



TECHNICAL REPORT



Smart grid standardization roadmap

INTERNATIONAL
ELECTROTECHNICAL
COMMISSION

ICS 29.240

ISBN 978-2-8322-4965-9

Warning! Make sure that you obtained this publication from an authorized distributor.

CONTENTS

FOREWORD.....	10
INTRODUCTION.....	12
0.1 Context.....	12
0.2 Overview	13
0.3 Purpose of the document	14
1 Scope.....	15
2 Normative references	15
3 Terms, definitions and abbreviated terms	15
3.1 Terms and definitions.....	16
3.2 Abbreviated terms.....	19
4 Smart Grid context	22
4.1 Smart Grid definitions	22
4.2 Smart Grid drivers.....	23
5 IEC Smart Grid Standardization Roadmap	25
5.1 High-level summary	25
5.1.1 IEC Core standards	25
5.1.2 Other IEC highly important standards	26
5.2 General framework	26
5.2.1 Overview	26
5.2.2 General method used for presenting existing Smart Grid standards	26
5.2.3 Content of this document.....	27
5.2.4 Limits of scope and usage	27
5.2.5 Selection of standards	28
5.2.6 Architecture framework: Reference architecture model (SGAM) introduction	29
5.3 Use cases framework.....	31
5.3.1 Main principles and associated standards.....	31
5.3.2 System Capabilities list.....	32
5.4 IEC Smart Grid Standards Map (use of).....	36
5.4.1 Motivation.....	36
5.4.2 Chart content.....	37
5.4.3 Component cluster descriptions	39
5.5 System breakdown over the SGAM	43
5.5.1 General	43
5.5.2 Mapping systems on SGAM – Rules	47
5.6 Interoperability.....	52
5.7 Main expected evolutions (in five years' time).....	52
5.7.1 General	52
5.7.2 Exchange of information: communication and advanced control.....	53
5.7.3 Decentralized developments: dispersed generation and storage, transition from network operator to system operator at a regional level.....	54
5.7.4 Isolated operation: "to be or not to be" connected to the distribution network	54
5.7.5 Smart Metering	54
5.7.6 Micro-grids: where a distribution grid is not available or its reliability is not enough	55

5.7.7	Electrical Vehicles: the act of charging and storage and the impact on the distribution grids	55
5.7.8	Managing the network and interfaces: supporting the Energy market with flexibility in normal and abnormal situations	55
5.7.9	Transmission networks: even smarter than they already are	55
5.7.10	Blockchains: decentralized consensus	56
5.8	Standards related to the electrotechnical aspects of Smart Grids	56
5.8.1	Planning for Smart Grid	56
5.8.2	Connecting and managing DER (Distributed Energy Resources)	56
5.8.3	Integrating power electronics in the electrical grid	59
5.8.4	Low voltage DC grids.....	60
5.8.5	LV installation.....	60
5.9	Per system standard breakdown	61
5.9.1	Generation management system.....	61
5.9.2	FACTS and HVDC systems for grids.....	71
5.9.3	Energy management system.....	79
5.9.4	Blackout prevention system	87
5.9.5	Advanced distribution management system (ADMS)	94
5.9.6	Distribution automation system	105
5.9.7	Substation automation system	113
5.9.8	DER management system	123
5.9.9	Electrical energy storage management system	134
5.9.10	Advanced metering infrastructure	138
5.9.11	Metering-related back office system.....	148
5.9.12	Marketplace system	154
5.9.13	Demand response / load management system	160
5.9.14	HBES/BACS system	169
5.9.15	Industrial automation system	177
5.9.16	E-mobility system	184
5.9.17	Assets management and condition monitoring system	190
5.9.18	Weather forecast system	197
5.9.19	Micro-grid systems	202
5.10	Cross-cutting technologies and systems	208
5.10.1	Communication network.....	208
5.10.2	Communication network management system.....	223
5.10.3	Data modelling	227
5.10.4	Security and privacy	229
5.10.5	Authentication, Authorization, Accounting systems	238
5.10.6	Clock reference system	246
5.10.7	EMC and Power Quality.....	250
5.10.8	Object identification, product classification, properties and documentation.....	256
5.10.9	Functional safety	257
Annex A (informative)	Standards	259
A.1	IEC Standards table.....	259
A.1.1	Available standards	259
A.1.2	Coming IEC standards.....	270
A.2	ISO and ISO/IEC standards	273
A.2.1	Available standards	273

