shows, the areas of distributed generation and storage, electromobility and data management are particularly relevant.

5.2.1. General recommendations

Recommendation SG-AE-1[29]: The development of uniform standards are of great importance for Smart Grids.

29 SG = Smart Grid, the following characters are abbreviations of the German headline
AE = Allgemeine Empfehlung / General Recommendations; SD = Sicherheit (Informationssicherheit) und Datenschutz = Information Security & Privacy,
K = Kommunikation = Communication; ANLT = Architektur und Netzleittechnik = Architecture and Power automation,
AV = Automatisierung Verteilungsnetze = Power Distribution Automation

Sufficient investment is conditional on a Smart Grid architecture which fulfils the requirements for distributability, extendability, safety and security, availability and interoperability.

Recommendation SG-AE-2: International standards are the basis of national implementation

The German standardization roadmap must be based on existing work, on the one hand to avoid reinventing the wheel, and on the other hand because there are already solutions which are standardized and applied for practical purposes. This roadmap recognizes that work and therefore builds upon the globally recognized Smart Grid standards as identified in Chapter 4, especially the IEC 62357 SIA from IEC/TC 57. Solutions from other standardization organizations such as ETSI, ITU, ISO and also from forums and consortiums are also to be included in the observations.

Security of investment for existing systems and products is to be considered in the further development of the standards wherever possible.

Generic, international standards can provide a basis for further-reaching standard profiles in a regional or national connection which are aimed at achieving interoperability and practicality, or supplementing specific national focal areas.

Recommendation SG-AE-3: Importance of involving the German experts in international standardization

In order to make the work at DKE on all relevant IEC Smart Grid core standards possible, it should be the aim of DKE to establish German mirror groups for all relevant TCs and WGs. Only in this way will it be possible for the German experts, manufacturers and users to contribute their knowledge and make their requirements known to the international standardization bodies of the IEC. An appeal is therefore issued to German industry to enable its experts to take part in national and international committees, to support these, and to document their requirements for standards. The standardization committees should be used to discuss and compare the implementation of the standards in practice – across industries and on an international basis.

Example: Establishment of a German mirror committee for Workgroups 13 and 14 at IEC/TC 57 (CIM)

Mirroring of international liaisons, for example with CIGRE, NIST or UCAiug, should be promoted. In particular, cooperation with NIST should be sought, so that German ideas can be contributed to its PAP[30] where appropriate.

Recommendation SG-AE-4: Safety and security of the systems and products in the traditional sense

The implementation of the Smart Grid visions will also have an influence on traditional products and systems. Examples include load shifts with household appliances, the influence of price-based demand response programmes, control by virtual power plants, protection systems in the power distribution networks and remote shutdown of loads. Not only information security is therefore to be considered; the classical safety philosophies are also to be examined in the relevant fields of application. In this context, cooperation between Smart Grid experts and the corresponding professional committees and testing institutes is called for.

Over and above this, the system as a whole, which is becoming more and more complex, should be examined with functional safety methods. A corresponding research project is recommended.

30 PAP Priority Action Plan

Complete coverage of these topics also requires, for example, the consideration of the installation regulations and protection measures in the low voltage range as set out in VDE 0100 (international IEC 60364 series).

Recommendation SG-AE-4a: Resilience of the indispensable core functionality of the Smart Grid

Processes and functionalities in the Smart Grid which are indispensable for security of supply should be designed to be robust and resilient. They should also be capable of maintaining their core functions as extensively as possible even in cases of faults or crises ("graceful degradation") and returning rapidly to normal operation at the end of the impairment.

Recommendation SG-AE-5: Use of existing methodologies

For the implementation of Smart Grids and the appropriate collection of data on requirements, taking particular account of IEC standards, there is IEC/PAS 62559 "IntelliGrid Methodology for Developing Requirements for Energy Systems", which is recommended for application, including such in the further development of this standardization roadmap.

Recommendation SG-AE-6: Checking of interoperability

For the standards recommended in this roadmap and the implementation of architectures by means of profiles, interoperability should always be checked, implemented with due regard to process aspects, and made available. This checking of interoperability ensures that implementations can be evaluated and the acceptance of the users and early adopters rises.

In the course of the discussion on compilation of the roadmap, it was noted in addition that professionally conducted version management, not only accepted but also practised by the market participants, is necessary, as difficulties have arisen in the past especially on changes of version, and the market cannot function without corresponding market communications. Corresponding test facilities are necessary for this purpose.

As the standards are in some cases heterogeneous, and generic interoperability standards present various alternatives, it should be assessed whether more closely tailored standard profiles based on generic, international standards should be described.

Recommendation SG-AE-7: Use cases and market roles

As outlined above, the descriptions of functionalities / use cases represent an important basis for the further work, including that on standardization. It is therefore recommended that the compilation of terminologies (Wiki for E-Energy / Smart Grid glossary in DKE working group 111.0.5) should be accompanied and supplemented by a description of functions and use cases by the Smart Grid / E-Energy community (E-Energy projects accompanying research, relevant standardization committees and further interested parties in the professional community).

Both the deregulation of the energy markets and technical innovations will lead term to a fundamental change in market roles in the medium term. It is therefore of great importance in the modelling of functions and use cases to have a clear distribution of functions and responsibilities between existing and possible new actors, taking account of the regulatory stipulations and new business models.

Recommendation SG-AE-8: DKE Expertise Centre for E-Energy

The DKE Expertise Centre for E-Energy, responsible nationally for this roadmap, should assume responsibility for the implementation of the contents of this roadmap relevant to standardization in cooperation with the individual national standardization committees in the DKE and DIN, and also with the ITG and ETC in VDE, and with the BDEW [ELAN2020], BITKOM and relevant professional groups, so as to facilitate consistent implementation of the German focal issues without duplication of effort.

Recommendation SG-AE-9: Further development of the roadmap

This roadmap should be further developed with regard to the focal topics identified, in cooperation with the corresponding professional groups and stakeholders.

