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SYSTEMS REFERENCE DELIVERABLE

Top priority standards development status in the domain of smart energy

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colour inside

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INTERNATIONAL
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COMMISSION

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TOP PRIORITY STANDARDS DEVELOPMENT STATUS IN THE DOMAIN OF SMART ENERGY

FOREWORD

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IEC SRD 63199, which is a Systems Reference Deliverable, has been prepared by IEC systems committee Smart Energy.

The text of this Systems Reference Deliverable is based on the following documents:

Draft SRD	Report on voting
SyCSmartEnergy/129/DTS	SyCSmartEnergy/139/RVDTS

Full information on the voting for the approval of this Systems Reference Deliverable 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- withdrawn,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.

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INTRODUCTION

0.1 General

IEC systems committee Smart Energy (SyC SE) addresses standardization issues in the field of smart energy with the purpose of identifying systems level requirements for standardization, coordination and guidance in the areas of smart grid and smart energy, including interaction in the areas of heat and gas.

To realize this, SyC SE has accepted the idea that "*One concrete approach consists of collectively elaborating on a master development plan to visualize new ideas under consideration by the TCs/SCs consistently with the ongoing program of work*"
[SOURCE: IEC SyC SE, WG2 IEC Smart Energy Development Plan].

To achieve this goal, SyC SE determined that it was essential to consult widely within the IEC community and the broader stakeholder community to provide overall systems level value, support and guidance to technical committees (TCs) and other standards development groups, both inside and outside the IEC. From this consultation effort, SyC SE was able to select important cases that would benefit from standardization. After identifying and assessing the importance of these standardization cases, SyC SE has worked with the affected TCs to promote these efforts and periodically updates their progress in an SRD report (called the SyC SE development plan).

The purpose of the SyC SE development plan is to assist TCs in coordinating and recognizing standardizing action needed for as well to raise awareness of the ongoing standardization efforts.

In order to develop new standards and amendments of existing standards for smart energy, it is important to analyse gaps, resolve each gap's standardization cases (milestones, timelines, dependencies, etc.), progress the development process in accordance with a timetable, and manage the development status by tracking the processes.

The ultimate goal is to boost, facilitate and monitor standardization work where needed, in order to get the most comprehensive and consistent set of standards in the given time scale, needed for a seamless deployment of smart energy domain worldwide.

0.2 Summary of development plan process

The development plan is in essence a living tool, not only because of the progressive resolution of standardization cases included in the development plan, but also because the list of entries will evolve during time.

In order to address this, a formal process was developed with the goal to formalize:

- a way to collect new standardization cases (cases where additional standardization could improve smart energy technology, interoperability and market support);
- a way to rank these standardization cases (from the highest priority to the lowest) – a necessary step in order to allocate the IEC SyC SE effort to the highest priorities only;
- a way to elaborate and select a resolution path;
- a way to engage, monitor and report on each standardization case resolution process.

This overall process is summarized in 4.1.

The review process of the development plan should be synchronized with updates of the smart grid roadmap [1], which consists of revision update and version update. Discussion with related TCs is very important for these updates. In principle, update of this document is expected to be synchronized with version update of the development plan.

TOP PRIORITY STANDARDS DEVELOPMENT STATUS IN THE DOMAIN OF SMART ENERGY

1 Scope

This document presents the current status of the IEC systems committee Smart Energy (SyC SE) development plan for readers (not limited to IEC smart energy related members). The document identifies items that require standardization, their current status and work required, possibly by multiple technical committees or working groups, to address any issues.

Since the content of this document represents a snapshot of the dynamic/living standardization processes to be updated, it is subject to future changes.

Users' perspectives are considered. For example, the analysis of influences of each item (development impact and chance to fill gaps) are stated.

2 Normative references

There are no normative references in this document.

3 Terms, definitions and abbreviated terms

3.1 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

- IEC Electropedia: available at http://www.electropedia.org
- ISO Online browsing platform: available at http://www.iso.org/obp

3.1.1
actor
entity that communicates and interacts

Note 1 to entry: These actors can include people, software applications, systems, databases, and even the power system itself.

Note 2 to entry: In IEC SRD 62913 (all parts) [2], this term includes the concepts of Business Role and System Role involved in Use Cases.

[SOURCE: IEC 62559-2:2015, 3.2 [3]]

3.1.2
architecture model
generic tool intended to support the modelling activities for use cases, functions, architectures, in order to analyse and visualize them with respect to interoperability, domains and zones

3.1.3
cyber security
protection against unauthorized access, theft, and damage to hardware, software or electronic data (whether stationary or transported), detection of such deliberate or inadvertent events, and coping during such a deliberate or inadvertent event

3.1.4
demand response
action resulting from management of the electricity demand in response to supply conditions

[SOURCE: IEC 60050-617:2011, 617-04-16]

3.1.5
grid code
<electric power system> collection of rules concerning rights and duties of the parties involved in a certain part of the electric power system

[SOURCE: IEC 60050-617:2009, 617-03-03, modified – The term "code" has been replaced by "grid code".]

3.1.6
microgrid
group of interconnected loads and distributed energy resources with defined electrical boundaries forming a local electric power system at distribution voltage levels, that acts as a single controllable entity and is able to operate in either grid-connected or island mode

Note 1 to entry: This definition covers both (utility) distribution microgrids and (customer owned) facility microgrids.

[SOURCE: IEC 60050-617:2017, 617-04-22]

3.1.7
protocol
defined set of procedures adopted to ensure communication between sets of processes which exist within the same layer of a hierarchy of layers

[SOURCE: IEC 60050-716:1995, 716-01-17]

3.1.8
role based access
policy-neutral access control mechanism defined around roles and privileges

3.1.9
smart energy grid
means to generate, store and distribute energy using electricity as an energy vector connecting energies, thus comprising also energy transformation between electricity and the other energies, and vice versa

3.1.10
standardization case
case where additional standardization could improve smart energy technology, interoperability and market support

3.2 Abbreviated terms

BACS	building automation and control system
CIM	common information model
DA	distribution automation
DER	distributed energy resources
DERMS	distributed energy resource management system
e-vehicle	electric vehicle
HBES	home and building electric system
IP	Internet Protocol
IPv4	Internet Protocol version 4
IPv6	Internet Protocol version 6
LV	low voltage
PV	photovoltaic system
SGAM	(1) smart grid architecture model (2) smart energy grid architecture model
SyC SE	systems committee Smart Energy

4 SyC Smart Energy development plan: development process

4.1 Purpose

The development plan is in essence a living tool, not only because of the progressive resolution of standardization cases included in the development plan, but also because the list of entries will evolve over time. There are many new reasons for having new entries, such as (but not limited to):

- new market trends (which may create new entries but also delete entries because no longer of high priority);
- new technology;
- new organization of IEC or external entities, which may trigger some re-arrangement of works.

In order to address this, a process needs to be set formally. It has the goal to formalize:

– a way to collect new standardization cases;

– a way to rank these standardization cases (from the highest priority to the lowest) – a necessary step in order to allocate the effort of IEC SyC SE to the highest priorities only;

– a way to elaborate and select a resolution path;

– a way to engage, monitor and report on each standardization case resolution process.

This overall process is summarized in 1) to 4) and in Figure 1.

1) A set of recommendations [4] is obtained from the smart grid roadmap [1].
2) These recommendations are assessed and ranked by NCs and TCs in order to select key standardization cases.
3) Multiple scenarios are developed aiming at resolving these standardization cases and are checked considering advantages and disadvantages.
4) Final scenarios are selected and further refined in the development plan. These procedures are described in 4.2 to 4.4.