A.2.2	Coming standards.....	275
A.3	ITU	276
A.3.1	Available standards	276
A.4	Other bodies	279
A.4.2	Standards from IEEE	285
A.4.3	Standards from CEN-CENELEC-ETSI.....	287
A.4.4	Other bodies.....	293
Annex B (informative)	Overview of the core IEC standards	296
B.1	IEC 61508 – Functional safety of electrical/electronic/programmable electronic safety-related systems	296
B.2	IEC 61850 – Communication networks and systems for power utility automation.....	296
B.2.1	Scope of application of IEC 61850 and history.....	296
B.2.2	Key features of IEC 61850.....	298
B.2.3	IEC 61850 documentation structure	298
B.2.4	Main parts	299
B.2.5	Main principles	300
B.2.6	IEC 61850-7-410 – Hydro power.....	301
B.2.7	IEC 61850-7-420 – DER	301
B.2.8	IEC 61400-25 – Wind turbine monitoring and controlling.....	302
B.2.9	IEEE 1815-1 – Mapping IEC 61850 data objects over DNP3	303
B.3	The CIM family.....	303
B.3.1	IEC 61970 – Common Information Model (CIM)	303
B.3.2	IEC 61968 – Common Information Model (CIM) – Distribution management.....	305
B.3.3	IEC 62325 – Framework for energy market communications	307
B.4	IEC 62056 – COSEM series	307
B.4.1	General	307
B.4.2	The basic principles followed in the IEC 62056 series.....	307
B.4.3	Data model and communication channels	310
B.4.4	The standards framework	310
B.5	IEC 62351 – Security	311
Annex C (informative)	List of known Regional or National Smart Grids standard roadmaps.....	313
Bibliography	314
Figure 1	– Smart Grid plane – domains and hierarchical zones	29
Figure 2	– Grouping into interoperability layers	30
Figure 3	– SGAM framework	31
Figure 4	– Smart Grid Mapping Tool – www.smartgridstandardsmap.com	38
Figure 5	– Systems mapping over the SGAM plane.....	47
Figure 6	– Mapping principles of systems over the SGAM planes.....	48
Figure 7	– Generation management system – Component layer.....	69
Figure 8	– Generation management system – Communication layer	70
Figure 9	– Generation management system – Information layer	71
Figure 10	– FACTS and HVDC systems – Component layer.....	77
Figure 11	– FACTS and HVDC systems – Communication layer	78
Figure 12	– FACTS and HVDC systems – Information layer	79

Figure 13 – EMS SCADA system – Component layer	85
Figure 14 – EMS SCADA system – Communication layer	86
Figure 15 – EMS SCADA system – Information layer	87
Figure 16 – WAMPAC – Component layer	92
Figure 17 – WAMPAC – Communication layer	93
Figure 18 – WAMPAC – Information layer	94
Figure 19 – DMS SCADA and GIS system – Component layer	103
Figure 20 – DMS SCADA and GIS system – Communication layer	104
Figure 21 – DMS SCADA and GIS system – Information layer	105
Figure 22 – Distribution automation system – Component layer	111
Figure 23 – Distribution automation system – Communication layer	112
Figure 24 – Distribution automation system – Information layer	113
Figure 25 – Smart Substation Automation with a process bus	114
Figure 26 – Substation automation system – Component layer	121
Figure 27 – Substation automation system – Communication layer	122
Figure 28 – Substation automation system – Information layer	123
Figure 29 – Example of a communications configuration for a DER plant	127
Figure 30 – Illustration of electrical connection points (ECP) in a DER plant	128
Figure 31 – DER management system – Component layer	132
Figure 32 – DER management system- Communication layer	133
Figure 33 – DER management system – Information layer	134
Figure 34 – The smart metering reference architecture	142
Figure 35 – Smart metering architecture (example) mapped to the SGAM component layer	146
Figure 36 – Smart metering architecture (example) mapped to the SGAM communication layer	147
Figure 37 – Smart metering architecture (example) mapped to the SGAM information layer	148
Figure 38 – Typical applications hosted by a metering-related back office system	149
Figure 39 – Metering-related back office system – Component layer	152
Figure 40 – Metering-related back office system – Communication layer	153
Figure 41 – Metering-related back office system – Information layer	154
Figure 42 – Marketplace system – Component layer	158
Figure 43 – Marketplace system – Communication layer	159
Figure 44 – Marketplace system – Information layer	160
Figure 45 – SGUI representation	162
Figure 46 – Demand response management system (example) – Component layer	167
Figure 47 – Demand response management system (example) – Communication layer	168
Figure 48 – Demand response management system (example) – Information layer	169
Figure 49 – HBES/BACS system (example) – Component layer	175
Figure 50 – HBES/BACS system (example) – Communication layer	176
Figure 51 – HBES/BACS system (example) – Information layer	177
Figure 52 – Industrial automation system (example) – Component layer	182
Figure 53 – Industrial automation system (example) – Communication layer	183