Recommendation SG-AE-10: Coordination committee for national implementation of the Smart Grid idea

The standardization roadmap should not only provide recommendations for the international implementation and development of standards, but also be embedded in a new coordination committee to be established on the national level. This committee should stipulate the national strategic objectives with which the Smart Grid in Germany is to be developed and implemented. Furthermore, possible market strategies and business models should be presented, and requirements for action identified, for example in the regulatory or legal framework conditions (Renewable Energy Act, privacy and data protection, etc.) or business processes in conjunction with the European and international activities. As an example, the activities of the EU Commission and ERGEG (see footnote 8) and the necessity of mirroring in Germany can be mentioned here. In this context, standardization – coordinated by the DKE Expertise Centre for E-Energy with partners at DIN and in E-Energy projects accompanying research teams and in cooperation with the corresponding professional groups – represents an important component of an overall strategy, but is only one aspect among others (see also the further general and regulatory recommendations).

GridWise in the USA has approached the subject with a similar holistic focus.

The standardization experts and the broad professional audience involved in the committees of DKE, DIN and VDE are thus available to politicians and authorities as neutral advisers on technical matters.

Recommendation SG-AE-11: Market launch

Above and beyond the present pilot and reference projects, the following actions are considered advisable for a sustainable and broad market launch and in addition to standardization proper:

- Specialists are to be trained in the application of the new technologies and the corresponding standards. The topic of Smart Grids must therefore be treated proactively in training and university education. Training courses are to be developed.

- The new system will only function with support from the users. Confidence in information security, privacy and corresponding market models as the basis of a successful market launch have already been addressed in other recommendations. In the area of private households in particular, the provision of comprehensive information to the public is to be considered so as not to repeat the errors of the past in the market launch of new technologies.

Recommendation SG-AE-12: Securing knowledge from R&D projects on Smart Grids

A vast amount of experience has been gathered in numerous research projects in past years, and such experience is still being gained. These projects, for a large part publicly funded, did of course publish their results, but there is no summarizing overview of the results in their entirety. The R&D results to date on Smart Grids and E-Energy should be grouped together in a uniform securing of knowledge at one location, both for the implementations in Europe which are now commencing and for the E-Energy projects. As there are many projects with European sponsorship and many further international projects, this work should be performed in English and preferably be conducted by an international organization.

5.2.2. Recommendations on regulatory and legislative changes

Recommendation SG-RE-1: Further development of Market Communication

With the Seamless Integration Architecture, IEC/TC 57 has placed its standards in a context which, in cooperation with TC 13 on electricity meters and smart meters, implements a technical reference architecture which facilitates both horizontal and vertical integration. IEC is aware that the IEC 62325 standard on general market communications by means of ebXML and CIM opposes national market mechanisms. The EDIFACT data format, introduced in Germany by the Federal Network Agency, for instance under GPKE, is not compatible with IEC 62357. The issue of a recommendation of the use of XML-based formats (for instance under the semantics of the CIM) has already been discussed in the E-Energy projects. The issue under discussion is improved universal communication. There, for example, know-how from other countries could be drawn upon. It is therefore recommended to pursue the integration of globally consistent data models for Smart Grid in the area of market communications.

Recommendation SG-RE-2: Bandwidth for communication with end-use consumers

In the area of the connection between metering point operators or similar market roles and the connection objects (and final customers' terminals), the aim with regard to the selection of communications protocols, formats and the quantity of data to be transferred is to take account of the bandwidth available to the households. It is recommended from the point of view of Smart Grids that the expansion of broadband networks promoted by the federal government should be accelerated even further.

Recommendation SG-RE-3: Establish framework conditions for variable tariffs

Against the background of the legal conditions which provide for load and time-dependent tariffs from 2011 onwards, the implementation of the goals pursued by the Smart Grid must also be specified in even greater detail as far as the various participating market roles are concerned, even if the actual tariff and service offerings will in the final analysis be determined by competition. New market roles (e.g. market aggregators, price and network agencies or virtual power plants) may require new legal frameworks with regard to the development of the Smart Grid and its functions.

5.2.3. Recommendations on security and privacy

Recommendation SG-SD-1: Importance of privacy and data protection

For the implementation of the Smart Grid concepts and for acceptance by the users, the protective objectives of availability, reliability, integrity and confidentiality are to be taken into account in the technical concepts and operation. The contacts for these issues are the privacy and data protection representatives of the federal states, the BSI[31] and national and international standardization organizations (e.g. IEC, DKE, DIN) with active assistance from the relevant associations (BITKOM, VDE/ITG).

In this connection, conceivable conflicts between objectives of data protection with the demand for data thrift on the one hand, and the Smart Grid approach with extended network management and the involvement of consumers by means of incentive-orientated load management systems on the other hand, are to be resolved.

Recommendation SG-SD-2: Information security

Information security should be regarded as a core topic in the development of the architecture for a Smart Grid. Scalable solutions with a focus on physical, role-based access, identity management and certificates for the communications and security architectures should be developed and defined as a 'national standard profile' by the DKE in cooperation with the regulators and associations. The term "profile" is taken here to define a specific selection of technology, function and data models from the higher level international standards. Existing solutions for the Smart Grid core architecture such as IEC 62351 or the BDEW White Paper on the topic of "Security for Network Operations" should be taken into account in this context.

Recommendation SG-SD-3: Development of security concepts and their assessment

The existing standards in the field of information security should be analysed with reference to the specific environment of electrical power supply (see availability, security of supply and critical infrastructure) and a system for the assessment of the comparability and applicability of security systems developed. This can be used to establish recommendations for universal security solutions which can then be adapted for the relevant products and fields of application.

Recommendation SG-SD-4: Security of supply as a protective aim for the Smart Grid

Maintaining security of supply in the Smart Grid in normal circumstances and crises should be taken into account in security considerations as an explicit superordinate protective aim wherever necessary.

5.2.4. Recommendations on communications

Recommendation SG-K-1: Observance of Mandate M/441

For the field of Smart Meters, the heterogeneous structure of the connection of households or object cells requires mapping towards various communications technologies. This covers both landline/fixed wiring and wireless technologies. Mandate M/441 requires suitable technologies for communication to the target points in the network to be identified, tested, and profiles for those technologies to be standardized. Here too, the requirements of the working group on "In-house Automation" should be taken into account (see below).