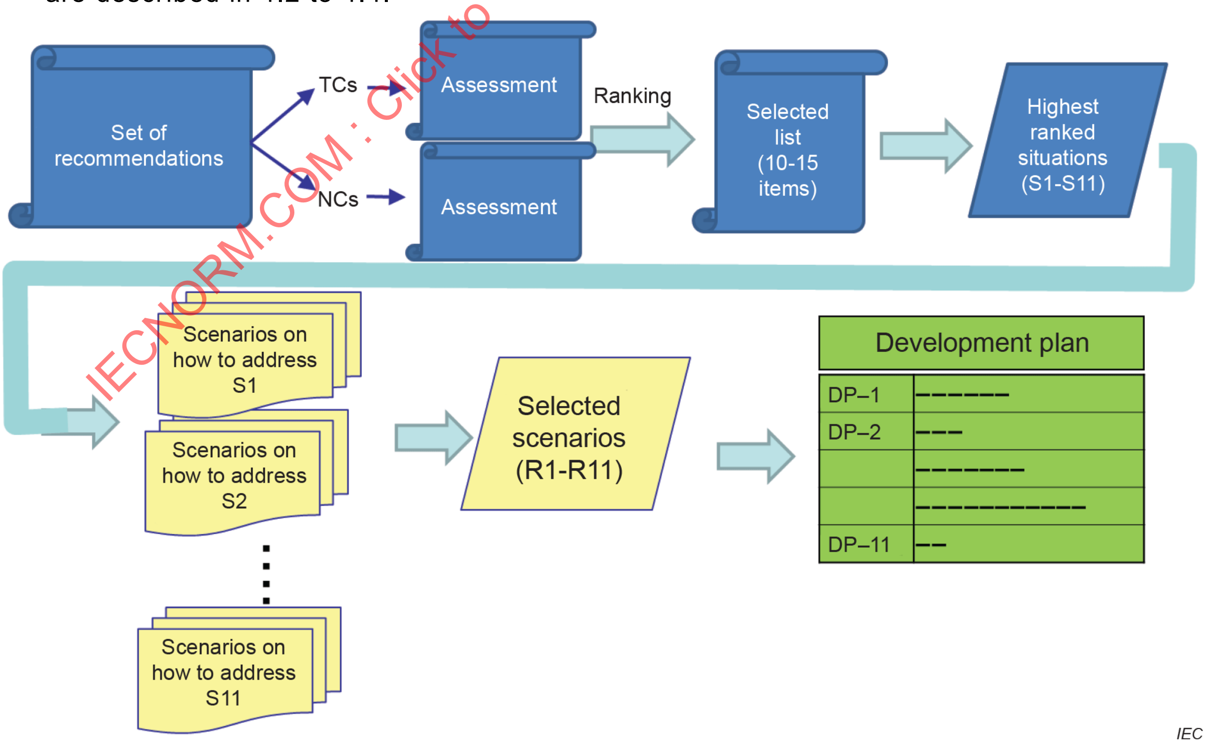


Figure 1 – Development plan overall process

By way of this iterative resolution process, the development plan version 1.3 was determined, as shown in Table 1.

Table 1 – List of selected items in the development plan version 1.3

No.	Selected items [a]
1	Increase profiling support
2	Connecting and managing DER standards
3	Installations with multiple power sources
4	Extensions to support dynamic system management
5	Guidance for IEC 61850 extensions
6	Promotion and expansion of IEC 61850-7-420
7	Cooperation of cross TCs for demand response applying to smart home and building automation systems
8	Standardization for interconnection and interoperability of large and distributed energy storage
9	Support for the long-term interoperability of IPv4 and IPv6
10	Guidelines of smart energy cyber security requirements
11	Extension of SGAM smart energy grid reference architecture

[a] Details of these items are given in SyCSmartEnergy/39e/INF [5].

4.2 Collection of standardization cases

There are many ways to collect inputs as "potential standardization cases", i.e. by identifying gaps or overlaps, or by recognizing other kinds of standardization needs potentially affecting the relevance of the IEC set of standards to fulfil the smart energy requirements.

Initially, the inputs mostly came from a former assessment performed by the IEC SG3 Smart Grids, formalized under its report "Release 1.0 of the IEC smart grid roadmap" [1], produced by IEC SG3 and then assessed in "IEC SyC1 Draft Set of Recommendations V3 0" [4]. At the end, more than 100 potential standardization cases were identified through this process.

4.3 Ranking process and results

4.3.1 General

The ranking process was published in "SyCSmartEnergy/37e/DC" [6].

4.3.2 Ranking criteria

Two main criteria for ranking the standardization were selected in order to ensure

- a quick answer from stakeholders, and
- a simple sorting and decision-making process.

At the end of the survey, a third criterion was used to evaluate the degree of consensus of the stakeholders.

As illustrated in Figure 2, the two criteria form the X and Y axes of a graph of each standardization case, while the size of the area indicates the degree of consensus.

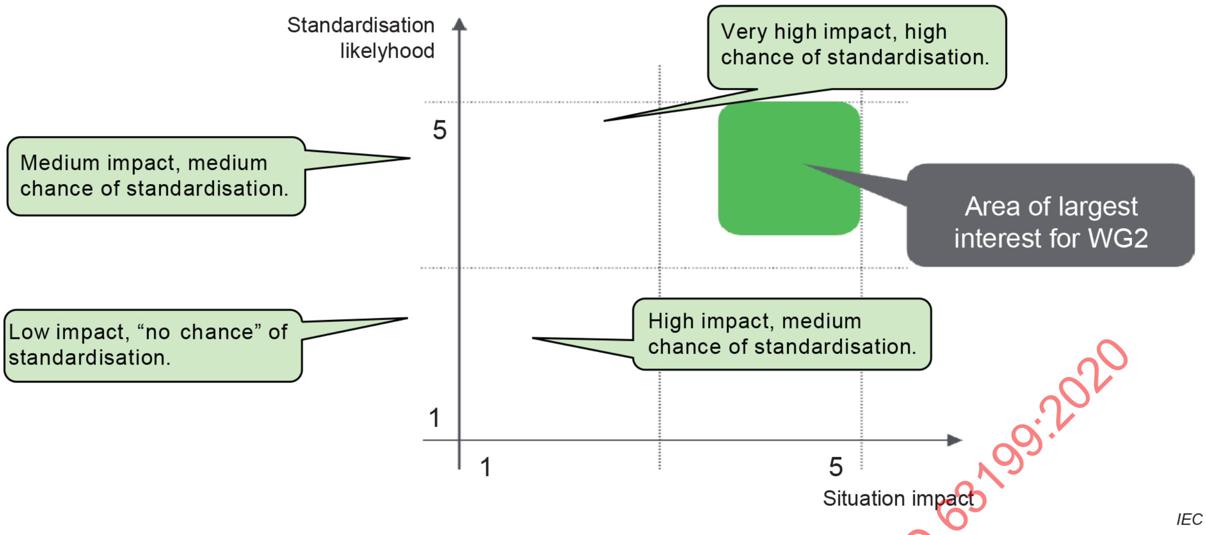


Figure 2 – Typical graphical output and conclusions

4.3.3 X-axis = Smart energy deployment standardization case impact

The objective of the first criterion was to evaluate how much the considered gaps could prevent (if absent) or boost (if present) smart energy worldwide. The importance measured the potential impact in the ability of smart energy to be deployed. The assessment of this criterion categorized the impact as follows:

- ? = don't know;
- 1 = almost no impact / not important / not relevant;
- 2 = small impact / less important;
- 3 = medium impact / medium importance (may be limited to some regions/countries);
- 4 = high impact / important / a continent;
- 5 = very high impact / very important / very relevant / worldwide.

The final criteria measurement averaged all received valid answers ("?" answer is ignored).

4.3.4 Y-axis = Standardization case resolution likelihood

The objective of the second criterion was to evaluate the risk, namely how achievable would the considered standardization work actually be. The assessment of this criterion asked stakeholders to choose between the following six positions:

- ? = don't know;
- 1 = not achievable / very high risk;
- 2 = difficult to achieve / high risk;
- 3 = medium difficulty / medium risk;
- 4 = low difficulty / relevant / low risk;
- 5 = easily achievable / no risk / just do it.

The final criteria measurement represents the average of all received answers ("?" answer is ignored).

