IEC SRD 63268

Edition 1.0 2020-10

SYSTEMS REFERENCE DELIVERABLE

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Energy and data interfaces of users connected to the smart grid with other smart grid stakeholders – Standardization landscape

IEC SRD 63268:2020-10(en)

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INTERNATIONAL
ELECTROTECHNICAL
COMMISSION

ICS 29.020, 29.240

ISBN 978-2-8322-8995-2

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

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

Draft SRD	Report on voting
SyCSmartEnergy/136/DTS	SyCSmartEnergy/144/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- withdrawn,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

One of the main impacts of the smart grid and/or the smart energy grid is the increasing interactions between the grid users and the other energy-related stakeholders.

The main driver remains the introduction of renewables to the grid which makes the grid operation much more complex, but other drivers are also the consequences of the digitalization trend and the coupling with energy efficiency and greener energy trends.

All these new interactions and trends make the interface between grid users and the other stakeholders more complex, and it is the ambition of this document is to build this new landscape.

It is in some way very close to the objective of the IEC TR 63097 [1] smart grid standardization roadmap, with however a clear focus on the area related to interfacing the grid users, and also the objective to map the roles of the different IEC entities coping with this objective.

This document aims as well at providing an entry point for solving the situation 7. S-HBES/BACS-1 of the IEC SRD 63199 SyC Smart Energy development plan established by the IEC SyC Smart Energy WG 2.

As decided in the Worcester joint IEC SyC SE WG 2/WG 3 meeting, in June 2018, addressing this point will need to get a global landscape of the grid user interface, and restricted neither to demand-response type of interface (which is just one type of interface) nor to home and buildings (except for the internal implementation of DER unit hosted within this grid user, all interfaces seem common to all types of grid user).

It will serve as well the IEC TR 63097 roadmap update but will also be a source for the SGAM (IEC SRD 63200 [2]) currently under development by the IEC SyC SE WG 6.

ENERGY AND DATA INTERFACES OF USERS CONNECTED TO THE SMART GRID WITH OTHER SMART GRID STAKEHOLDERS – STANDARDIZATION LANDSCAPE

1 Scope

This document depicts a comprehensive standardization landscape of the interfaces between the main grid stakeholders and the grid users, grid users comprising DERs and Customer Premises.

This document considers the main "physical" and "logical" interactions (i.e. through wires/functions – power and/or communication) between grid users and grid stakeholders, both from an electrical standpoint and from a data standpoint. Then for each interaction type, the document presents the standardization landscape.

This document depicts, as well, the interactions between the grid stakeholders manipulating grid user related data, themselves. Effectively it appears that considering the sole landscape of the interfaces between the grid users and the grid would be very limited without considering the way the data attached to grid users are manipulated/managed within and between the different stakeholders holding these data. Providing a seamless vision of the management of these data is becoming of highest priority.

The document focuses exclusively on Distribution grid users, excluding as such "bulk generation" grid users and "transmission connected grid users", the main reason being that the main breakthrough resulting from the introduction of distributed energy resources affects mostly the Distribution grid users.

This document mostly focuses on establishing the standardization landscape for the considered domain, including the IEC entities involved in producing reports, technical specifications and standards related to it. From this assessment a first set of recommendations is issued related to the way IEC addresses this scope.

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
grid user
entity physically connected to the distribution or transmission grid (in SGAM sense, i.e. connected to an actor attached to the Distribution domain or Transmission domain) to consume, produce or store energy, either as a primary goal to interact with the grid stakeholders or as a means to run a process

Note 1 to entry: This document only considers Distribution grid users.

EXAMPLE 1 Typical grid user having as primary goal to interact with the grid stakeholders: entity of the DER SGAM domain such as a DER plant.

EXAMPLE 2 Typical grid user not having as primary goal to interact with the grid stakeholders and running its own process: entity of the Customer Premises SGAM domain such as homes, buildings, industries and infrastructures.

3.2 Abbreviated terms

AMI	automatic metering infrastructure
BRP	balance responsible party
CEM	customer energy manager
CHP	combined heat and power
CSMS	charging stations management system
CSO	charging stations operator
DER	distributed energy resource
DERMS	distributed energy resource management system
DMS	distribution management system
DR	demand-response
DSO	distribution system operator
EMC	electro-magnetic compatibility
EMS	energy management system
EMSP	e-mobility service provider
ERP	enterprise resource planning
EV	electric vehicle
EVSE	electric vehicle supply equipment
H&B	home and building
HVAC	heating, ventilation and air-conditioning
JTC	joint technical committee
LAN	local area network
LNAP	local network access point
MDM	meter data management
NNAP	neighbourhood network access point
PV	photovoltaic
SC	subcommittee
SCADA	supervisory, control and data acquisition
SDO	standards development organization
SGAM	smart energy grid architecture model
SBP	strategic business plan
SRD	systems reference deliverable
SyC SE	systems committee Smart Energy

TC	technical committee
TF	task force
TSO	transmission system operator
VPP	virtual power plant
V2G	vehicle-to-grid
WAN	wide area network

4 Executive summary

4.1 General

Interfacing the grid users requires consideration of many kinds of interfaces, with many links linking them together, and where consistency is key.

This document concludes with many needed improvements on how IEC addresses the situation, unfortunately with a too much siloed approach. It lists a series of recommendations for better supporting the domain, and especially by better bridging some IEC activities. This appears to be a prerequisite for reaching the needed consistency between all IEC productions and limiting overlaps and different ways for treating the same subjects.

4.2 IEC entities involvement summary

4.2.1 General

Table 1 below summarizes the main IEC entities involved in managing grid user related interfaces, sorted by type of interface (refers to the interactions breakdown exposed in 5.4).

Cybersecurity is fully part of the considered interfaces, however this aspect is not treated in this document but fully addressed in IEC Technology Report "Cyber security and resilience guidelines for the smart energy operational environment" [9][1]. All references to cybersecurity standardization activities or standards are thus voluntarily omitted.

NOTE The standards related to non-specific cross-cutting technologies such as EMC, quality, safety, security, low layers communication protocols, are not considered in this approach. They can be found in the IEC TR 63097 [1] roadmap document.

1 Numbers in square brackets refer to the Bibliography.

Table 1 – Summary of IEC entities involved in supporting interfaces of smart grid users

IEC entities	Utility interfaces (Annex A)	DER grid users for operation purpose (B.3.2)	H&B grid users for operation purpose (B.3.3)	Industry grid users for operation purpose (B.3.4)	Multi-owner microgrid for operation purpose (B.3.5)	Market places interfaces (Annex D)	Service providers and energy metering interfaces (Annex C)
IEC TC 8/SC 8A	X				X		
IEC SC 8B	X				X		
IEC TC 13							X
IEC TC 23, SC 23K			X		X		
IEC TC 57 WG 13/ WG 14	X					X	X
IEC TC 57 WG 16						X	X
IEC TC 57 WG 17	X	X	X	X	X		
IEC TC 57 WG 21		X	X	X	X		X
Ex – IEC PC 118 [a]		X	X	X	X		X
IEC TC 64	X		X		X		
IEC TC 65				X			X [b]
IEC TC 69	X						
IEC TC 69/TC 57 JWG 11		X	X	X	X		
IEC TC 82	X						
IEC TC 88	X				X		
IEC TC 120	X				X		
IEC TC 88/TC 57 JWG 25		X			X		
IEC TC 100			X				
ISO/IEC JTC 1/SC 25			X		X		
ISO/IEC JTC 1/SC 41							X [b]

[a] IEC PC 118 was disbanded end of 2018.

[b] Especially when considering the coming delivery of the IEC TC 65–ISO/IEC JTC 1/SC 41 JWG 17 work.

4.2.2 Main gaps

This list of gaps and their ranking will be developed in a future edition of IEC SRD 63268, logically worked after the publication of this document.