Figure 54 – Industrial automation system (example) – Information layer	184
Figure 55 – E-mobility system (example) – Component layer	188
Figure 56 – E-mobility system (example) – Communication layer	189
Figure 57 – E-mobility system (example) – Information layer	190
Figure 58 – Assets management and Condition Monitoring System – Component layer	195
Figure 59 – Assets management and Condition Monitoring System – Communication layer	196
Figure 60 – Assets management and Condition Monitoring System – Information layer.....	197
Figure 61 – Weather forecast and observation system – Component layer.....	200
Figure 62 – Weather forecast and observation system – Communication layer.....	201
Figure 63 – Weather forecast and observation system – Information layer	202
Figure 64 – Micro-grids – possible domains and systems breakdown.....	204
Figure 65 – Mapping of communication networks on SGAM	210
Figure 66 – Communication network management – Component layer.....	225
Figure 67 – Communication network management – Communication layer.....	226
Figure 68 – Communication network management – Information layer	227
Figure 69 – Data modelling and harmonization work mapping	228
Figure 70 – Smart Grid information security standards areas	231
Figure 71 – Current Smart Grid information security standard landscape analysed	232
Figure 72 – Security standard applicability.....	233
Figure 73 – AAA Example in a substation automation use case	239
Figure 74 – EAP Overview	240
Figure 75 – Mapping of standards used in the AAA example on SGAM – Component layer	243
Figure 76 – Mapping of standards used in the AAA example on SGAM – Communication layer	245
Figure 77 – Mapping of standards used in the AAA example on SGAM – Information layer	246
Figure 78 – Clock reference system – Component layer.....	249
Figure 79 – Clock reference system – Communication layer	250
Figure 80 – Clock reference system – Information layer	250
Figure B.1 – Scope of application of IEC 61850	297
Figure B.2 – IEC 61850 main parts	299
Figure B.3 – Interface model of substation automation based on IEC 61850	301
Figure B.4 – Overview: Conceptual organization of IEC 61850-7-420 logical devices and logical nodes (DER)	302
Figure B.5 – Overview of advanced EMS architecture	304
Figure B.6 – IEC 61968 compliant interface architecture.....	306
Figure B.7 – The standards framework for smart metering	311
Table 1 – Smart Grids – IEC core standards	25
Table 2 – Smart Grids – Other IEC highly important standards	26
Table 3 – Use cases approach – Available standards	32
Table 4 – Use cases approach – Coming standards.....	32
Table 5 – Summary list of System Capabilities.....	33