4.3.5 Evaluation of the degree of consensus

At the end of the ranking process, an evaluation of the degree of consensus was performed.

In order to measure the stakeholder’s alignment on each selected standardization case, the number of received answers having evaluated the considered standardization cases with large impact criteria (i.e. impact criterion ≥ 4) was computed.

4.3.6 Who were involved for prioritizing?

The stakeholders requested to contribute to the survey were

- the technical committees or subcommittees (TCs/SCs), and
- the P-member National Committees (NCs).

Each stakeholder counted as one "voice".

4.3.7 Ranking result

The ranking elements and results were published in "Situation Ranking Results – SyCSmartEnergy/39e/INF" [5]. An additional consideration in selecting standardization cases was whether the effort could be seen as a systems approach, thus involving more than one standardization entity. Table 2 shows the ranking results, in which 11 standardization cases were selected.

Table 2 – Ranking results: selected 11 items

Nb [a]	ID [b]	Standardization case summary	Standardization case Impact	Standardization likelihood	Consensus level
13	S-INT-1	Considering the increasing number of options in smart energy standards, and the increasing need for multi-vendor interoperability, IEC should encourage and support the profiling of use of these standards (an agreed-upon subset and interpretation of a specification). Such an approach needs a complete framework to cover the full process from specification to testing, i.e. guidelines, processes, tools and hosting.	4.6	3.4	86 %
17	S-CNC-2	Develop IEC product standards (IEC TC 82, TC 88, TC 95, etc.) permitting to demonstrate compliance with grid connection requirements.	4.1	3.4	71 %
19	S-CNC-4	To review installation rules for safety, especially with multisources aspect. IEC TC 64 should develop a dedicated part within the IEC 60364 series [7] to cover this need together with IEC TC 8 for the Grid aspect of multisource installations.	4.0	3.7	67 %
54	S-SA-10	Develop the needed extensions (data model and/or services) to support dynamic system management.	4.2	3.5	83 %
55	S-SA-11	In order to keep IEC 61850 overall consistency, and avoid potential overlaps, provide guidance to other TCs than TC 57 on the process and technical rules to apply to make extensions to IEC 61850 in their own expertise domain. This applies to all potential application domains of IEC 61850 (i.e. is not substation automation system specific).	4.1	4.0	86 %
57	S-DER-1	Promote the use of IEC 61850-7-420 for all DER equipment and expand the standard to all kinds of possible equipment. This should be done in a generic way, which enables the inclusion of all kinds of DER equipment without explicitly describing single DER equipment. The current standard (IEC 61850-7-420:2009) is too detailed and therefore poses difficulties in achieving interoperability.	4.4	3.5	80 %

Nb [a]	ID [b]	Standardization case summary	Standardization case Impact	Standardization likelihood	Consensus level
60	S-HBES/BACS-1	A close cooperation with the "demand response" activities is needed. Here use cases need to be defined in order to specify the scope and involvement of the different stakeholders. For example, the contribution of HBES/BACS needs to be described in order to define their share in the overall systems.	4.0	3.6	60 %
62	S-ES-1	IEC TC 57 should develop an equivalent standard for connection of large and distributed storage systems. The result should be a generic description of the necessary data models, in order to accommodate the different requirements and possibilities of large and distributed energy storage.	4.5	3.7	100 %
81	G-C-7	Anticipate the use of IPv6, and ensure the availability of the concerned standards supporting IPv6.	4.3	4.0	100 %
86	G-S-5	Given the complexity of business processes and the wide variety of cyber assets used in the smart energy environment, there is significant confusion about how to assess cyber security requirements and what cyber security standards are applicable. It is clear that no single cyber security standard can address all security requirements, security controls, resilience strategies, and technologies. Some existing standards and guidelines are focused on the high level organizational security requirements and the more detailed recommended controls (What), while other standards focus on the technologies that can be used to provide these cyber security controls (How). The main challenge is to clearly describe the issues around cyber security for smart energy operations, to provide guidelines for how best to use the existing cyber security standards, and what gaps might exist where new cyber security standards should be developed.	4.7	3.4	100 %
	S-AM-1	Documentation and extension of the SGAM to interfaces to other energies	Not quoted		

[a] "Nb" is the classification number defined by the IEC smart grid roadmap and does not indicate any order of importance.

[b] IDs are "the name of items". Details are given in SyCSmartEnergy/39e/INF [5].

4.4 From advantages and disadvantages of paths to the resolution of standardization cases

Once standardization cases are selected, exactly who is to undertake them and how do they need to be resolved? Before (or even after) starting the resolution process, several paths need to be carefully considered. For instance, with the TCs, SyC SE just helped to coordinate the work through joint discussions with the affected TCs. Usually a few possible paths were identified for achieving the standardization case. If there were several TCs involved, SyC SE worked with an appointed leader to identify these possible paths. Then advantages and disadvantages were identified for each of the paths so that the most effective path could be selected. After careful considerations by comparing these advantages and disadvantages, SyC SE set the priority of each path.

Table 3 is the example of advantages and disadvantages comparison (standardization case of S-DER-1: Promotion and expansion of IEC 61850-7-420)

Table 3 – Example of scenarios comparison (S-DER-1)

Potential scenario for addressing standardization cases	Advantages	Disadvantages	Priority
1.Ask TC 57 to take the lead without creating liaisons with other groups.	Can keep consistency of the standard from TC 57 perspective.	Difficult to consider all use cases including major TCs activities on DER. Not able to go into adequate detail for each equipment.	3
2. TC 57 leads and works with relevant TCs: by correspondence, joint workshops.	Can reflect opinions of relevant TCs.	Getting and keeping the involvement of relevant TCs over time may be difficult.	1
3. TC 57 leads and forms a joint working group (JWG) with relevant TCs.	Get strong contribution of relevant TCs.	Not easy to manage JWGs.	2

Finally, SyC SE selected the most appropriate paths and created into dashboard sheet. After checking the advantages and disadvantages of all 11 standardization cases, SyC SE created the development plan shown in Table 4.

Table 4 – Development plan V1.3

ID [a]	Standardization case objective summary
1. S-INT-1 <BAP>	**Increase profiling support:** Considering the increasing number of options in smart energy standards, and the increasing need for multi-vendor interoperability, IEC should encourage and support the profiling of use of these standards (an agreed-upon subset and interpretation of a specification). Such an approach needs a complete framework to cover the full process from specification to testing, i.e. guidelines, processes, tools and hosting.
2. S-CNC-2	**Connecting and managing DER standards:** Develop IEC product standards (IEC TC 82, TC 88, TC 95, etc.) permitting to demonstrate compliance with grid connection requirements.
3. S-CNC-4 (CN&MGng DER)	**Installations with multiple power sources:** To review installation rules for safety, especially with multisources aspect. IEC TC 64 should develop a dedicated part within the IEC 60364 series to cover this need together with IEC TC 8 for the Grid aspect of multisource installations.
4. S-SA-10	**Extensions to support dynamic system management:** Develop the needed extensions (data model and/or services) to support dynamic system management.
5. S-SA-11	**Guidance for IEC 61850 extensions:** In order to keep IEC 61850 overall consistency, and avoid potential overlaps, provide guidance to other TCs than IEC TC 57 on the process and technical rules to apply to make extensions to IEC 61850 in their own expertise domain. This recommendation applies to all potential application domains of IEC 61850 (i.e. is not substation automation system specific).
6. S-DER-1	**Promotion and expansion of IEC 61850-7-420:** Promote the use of IEC 61850-7-420:2009 for all DER equipment and expand the standard to all kinds of possible equipment. This should be done in a generic way, which enables the inclusion of all kinds of DER equipment without explicitly describing single DER equipment. The current standard is too detailed and therefore poses difficulties in achieving interoperability.