4.2.3 Standardization entity coordination improvement

The detailed assessment provided in Annex A to Annex E helps identifying some needed coordination between entities working on the same areas or having de facto common interfaces.

The list below sums up the results of this assessment but also suggests recommendations for a more consistent standardization approach of the domain. A few of them are marked with a "high importance" statement, for these cases these interactions are considered as essential for the production of a consistent set of standards.

1) Coordination between TC 57 WG 13/WG 14 and TC 57 WG 17 mostly around a common modelling approach of DER from both IEC CIM and IEC 61850 [22] sides. A joint TF is effectively already in place under IEC TC 57 WG 19 aiming at reaching that goal (results should be formalized in IEC 62361-102).
2) Coordination between TC 8/SC 8A/SC 8B and TC 95 on grid codes related functions, especially in frequency measurements. Already in place through the IEC TC 8/TC 85 JWG 12 (joint as well with TC 85 and SC 77A).

3) Coordination between TC 8/SC 8A/SC 8B and TC 57 WG 17 on grid codes functions. This would need a better formalization, although some informal exchanges have already taken place.

4) Coordination between TC 8/SC 8A/SC 8B. Already in place and formalized in the IEC TC 8 SBP.

5) Coordination between TC 8/SC 8A/SC 8B and TC 64, TC 82, TC 88, TC 120, TC 69 on Grid code implementation and other grid connection requirements. This coordination process has started with the establishment of the IEC TC 8 JWG 10 joint with TC 120, TC 82, the other TCs being in the process of setting up equivalent liaisons.

6) Coordination between TC 57 WG 21, TC 57 WG 17 activities dealing with demand-response and flexibilities. In that respect the border between the usage of IEC CIM and the usage of IEC 61850 [22] seems very difficult to position, and thus it is more likely to have both modelling techniques supporting the same features. Joint meetings between these 2 bodies took place, however the consistency of their deliveries together with the points addressed in Annex A would need a real formalization.

7) Coordination between TC 88/TC 57 JWG 25 and TC 57 WG 17. Some joint meetings were set up and are still to be encouraged.

8) Coordination between TC 69/TC 57 JWG 11 and TC 57 WG 17. Quite active liaisons are already in place with cross reporting and contribution. However, JWG 11 still suffers from a lack of representative of experts reflecting the DER aspect of the EV. The problem is known and mitigation should take place to overcome the issue.

9) High importance. Coordination between TC 57 WG 21, TC 57 WG 17 activities and the SC 23K and ISO/IEC JTC 1/SC 25 dealing with demand-response and flexibilities. This would need to be set up.

10) High importance. Coordination between TC 69/TC 57 JWG 11 and SC 23K and ISO/IEC JTC 1/SC 25, to facilitate the integration of EV and its charging system into a HBAC/HBES.

11) Coordination between TC 57 WG 21, TC 57 WG 17 to consider hierarchical approach of DERs/microgrids. Already engaged – refer to 6).

12) Coordination between TC 57 WG 21, TC 57 WG 17 and the SC 23K and ISO/IEC JTC 1/SC 25 dealing with operating flexibilities inside the building. This would need to be set up – refer to 9).

13) High importance. Coordination between TC 57 WG 21, TC 57 WG 17 activities and the IEC TC 65–ISO/IEC JTC 1/SC 41 JWG 17 and dealing with demand-response and flexibilities. This would need to be set up.

14) Coordination between TC 69/TC 57 JWG 11 and TC 65, to facilitate the integration of EV and its charging system into industrial process control systems.

15) Coordination between SC 8B and TC 88/TC 57 JWG 25 on operating wind farms in microgrids.

16) Coordination between SC 8B and TC 57 WG 17 on operating DERs in microgrids.

17) High importance. Coordination between SC 8B and TC 69/TC 57 JWG 11 on operating EVs in microgrids.

18) Coordination between TC 57 WG 13/WG 14 and WG 16 on metering and market related services.

19) High importance. Coordination between TC 57 WG 13/WG 14 and WG 21 on metering and market related services.

20) High importance. Coordination between TC 57 WG 16 and WG 21 on metering and market related services, with in addition the handling of the specificities of the smart charging of EV from IEC TC 69/TC 57 JWG 11.

21) Coordination between TC 57 WG 16 and TC 13 on metering related services.

22) Coordination between TC 57 WG 13/WG 14 and TC 13 on metering related services.

23) High importance. Coordination between IEC TC 69/TC 57 JWG 11 and TC 13 for handling energy and market related services.

24) Coordination between TC 57 WG 21 (and ex IEC PC 118 and TC 57 WG 17) and IEC TC 69 WG 9 on how roaming could impact flexibility management.

25) Coordination between IEC TC 69 WG 9 and IEC TC 69/TC 57 JWG 11 on how energy contracts are handled, and information conveyed across the information architecture.

26) Coordination between IEC TC 64 and IEC TC 69−ISO/TC 22 JWG 1 for any electrical issues related to the electrical connection of EV/EVSE into a private electrical network.

5 Introducing the main interactions between the grid and the grid users

5.1 Reference to SGAM

In order to clarify the positioning of the different elements listed in this document, the SGAM, (Smart Energy Grid Architecture Model) is systemically used. For that reason, 5.2 re-introduces the main principles of the SGAM (extracted from IEC SRD 63200 – the coming SRD related to the SGAM and currently handled by IEC SyC SE WG 6).

Subclause 5.3 explains, in order to really depict the landscape, both the DER and the Customer Premises SGAM domains which are further broken down into three subdomains:

1) DER grid user/Customer Premises grid user (i.e. the real entity connected to the grid);
2) Aggregators/service providers (providing the ability to aggregate the energy-related capabilities/behaviours of DER grid users/Customer Premises grid users) – including energy retailer;
3) Energy metering, providing metrology-based information as a support to energy sales thus connected to a set of DER grid users and Customer Premises grid users, but also as a support to any kinds of energy-related services.

Subclause 5.4 introduces the main types of interactions between grid users and grid stakeholders, derived from a conceptual model formalizing these interactions.

NOTE Subclause 5.2 will feed and be fed by/aligned with the current edition of IEC SRD 63200.

5.2 SGAM principles (reminder)

5.2.1 General

The SGAM framework and its methodology are intended to present the design of smart grid use cases in an architectural but solution and technology neutral manner. The SGAM framework allows the validation of smart grid use cases and their support by standards.

The SGAM framework consists of five layers representing business objectives and processes, functions, information exchange and models, communication protocols and components. These five layers represent an abstract and condensed version of the interoperability categories introduced in 5.2.2. Each layer covers the smart grid plane, which is spanned by electrical domains and information management zones.

NOTE The SGAM definitions are currently re-assessed by IEC SyC SE WG 6, to produce the coming IEC SRD 62300. As soon as IEC SRD 62300 document drafts are submitted, the current document on interfaces for smart grid users will be updated to reflect the latest content.

5.2.2 SGAM interoperability layers

In order to allow a clear presentation and simple handling of the architecture model, the interoperability categories described in 5.2.2 are aggregated into five abstract interoperability layers (refer to Figure 1).