Recommendation SG-K-2: Semantics of object models and relationships between object models (ontologies)

In the area of communications, there must always be clarification as to what is being exchanged ("WHAT") and how it is exchanged ("HOW"). The "WHAT" is to be defined by

31 BSI Bundesamt für Sicherheit in der Informationstechnik (Federal Office for Information Security)

long-lived object models, which then have to be mapped to the communications layers by means of abstraction layers. These technical mappings are of greater variety, and are subject to more rapid technical change. In the implementation of Smart Grids, technical change is to be taken into account in order to achieve sustainability of technical solutions, as has already been the case with IEC 61850 and IEC 61970/61968, so that basic communications technologies can be replaced in response to technical progress without any effects on the higher level logical function and data layers. This a relevant issue for users with regard to security of investment, and also of importance with regard to the migration and integration of existing communications technologies, for example on transition from data point orientated TASE.2 to IEC 61850.

Recommendation SG-K-3: Seamless Integration for improved interoperability

IEC SIA 62357 demands seamless integration of the TC 57 standards; this however requires mappings and harmonization between these standards, which are brought together in IEC/TC 57 WG 19. The mapping of CIM and IEC 61850, and intersystem and subsystem communications in IEC 62357 must be promoted by profile creation for mapping, i.e. semantic mapping of the individual core standards against each other. It is therefore the objective of a German roadmap to contribute profiles specific to E-Energy and results from the application of the IEC 62357 reference architecture to the harmonization work.

Recommendation SG-K-4: Use and development of the IEC/TC 57 models, also for non-electrical media

The focus of phase 1 of this roadmap is on the field of standardization for the electrical components of the Smart Grid. The concept of IEC 62357, a divided, common data model (CIM, Common Information Model) and a flexible architecture with loose coupling based on internet technologies for WAN communications and distributed systems (service-oriented architecture) can also be applied to the field of non-electrical power. It should therefore be an aim of this roadmap and the work required to develop extension mechanisms for IEC 61970 and the communications technologies of IEC 62357 and to bring the corresponding sectors together in networking with the DKE standardization roadmap for a Smart Grid in the multiutility field – Phase 2.

5.2.5. Recommendations for the area of architectures and power automation

Recommendation SG-ANLT-1: Reference architecture

IEC TR 62357 Seamless Integration Architecture facilitates both a strongly centralized architecture and a hierarchical architecture with data aggregators. The data models and communication protocols can be implemented flexibly. The non-functional requirement for bandwidth into the field plane and the option of aggregation there are of particular importance. A kind of reference architecture for Smart Grids can be furthered by the E-Energy regions, providing the model on the basis of the IEC 62357 meta-models.

Recommendation SG-ANLT-2: Harmonization of the data models of IEC 61970: Common Information Model CIM and IEC 61850

The standards presented in IEC 62357 were developed by different working groups, and still in part require harmonization. Above all the data models of IEC 61970, “Common Information Model CIM” and IEC 61850 are in the focus of unification and harmonization. There are admittedly already various attempts in progress, but the experience of the E-Energy projects with the coupling of distributed generators through network I&C to the market for a virtual power plant with a consistent data model in particular provides valuable input for international standards. Mappings in the form of profiles should be published as technical reports in the standardization process.

Recommendation SG-ANLT-3: Standardized naming of objects

For the processing of objects by means of IT, they should not only have an unequivocal class within the CIM, but also and above all an unequivocal object identifier. For the SIA and interoperability of the E-Energy regions, it is recommended to adopt the ISO/IEC 81346 Reference Designation and IEC 61360, in order to obtain uniform, interoperable identifiers for data exchange in the implementation.

Recommendation SG-ANLT-4: Repository for models

The object models which already exist in standards should be available in a suitable digital manner, for example as UML models, and permit additions accordingly.

5.2.6. Recommendations for the area of distribution system automation

Recommendation SG-AV-1: CIM in the area of distribution system management

IEC 61968, "System Interfaces for Distribution Management Systems" standardizes various system interfaces, semantic object models and processes located in the area of active distribution systems on the basis of the roadmap produced by IEC/TC 57 WG 14. The E-Energy projects should result in requirements for that standard, to be transferred into the international standardization process. The aim of the roadmap is therefore to contribute these results internationally and to continue to focus on the CIM as the common data model in the field of distribution system management. This will also require above all work on modelling of distributed generators using CIM and an ad-hoc integration with IEC 61850-7-420 and with AMI[32] and HAN data models. As there is German preliminary work in this field, and the active distribution network is also at the heart of the E-Energy projects, German activities should be pushed ahead here.

Recommendation SG-AV-2: Information models

In the area of distribution system automation, the various automation concepts also require mirroring in information models. IEC 61850-7-4 should therefore also be extended to include objects which are required for distribution system automation. This requires the development of profiles and logical nodes, the requirements for which can specifically be obtained from the E-Energy projects.

5.2.7. Recommendations for the area of Smart Metering

Assessment:

The topic of Smart Metering is already being extensively discussed on various levels by the experts, and practical experience is being gathered in many field trials. The topics relevant to standardization are receiving attention in the professional committees, on the European level in the Smart Meters Coordination Group (SM-CG), and internationally in IEC/TC 13 and the corresponding German mirror committees. Proposals on the further

32 AMI Advanced Metering Infrastructure

development of standardization are presented in the report of the SM-CG [CENELEC]. It is therefore not considered necessary to repeat the proposals here, but rather to restrict attention to further-reaching and national peculiarities.

The required development of standard profiles with the aim of extensive interoperability is already well advanced in the field of Smart Meters in Germany with the specifications of the FNN [FNN][33] in cooperation with Open Metering, for example in the form of the MUC[34] specification or the description of SML[35] which was contributed to the international standardization process at CENELEC / IEC via the DKE.

Recommendation SG-SM-1: Use of the preliminary work of FNN for a standard profile and further development on the basis of implementation of the European Mandate M/441

EU Mandate M/441 issued to CEN, CENELEC and ETSI will provide firm recommendations for the six different main interfaces in the field of multiutility Smart Meters (see section 4.4). In addition, the EU "Open Meter" project will build up further pressure for standardization and harmonization in accordance with the current EU Framework Call.