ID [a]	Standardization case objective summary
7. S-HBES/BACS-1	**Cooperation of cross TCs for demand response applying to smart home and building automation systems:** A close cooperation with the "demand response" activities is needed. Here use cases need to be defined in order to specify the scope and involvement of the different stakeholders. For example the contribution of HBES/BACS needs to be described in order to define their share in the overall systems.
8. S-ES-1	**Standardization for interconnection and interoperability of large and distributed energy storage:** IEC TC 57 should develop an equivalent standard for connection of large and distributed storage systems. The result should be a generic description of the necessary data models, in order to accommodate the different requirements and possibilities of large and distributed energy storage.
9. G-C-7 (comm. Nwk)	**Support for the long-term interoperability of IPv4 and IPv6:** Anticipate the use of IPv6, and ensure the availability of the concerned standards supporting IPv6.
10. G-S-5 (Security)	**Guidelines of smart energy cyber security requirements:** Given the complexity of business processes and the wide variety of cyber assets used in the smart energy environment, no single cyber security existing standard can address all security requirements, security controls, resilience strategies, and technologies. Some standards and guidelines are focused on the high level organizational security requirements and more detailed recommended controls (What), while other standards focus on the technologies that can be used to supply these cyber security controls (How). The main challenge is to clearly describe the issues around cyber security for smart energy operations and to provide guidelines for how best to use the cyber security standards.
11. S-AM-1&New	**Extension of SGAM smart energy grid reference architecture:** The SGAM framework is established by merging the concept of the interoperability layers with the smart grid plane. To describe the interaction between the electrical grid and the systems in the areas of heat and gas, SGAM extension will be needed.

[a] IDs are "the name of items". Details are given in SyCSmartEnergy/39e/INF [5].

4.5 Facilitation of standardization case activities by SyC SE

In producing this development plan, SyC SE is seeking to facilitate these standardization case activities by involving the relevant groups, and by monitoring and reporting on progress.

Basically, the development plan standardization cases fall into the following three scenarios.

1) Lead Group Scenario when the lead groups exist

   A scenario where one of the concerned entities is recognized as the leader to conduct the work, with an "extended perspective" corresponding to the scope agreed with SyC SE.

2) Parallel Groups Scenario when coordination is needed across groups which are working in parallel

   A scenario where specific activities involving concerned entities with associated co-ordination are set under the assistance of SyC SE.

3) Hosted by SyC SE Scenario other than 1) and 2), in which the standardization case needs to be hosted by SyC SE

   A last scenario where all the activities are hosted by SyC SE with liaisons with the concerned bodies. This is only the case when abovementioned 1) and 2) are not feasible. This is limited to the activities that SyC SE can effectively host (such as guides, reports, consistency framework, and glossary).

According to this classification, standardization cases in the development plan are categorized as follows.

a) Lead Group Scenario – three cases:
   - S-INT-1: Increase profiling support;
   - S-SA-10: Extensions to support dynamic system management;
   - S-SA-11: Guidance for IEC 61850 extensions.

b) Parallel Groups Scenario – five cases:
   - S-CNC-2: Connecting and managing DER Standards;
   - S-CNC-4: Installations with multiple power sources;
   - S-DER-1: Promotion and expansion of IEC 61850-7-420;
   - S-HBES/BACS-1: Cooperation of cross TCs for DR applying to smart home and building automation systems;
   - S-ES-1: Standardization for interconnection and interoperability of large and distributed energy storage.

c) Hosted by SyC SE Scenario – three cases:
   - G-C-7: Support for the long-term interoperability of IPv4 and IPv6;
   - G-S-5: Guidelines of smart energy cyber security requirements;
   - SGAM: Extension of smart energy grid architecture.

5 Assessment of each standardization case

5.1 S-INT-1: Increase profiling support

5.1.1 Purpose of IEC effort

Interoperability is clearly one of the most important challenges the smart energy domain has to face, and the main reasons can be summarized as below:

- higher variety of actors (generation, transmission, distribution, grid users including DER and customer premises, and energy market related actors) needing to exchange data, including the fact that these actors were not used to interacting in such way;
- higher number of actors needing to exchange data (a new order of magnitude needing to be reached, stepping from hundreds to tens of thousands or even higher);
- new businesses and functions, requesting new data (including the fact that some of these new businesses and associated functions are not fully matured);
- more complex data to exchange;
- an evolving standardization case.

Facing such a challenge has been the main driver for creating and promoting the Smart Energy Grid Architecture Model, also presented as standardization case described in 5.11.

So on one hand, the standards are becoming more and more complex (in the sense that they include a larger and larger number of parts and elements), and on the other hand, the need for interoperability increases.

One way to address such a standardization case is to derive profiles from a general purpose standard. These profiles focus on specific applications of this standard by defining some agreed-upon restrictions of usage of the optional parameters of a considered standard, fitting the specified application. Applying such profiles increases the chance of components being interoperable by design.

IEC needs thus to provide the method and guidelines to explain how to proceed, as well as to provide tools and support machine-processable ways to define, host and maintain such profiles. This impacts potentially all IEC entities of the smart energy domain dealing with digital communication.

Such profiles may be particularly relevant to S-CNC-2 (see 5.2) and S-DER-1 (see 5.6) especially by better supporting regional applications of grid codes.

Providing tools to support to profile definitions is also the objective of S-AM-1 (refer to 5.11).

5.1.2 Description of current standardization efforts

The first challenge has been to consider the existing practices of profiling, especially in IEC TC 57, and in providing a common framework. This resulted in the publication of IEC TR 62361-103 [8] providing guidelines on how to perform the profiling of the Common Information Model (CIM) and IEC 61850 (Communication networks and systems for power utility automation) standard.

Defining smart energy requirements down to a point where profiles can be defined is described in the IEC 62559 series (use case approach) [9], complemented by IEC SRD 62913-1 [2], and a future SRD on the SGAM.

The next phase has been to document such profiling activity in the specific case of IEC 61850, and this led to the publication of IEC TR 61850-7-6 [10]. A new profiling work is currently in development which identifies the IEC 61850 data objects for grid codes and other functions and maps them to a specific protocol, initially IEEE 1815 (DNP3).

5.1.3 Description of remaining standardization efforts

Some important works still remain:

- Demonstrate by real cases the application of basic application profiles.
- Provide a machine-processable way of specifying a profile (in the case of IEC 61850).
- Define a way of hosting and maintaining profiles, with possibly an important contribution of users associations:
  - possibly under the form of a "database",
  - with adequate IP and licensing rules.

The DER world may be a first relevant case of application of such profiling activity, especially when considering grid codes related requirements for observability and controllability of DERs (then refer to S-CNC-2 in 5.2).

5.2 S-CNC-2: Connecting and managing DER standards

5.2.1 Purpose of IEC effort

The integration to the grid of variable power generation from renewables such as PV, wind energy, storage, fuel cells, reciprocating engines, e-vehicles with their charging stations – any kind of electricity generators and/or flexible loads, of whatever installed power size – starting from the smallest of few watts, is becoming a must.

This becomes even more critical in three senses: the increased ratio of renewables connected to the grid, considering that their variability and predictability impact the functioning of the whole electricity grid, the increasing inter-connection of transmission grid (which imposes balanced contribution of grid users to these parameters), as well as the development of microgrids with very little energy inertia.

Thus preparing and coordinating the development of International Standards and other deliverables related to connection of grid users to the grid, to ensure a smooth, balanced operation and stability of the grid, is as well becoming a must.

Such an activity should cover grid integration standards for renewable energy (as much as possible agnostic in terms of the generation technology), aggregating contributions of all grid users and prescribing interaction modes between the grid and power plants. This includes requirements for interconnection and related tests for grid code compliance, as well as standards or best practice documents for planning, modelling, forecasting, assessment, control and protection, scheduling and dispatching of renewables with a grid level perspective.

Developing grid level requirements to enable secure, non-discriminatory and cost-effective operation of electricity supply systems with a significant share of renewable generation leads to setting up a requirement for co-ordination between IEC TC 8, SC 8A, TC 13, TC 69, TC 82, TC 88, TC 95, TC 114, TC 115, TC 117, and TC 120. On the IT part, the same approach will be used by ensuring that data models and functions related to grid users connection are able to interoperate.

