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Edition 1.0 2019-05

SYSTEMS REFERENCE DELIVERABLE

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Generic smart grid requirements –
Part 2-1: Grid related domains

IEC SRD 62913-2-1:2019-05(en)

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Generic smart grid requirements – Part 2-1: Grid related domains

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GENERIC SMART GRID REQUIREMENTS –

Part 2-1: Grid related domains

FOREWORD

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IEC SRD 62913-2-1, 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/78/DTS	SyCSmartEnergy/96/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.

A list of all parts in the IEC SRD 62913 series, published under the general title *Generic smart grid requirements*, can be found on the IEC website.

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- withdrawn,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

Under the general title *Generic smart grid requirements*, the IEC SRD 62913 series consists of the following parts:

- *Part 1: Specific application of the Use Case methodology for defining generic smart grid requirements according to the IEC systems approach*;
- Part 2 is composed of 5 subparts which refer to the clusters that group several domains:
  – *Part 2-1: Grid related domains* – these include transmission grid management, distribution grid management, microgrids and smart substation automation;
  – *Part 2-2: Market related domain*;
  – *Part 2-3: Resources connected to the grid domains* – these include bulk generation, distributed energy resources, smart home / commercial / industrial / DR-customer energy management, and energy storage;
  – *Part 2-4: Electric transportation related domain*;

The IEC SRD 62913 series refers to 'clusters' of domains for its different parts so as to provide a neutral term for document management purposes simply because it is necessary to split in several documents the broad scope of smart energy.

The purpose of the IEC SRD 62913-2 series is to initiate the process of listing, organizing, making available the Use Cases which carry the smart energy requirements that should be addressed by the IEC core technical standards. The IEC's systems approach will require adapted tools and processes to facilitate its implementation, and until they are available to IEC technical committees, National Committees and experts, the IEC SRD 62913-2 series should be seen as an illustration and the first stepping stone towards this systems approach implementation. Referencing, naming and grouping Use Cases or requirements will be further developed when tools such as IEC Use Case repository are available (using SGAM and other classification methods). The current content of the IEC SRD 62913-2 series is not exhaustive, but the current content illustrates the priorities for the smart energy domain at the time of publication. It is important that the content in terms of Use Cases, roles and requirements continues to grow to encompass the requirements of the broad smart energy stakeholders (both within the IEC community and more generally the other market stakeholders).

Use Cases are, for now, classified as follows.

- For business Use Cases: SGAM Domain {G|T|D|DER|CP} (multiple domains possible) / B_{Business Use case number}/SB_{ sub BUC Use case number/…}
- For system Use Cases: SGAM Domain {G|T|D|DER|CP} (multiple domains possible) / (sub) Business use Case Ref /S_{ System Use cases number}/SS_{ Sub System Use cases number/…}

The document for each domain is composed as follows.

- Purpose and scope.
- Business analysis: to address the domain's strategic goals and principles regarding its smart grid environment. It also lists business Use Cases and system Use Cases identified, their associated business roles and system roles (actors) and the simplified role model highlighting main interactions between actors.
- Generic smart grid requirements: extracted from Use Cases described in Annex B.
- Annex A lists links between domains and technical committees.
- Annex B includes a complete description of Use Cases per domain based on IEC 62559-2.
- Bibliography.

This document is based on the inputs from domain experts as well as existing materials in a smart grid environment.

GENERIC SMART GRID REQUIREMENTS –

Part 2-1: Grid related domains

1 Scope

This part of IEC SRD 62913 initiates and illustrates the IEC's systems approach based on Use Cases and involving the identification of generic smart grid requirements for further standardization work for grid related domains – i.e. grid management regrouping: transmission grid management, distribution grid management, microgrids and smart substation automation domains – based on the methods and tools developed in IEC SRD 62913-1.

The Grid management domain groups Use Cases and associated requirements common to the EHV, HV and MV/LV networks operations and the business analysis of the general electric network life cycle. Use Cases specific to parts of the general electric network are described in transmission grid management, distribution grid management, microgrids and smart substation automation clauses.