Table 6 – IEC Smart Grid Standards Map clusters description	39
Table 7 – IEC Smart Grid Standards Map – component description	40
Table 8 – Smart Grids – list of the main systems	44
Table 9 – Typical components used for system mapping on SGAM	49
Table 10 – Typical links used for system mapping on SGAM.....	49
Table 11 – Example in binding system standards and low OSI layer communication standards.....	50
Table 12 – Capabilities coverage example	51
Table 13 – Connecting and managing DER – Available standards	57
Table 14 – Connecting and managing DER – Coming standards.....	59
Table 15 – LV installations available standards.....	61
Table 16 – LV installations coming standards	61
Table 17 – Generation management systems – Capabilities	63
Table 18 – Generation management system – Available standards.....	65
Table 19 – Generation management system – Coming standards	68
Table 20 – FACTS and HVDC systems – System Capabilities.....	74
Table 21 – FACTS – Available standards.....	75
Table 22 – FACTS and HVDC systems – Coming standards	76
Table 23 – EMS SCADA system – Capabilities	82
Table 24 – EMS SCADA system – Available standards	83
Table 25 – EMS SCADA system – Coming standards	84
Table 26 – WAMPAC – System Capabilities.....	88
Table 27 – WAMPAC – Available standards.....	89
Table 28 – WAMPAC – Coming standards	90
Table 29 – DMS SCADA and GIS system – Capabilities	98
Table 30 – DMS SCADA and GIS system – Available standards	100
Table 31 – DMS SCADA and GIS system – Coming standards	101
Table 32 – Distribution automation system – System Capabilities	107
Table 33 – Distribution automation system – Available standards	108
Table 34 – Distribution automation system – Coming standards.....	110
Table 35 – Substation automation system – Capabilities.....	115
Table 36 – Substation automation system – Available standards	117
Table 37 – Substation automation system – Coming standards.....	119
Table 38 – DER management system – Capabilities	125
Table 39 – DER management system – Available standards	129
Table 40 – DER management system – Coming standards	130
Table 41 – Electrical energy storage management system – Capabilities.....	136
Table 42 – Electrical energy storage management system – Available standards.....	137
Table 43 – Electrical energy storage management system – Coming standards.....	138
Table 44 – Supported business processes and use cases.....	140
Table 45 – AMI system – available standards for smart metering	143
Table 46 – AMI system – Coming standards for smart metering	145
Table 47 – Metering-related back office system – Capabilities	150

Table 48 – Metering-related back office system – Available standards	151
Table 49 – Metering-related back office system – Coming standards	151
Table 50 – Marketplace system – Capabilities	155
Table 51 – Marketplace system – Available standards	156
Table 52 – Marketplace system – Coming standards	157
Table 53 – Demand response management system – Capabilities	163
Table 54 – Demand response management system – Available standards	164
Table 55 – Demand response management system– Coming standards	166
Table 56 – HBES/BACS system – Capabilities	171
Table 57 – HBES/BACS system – Available standards.....	172
Table 58 – HBES/BACS system– Coming standards	174
Table 59 – Industrial automation system – Use cases	179
Table 60 – Industrial automation system – Available standards.....	180
Table 61 – Industrial automation system – Coming standards	181
Table 62 – E-mobility system – Available standards.....	186
Table 63 – E-mobility system – Coming standards	187
Table 64 – Assets management and Condition Monitoring System – Capabilities.....	192
Table 65 – Assets management and Condition Monitoring System – Available standards.....	193
Table 66 – Assets management and Condition Monitoring System – Coming standards.....	194
Table 67 – Weather forecast and observation system – Capabilities	198
Table 68 – Weather forecast and observation system – Available standards	198
Table 69 – Weather forecast and observation system – Coming standards	199
Table 70 – Industrial automation system – Capabilities	205
Table 71 – Micro-grid systems – Available standards.....	206
Table 72 – Micro-grid systems – Coming standards	207
Table 73 – Applicability statement of the communication technologies to the Smart Grid sub-networks.....	212
Table 74 – Communication – Available standards	213
Table 75 – Communication – Coming standards	221
Table 76 – Higher level communication protocols – Available standards	222
Table 77 – Higher level communication protocols – Coming standards	223
Table 78 – Communication network management – Available standards	224
Table 79 – Data modelling – Available standards	228
Table 80 – Data modelling – Coming standards	229
Table 81 – Security – Available standards	234
Table 82 – Security – Coming standards.....	237
Table 83 – AAA systems – Capabilities	241
Table 84 – AAA system – Available standards	242
Table 85 – AAA system – Coming standards.....	242
Table 86 – Clock reference system – System Capabilities	247
Table 87 – Clock reference system – Available standards.....	247
Table 88 – Clock reference system – Coming standards	248
Table 89 – EMC – Power Quality – Available standards	254