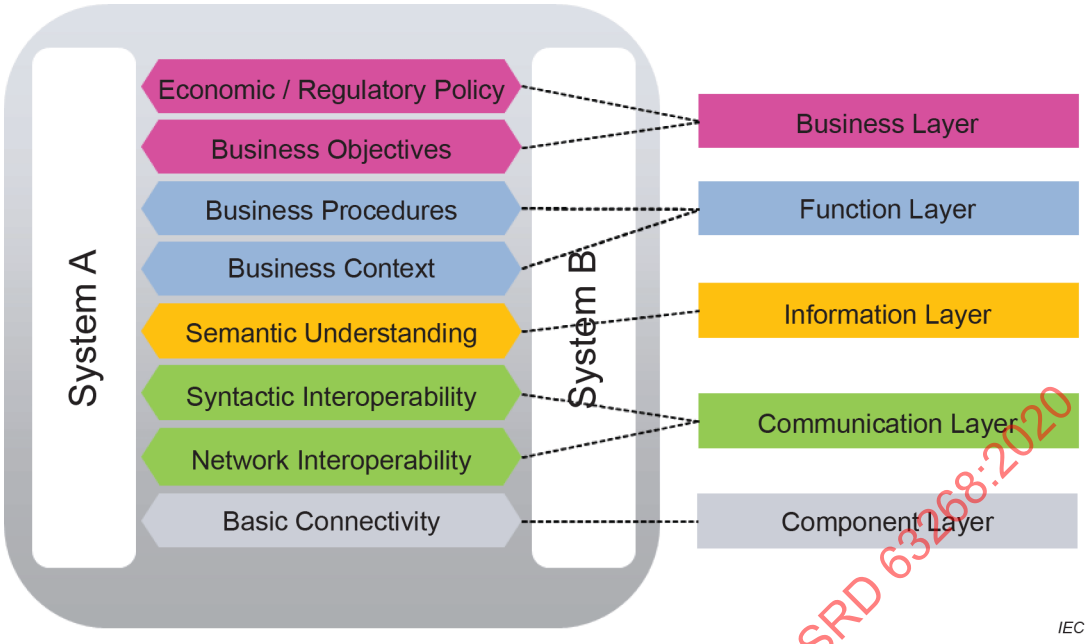


Figure 1 – Grouping into SGAM interoperability layers

Table 2 presents a brief introduction of interoperability layers:

Table 2 – SGAM interoperability layers

Interoperability layer	Description/objectives
Business layer	The business layer represents the business view on the information exchange related to smart grids.
Function layer	The function layer describes use cases, functions and services including their relationships from an architectural viewpoint.
Information layer	The information layer describes the information that is being used and exchanged between functions, services and components. It contains information objects and the underlying canonical data models.
Communication layer	The communication layer describes protocols and mechanisms for the interoperable exchange of information between components in the context of the underlying use case, function or service and related information objects or data models.
Component layer	The component layer reflects the physical distribution of all participating components in the smart grid context. This includes system and device actors, power system equipment (typically located at process and field level), protection and tele-control devices, network infrastructure (wired/wireless communication connections, routers, switches, servers) and any kind of computers.

5.2.3 SGAM – smart grid plane

5.2.3.1 General

In general power system management distinguishes between electrical process and information management viewpoints. These viewpoints can be partitioned into the physical domains of the electrical energy conversion chain (and associated business actors) and the hierarchical zones (or levels) for the management of the electrical process (refer to IEC TR 62357-1 [3]), as shown on the smart grid plane in Figure 2. This smart grid plane enables the representation on which levels (hierarchical zones) of power system management interactions between domains take place.

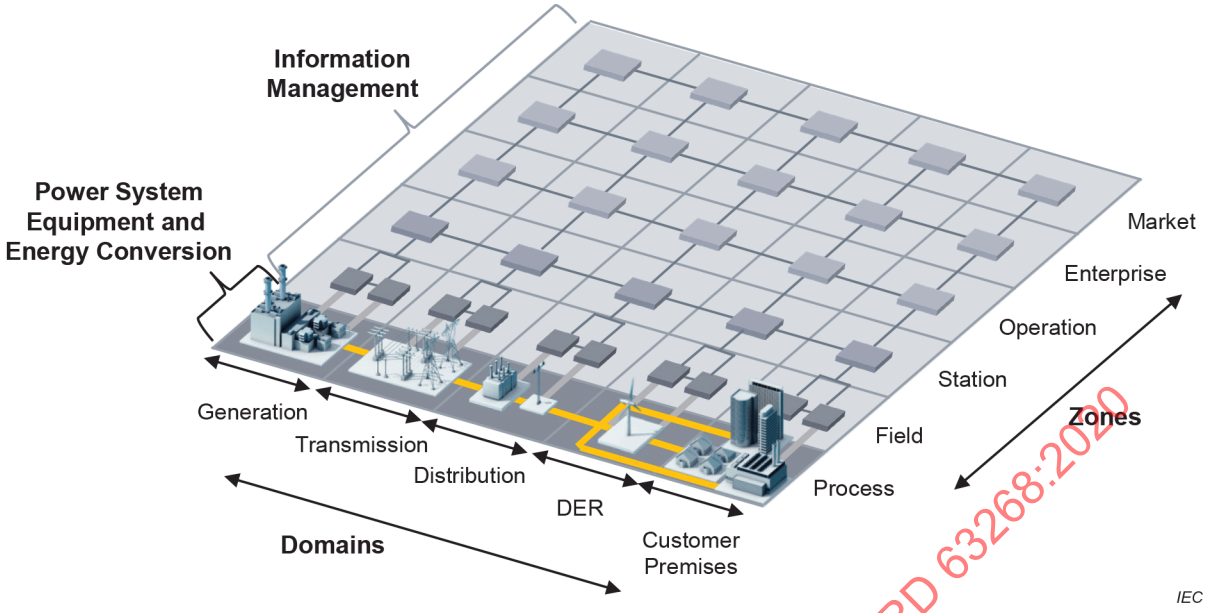


Figure 2 – Smart grid plane – domains and hierarchical zones

5.2.3.2 SGAM domains

The smart grid plane covers the complete electrical energy conversion chain and associated business actors. This includes the domains listed in Table 3:

Table 3 – SGAM domains

Domain	Description
(Bulk) Generation	Set of roles representing the generation of electrical energy in bulk quantities typically connected to the transmission system, such as by fossil, nuclear and hydro power plants, off-shore wind farms, large scale solar power plant (i.e. PV, CHP).
Transmission	Set of roles involved in transporting energy over long distances, and/or large quantity of energy to either roles from the Distribution domain, and/or in some cases directly to energy intensive Customer Premises.
Distribution	Set of roles involved in transporting energy to and from DER domain roles and/or Customer Premises domain roles.
DER[a]	Set of roles connected to actor(s) from the Distribution domain and Customer Premises, defined as the business goal of providing energy services to the grid typically as production and/or storage and/or any types of ancillary services. It includes distributed energy resources directly connected to the distribution grid, applying typically power generation and consumption technologies, as well as energy related actors providing services to these (aggregators, VPPs, etc.). These distributed electrical resources may be directly or indirectly controlled by different stakeholders for the business goal of providing energy services to the grid, such as TSO, DSO, an aggregator, a customer, a microgrid EMS, or balance responsible party (BRP).
Customer Premises	Set of roles with their primary business goals not directly related to providing energy services to the grid while using the energy grid as one energy source. Examples include home or building facilities, industries (e.g. industrial plants), non-energy-related infrastructures (such as transportation, airports, harbours, shopping centres, campus), and EV systems. It also includes the energy related roles providing services to these, such as aggregators and energy retailers. It may host local energy producer units in the form of, for example, photovoltaic generation, electric vehicles storage, batteries, micro turbines. It also includes the electro-intensive grid users connected to actors from the Transmission domain
[a] The SGAM DER domain includes much more than the DER physical unit and even much more that the DER grid user. It includes all associated business actors as well.	

5.2.3.3 SGAM zones

The SGAM zones represent the hierarchical levels of power system management. The zones are described in Table 4.