Many different cases may be faced:

- Product TCs may have addressed (or will address) the grid connection requirement differently on a product basis (typically PV may define something different and not interoperable with energy storage, energy storage different from e-vehicle). This would mean than some standards are already published, but not with the expected consistency between them.
- Local or regional standards may already exist.
- Local or regional regulation may be in place superseding any willingness to converge on a set of harmonized standards.

5.2.2 Description of current standardization efforts

A new entity SC 8A – derived from and reporting to IEC TC 8 – was formed to address grid connection requirements and compliance. IEC TS 62786:2017 [11] is being revised as a multi-part series of Technical Specifications: IEC TS 62786 (all parts).

A joint standardization activity is progressively encompassing the most important generation technology such as PV, wind, energy storage, and thus contributing to a sort of horizontal standard.

5.2.3 Description of remaining standardization efforts

Some important work still remains:

- Further extend the scope to ensure that all types of grid user are considered (typically e-vehicle, flexible loads, …).
- Support potentially with IEC TC 95 and/or TC 85 the definition of specific "protection" and/or "measurement function" needed to support the grid connection functional requirement.
- Ensure the coordination and alignment with other standards such as IEEE 1547.
- Ensure the coordination and alignment with local or regional standards, such as EN 50549 from CENELEC.

NOTE The last two items may be addressed through a sort of profiling (as described in the S-INT-1 standardization case – refer to 5.1).

5.3 S-CNC-4: Installations with multiple power sources

5.3.1 Purpose of IEC effort

The integration of generation at all levels of the grid is becoming a reality, raising the question of how to define the limit between what used to be called the "supply side" and what used to be called the "demand side". This means for example that generators may be more and more connected internally to a "customer premises" installation, while remaining connected on the grid, with a potentiality to export energy when possible and relevant. Such a grid user may even under certain conditions decide to run temporarily off-grid, having inside enough electricity generation capability to support its loads.

Having this "new" way of operating a grid user installation changes many things at both sides:

- From a grid perspective, this would mean that the flow is bidirectional and changing. The consumption of energy from the grid may depend on local user strategies, which are unknown by the grid operator, leading to some issues regarding energy balancing, congestion and voltage management (among the possible difficulties). This may also affect the way maintenance of a feeder should happen, to guarantee the absence of energy during field work for example.

- From a customer premises perspective, this would mean that the installation should be able to manage safely and securely these two modes (on-grid, off-grid) and the transition between both, that the loads and generators will be protected at the same level against an unexpected electricity event, that the earth will be as well managed properly when islanding, etc.

Whatever the view, an adequate set of standards is required to design, protect, operate, and maintain such new types of installation.

Microgrids may be seen from both sides: as a small scale distribution grid, or as a specific customer installation. Thus typically IEC TC 8 (top-down) and TC 64/TC 99 (bottom-up) may all work on the subjects, leading to potential discrepancies. This may have also some impacts on the design of key components such as PV panels, inverters, storage elements and associate inverters, e-vehicles and associated charging stations.

The main challenge is to ensure the production by IEC of a consistent and comprehensive set of standards.

It has links with grid codes as depicted in the S-CNC-2 standardization case presented in 5.2. It has as well some links with the information technology side of the standardization case depicted in S-DER-1 (refer to 5.6).

5.3.2 Description of current standardization efforts

A new entity SC 8B – derived from and reporting to IEC TC 8 – was formed to address microgrid issues. A new series of Technical Specifications – IEC TS 62898 (all parts) – is being developed.

IEC TC 64 has engaged work to complete the IEC 60364 series, to guide LV main stakeholders such as installers on how to cope with such request (IEC 60364-8-2 and IEC TS 60364-8-3).

A joint standardization roadmap is progressively being set up between TC 8 and TC 64, with potential cross-contributions of experts in both series mentioned above (IEC TS 62898 and IEC 60364).

IEC TC 57 is intending to provide data models and communication standards to support microgrids specific features (extending the work done on DER) through an extension of the IEC 61850 series.

5.3.3 Description of remaining standardization efforts

Some important work still remains:

- Transform the joint roadmap into concrete deliverables.
- Take into account the grid codes requirements as expressed in IEC TS 62786 [11] (refer to S-CNC-2 depicted in 5.2).
- Ensure the coordination and alignment with other "product" standards such as produced by IEC TC 82, TC 69, and TC 120.

5.4 S-SA-10: Extensions to support dynamic system management

5.4.1 Purpose of IEC effort

It is a reality that digital installations are more and more dynamic animals. Many reasons lead to modifying an existing digital installation, such as (but not limited to):

- shorter life cycle than conventional electro-technologies;
- evolving needs, requesting agility from the already deployed installation, to adapt their functions and architectures to new requirements;
- cybersecurity patches – an existing installation can't run with a known cybersecurity vulnerability. Patches will have to be installed to ensure such vulnerability is fixed.

At the same time:

– installations comprise a larger and larger number of devices, which makes manual intervention not practical;
– efficiency of field teams is under huge pressure, which would favour remote activities;
– configuration of digital devices is getting more and more complex, potentially requiring skills from many technical domains (protection, measurement, power quality, communication, automation, etc.).

As a conclusion, system management of digital installations within the smart energy domain (but not only), maximizing machine-to-machine system management, limiting the intervention of humans, will become a must.

While a solution needs to be brought for smart energy, should this solution be smart energy specific? Or should it be shared by other domains? To what extent should a solution be specific to a smart energy technology?

The main challenges are:

- to collect the requirements in a "domain agnostic" manner;
- to address the cases of firmware update, configuration update, device replacements.

This has links with some cybersecurity standardization case (G-S-5 exposed in 5.10), where:

– role based access is a key aspect of system management;
– patch management is a key expected requirement;
– etc.

As a starter, IEC TC 57 is the most involved body as far as the smart energy domain is concerned; however, TC 65 (for smart manufacturing aspects) or ISO/IEC JTC1/SC 41 for Internet of Things should be included as well.

5.4.2 Description of current standardization efforts

A new work item is engaged in IEC TC 57, with a joint specific task force established within the TC, with the goal to capture the requirements. The second CD of IEC TR 61850-90-16 has been circulated.

5.4.3 Description of remaining standardization efforts

Some important works still remain:

- Finalize the requirement phase and publish IEC TR 61850-90-16.
- Elaborate technical scenarios to meet the requirements.
- Elaborate a technical solution – should be handled at current time by IEC TC 57 WG10.

5.5 S-SA-11: Guidance for IEC 61850 extensions

5.5.1 Purpose of IEC effort

Born to meet the requirement of substation automation, IEC 61850 has a much wider potential to address the whole set of communication requirements of power utilities systems, at field level, and this encompasses feeder automation, DER, hydro plants, wind farms, and potentially charging stations of e-vehicles.

This means that an increasing number of technology domains are considering extending IEC 61850 for their own domains.

Unfortunately, IEC 61850 was not documented or organized to support such a wide number of different stakeholders. Without clear guidelines on how to extend IEC 61850, the other entities could break the overall consistency, produce conflicting models, and at the end miss the key target of supporting the smart energy field level communication, as expressed in the smart grid standardization roadmap in IEC TR 63097 [12] and completed by the IEC power utilities targeted architecture, expressed in IEC TR 62357-1 [13].

Writing such guidelines is not as such a cross cutting issue. However, ensuring its application in all entities working at extending IEC 61850, while ensuring the good level of support by IEC TC 57 is de facto cross-cutting.

The main challenges are:

- to write down the existing rules, mostly set in the mind of key experts;
- to extend the rules and associated processes to allow parallel extensions by multiple IEC (and other) entities;
- to adapt the IP and licensing rules of IEC to support code components within standards;
- to adapt the publication process to support as well code components spreading;
- to organize the evolution of core features and rules to support new domains.

This has links with the standardization case depicted in S-DER-1, which is de facto a major case of extension of IEC 61850 (refer to 5.6).