Table 90 – EMC – Power Quality – Coming standards	255
Table 91 – Identification and classification of objects – Available standards	257
Table 92 – Electronic product description – Available standards	257
Table 93 – Identification and classification of objects – Coming standards.....	257
Table 94 – Functional safety – Available standards.....	258
Table B.1 – IEC 61970 main parts (available and coming)	305
Table B.2 – IEC 61968 main parts (available and coming)	306
Table B.3 – IEC 62325 main parts	307
Table B.4 – IEC 62351 main parts	312

INTERNATIONAL ELECTROTECHNICAL COMMISSION

SMART GRID STANDARDIZATION ROADMAP

FOREWORD

- 1) The International Electrotechnical Commission (IEC) is a worldwide organization for standardization comprising all national electrotechnical committees (IEC National Committees). The object of IEC is to promote international co-operation on all questions concerning standardization in the electrical and electronic fields. To this end and in addition to other activities, IEC publishes International Standards, Technical Specifications, Technical Reports, Publicly Available Specifications (PAS) and Guides (hereafter referred to as "IEC Publication(s)"). Their preparation is entrusted to technical committees; any IEC National Committee interested in the subject dealt with may participate in this preparatory work. International, governmental and non-governmental organizations liaising with the IEC also participate in this preparation. IEC collaborates closely with the International Organization for Standardization (ISO) in accordance with conditions determined by agreement between the two organizations.
- 2) The formal decisions or agreements of IEC on technical matters express, as nearly as possible, an international consensus of opinion on the relevant subjects since each technical committee has representation from all interested IEC National Committees.
- 3) IEC Publications have the form of recommendations for international use and are accepted by IEC National Committees in that sense. While all reasonable efforts are made to ensure that the technical content of IEC Publications is accurate, IEC cannot be held responsible for the way in which they are used or for any misinterpretation by any end user.
- 4) In order to promote international uniformity, IEC National Committees undertake to apply IEC Publications transparently to the maximum extent possible in their national and regional publications. Any divergence between any IEC Publication and the corresponding national or regional publication shall be clearly indicated in the latter.
- 5) IEC itself does not provide any attestation of conformity. Independent certification bodies provide conformity assessment services and, in some areas, access to IEC marks of conformity. IEC is not responsible for any services carried out by independent certification bodies.
- 6) All users should ensure that they have the latest edition of this publication.
- 7) No liability shall attach to IEC or its directors, employees, servants or agents including individual experts and members of its technical committees and IEC National Committees for any personal injury, property damage or other damage of any nature whatsoever, whether direct or indirect, or for costs (including legal fees) and expenses arising out of the publication, use of, or reliance upon, this IEC Publication or any other IEC Publications.
- 8) Attention is drawn to the Normative references cited in this publication. Use of the referenced publications is indispensable for the correct application of this publication.
- 9) Attention is drawn to the possibility that some of the elements of this IEC Publication may be the subject of patent rights. IEC shall not be held responsible for identifying any or all such patent rights.

The main task of IEC technical committees is to prepare International Standards. However, a technical committee may propose the publication of a Technical Report when it has collected data of a different kind from that which is normally published as an International Standard, for example "state of the art".

IEC TR 63097, which is a Technical Report, has been prepared by IEC Systems Committee: Smart energy.

The text of this Technical Report is based on the following documents:

Enquiry draft	Report on voting
SyCSmartEnergy/50/DTR	SyCSmartEnergy/59/RVDTR

Full information on the voting for the approval of this Technical Report can be found in the report on voting indicated in the above table.

This document has been drafted in accordance with the ISO/IEC Directives, Part 2.

The committee has decided that the contents of this document will remain unchanged until the stability date indicated on the IEC website under "<http://webstore.iec.ch>" in the data related to the specific document. At this date, the document will be

- reconfirmed,
- withdrawn,
- replaced by a revised edition, or
- amended.

A bilingual version of this publication may be issued at a later date.

IMPORTANT – The 'colour inside' logo on the cover page of this publication indicates that it contains colours which are considered to be useful for the correct understanding of its contents. Users should therefore print this document using a colour printer.

INTRODUCTION

0.1 Context

Smart Grid is a term which embraces an enhancement of the power grid to accommodate the immediate challenges of today (such as the integration of distributed energy resources) and provides a vision for the future power. Its main focus is on an increased efficiency, reliability, observability and controllability of the power grid and connected users, for the benefit of all concerned actors.