For German standardization and for this roadmap, it is recommended to use the results of the FNN as the present standard profile and to develop these on the basis of the national and international developments in meter standards, privacy, data protection and information security. German experts should actively contribute their experience to the European and international developments in cooperation with the relevant DKE mirror committees as previously.

Recommendation SG-SM-2: Cooperation between TC 13 and TC 57

In the area of IEC standards, closer cooperation between TC 57 and TC 13 is aimed at; in particular, DLMS/COSEM objects could be added to the data models of IEC 61850 without directly having to change those standards. Currently, meter data are only included in the CIM in the area of the TC 57 framework, but not in field device object models. An extension will be necessitated by electromobility or DER[36] in any case[37]. The objective would be, for example, an integration of meter data relevant to billing via IEC 61850.

Recommendation SG-SM-3: Home gateway and demand response functions

With regard to functionalities, up to date tariff/price information and where appropriate forecast information has to be provided for home gateways (energy management gateways). Application experience will be gained from the E-Energy projects, with the availability of data from digital meters constituting one of several possibilities.

Recommendation SG-SM-4: Consideration of DLMS and COSEM extensions

IEC recommends an extension of the existing IEC 61334 for Power Line Communication to include current developments covered by IEC 62056. This recommendation should be adopted for the German Smart Grid concept, so as to use DLMS and COSEM better together.

Recommendation SG-SM-5: Smart Metering and calibration law

Attention was drawn repeatedly in the public

33 FNN Forum Netztechnik/Netzbetrieb im VDE

34 MUC Multi-Utility Communication

35 Smart Message Language

36 DER Distributed Energy Resource

37 A working group on "Energy metering and electromobility" is currently being founded in DKE K 461

commenting to regulatory conditions and conditions imposed by calibration law and data protection which are seen as obstructive to the Smart Grid. Further studies and recommendations in this connection are therefore recommended in connection with the new coordination committee, proposed with SG-AE-10.

5.2.8. Recommendations for the area of distributed generation and virtual power plants

Recommendation SG-DER-1: Further development of IEC 61850-7-420

The use of IEC 61850-7-420 for distributed generators, strongly pursued in Germany, is also demanded and supported by the IEC. This demand merits agreement. An extension to electro-mobility and battery storage and the promotion and establishment of further technology and communications mapping appropriate to the relevant application scenario should therefore also be pursued by the German roadmap. Furthermore, profiles are to be defined indicating which nodes and functionalities/ use cases, and possibly which communications mapping and compatibility stages, are to be used for which distributed generators. This can lead to the establishment of low-cost and less complex, though still standardized solutions for control of DERs.

Recommendation SG-DER-2: Future communications mappings

There are various technology mappings for IEC 61850-7-420, among which the Manufacturing Message Specification (MMS) is of special importance on account not only of its widespread use, but also of its complex implementation. Initiatives such as the INS projects (Innovation with Norms and Standards – see footnote 25) sponsored by the BMWi aim at making an open reference implementation available so that the communications technology is further disseminated. This method of dissemination should be examined for further communications technologies and made available for this field by means of suitable standardization instruments.

Recommendation SG-DER-3: Distributed control and modelling of decentralized systems and virtual power plants

Up to now, IEC 61850-7-420 has focused above all on individual decentralized systems, their object models and their control. Distributed control of several decentralized systems via IEC 61850-7-420 – where appropriate in combination with documentation of sequences in distributed automation – in conjunction with coordination and billing via CIM messages leads to an SIA-compliant modelling of virtual power plants, which therefore could be used not only in the E-Energy projects, but also globally. Work in this area should be actively promoted by the German standardization bodies with NWIPs[38].

5.2.9. Recommendations on the area of electromobility

Recommendation SG-EM-1: Convergence of sectors

Mobility will create new cooperation between sectors of industry, in which context electromobility requires the consideration of power grid, charging, control and billing infrastructures, consistent data transfer systems, process and traffic control centres, etc. It must not however be forgotten that electromobility will only play a small part in the electricity market for the foreseeable future, compared with the requirements of securing energy supply as a whole.

38 NWIP New Work Item Proposal to IEC

Recommendation SG-EM-2: Inter-committee cooperation on electromobility

Prior to the necessary establishment of an intelligent charging infrastructure for this new mobility paradigm, the topic of standardization is of great importance. Apart form the communications network needed (cf. BDEW ELAN 2020 study on ICT for electromobility), communication between metering point operators, suppliers and similar market roles on the one hand and the electric vehicle on the other hand via the connection to households is to be standardized. The aim of the German standardization roadmap is therefore actively to contribute the results of the German research programme "ICT for Electromobility" and further relevant research results, and to expand the German preliminary work in the area of communication with distributed generators such as in IEC 61850-7-420 to the field of electromobility. Work is also already in progress on a draft standard on communication between the automobile and the charging station.

Integration of electromobility in the Smart Grid in a seamless way can only be achieved with consideration of the data models, communications protocols and semantic interoperability conditions of the existing Smart Grid automation. This requires close cooperation between the IEC/TC 57 and TC 69 mirror committees and ISO/TC 22/SC3 JWG V2G. Cooperation and the flow of information in the corresponding committees in Germany is to be ensured via DIN and DKE.

Recommendation SG-EM-3: Price and tariff data models

In the light of the requirements of the NIST roadmap, IEC 61970 will have to be expanded to include the new requirements for price and tariff models. This work is partly in progress in the E-Energy model regions. The results are to flow into international standardization and also be communicated to ISO TC22/SC3 JWG V2G.

5.2.10. Recommendations for the area of storage

Recommendation SG-S-1: Control of storage facilities

The field of storage is still a major area of research for the electrical and power engineering industries. Storage of electrical energy in connection with grid management, for instance for storage of energy which is generated in wind farms but cannot be fed into the grid on account of bottlenecks is – according to the definition applied here – a core aspect of the required Smart Grid. Similarly to distributed generation, IEC 61850-based control for this storage option is also a core standard of a future Smart Grid. The national work and a large amount of experience in the field of IEC 61850-7-420 and the commitment of the experts should be used to pursue this area actively and to establish the standards.