5.5.2 Description of current standardization efforts

A Technical Specification has been developed within IEC TC 57 – IEC TS 61850-1-2 [14].

5.5.3 Description of remaining standardization efforts

Some important works still remain:

- Finalize the work.
- Ensure all concerned entities apply correctly the set of proposed rules.
- Set up a transverse process to evaluate requirements coming from new domains, and adapt the rules in consequence.

5.6 S-DER-1: Promotion and expansion of IEC 61850-7-420

5.6.1 Purpose of IEC effort

IEC 61850-7-420 [15] defines the IEC 61850 information models to be used in the exchange of information with distributed energy resources (DER) and distribution automation (DA) systems, aiming at generating a new model as generic as possible.

The modelling proposal is clearly in line with the objective of harmonization between all types of DER.

Difficulties are identified in developing a generic model from the existing IEC 61850 considering all kinds of DER together with the modelling principle of the individual DER which is developed and standardized in different TCs in different perspectives.

The main standardization challenge is to harmonize DER models, whatever their type (generation, storage and loads), by sharing modelling principles with other models (especially CIM, in order also to establish a well harmonized modelling approach by design).

Addressing the above standardization challenges will imply the contribution of IEC TC 57, TC 69, TC 82, TC 88, TC 105, TC 8/SC 8A/JWG10, SC 8B, TC 120, and TC 8.

5.6.2 Description of current standardization efforts

Here is a list of already engaged standardization works:

- IEC 61850-7-420: Distributed energy resources logical nodes – including grid connection function modelling (from IEC TR 61850-90-7). A second edition is under development.
- IEC TR 61850-90-6: Use of IEC 61850 for distribution automation systems.
- IEC TR 61850-90-8: Object model for electric mobility [16].
- IEC TR 61850-90-9: Object model for electric energy storage (under development).
- IEC TR 61850-90-10: Object model for scheduling.

- IEC 61850-8-2 – SCSM – Mapping to Extensible Messaging Presence Protocol (XMPP).

NOTE For some documents listed in 5.6.2 and 5.6.3 with the description of "under development", submission is currently scheduled but may be delayed or changed due to TC- or market-related issues. This document is in line with the IEC internal publication SyCSmartEnergy/95/INF related to the content of development plan v1.3.

5.6.3 Description of remaining standardization efforts

Some important work still remains:

- Finalize IEC TR 61850-90-9 to support electrical energy storage.
- Finalize the work of issuing the second edition of IEC 61850-7-420, currently approved for CDV, and publish the IS.
- Ensure all concerned entities apply correctly the set of proposed rules.
- Ensure seamless interoperation with CIM.
- Guidelines like IEC TR 61850-7-520 and IEC TR 61850-90-15 are supposed to be drafted considering the existing issues among related TCs. Main efforts are expected to be made and organized by IEC TC 57.

5.7 S-HBES/BACS-1: Cooperation of cross TCs for DR applying to smart home and building automation systems

5.7.1 Purpose of IEC effort

The demand response (DR) management system comprises all the needed components to perform the expected demand flexibility, and is mostly made of application servers, front-end communication processors and interfaces to the DR contributor, which can be of home, building, and industry, or DER types. It may comprise the AMI (advanced metering infrastructure) itself, if the communication channel considered for getting connected to the DR contributor is the metering channel.

A close cooperation with the demand response activities is needed. Here use cases need to be defined in order to specify the scope and involvement of the different stakeholders. For example, the contribution of HBES/BACS needs to be described in order to define their share in the overall systems.

Standardization needs to address these challenges to provide multi-vendor interoperable and easy to integrate solutions for demand response (DR) management systems.

A set of profiles should be described and standardized in order to give guidelines for paths to the interoperability between distribution grid domain and customer domain.

This item relates to S-DER-1 because DR management systems will control some customer side DER.

Addressing the above standardization challenges will imply the contribution of IEC TC 13, TC 23, TC 57, TC 65, TC 100, ISO/TC 205 and ISO/IEC JTC 1/SC 25.

5.7.2 Description of current standardization efforts

A minimal data model and services for demand response (DR), pricing, and distributed energy resource (DER) communications had been specified by IEC 62746-10-1 [17]. But the CIM (Common Information Model) mapping between grid domain and customer domain is still under study.

International Standards related to this issue are listed in Table 5.

Table 5 – International Standards related to S-HBES/BACS-1

Standard	SDO	Technical body
ISO 16484-2 (BACS), -3	ISO	TC 205/WG3
IEC 62325 all parts (DR CIM) IEC 62325-451-6:2018 [18]	IEC	TC 57/WG16
IEC 61968 all parts (DCIM) IEC 61968-11 ED3	IEC	TC 57/WG14
IEC TR 62746-2 (DR use cases) [19]	IEC	TC 57/WG21
IEC 62746-10-1 (Open ADR)	IEC	PC118
IEC 62746-10-2 (CIM mapping)	IEC	TC 57/WG21
IEC 62746-10-3 (CIM-Open ADR adapter) [20]	IEC	PC118

In addition, a specific system-level activity is launched by IEC SyC SE to get a comprehensive and agreed standardization landscape related to interfaces to any Smart Grid users. This will help reaching the next steps.

5.7.3 Description of remaining standardization efforts

A close cooperation with the demand response activities is needed. Here use cases need to be defined in order to specify the scope and involvement of the different stakeholders. For example, the contribution of HBES/BACS needs to be described in order to define their share in the overall systems.

The following action plan needs to be performed.

1) Ensure mutual understanding between the concerned bodies of use cases for DR and HBES/BACS, especially where each standard locates in the system. IEC SRD 63268 [21] should help.
2) Specify the gaps within related bodies.
3) Share this assessment with corresponding bodies.
4) Revise or develop standards within the relevant bodies.

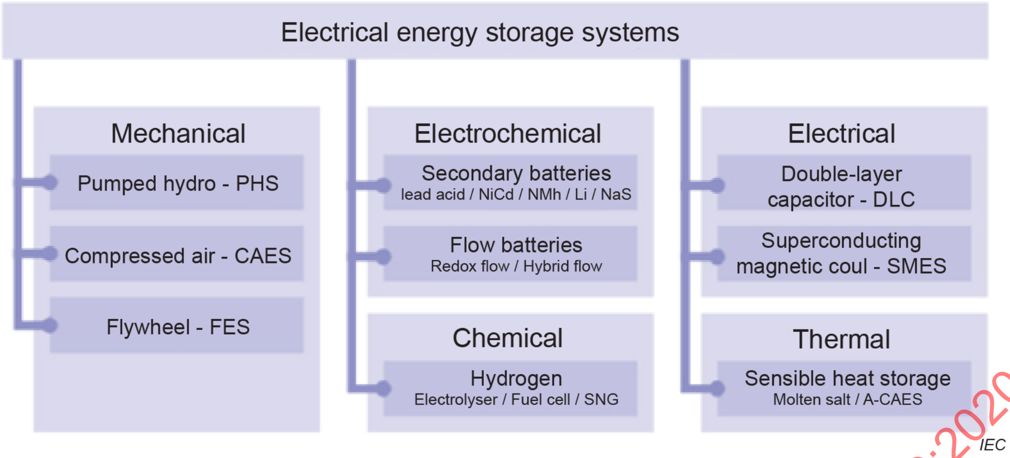
5.8 S-ES-1: Standardization for interconnection and interoperability of large and distributed energy storage

5.8.1 Purpose of IEC effort

Storage is becoming more and more important in grid management with renewable energy. Connecting and interacting with such new equipment or systems are raising new types of standardization requirements.

There are many efforts by different groups including the IEC to address the interconnection of storage with the grid. Coordinating these efforts requires understanding of both the storage characteristics and the impacts on the grid. In addition, communication requirements among all actors involved in installing, interconnecting, operating, and maintaining storage resources are critical. By this effort, we can align and construct total DER families. One main specificity of storage is that it can both generate energy and act as easily controllable load when charging. One other specificity is the rapid evolutions of this domain, both from a technological point of view and from a user point of view. As a first step, as far as modelling is concerned, IEC focuses on energy storage (ES) devices; later, it is expected to address systems that are equivalent to electric energy storage such as thermal storage, microgrids, and combinations of generation, storage and loads.