Table 4 – SGAM zones

Zone	Description
Process	Includes the physical, chemical or spatial transformations of energy (electricity, solar, heat, water, wind, etc.) and the physical equipment directly involved in the flow of energy (generators, transformers, circuit breakers, overhead lines, cables, electrical loads, any kind of sensors and actuators which are part or directly connected to the process, etc.).
Field	Includes "intelligent" equipment to directly manage the flow of energy, including to protect, control and monitor the process of the power system, e.g. protection relays, bay controller, any kind of electronic devices which acquire and use process data from the power system.
Station	Includes the area aggregation level for field level participating in the same "application", e.g. for data concentration, functional aggregation, substation automation, local SCADA systems, industrial workshop controller, local HVAC controller.
Operation	Includes the hosting power system management capabilities in the respective domain, e.g. distribution management systems (DMS), energy management systems (EMS) in generation and transmission systems, microgrid management systems, virtual power plant management systems (aggregating several DER), electric vehicle (EV) fleet charging management systems, building management system, industrial plant management system.[a]
Enterprise	Includes the commercial and organizational processes, services and infrastructures for enterprises (utilities, service providers, energy traders, etc.), e.g. asset management, logistics, work force management, staff training, customer relation management, billing and procurement.
[a] It is not because Customer Premises has only one location (typically a home) that it has no operation zone element. Typically a customer energy manager is usually at operation zone level because often dealing with many local subsystems (such as HVAC, electrical water heating, electrical heating, EV).	

In general organizations can have roles in several domains and zones. In the smart grid plane the areas of the activity of these roles can be shown. For example, according to the business area of a transmission utility it is likely that the utility covers all segments of the Transmission domain, from process to market.

A service provider role offering weather forecast information for distribution system operators and DER operators could be located for example in the operation zone interacting with the operation zone in the Distribution and DER domain. But a weather forecast subsystem could be located in the station zone if dedicated to the geographical area where the station is located, based on sensors located in the process zone.

5.2.4 Global SGAM framework

The SGAM framework is established by merging the concept of the interoperability layers defined in 5.2.2 with the smart grid plane introduced in 5.2.3. This merge results in a model (see Figure 3) which spans three dimensions:

- X: domain;
- Y: interoperability (layer);
- Z: zone.

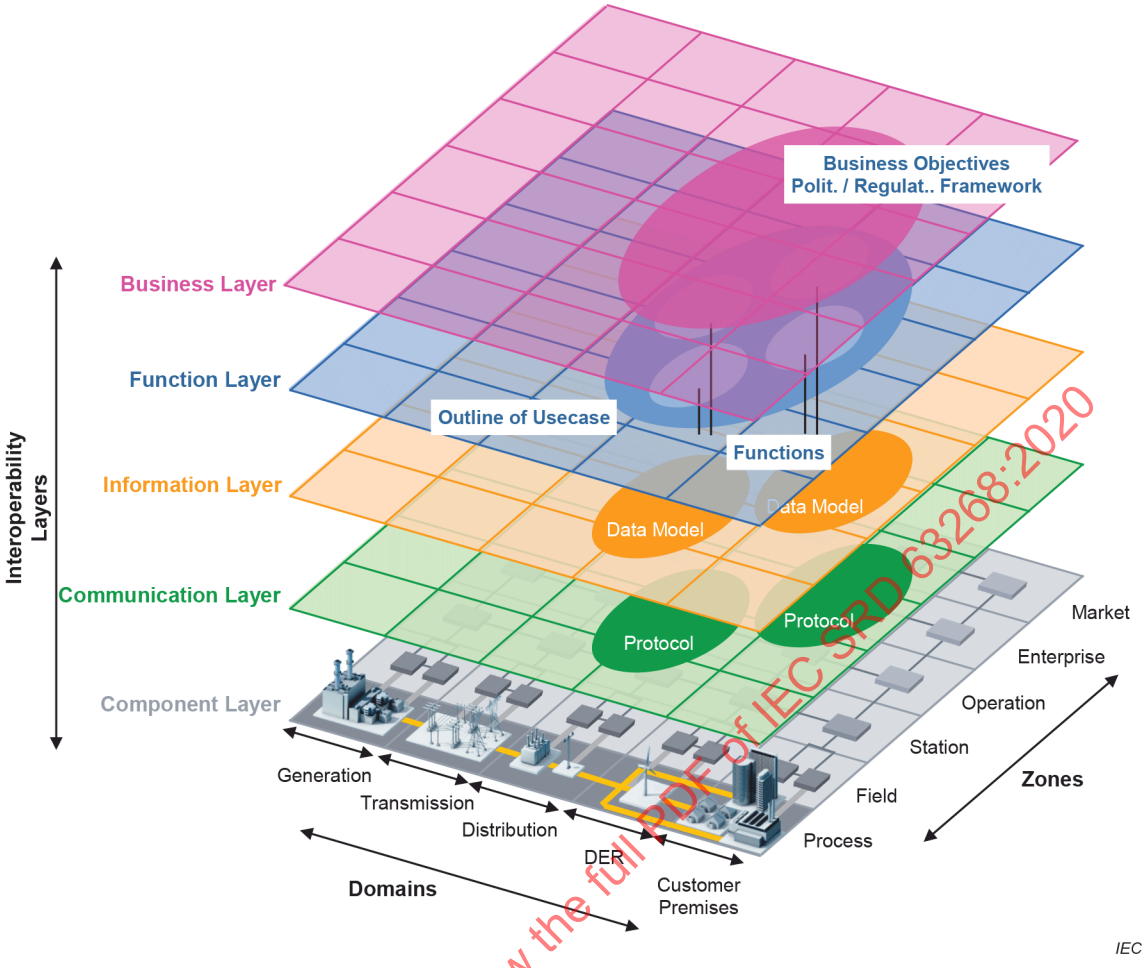


Figure 3 – The SGAM framework

Consisting of the five interoperability layers, the SGAM framework allows the representation of entities and their relationships in the context of smart grid domains, information management hierarchies and in consideration of interoperability aspects.

5.3 Breaking down DER and Customer Premises domains into subdomains

Grid user related domains are actually made of various business actors. Effectively in both cases, they include:

- The so-called grid user, which could be a DER plant or a whole facility
- The energy-related information metering which is a prerequisite to energy related services at the point of connection of the grid user to the grid. (This data may go far beyond the measurement of physical data like quantity of energy, current, voltage, etc., to also include actual flexibility metering.) It also includes business actors involed in storing and sharing the collected data with other stakeholders who are interested in using these data for different purposes.
- All types of energy-related service providers interacting with the grid users having as business goals to enable the grid users to reach other energy-related goals than just active power consumption/production. Typically, these could be related to
  - energy retailing with or without optimized energy prices,
  - optimized DER/Facility energy operation services or asset optimization through centralized remote operation (one type of aggregation),
  - energy efficiency services,
  - greener energy services (possibly related as well to energy retailer),

– better position on the active power energy market places through aggregation,
– selling energy flexibilities typically but not only through demand-response,
– providing grid ancillary services, through aggregation,
– etc.

Breaking down the domains into subdomains as shown in Figure 4 helps greatly to clearly define what the so-called "smart grid user" interface needs to deal with.