This document captures possible "common and repeated usage" of a smart grid system, under the format of "Use Cases" with a view to feeding further standardization activities. Use Cases can be described in different ways and can represent competing alternatives. From there, this document derives the common requirements to be considered by these further standardization activities in term of interfaces between actors interacting with the given system.

To this end, Use Case implementations are given for information purposes only. The interface requirements to be considered for later standardization activities are summarized (typically information pieces, communication services and specific non-functional requirements: performance level, security specification, etc.).

This analysis is based on the business input from domain experts as well as existing material on grid management in a smart grid environment when relevant. Table 1 highlights the domains and business Use Cases described in this document.

Table 1 – Content of IEC SRD 62913-2-1:2019

Domain	Content	Scope
Grid management	Described with 1 business Use Case	Asset management
Transmission grid management	n/a	
Distribution grid management	Described with 1 business Use Case and 2 system Use Cases	Network operations in real time using new automations / centralized voltage control
Microgrids	Described with 1 business Use Case	
Smart substation automation	Described with 1 business Use Case	

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
flexibility
modification of electricity injection and/or extraction, on an individual or aggregated level, in reaction to an external signal in order to provide a service within the energy system

Note 1 to entry: This definition is based on Eurelectric, Active Distribution System management. A key tool for the smooth integration of distributed generation, 2013.

3.1.2
grid
electrical power system through which power is generated, transmitted, and distributed to the end user

3.1.3
electrical network constraint
network state where the operation requirements are locally not met and which depends on the split between injection and withdrawal, the network topology and random event in a specific area of the distribution network (faults, transmission limitation or transmission outage, and load transfers)

[SOURCE: based on evolvDSO, D2.1 Business Use Cases Definition and Requirements, 2014]

3.1.4
on-load tap-changer
OLTC
switch group allowing transformer tappings to be changed without interrupting the traction circuits

[SOURCE: IEC 60050-811:2017, 811-29-28]

3.1.5
optimization levers
operational solutions or measures to be used by a system operator to operate its network in an optimized way

Note 1 to entry: The access and use of optimization levers, especially those related to flexibilities connected to HV/MV/LV networks, should be coordinated between the system operators operating in the same zone in order to ensure a technical and economic optimum.

Note 2 to entry: Some levers have a global impact on network operations, while others have a localized impact.

Note 3 to entry: Three categories of levers are defined:

– technical levers (HV or MV network reconfiguration, bus-bar voltage regulation in primary substation, etc.);
– market-based and contracted flexibilities for the system operator needs – to be further defined in close coordination with transmission grid management, distribution grid management and market domains;
– emergency levers (targeted power limitation, load-shedding, etc.).

Note 4 to entry: Emergency levers are only used if no other optimization levers are available.

Note 5 to entry: Optimization criteria may embrace many criteria, such as OPEX optimization, CAPEX optimization, customer satisfaction, regulation compliance, environmental impacts, company awareness, etc.

[SOURCE: based on evolvDSO, D2.1 Business Use Cases Definition and Requirements, 2014]

3.1.6
quality of service
collective effect of service performance which determines the degree of satisfaction of a user of the service

Note 1 to entry: The quality of service is characterized by the combined aspects of service support performance, service operability performance, serveability performance, service integrity and other factors specific to each service.

Note 2 to entry: ISO defines "quality" as the ability of a product or service to satisfy user's needs.

[SOURCE: IEC 60050-191:1990, 191-19-01]

3.1.7
security
<of an electric power system> ability to operate in such a way that credible events do not give rise to loss of load, stresses of system components beyond their ratings, bus voltages or system frequency outside tolerances, instability, voltage collapse, or cascading

Note 1 to entry: In the context of smart grid the term 'security' may be too vague. In this document it may be replaced by 'operational reliability' or 'operational security' to reflect the real practices of, for example, NERC or ENTSO-E.