For example, Figure 3 illustrates a typical classification for storage systems according to their form of energy storage.



[SOURCE: IEC 410 White Paper Electrical Energy Storage:2011]

Figure 3 – Classification of electrical energy storage systems according to energy form

Standardization needs to address these challenges to provide multi-vendor interoperable and easy to integrate solutions for both market and grid management requirements, consistent with other generation and load management solutions.

IEC should develop an equivalent standard for connection of large and distributed storage equipment. The result should be a generic description of the necessary data models, in order to accommodate the different requirements and possibilities of large and distributed energy storage.

For large EES data model, see Annex A.

This item relates as well to S-DER-1 (5.6) because storage is "just" a kind of DER.

Addressing the above standardization challenges will imply the contribution of IEC TC 57, TC 120, TC 21, SC 21A, SC 8A, TC 69, TC 8/JWG10, TC 13, and SC 22F.

NOTE This item was originally named "Equivalent standard for connection of large and distributed energy storage".

5.8.2 Description of current standardization efforts

Most of the effort has involved working at solving modelling issues for operation (IEC 61850 domain) and standardization bridging to electrotechnical aspects (refer to S-CNC-2, 5.2).

- IEC 61427-2, *Secondary cells and batteries for renewable energy storage – General requirements and methods of test – Part 2: On-grid applications* [22]
- IEC 62933-1:2018, *Electrical energy storage (EES) systems – Part 1: Vocabulary*
- IEC 62933-2-1:2017, COR1:2019, *Electrical energy storage (EES) systems – Part 2-1: Unit parameters and testing methods – General specification* [23]
- IEC TS 62933-3-1:2018, *Electrical energy storage (EES) systems – Part 3-1: Planning and performance assessment of electrical energy storage systems – General specification* [24]
- IEC TS 62933-4-1:2017, *Electrical energy storage (EES) systems – Part 4-1: Guidance on environmental issues – General specification* [25]
- IEC TS 62933-5-1:2017, *Electrical energy storage (EES) systems – Part 5-1: Safety considerations for grid-integrated EES systems – General specification* [26]
- IEC TR 61850-90-9:–[1], *Communication networks and systems for power utility automation – Part 90-9: Use of IEC 61850 for electrical energy storage systems*

1 Under preparation. Stage at the time of publication: IEC DTR 61850-90-9:2109.

- IEC 61850-7-420:–[2], *Communication networks and systems for power utility automation – Part 7-420: Basic communication structure – Distributed energy resources logical nodes*
- IEC 62933-5-2:2020, *Electrical energy storage (EES) systems – Part 5-2: Safety requirements for grid integrated EES systems – Electrochemical based systems*

5.8.3 Description of remaining standardization efforts

- Provide storage requirement inputs to DERMS.
- Extend modelling activities to CIM.
- Extend to e-mobility.

5.9 G-C-7: Support for the long-term interoperability of IPv4 and IPv6

5.9.1 Purpose of IEC effort

The Internet Protocol version 6 (IPv6) is the most recent version of the Internet Protocol (IP), the communications protocol that provides an identification and location system for computers on networks and routes traffic across the Internet. IPv6 was developed by the Internet Engineering Task Force (IETF) to deal with the long-anticipated problem of IPv4 address exhaustion. IPv6 is intended to replace IPv4, and communication networks are gradually shifting to use IPv6 rather than IPv4.

IPv6 provides other technical benefits in addition to a larger addressing space. In particular, it permits hierarchical address allocation methods that facilitate route aggregation across the Internet, and thus limit the expansion of routing tables. The use of multicast addressing is expanded and simplified, and provides additional optimization for the delivery of services. Device mobility, security, and configuration aspects have been considered in the design of the protocol.

However, this shift will take time and many networks will need to support IPv4 and IPv6 simultaneously. The two protocols were not designed to be interoperable, complicating the transition to IPv6. Several IPv6 transition mechanisms have been devised to permit communication between IPv4 and IPv6 hosts, but these did not necessarily meet the availability, reliability, and performance requirements of power system operations.

For the power industry, this necessitated the review and study of possible solutions that would meet these availability, reliability and performance requirements.

- IEC TR 61850-90-12 raised the issues of IPv4 transition to IPV6 [27].
- IEC TR 62357-200:2015 [28] was developed to address the issues.

5.9.2 Description of current standardization efforts

IEC TR 62357-200:2015 [28] applies to information exchange in power systems including, but not restricted to, substations, control centre, maintenance centre, energy management systems, synchrophasor-based grid stability systems, bulk energy generation, distributed energy generation (renewables), energy storage, and load management.

It addresses the issues encountered when migrating from Internet Protocol version 4 (IPv4) to Internet Protocol version 6 (IPv6). It describes migration strategies, covering impact on applications, communication stack, network nodes, configuration, address allocation, cyber security and the related management. IEC TR 62357-200:2015 considers backward compatibility and shows concepts as well as necessary migration paths to IPv6 from IPv4 where necessary, for a number of protocols in the IEC 61850 framework.

5.9.3 Description of remaining standardization efforts

No further standardization efforts are needed, since IEC TR 62357-200 [28] addresses the IPv4/IPv6 issues.

[2] Under preparation. Stage at the time of publication: IEC CDV 61850-7-420:2020.

5.10 G-S-5: Guidelines of smart energy cyber security requirements

5.10.1 Purpose of IEC effort

Given the complexity of business processes and the wide variety of cyber assets used in the smart energy environment, no single cyber security existing standard can address all security requirements, security controls, resilience strategies, and technologies. Some standards and guidelines are focused on the high level organizational security requirements and more detailed recommended controls (What), while other standards focus on the technologies that can be used to supply these cyber security controls (How).

While many additional documents and regulations are applicable to national and local regions, the key IEC, ISO, IEEE, NIST, and Internet-based cyber security standards and best practices should be identified, while their coverage, gaps, and overlaps should be described.

Since cyber security standards have been developed by different organizations, getting a common understanding by security experts of the purposes and meanings of these standards is very challenging.

In addition, most non-cybersecurity experts do not understand these cyber security requirements very well.

The main challenge is to clearly describe the issues around cyber security for smart energy operations and to provide guidelines for how best to use the cyber security standards, especially coming from ISO/IEC JTC 1/SC 27, IEC TC 57 WG15, IEC TC 65C, SyC SE WG3 cyber security task force, NIST, IETF, etc. The key standards and guidelines are shown in Figure 4.