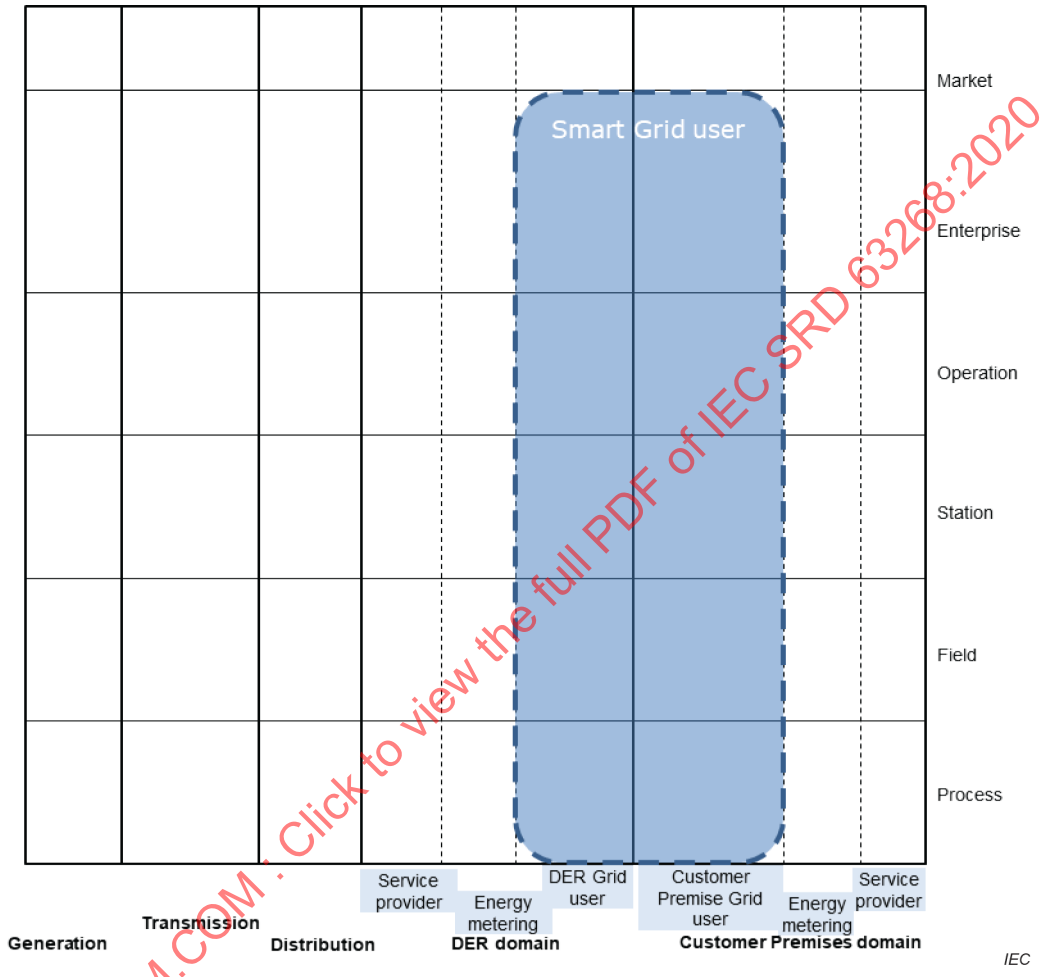


Figure 4 – SGAM illustrating the smart grid user interface and its interfaces

5.4 Main considered interactions

5.4.1 General

Now that the smart grid user is more properly defined, 5.4 identifies the main expected interactions with other smart grid stakeholders.

5.4.2 Conceptual model basis

In order to identify the main interactions, one easiest way consists in starting from the conceptual model established by CEN-CENELEC-ETSI SG-CG/M490/J_ General Market Model Development [4] (an extract is provided in Annex G), and to re-work it in order to fit the objectives of this document, i.e. identifying all interaction between the grid user and its environment. For that purpose the metering operation, which plays a key role here, is split from the original global element "Operations" as stated in [4] and repeated in Annex G. The result of this work is shown in Figure 5.

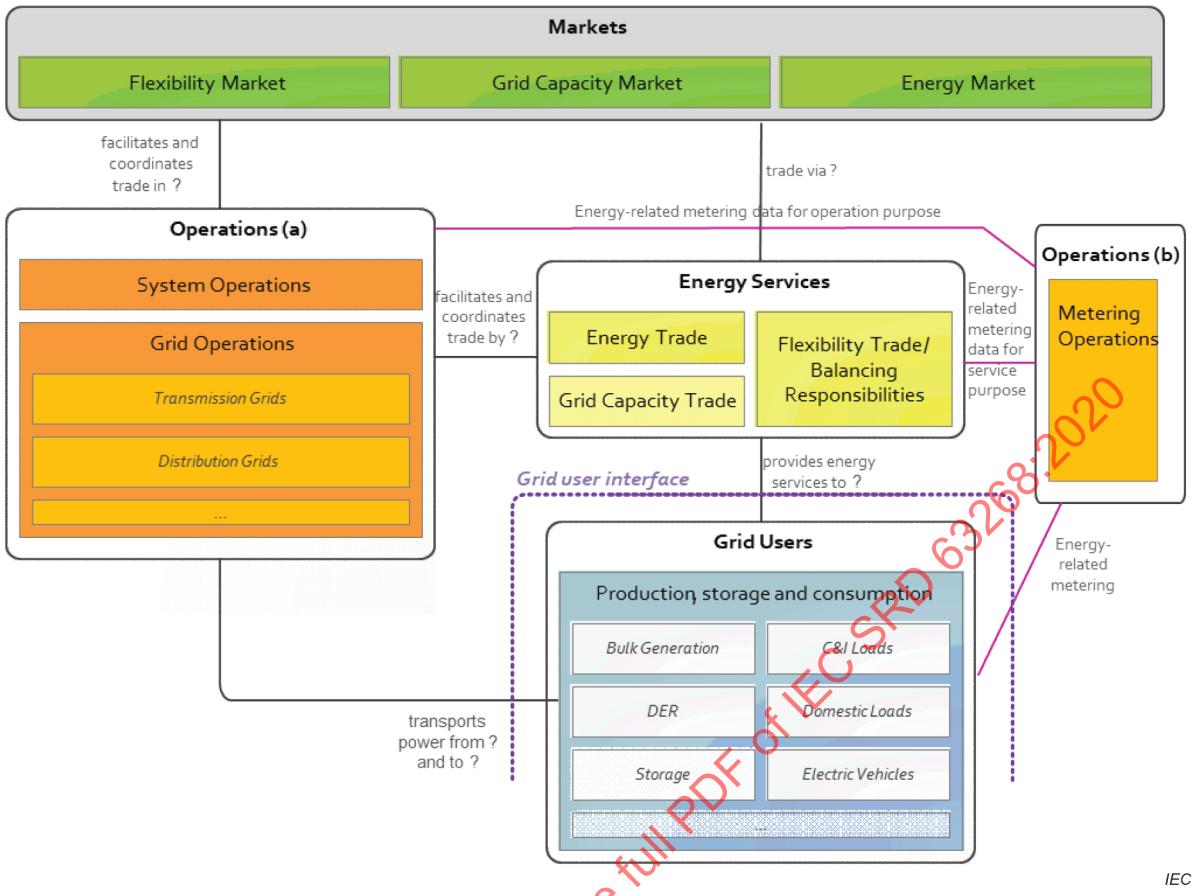


Figure 5 – Reworked smart grid conceptual model based on the SG-CG one

5.4.3 Transposition into the SGAM concepts

The next step consists in mapping the above concepts onto the SGAM principles, either domains or zones. The result, applying the breaking down of DER and Customer Premises into sub-domains presented in 5.3 is exposed in Figure 6.

While the Generation domain can follow the same path, it is excluded from this approach, because by convention excluded from the scope of this document.