Storage of electrical energy in this connection is not to be restricted to electrical energy in the broader sense, with for example batteries, pumped-storage or compressed air storage power plants, but extended to cover the use of other forms of energy, as with the intelligent use of existing thermal storage systems: storage radiators, heat pumps, refrigerators, refrigerated storage facilities, hot water tanks and so on.

Recommendation SG-S-2: Bundling of mirror committees

At the IEC, TCs 21 and 35 are working on verification, testing and classification standards for the harmonization and development of core parameters and methods for use of batteries in the Smart Grid (for example charging history, residual capacity and technical connection conditions). The DKE's Expertise Centre for E-Energy should concert these activities of the German mirror committees and link them with the activities in the fields of electromobility and ICT.

Recommendation SG-S-3: Application of IEC 61850 to storage techniques

Electromobility and storage of electrical energy are closely related topics, particularly if the electric vehicle is also to provide system services. The solutions developed for large-scale storage facilities based on an IEC 61850 derivative should be assessed for applicability to the field of electromobility and the work accelerated in this area.

5.2.11. Recommendations for the area of load management (demand response)

Recommendation SG-LD-1: Coupling of in-house automation and demand response

In its roadmap, the IEC refers to increased coupling of IEC 61850-7-420, Smart Meters, home gateways to/through the buildings and buses with the functionalities / use cases from the active distribution system and interfaces to commercial buildings as a major challenge. The German standardization roadmap will also have to perform work in the area of integration of these three systems (see below).

Recommendation SG-LD-2: Incentives by means of technical price signals

The aim is to exploit potential for flexibilization of load, for instance by providing incentives to domestic customers or commercial and industrial customers by means of corresponding price signals.

There is great potential for load and generation management in industry and with major consumers (see also examples from the E-Energy projects or [BMWi2]), which is only being exploited for energy management at present to a small extent. The opportunities for energy management in the area of building or factory automation must be identified and simple connections to the grid established. The development of a consistent communication system between market roles in the energy industry and the industrial facilities must also simplify the integration of plants and systems in market and network management in this field. Existing building automation systems should be taken into account here.

5.2.12. Recommendations for the area of building and home automation (in-house automation)

Recommendation SG-IA-1: Taking account of existing equipment

To allow energy management which is not merely to be used in new buildings one must take into account the large amount of old buildings and equipment inside.

Ease of retrofitting in existing buildings and homes and buildings must therefore be ensured. Powerline or wireless systems can avoid recabling in that context.

The extent to which existing equipment can be retrofitted with additional devices for energy management is also to be examined.

Recommendation SG-IA-2: Cooperation with other in-house energy management systems

For energy optimization as a whole, not only electrical consumers and devices are to be considered, but other energy types (thermal power, traffic and transport) also have to be involved: heating systems, air conditioning systems, heat pumps or combined heat and power (CHP), thermal or electrical storage systems, and electromobility.

Recommendation SG-IA-3: Cooperation with other domains

Building automation has in part been implemented, and is expected in future to be used not only for energy management, but also for example for AAL[39], media control, convenience functions (control of blinds, shutdown of loads, e.g. everything off when people leave the home, etc.) or home surveillance systems. It is further to be assumed that equipment from various manufacturers will be used in one system, and thus integration based on protocol standards will be necessary. Nevertheless, over and above protocol standards, the standardization of information models, transactions or the use cases associated with the services will also be useful for further sustainable integration.

It is expected that on the one hand relatively complex devices may in future be controlled directly via IP, but that on the other hand simple terminal devices will not have the necessary intelligence and will have to be controlled by means of simpler communications protocols or additional equipment.

Recommendation SG-IA-4: Variance of existing standards in the area of buildings

There are three communications standards in Europe for the field of home and building automation: BACnet (DIN EN ISO 16484, Parts 5 and 6), KNX (DIN EN 50090 and DIN EN 13321) and LON (DIN EN 14908). Products with these communications systems are widespread on the market and are being further developed (e.g. integration of ZigBee and EnOcean).
The various terminal devices (final nodes) in buildings are to be interoperable with the central energy management system; the smart grid functions of the terminal devices (final nodes) should be available even after a change of building. Therefore, from the point of view of consumers or of the manufacturers of the terminal devices, a further reduction in the number of alternative protocols and systems in the area of building automation would be desirable, but is at present considered unrealistic.

It should be discussed whether recommendations for a manageable number of standards can be issued.

Recommendation SG-IA-5: Use cases, functions and services

Independently of the communications protocols actually used, use cases which uniformly describe the fundamental functions on a higher plane of abstraction (uniform semantics, see above) are being developed. It is to be examined whether generic equipment profiles and existing functional descriptions such as DIN EN ISO 16484-3 “Functions” can be extensively used as a basis. The functions could then be implemented with various protocols (layer model).

Recommendation SG-IA-6: Reference architecture and interfaces

Based on the use cases, a reference architecture should be developed for the field of in-house automation and the corresponding requirements for interfaces thus also stipulated.

39 AAL Ambient Assisted Living

6. Prospects for continuation of the standardization roadmap

6.1. Implementation of the standardization roadmap – Phase 1

The DKE Expertise Centre for E-Energy was founded in September 2009 in close co-operation with the E-Energy projects. The aim is to achieve both an early transfer of ideas from the research projects into standardization as well as support to the projects in questions on this topic.

It rapidly became apparent that the original approach would have to be broadened. For further clarification, the compilation of this roadmap was therefore also approached as a basis for the work of the E-Energy Expertise Centre. This roadmap is in consequence also to be regarded as a first step. Together with the impending implementation of the recommendations, regular reviews are to be conducted to check the status of this roadmap, and Version 2.0, incorporating new findings, is planned for the first half of the coming year (see Figure 10).