[SOURCE: IEC 60050-191:1990/AMD1:1999, 191-21-03]

3.1.8
work programme
schedule for operations related to the creation, maintenance, and repair of network assets on the transmission or distribution grid

[SOURCE: evolvDSO, D2.1 Business Use Cases Definition and Requirements, 2014]

3.2 Abbreviated terms

BRP	Balance Responsible Party
CAPEX	CAPital EXpenditure
DER	Distributed Energy Resources
DGA	Dissolved Gas Analysis
DMS	Distribution Management System
DR	Demand-Response
DSO	Distribution System Operator
EES	Electrical Energy Storage
EHV	Extremely High Voltage
EV	Electric Vehicle
FCR	Frequency Control Reserve
FLISR	Fault Location, Isolation, and Service Restoration
FPI	Fault Passage Identification
FRR	Frequency Restoration Reserve
HV	High Voltage

HVDC	High Voltage Direct Current
IED	Intelligent Electronic Device
ICT	Information and Communication Technologies
LV	Low Voltage
MEMS	Microgrid Energy Management System
MV	Medium Voltage
OPEX	OPerational EXpenditure
RR	Restoration Reserve
RTU	Remote Terminal Unit
SCADA	Supervisory Control And Data Acquisition System
SGAM	Smart Grid Architecture Model
TSO	Transmission System Operator

4 Grid management

4.1 Purpose and scope

4.1.1 Objective

The purpose Clause 4 is to present a business analysis of the grid management, and more specifically to describe some smart grid requirements using the Use Case approach as defined in IEC SRD 62913-1.

This analysis is based on existing materials, including user stories, set of Use Cases, and architectures.

4.1.2 Informative general context of grid management

4.1.2.1 General context and challenges facing grid management domains

Grid management domains today face several challenges, which tend to significantly change the way their actors operate. These challenges are the following:

- a continuous growth of the peak load in most countries, both at system and local levels, and in some cases the increase of the annual demand for electricity;
- the integration of a fast growing number of distributed energy resources (DER), mostly connected to MV/LV networks, variable and uncertain by nature;
- new and changing usages of electricity, with the development of demand response (DR), the growth of electric vehicles (EV), the implementation of energy demand management policies and customer empowerment initiatives;
- the evolution of electricity markets and the creation of new ones, such as flexibility and ancillary services markets, which tend to operate ever closer to real time;
- modifications in the regulatory frameworks and the strong expectations from regional and national regulatory authorities, which aim at managing or facilitating these transformations with the overall goal of promoting a sustainable, secure, and competitive energy supply;
- technological developments and innovations, which represent both opportunities and constraints for the different actors and stakeholders of the electric power system;
- development of individual and/or collective strategies of electrical grid users (or sets of electrical grid users) in relation with the electricity management, possibly leading to unexpected behaviour changes;
- increased cyber-threats impacting the grid operation, made possible by the increased use of “public” telecommunication means or technologies.

These changes and their combination contribute to transform in depth system operators. They have already started to and will continue to impact their business model and business processes.

4.1.2.2 The responsibilities of system operators in a changing environment

As indicated above, there are different types of networks: EHV, HV, MV, and LV networks and different boundaries between voltage levels which vary from country to country and system to system. MV/LV networks are generally operated with a radial grid topology, while EHV and HV networks are mainly operated with a mesh grid topology. They are usually operated by different system operators:

- Transmission system operators generally operate EHV and in some cases HV networks.
- Distribution system operators generally operate MV and LV networks, and potentially HV networks as well depending on the system.

Concerning the roles, the terms EHV, HV, and MV/LV system operators are used in this document.

System operators' responsibilities have fundamentally not been modified by the challenges facing the electric power system. Their core duties remain to develop, operate and maintain the network in order to deliver high-quality services to grid users and other stakeholders of the electric power system, while ensuring safety of people, most efficient use of assets, and system security. Each system operator remains responsible for managing the constraints of its own network (voltage regulation, reactive power, power quality, etc.). The coordination of the frequency remains in the hands of the transmission system operators in close cooperation with the other TSOs and all other actors connected on the same frequency area. More recently, the contribution to the transition towards a sustainable economy has emerged as an additional mission of system operators, along with other actors of the electric power system. These responsibilities are shared by all system operators and do not vary according to regional and national regulations or market models – only the way they exercise those may differ from one country to another and one system operator to another.