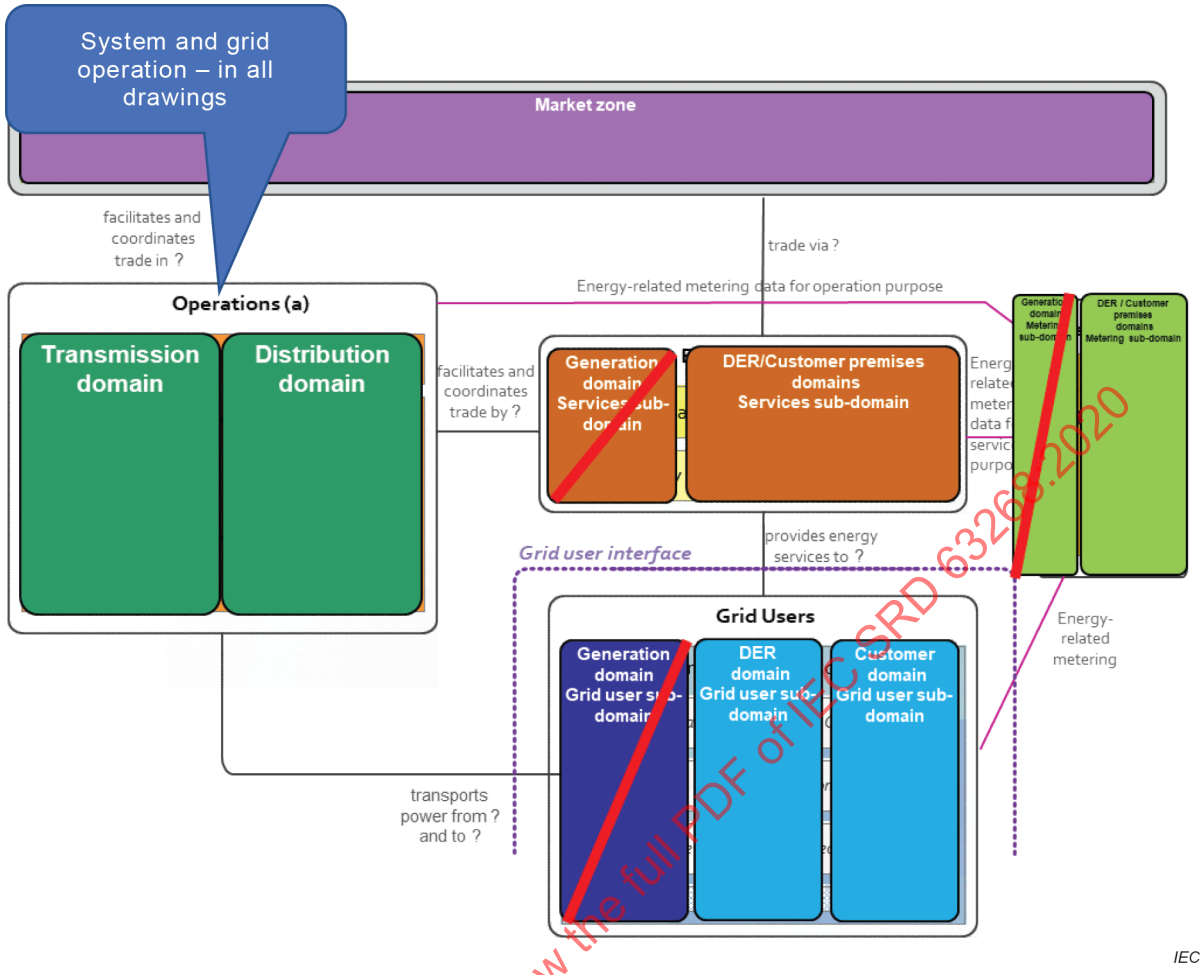


Figure 6 – Main stakeholders' interactions, simplified view – Mapping the conceptual model over the SGAM one

5.4.4 Interactions detailed identification

Deduced from Figure 6, Figure 7 presents the main interactions identified and described in 5.4.1 mapped over the SGAM.

Having broken down the grid users of DER domain and the Customer Premises domain according to zones helps to map properly these interactions.

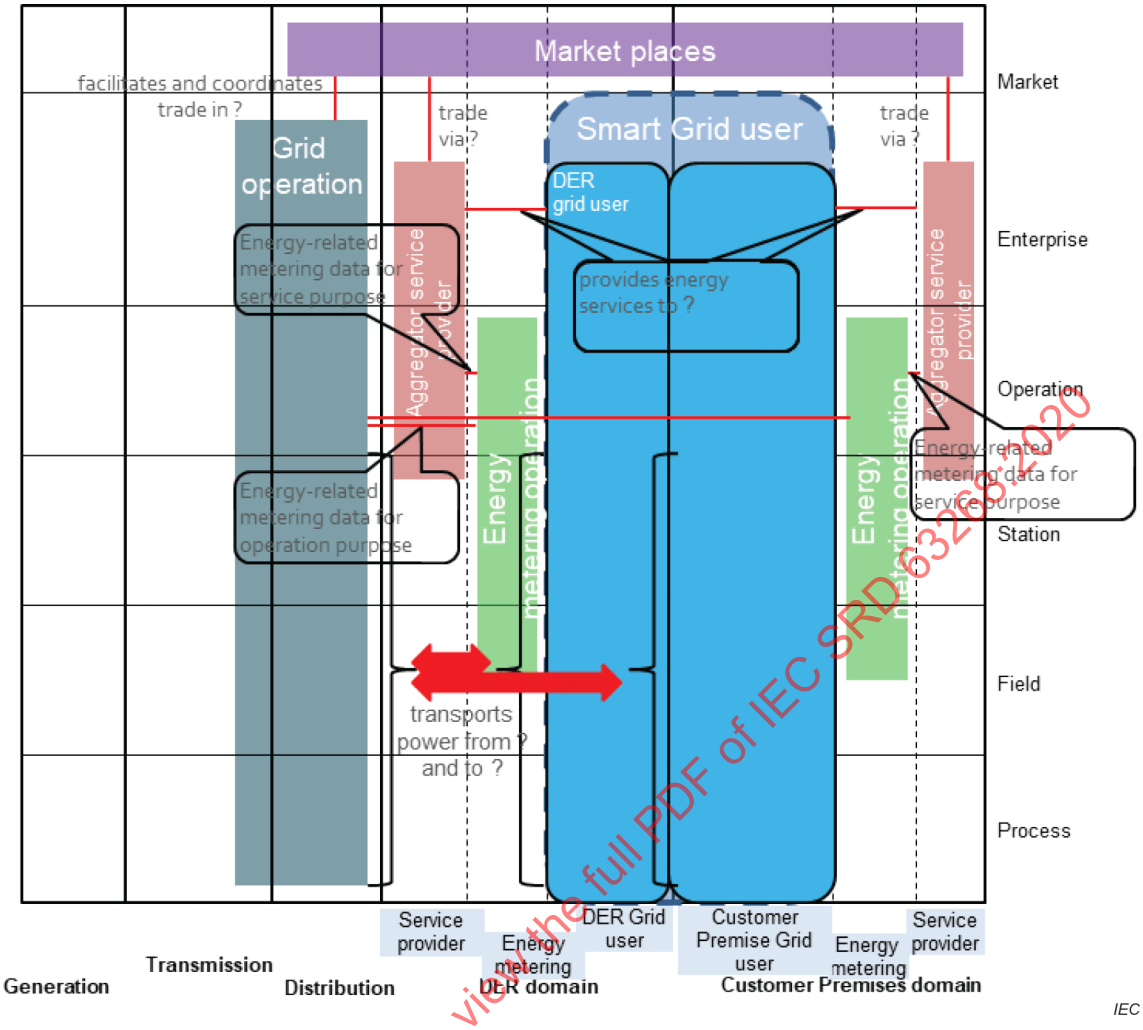


Figure 7 – Global smart grid user interface mapped over the SGAM

Having some further breakdown helps to discriminate the "physical, electrotechnical" types of interaction, e.g. 1, from the digital interactions, e.g. 6. The result is shown in Figure 8.

Each interaction type is attached to a number from 1 to 10.

It helps as well to discriminate the communication which is global – operation zone and above – from communication which is local – station zone and below.