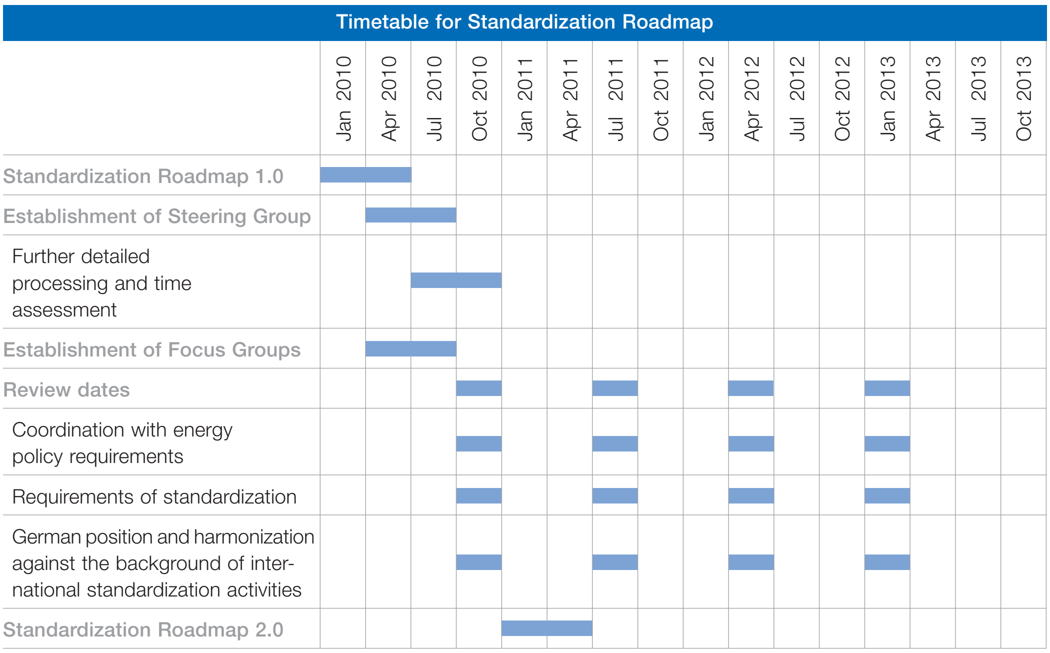

Figure 10: Timetable for implementation of Phase 1 of the standardization roadmap

The foundation of a Steering Group with all the relevant stakeholder groups is in planning for the operational implementation of the standardization roadmap. The function of this steering group is the strategic management and implementation of the topic as a whole. Focus and cross-cutting groups are to ensure the substantive links between the general level of "Smart Grid" and the detailed work in the standardization committees (see Figure 11). The organization outlined is not intended to develop in parallel to existing standardization committees in the DKE and DIN, but to complement them appropriately as an intercommittee component. Where it is seen as appropriate, existing committees can also take on the handling of a focal topic and thus make the additional formation of new committees superfluous.

A further objective of this organization for implementation of the roadmap is the integration of the various national activities on Smart Grids where questions of standardization are concerned (see recommendation SG-AE-8).

Together with these more national topics, the various international committees and activities now starting are to be kept in view. A national SMART.GRID mirror committee has already been defined for IEC/SMB SG3 and for ISO/IEC JTC1/SWG Smart Grid. The aim is to observe and to play an active part in shaping developments.

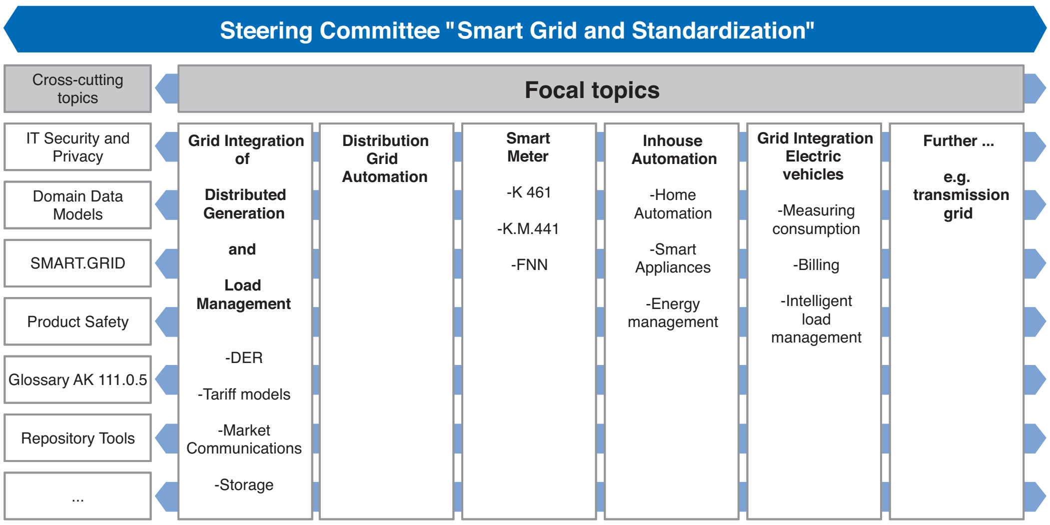

Figure 11: Proposal for organizational implementation of the standardization roadmap

6.2. Further topics for Phase 2

Current international projects are in most cases not aimed at the multi-utility aspect[40], but are restricted to the electrical power industry. It is to be expected that in the course of technological convergence energy trading, power generation, networks, the automobile and telecommunications industries and the utilities (gas and water) will grow more closely together and will have to work together to facilitate a Multi-Utility Smart Grid – ranging up to a Smart Energy System. In that context, various aspects will once again have to be dealt with in standardization, for example the equipping of transformer substations and secondary unit substations with sensor systems and extended functionalities for EMS[41] and DMS[42].

In many cases, work is being performed in the E-Energy projects on new marketplaces and new market roles. That will also necessarily entail an examination / review of the standards for market communication.

Together with the functions examined to date, important new functions in the transmission systems will also require closer observation. The following examples are worthy of mention:

Connection of large-scale power plants for the generation of electricity from renewable sources, such as offshore wind farms or solar power plants, ranging up to the discussion on the use of solar energy from sunny areas around the Mediterranean and North Africa, and transmission of the power to Central Europe (Desertec[43]). Such plants are options in the securing of future-proof energy supplies. They will require new technologies such as HVDC transmission, FACTS[44] or Wide Area Monitoring.