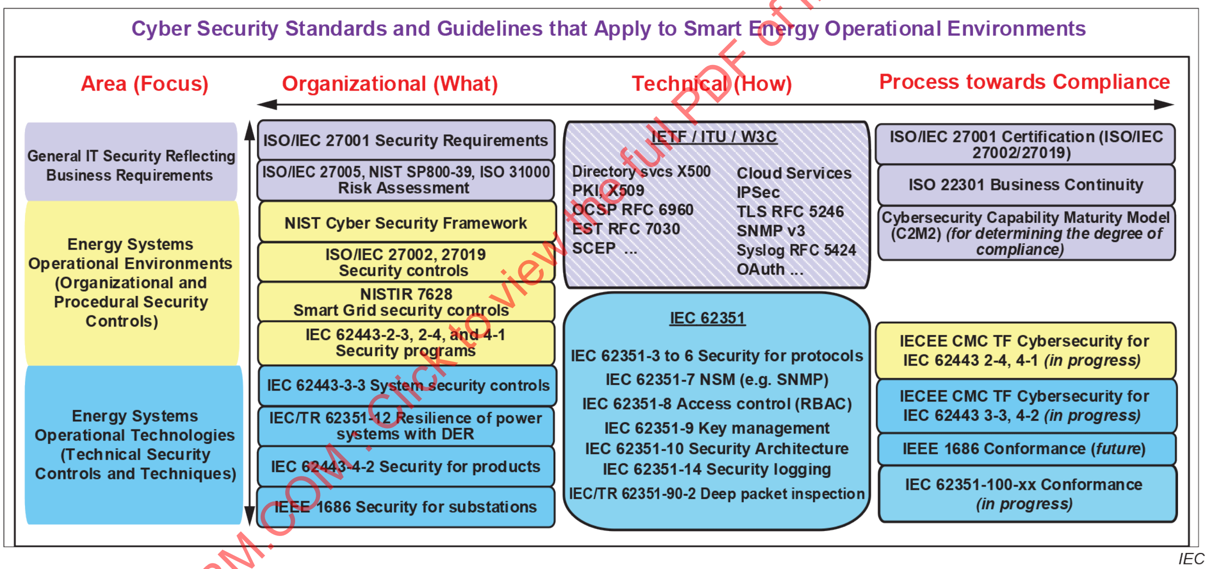


Figure 4 – Key cyber security standards and guidelines

5.10.2 Description of current standardization efforts

- Executive summary of cyber security and resilience guidelines for the smart energy operational environment (Phase 1).
- Detailed assessment of cyber security and resilience standards for the smart energy operational environment (Phase 2).

5.10.3 Description of remaining standardization efforts

Some important work still remains:

- Complete Phase 1 and Phase 2 documents.
- Publish for free at least Phase 1.
- Identify for the SyC SE gaps and conflicting overlaps.
- Determine what other cyber security cross-cutting efforts could or should be undertaken.
- Interact with ACSec, TCs, and other IEC groups on their cyber security efforts and interests for future work.

5.11 S-AM-1&New Extension of SGAM smart energy grid reference architecture

5.11.1 Purpose of IEC effort

The concept of SGAM, introduced by the CEN-CENELEC-ETSI Smart Grid Coordination Group (refer to [29]), has already been disseminated widely as a well-known concept, but there was no official definition. And recently, interactions between Smart Grid systems and heat/gas systems are becoming increasingly necessary. Therefore, an official definition of SGAM and its expansion to potentially include heat/gas systems is required.

An official definition of SGAM should be provided by SyC Smart Energy as a Systems Reference Deliverable, associated with a formal ontology provided in a textual format as well as with code components.

The work will be conducted so that generic elements that could be used by different domains are separated from the specific application of the generic elements to the smart energy grid domain.

All eleven standard development items are related to this item because they are for the Smart Grid standardization activities, and the SGAM may be of relevant use to describe their standardization cases.

The Smart Grid Coordination Group in CEN-CENELEC-ETSI is closely related to this standardization because SGAM was designed and defined by them. IEC TC 57 is also closely related because it provided the roadmap document (IEC TR 63257-1 [13]) and showed the components of Smart Grid. IEC TC 1, TC 3, TC 8, TC 65 and TC 120 are also related, as are other IEC systems committees such as AAL, Smart Cities and Smart Manufacturing.

5.11.2 Description of current standardization efforts

The Smart Energy Grid Architecture Model (SGAM) is a three-dimensional architectural framework (see Figure 5) that can be used to model the exchange of information between different entities located within the smart energy arena. The three dimensions are domains, zones, and layers.

- Domains identify a set of roles associated with five different areas of the energy grid: bulk generation, transmission, distribution, distributed energy resources, and customer.
- Zones represent the six hierarchical levels of power system management: market, enterprise, operation, station, field, and process.
- Layers represent the five aspects of information exchanges: business objectives, functional processes, information models, communication protocols, and components.

The primary focus of the SGAM is on interoperability, since the exchange of information is the key to the smart energy grid. However, the SGAM can be used for many different purposes involving interoperability, including:

– use cases, by identifying where the various roles, systems, and information exchanges take place within the three-dimensional SGAM structure;

– standards development, by assigning different types of information exchange standards to the areas that they are designed for, which may facilitate a better coordination between entities, solving potential overlaps and gaps;

– architectures, by identifying the portions of the three dimensions that are applicable to the architecture of interest;

– implementations, by designating the different interactions between different systems within different domains at different layers.

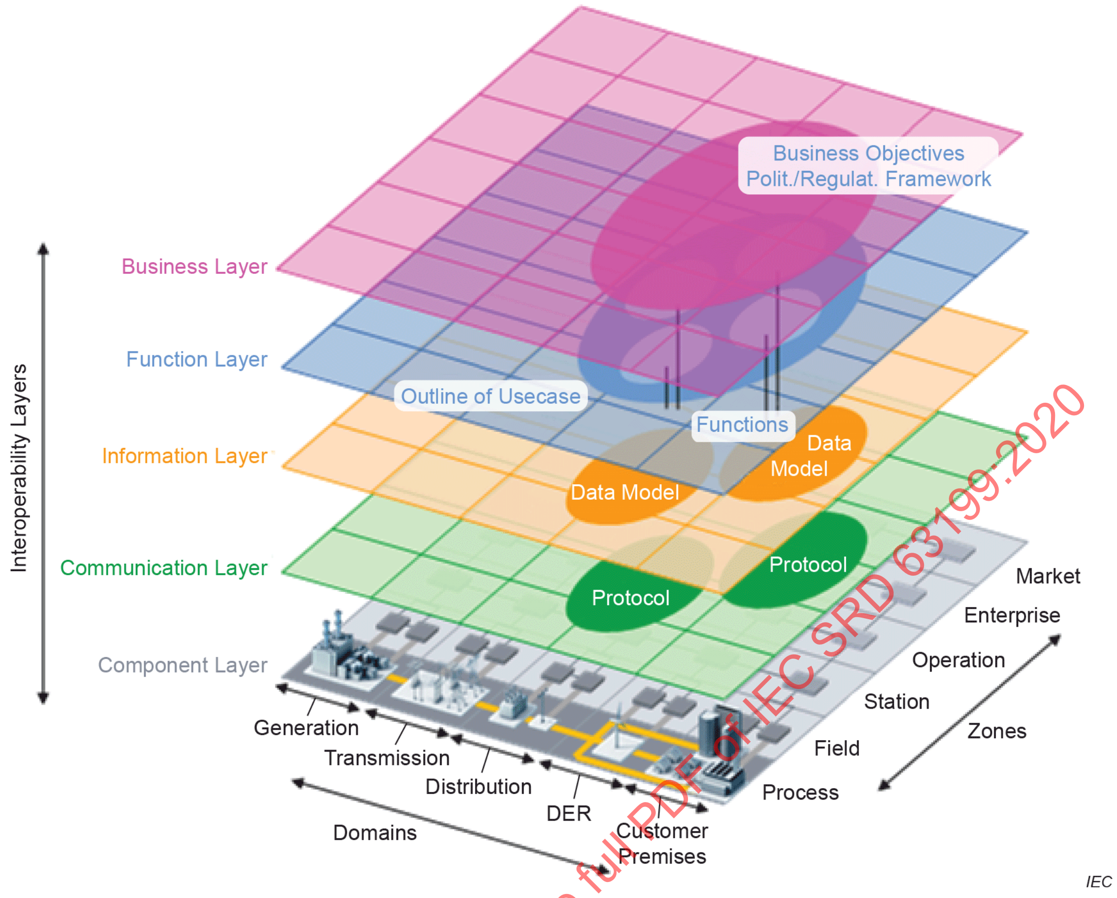


Figure 5 – The SGAM framework

The extension of SGAM for the interaction in the areas of heat and gas has started.

In order to describe the smart energy grid architecture, two kinds of energy interactions, such as (a) energy and information flows between the grid and heat, and (b) energy and information flows between the grid and gas, need to be represented within a single framework. One of the methods is to prepare (a) a heat model plane and (b) a gas model plane, to describe each architecture on each plane, and also to describe the interactions among those three different types of energy resources.

This extended component layer is shown in Figure 6.