However, the challenges previously stated have a strong impact on the capacity of system operators to carry out their responsibilities. More precisely, they impact the way they design, operate, and maintain their networks. The integration of variable and uncertain generation capacities, combined with increased peak demand as well as other key factors, tends to intensify the need for network reinforcements and add complexity to the supervision and control of the electrical grid. These consequences may ultimately undermine system operators' ability to provide electrical grid resiliency, reliability of supply and quality of service in a cost-effective way.

The impact of these challenges may be different for system operators, depending on the network(s) they are responsible for managing.

The topology has consequences on the nature and criticality of the impacts induced by the challenges stated above, but also on the methods and tools used by system operators to manage their electrical grid.

For instance, the development of electric vehicles and the associated deployment of public and private EV charging stations will mostly have a significant impact on LV networks, to which they are connected.

Operational planning activities have already been developed in most systems for HV networks and implemented by EHV and HV system operator, while they have generally not been developed for MV/LV networks management.

4.1.2.3 The current design of electricity networks, its limits, and new possibilities

EHV, HV and MV/LV system operators have historically designed and operated their network according to a “networks follow demand” paradigm, by delivering energy flows in one direction from EHV centralized generations to the end users. Up until now, EHV, HV and MV/LV system operators prevented local constraints (function of protection systems, overcurrent, voltage limits) and congestions by planning network investments and adjusting the configuration of the electrical grid, in order to accommodate energy flows and meet peak loads. This method is known as the “fit and forget” approach as potential operational problems are solved in the planning phase.

Nonetheless, increased penetration of DER – which are in majority connected to the MV/LV network –, the rise of peak demand, and the development of new usages such as demand response programmes or electric vehicles, contribute to dramatically transform the power grid. Power flows are indeed operating in two directions and between a growing number of connected actors and devices. They become as a result less predictable. If the “network follows demand” approach does not require sophisticated control and supervision systems, it implies substantial network investments to integrate high shares of variable generation/load capacities and absorb peak demand, which constitutes one of the major drivers for network costs. With the transformations previously stated, connection costs and delays will potentially significantly rise as the extension and the maintenance of the networks are becoming more complex. Besides, the variability of power flows will increase the need for improved real-time monitoring and control tools. Such investments will turn out to be too heavy to be borne by system operators, customers, or decentralized producers.

Besides, constraints will occur more frequently, and are likely to be more critical and more complex to manage at both local and system levels (Eurelectric, 2013, ENTSO-E). More particularly, the occurrence, duration, and depth of faults, variations in voltage, and network perturbations such as flickers will continuously increase. Congestions or bottlenecks, which may lead to generation feed-in or supply interruptions, will also appear more frequently. The growing number and diversity of production and consumption installations connected to the MV/LV grid will heighten the variability of power flows and increase the system frequency variability. Ensuring grid connection and access and restoring power supply after a fault on the network will therefore become more complex and require more precaution and time.

As traditional means will no longer be technically sufficient or economically viable, EHV, HV and MV/LV system operators need to find new solutions to continue ensuring quality and security of supply at an affordable cost and in a non-discriminating way. In addition to necessary investments on the network, the transformations previously stated urge the need for the development of a more active system management approach. This approach, opposed to the purely passive one previously described or a ‘reactive’ one consisting of managing problems only in the operational phase, would allow for interaction between the network’s different timeframes (Eurelectric, 2013):

- planning and connection, with a range of network planning and access options enabling EHV, HV and MV/LV system operators to optimize their investments and the most efficient use of network assets – including decisions regarding asset renewal priorities and maintenance programmes optimization;
- operational planning, with technical tools allowing EHV, HV and MV/LV system operators to prepare network operations in advance;
- real-time operations, with the optimization of demand and generation management and improved handling of emergency and fault situations;
- evaluation and ex-post control, to facilitate electricity markets via data management and provision, but also to improve network planning and operation processes using processed data.

It includes business Use Cases and system Use Cases related to:

- the long-term planning and development of the electricity system, including connection and access;