These fields have initially been excluded from consideration for reasons of concentration on focal topics. The German mirror committees of the relevant IEC committees will however continue to pursue this work as previously, and where appropriate contribute to a revision of this standardization roadmap.

40 Multi-Utility denotes a cross-sector approach involving various media and energy types such as heat, gas, water and electricity

41 EMS Energy Management System

42 DMS Distribution Management System

43 www.desertec.org/de/

44 FACTS Flexible Alternating Current Transmission System

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8. Key to the abbreviations

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)
BDI	Bundesverband der Deutschen Industrie e.V. (Federation of German Industries)
BITKOM	Bundesverband Informationswirtschaft, Telekommunikation und neue Medien e.V. (Federal Association for Information Technology, Telecommunications and New Media)
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)
BSI	Bundesamt für Sicherheit in der Informationstechnik (Federal Office for Information Security)
CEN	Comité Européen de Normalisation
CENELEC	Comité Européen de Normalisation Électrotechnique
CIGRÉ	Conseil International des Grands Reseaux Électriques
CIM	Common Information Model
CIP	Critical Infrastructure Protection
CIS	Component Interface Specification
COSEM	Companion Specification for Energy Metering
DA	Data Access
DER	Distributed Energy Resource
DG	Distributed Generation
DIN	Deutsches Institut für Normung e.V. (German Institute for Standardization)
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
DMS	Distribution Management System
DNP	Distributed Network Protocol
DoE	Department of Energy
DR	Demand/response
ebXML	Electronic Business using eXtensible Markup Language
EDIXML	Electronic Data Interchange XML
EDM	Energy Data Management
EEBUS	E-Energy Bus
EEG	Erneuerbare-Energien-Gesetz (Renewable Energy Act)
EISA	Energy Independence and Security Act
EMS	Energy Management System
ENTSO-E	European Network of Transmission System Operators for Electricity
EPRI	Electric Power Research Institute
ETG	Energietechnische Gesellschaft (Power Engineering Society in VDE)
ETP	European Technology Platform
ETSI	European Telecommunications Standards Institute
EU	European Union
FACTS	Flexible Alternating Current Transmission System
FNN	Forum on Netztechnik / Netzbetrieb im VDE (Forum Network Technology / Network Operation in the VDE)
GID	Generic Interface Definition
GML	Geography Markup Language
GPKE	Geschäftsprozesse zur Kundenbelieferung mit Elektrizität (Business Processes for Supply of Electricity to Customers)
GSE	Global Standards for E-Energy
HAN	Home Area Network

Key to the abbreviations

HVDC	High-Voltage, Direct Current
ICT	Information and Communication Technology
IEC	International Electrotechnical Commission
IED	Intelligent Electronic Device
IEEE	Institute of Electrical and Electronics Engineers
INS	Innovation with Norms and Standards
ISO	International Organization for Standardization
IT	Information Technology
ITA	Industry Technical Agreement
ITG	Informationstechnische Gesellschaft (Information Technology Group in VDE)
JWG	Joint Working Group
LON	Local Operating Network
MMS	Manufacturing Message Specification
MUC	Multi-Utility-Communication
NERC	North American Electric Reliability Corporation
NIST	National Institute for Standards and Technology
NWIP	New Work Item Proposal
Ofgem	Office of Gas and Electricity Markets
OGEMA	Open Gateway Energy Management Alliance
Opden ADR	Open Automated Demand Response
OSGi	Open Services Gateway Initiative
OWL	Web Ontology Language
PAP	Priority Action Plan
PAS	Publicly Available Specifications
PLC	Power Line Carrier
PMU	Phasor Measurement Unit
RDF	Resource Description Framework
SA	Substation Automation
SAS	Substation Automation Systems
SCADA	Supervisory Control and Data Acquisition
SERA	Smart Energy Reference Architecture
SG	Strategic Group / Smart Grid
SIA	Seamless Integration Architecture
SIDMS	System Interfaces for Distribution Management Systems
SML	Smart Message Language
SMB	Standardization Management Board
SOA	Service-Oriented Architecture
SPC	Programmable Logic Controller (PLC)
SWG	Special Working Group
TC	Technical Committee
TR	Technical Report
TSO	Transmission System Operator
UA	Unified Architecture
UCA	Utilities Communications Architecture
UCAiug	UCA International User Group
UCTE	Union for the Coordination of Transmission of Electricity
UML	Unified Modeling Language
UN/CEFACT	United Nations Centre for Trade Facilitation and Electronic Business
UN/EDIFACT	United Nations Electronic Data Interchange For Administration, Commerce and Transport
USA	United States of America
V2G	Vehicle to Grid
VDE	Verband der Elektrotechnik, Elektronik und Informationstechnik e.V. (Association for Electrical, Electronic & Information Technologies)
VDA	Verband der Automobilindustrie (German Association of the Automotive Industry)
VPP	Virtual Power Plant
WAN	Wide Area Network
WG	Working Group
XML	Extensible Markup Language
ZVEI	ZVEI Zentralverband Elektrotechnik- und Elektronikindustrie e.V. (German Electrical and Electronic Manufacturers' Association)

9. Strategy Group for the Standardization Roadmap in the DKE German Commission for Electrical, Electronic & Information Technologies of DIN and VDE