“Smart Grid” is one of the major trends and markets which involve the whole energy conversion chain from generation to consumer. The power flow will change from a unidirectional power flow (from centralized generation via the transmission grids and distribution grids to the customers) to a bidirectional power flow. Traditional energy architectures consisting of bulk generation, transmission and distribution will be impacted by these new technologies and will need to adapt to support new configurations with more distributed energy generation and storage.

Furthermore, the way a power system is operated changes from the hierarchical top-down approach to a distributed control.

Consumers too are leveraging smart technologies along with new options for local energy generation and storage to access new energy options.

This will then demand a higher level of syntactic and semantic interoperability of the various products, solutions and systems that build up a power system. Furthermore, specific requirements like long term investment security and legacy systems need to be considered. These two rationales – interoperability and investment security – make it absolutely necessary to base all developments and investment on a sound framework of standards.

Thus standardization plays a key role to enable the development of new applications for today and a future power system.

As a reminder, within the IEC, SMB Strategic Group 3 “Smart Grid” published a first release 1.0 of the IEC Smart Grid roadmap.

This original document has been reworked, and updated thanks to IEC Systems Evaluation Group (SEG) 2, which was formed with the mission of assessing the need for an IEC system committee on Smart Grids.

This work is now undertaken by IEC SyC Smart Energy, and its first mission is to finalize this work.

As a reminder IEC SyC Smart Energy has the mission:

- to provide systems level standardization, coordination and guidance in the areas of Smart Grid and Smart Energy, including interaction in the areas of heat and gas;
- to widely consult within the IEC community and the broader stakeholder community to provide overall systems level value, support and guidance to the technical committees and other standards development groups, both inside and outside the IEC;
- to liaise and cooperate with the SEG Smart Cities and future SEGs, as well as the future Systems Resource Group.

Several updates to the IEC Smart Grid roadmap have been brought to this document, especially by including the latest publications and upcoming standards. This document also

tries to take into account some of the relevant outcomes from other regions and countries, and among many sources, the work performed by the CEN-CENELEC-ETSI Smart Grid-Coordination Group [1][2][3][4]¹ and the NIST SGIP roadmap [5][6].

At the current stage, the real scope considered in this approach remains the “Smart Grids”, meaning that the full Smart Energy scope has not been addressed yet (i.e. the consideration necessary to include the interactions with other energies such as gas, and heat).

Work is also underway within IEC SyC Smart Energy to progressively build a technical Smart Energy system framework. An alignment of this document with the IEC 62913² series will be performed as soon as these elements are available.

As a reminder, this document does not intend to present all standards which are applicable in the context of Smart Energy, but to highlight those which have been specifically designed and provide significant value to support a transition to a Smarter Energy, especially considering the need for an easier interoperability among devices and systems within the Smart Energy Domain.

This roadmap document is one element.

One other main element is the Smart Grid Standards Map (www.smartgridstandardsmap.com), a web tool presented in 5.4, and whose content will be aligned with this document.

Finally, IEC SyC Smart Energy also intends to create a specific relationship with user associations. The dissemination of the information included in this document will be one objective.

0.2 Overview

The aim of this document is to provide standards users with guidelines to select a most appropriate set of standards and specifications. These standards and specifications are either existing or planned, and are provided by IEC or other bodies also fulfilling use cases.

It also aims at creating a common set of guiding principles that can be referenced by end-users and integrators who are responsible for the specification, design, and implementation of Smart Energy Systems.

As a living document, this roadmap will be subject to future changes, modifications and additions, and will be incorporated into future editions.

At the current stage, the focus remains the “Smart Grids”. This means that the full Smart Energy scope has not been addressed yet (i.e. the consideration necessary to include the interactions with other energies such as gas, and heat) and will be considered in a future edition of this document.).

This roadmap presents an inventory of existing and future standards, and puts them into perspective regarding the different Smart Grid applications. The intention is to facilitate the choice of the relevant standards for all Smart Grid products, applications and systems, given the fact that such a scope is complex and moving.

The IEC, as the only international standardization organization in the field of electrotechnical standardization, is ideally positioned to provide such document. However, IEC is not the only

¹ Numbers in square brackets refer to the Bibliography.