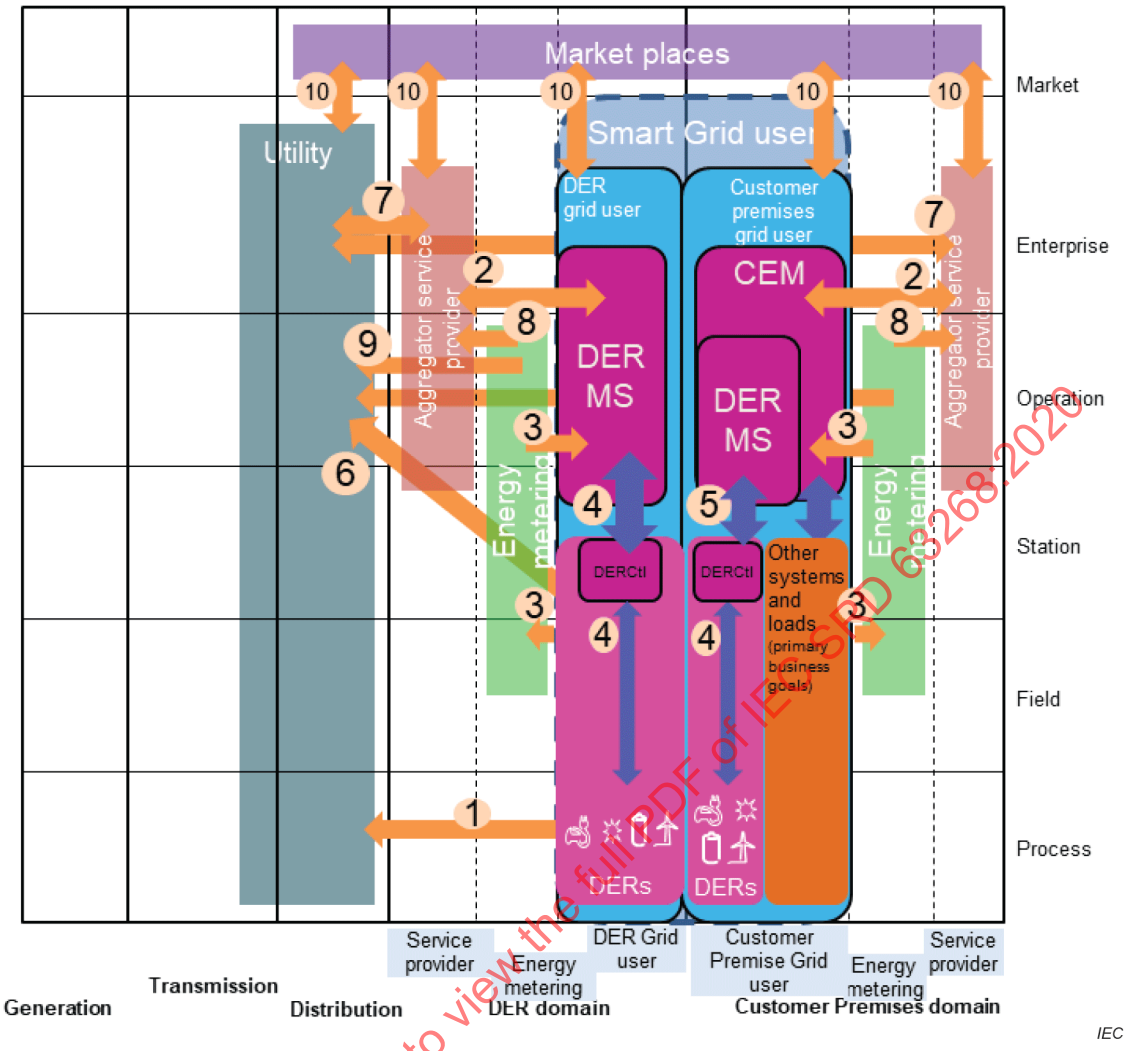


Figure 8 – Detailed smart grid user interface mapped over the SGAM

This leads to identify 10 types of interaction, which are further summarized in Table 5.

Table 5 – Main (direct) smart grid users related interactions

No.	Title	Description	From	To	Bi-directional
1	Physical connection to the grid	Includes all types of electrotechnical interactions between the grid and the grid users, including power quality requirements, as well as electrotechnical grid code requirements.	Grid operator (DSO typically)	Grid user	Yes
2	Service provider interaction	Includes all types of interactions, enabling a service provider to provide energy-related service to the grid users – refer to 5.3.	Service provider	Grid user	Yes
3	Energy metering interactions	Includes all types of interactions, between a grid user and energy metering. This is an enabler for any type of energy-related services including energy retailing (sell and invoice energy delivered by the grid, or from the grid to the grid user). This includes getting the metered data reflecting the consumed or produced energy. Includes pre-payment activities as well.	Energy metering	Grid user	Yes – feedback is usually expected at operation level
4	Interaction between the DER units (located possibly at DER grid user or at Customer Premises grid users) and the DER unit operation	Internal to the DER owner or external to it, includes all interaction needed to operate the DER unit.	DER operator	DER units from DER grid users or Customer Premises grid users	Yes
5	Interaction between the DER operator and the Customer Premises energy management system	Reflect the two sub-system interactions present within a Customer Premises, merging the management of systems and loads connected to the primary business goal with the management of the DER unit (if any).	Customer energy manager from Customer Premises grid users	DER operator	Yes
6	IT interaction between the grid users hosting DER units and the grid operator	Reflects the IT data exchange between the grid users (if hosting DER units) and the grid operator, for the purpose of observability and controllability (often expressed through grid codes requirements).	Grid operator (may be TSO or DSO typically)	Grid user (hosting DER units)	Yes
10	Interaction between grid users and market places	Possibly set directly between the grid users and the market places, supposing the grid users meet the requirement for connecting to this market place (usually expressed in installed power threshold).	Market places	Grid user	Yes

To the list of interactions expressed in Table 5, it is important to also consider the indirect interactions. The main reason for extending this list to indirect interactions is to consider that indirect interactions convey very often data directly extracted/composed from the grid user interface such as grid user's energy consumption, grid user's nameplate, grid user's forecast, grid user's flexibilities, etc. Thus considering that a seamless approach of the data management related to grid users is of highest importance, the first list of direct interactions is extended by the list of indirect interactions listed in Table 6.

Table 6 – Main (indirect) smart grid users related interactions

No.	Title	Description	From	To	Bi-directional
7	Service provider interaction with the utility	Includes all types of interactions between the service provider and the utility, mostly resulting from the aggregation of capabilities/features from the grid users in case the service provider wants to provide services to the grid (typically nameplate information, forecast, observability and controllability of a pool of grid users).	Service provider	Utility	Yes
8	Service provider interaction with the energy metering	Includes all types of interactions, enabling to monetize energy-related service to the grid users based on metered data – refer to 5.3.	Energy metering	Service provider	Basically monodirectional
9	Energy metering interaction with the utility	Includes all types of interactions, enabling a utility to benefit from metered values at grid user side.	Energy metering	Utility	Basically monodirectional
10	Interaction between other stakeholders than the grid users and market places (complete the description given in Table 5)	In addition to what is exposed in Table 5, includes all types of interactions between grid stakeholders (utility, service providers) and the market places.	Utility, service provider	Market places	Yes
NOTE Link 7 together with link 2 can also be used for "passing-through" information between the utility and the grid users through the service provider (seen as an optimal way of implementing observability and controllability of widely spread DERs), and thus like the information flow (6).					

5.4.5 Specific case of EV and associated interactions and SGAM mapping

The integration of EV on the landscape introduces some needed refinements of the architecture and new types of interactions, especially because EV is by essence mobile.

The first specificity is the presence on an internal level of control and management local to the grid user and dedicated to EV, called CSMS.