Editor

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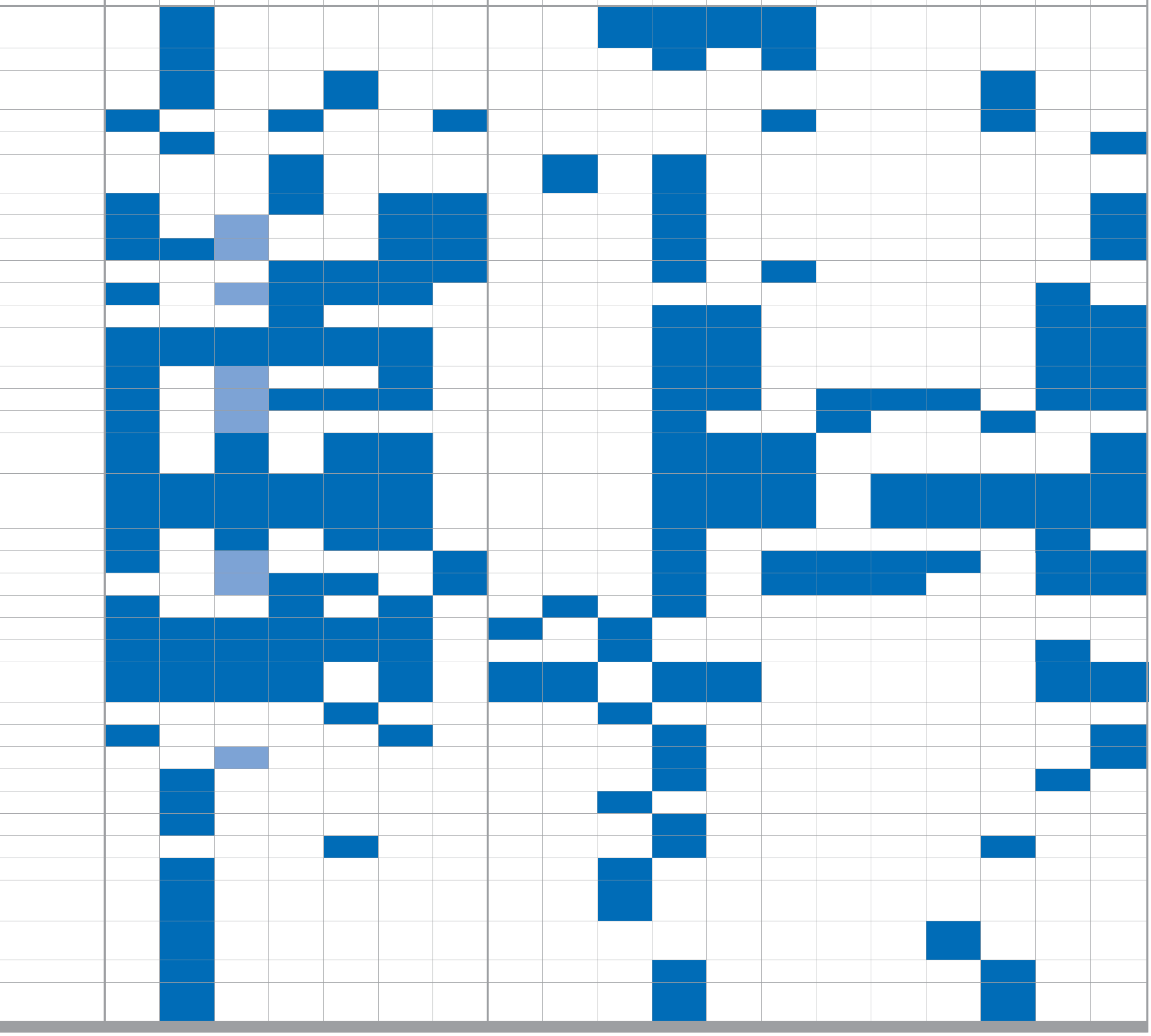
Comparison of various studies on Smart Grid standardization

Value Chain								TC 57 Reference Architecture					Standard	
Generation	Energy trading	Sale	Transmission	Storage	Distribution	Measuring	Application	integration of business partners	integration of applications	integration of devices and plants	security	data management	Standard	Description
						■			■	■	■	■	AMI-SEC System Security Requirements	Advanced metering infrastructure (AMI) and SG end-to-end security
						■			■	■		■	ANSI C12.19/MC1219	Revenue metering information model
							■			■			BACnet ANSI ASH-RAE 135-2008/ISO 16484-5	Building automation
						■	■			■			Digital meter / Homegateway	Mandate M/441 of CEN/CENELEC
					■					■			DNP3	Substation and feeder device automation
	■	■						■	■				EDIXML	Market communication for Germany
			■		■					■			IEC 60870	Communications protocol
			■		■					■			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	SPS and Automation, Profile for IEC 61850
■			■	■	■					■			IEC 61850	Substation automation and protection,Distributed generation, Wind parks, Hydro, 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), Domain Ontology, Interface, Exchange format, Profile, Process blueprints, 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 communications using CIM
											■		IEC 62351	SIA Security
											■		IEC 62351 Parts 1-8	Information security for power system control operations
■	■	■	■		■	■	■	■	■	■	■	■	IEC 62357	IEC 62357 Reference Architecture – Service-oriented Architecture, EMS, DMS, Metering, Security, Energy Management Systems, Distribution management Systems
■	■	■	■		■	■	■				■		IEC 62443	General Security
							■		■	■	■	■	IEC 62541	OPC UA (Automation)
													IEC TR 61334	DLMS, Distribution Line Message Service
■										■			IEEE 1547	Physical and electrical interconnections between utility and distributed generation (DG)
											■		IEEE 1686-2007	Security for intelligent electronic devices (IEDs)
													IEEE C37.118	Phasor measurement unit (PMU) communications
							■			■			ISO / IEC 14543	KNX, 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 communication, measurement, and control
							■			■			ZigBee/HomePlug Smart Energy Profile	Home Area Network (HAN) Device Communications and Information Model

	Approach							Recommendations											
	DKE Normungsroadmap Smart Grid 1.0	NIST IOP Framework Roadmap 1.0	SMB SG 3 IEC	BMWi E-Energy Program Recommendations OFFIS	BDI - Internet der Energie	CIGRE D2.24	CEN/CENELEC M/441	General Recommendation	Regulatory Recommendation	Recommendation for Security, Safety or Privacy	Recommendation for Communication	Recommendation Active Distribution grid	Recommendation Smart Meter	Recommendation Electric Vehicles	Recoemmndation Storage	Recommendation Load management and Demand Response	Recommendation Building and Home Automation	Recommendation Distributed generation	Recommendation Architectures and SCADA



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