² Under preparation.

body contributing to Smart Energy standardization; this document shows that IEC covers only 50 % of the used standards or specifications.

Based on this assessment, this document tries to not restrict the set of standards, except the fact that preference is given to International Standards (IEC, ISO, ITU). Regional specificities are also taken into account, especially when they fill gaps not yet realized at an international level.

Other bodies are also considered as long as they fulfil the “open specification” criteria defined in 5.2.5.

Gaps between actual standards and future requirements are listed and will lead to recommendations for evolution within IEC (the recommendations are included in a separate IEC publication). This framework will be then at the core of new developments and benefits reached through the implementation of Smart Grid.

As a roadmap this document also shows possible developments and future trends in Smart Energy technologies: Evolutions in communication, centralization, micro-grids, etc. are outlined in 5.7.

0.3 Purpose of the document

The importance of these standards will vary in their relation to Smart Energy applications and solutions. A number of standards form a core set of standards, which are valid or necessary for nearly all Smart Energy applications. These standards will be considered as IEC priority standards. Their further promotion and development will be a key for the IEC to provide support for Smart Energy solutions. (See also <http://www.iec.ch/smartgrid/standards/>).

Besides these IEC priority standards, the goal will also be to provide an overview of the IEC standards specifically capable of serving as a base for Smart Energy. The objective is that the collection should be comprehensive and also provide an overview of all the standardization involved.

Furthermore, not only does the roadmap consider the available standards but also the coming ones (see in 5.2.5 the triggers attached to these definitions “available” and “coming”). With this the IEC will provide a necessary precondition for Smart Energy to become widely accepted by the market. Since Smart Energy investments are long-term investments, it is absolutely necessary to provide the stakeholders with a needed vision as a basis for a sustainable future investment.

A specific focus is put on interoperability standards, which will help to reach the goal of increased observability and controllability of the power system. In this respect the IEC offers the absolute precondition for a further promotion of Smart Grid. It offers as well the conditions for profiling the usage of these standards and then improves the interoperability as explained in 5.6. On the other hand, the IEC refrains from standardization of solutions or applications itself. This would actually block innovation and the further development of Smart Energy.

Even if standards from other Standards Development Organizations (SDOs) are not the main focus of this roadmap, they are part of the complete story, and so need to be included.

The IEC acknowledges the vast literature and documentation which is already available on the Smart Grid topic and, to a far lesser extent, also on the standardization of Smart Energy (some documents are identified in Annex C and in the Bibliography [5][6][7][8]).

SMART GRID STANDARDIZATION ROADMAP

1 Scope

This document provides standards users with guidelines to select a most appropriate set of standards/specifications (either existing or coming, from IEC but possibly coming from other bodies) fulfilling the set of Smart Energy use cases, then relevant for Smart Energy project implementation.

It provides a summary of the core standards which form the pillars of the Smart Energy standards set.

Then the main areas of Smart Grid are investigated. The structure of this document has evolved in order to embrace the full scope of Smart Grids.

A new first area introduces the general IEC framework.

Then standards are presented, following these main guidelines:

- standards in relation with electrotechnics (planning the grid, integrating DER, coping with power electronics, coping with DC grids, and impact on the low voltage installations).
- standards related to communicating systems, divided into nineteen sections: generation management systems, FACTS, energy management systems, blackout prevention systems, advanced distribution management systems, distribution automation systems, smart substation automation systems, distributed energy resources operation systems, advanced meter infrastructure, meter-related back office systems, market place systems, demand response and load management systems, HBES/BACS systems, industrial automation systems, electrical storage management systems, electro-mobility systems, weather forecast systems, asset management and condition monitoring systems, micro-grid systems.
- standards which cover cross-cutting areas such as communication, data modelling, cyber-security, authentication, authorization, accounting, clock management, EMC, power quality, functional safety.

Annexes provide

- tables which indicate for each standard its main area of use;
- an overview of the core IEC standards;
- references to known Smart Grid/Smart Energy roadmaps provided by some regional bodies.

In total, this document identifies over 500 relevant standards/specifications and/or standard parts for the considered domain. Five electrotechnical domains, nineteen specific systems and nine cross-cutting topics have been analysed.

2 Normative references

There are no normative references in this document.