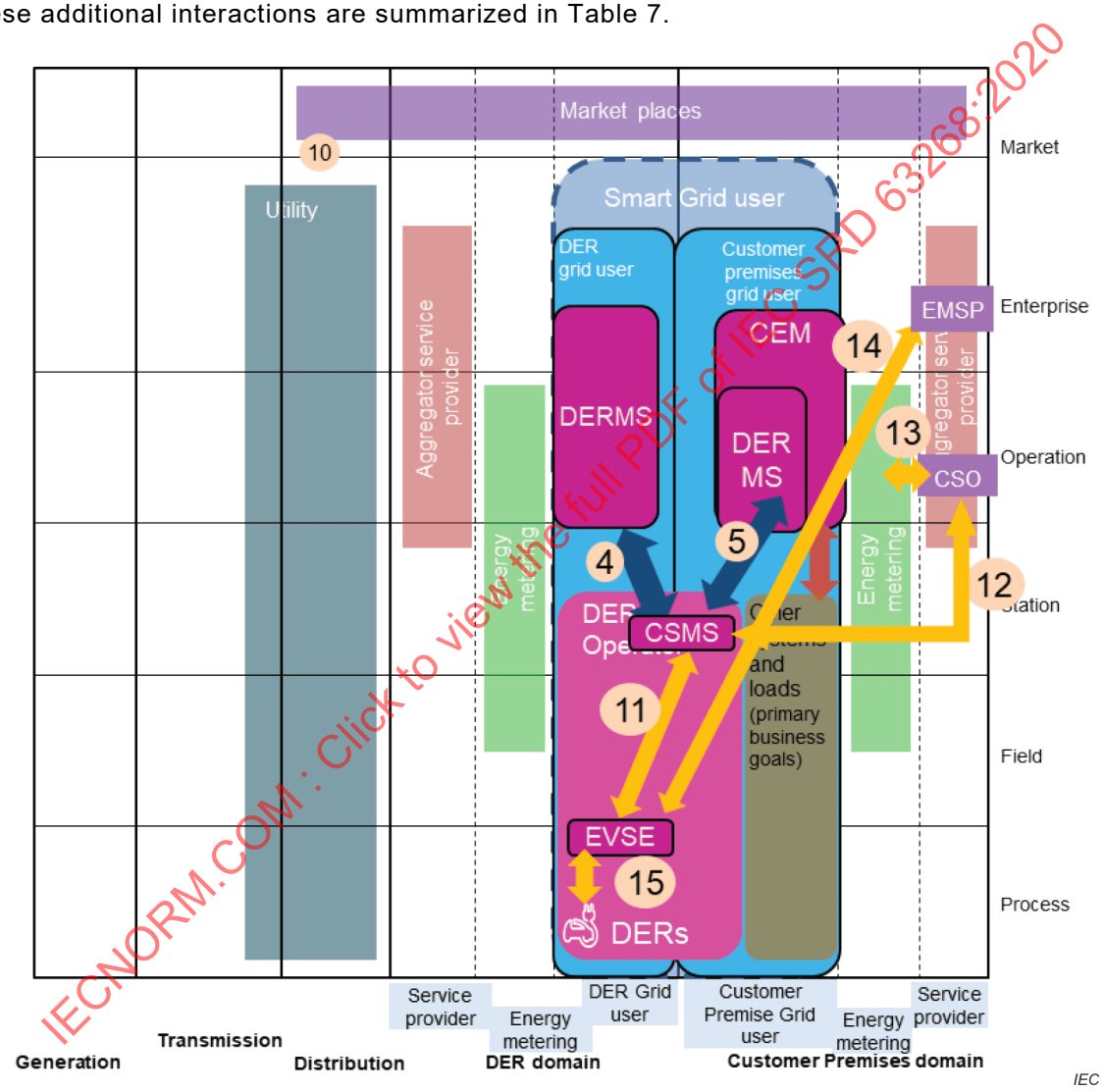
The very important specificity of EV is the very specific set of interactions which may take place directly between this intermediate point of control (CSMS) and dedicated secondary actors (numbered 12 in Figure 9), not going through the DERMS or the CEM as is the case for other DERs. This will have de facto an impact on interactions numbered 4 and 5, especially to ensure that mutual constraints between the Grid User site and the EVs are known and considered.

EV and EV charging stations are managed from this element of control (CSMS). Interactions between the EV and its charging station (numbered 11 in Figure 9) and between the charging

station and this element of control are specific because, in addition to DER "generic" interactions (numbered 5 in Figure 9 – depending whether it is part of "DER domain" or "Customer Premises domain"), they have to support the flow of information resulting from the one above numbered 12.

The metering of energy is also impacted by the integration of EV, EVs having potentially their own meters [in the EV or in the EVSE, having as well potentially specific energy retail or services contracts through their EMSP (interactions numbered 14 in Figure 9), and thus having the CSOs interacting with EMSP liaised with the site metering]. These interactions are numbered 13 in Figure 9.

These additional interactions are summarized in Table 7.



NOTE For the sake of simplicity, this drawing only considers EVSE applying the same way as part of the DER domain, such as public charging stations, or as part of the Customer Premises domain, such as embedded into a home or building management system.

Figure 9 – EV additional interactions – mapped over the SGAM

Table 7 – Additional interactions to consider for supporting EV integration

No.	Title	Description	From	To	Bi-directional
5	Additional interactions between the DER control element, specialized here as CSMS, and the customer energy manager	Typically, CSMS and CEM exchange information about the aggregated power and energy budget dedicated to e-mobility. The CEM, when necessary, allocates energy and power budget valid until the next allocation. The CSMS informs the CEM of any significative variation in aggregated power and energy. The disaggregation of the power and energy budget for each EV results from the e-mobility needs expressed by EV user and contract terms with EMSP.	CSMS	CEM	Yes
11	Interaction between electric vehicle supply equipment (EVSE) and charging stations management system (CSMS)	Differs from type 4 above described for all types of DER, by the fact that EVs are not primarily DER (the main usage of EV is to support transportation of passengers) and are potentially from different owners and in addition mobile. In addition, EVs may have their own energy contract.	EVSE	CSMS	Yes
12	Interaction between the charging stations management system (CSMS) and charging station operator (CSO)	Differs from type 5 above, by the fact that EVs are potentially from different owners and in addition mobile and may have their own energy contract. Note that this interaction may "compete" with the operation of DERs of the same site.	CSMS	CSO	Yes
13	Interaction between the e-mobility service providers (EMSPs) and the metering infrastructure	Because each EV may have its own energy service contract, there is a need for the loop back to EMSP through involved CSOs by the energy metering infrastructure about the effective consumed energy.	Energy metering infrastructure	CSO	Yes
14	(Logical) interactions between electric vehicles (EVs) and e-mobility service providers (EMSPs)	The needed information is exchanged between an EV (plugged into whatever charging station) and its own e-mobility service provider.	EVSE(EV)	EMSP	Yes
15	(Logical) interactions between electric vehicles (EVs) and electric vehicle supply equipment (EVSE)	The needed information is exchanged between an EV (plugged into whatever charging station) and the EVSE it is connected to, especially for exchanging the list of energy-related functions which are supported by the EV, and associated ratings/settings.	EVSE	EV	Yes
NOTE 1 Interactions 11 and 12 allow multiple EV–EMSP contracts. The specificities of each contract regarding energy transfer conditions are relayed to each EV locally by the CSMS – shown through the link 13. NOTE 2 Interaction 14 is represented here as a direct interaction crossing the whole architecture; however, practically such flow of information will use existing communications set between the chains of involved actors such as the EVSE, the CSMS, the CSO.					

6 Standardization assessment of the main smart grid user interfaces

6.1 General

The purpose of Clause 6 is to identify for each type of interface the main use cases and the IEC entities in charge of providing standards to support these use cases (if any) and to list the existing and coming standards, and gaps if any.

In order to simplify the reading of this document, the interactions are grouped by business actors into four groups as presented in 6.2 to 6.5.

However, it is key to understand that the presented elements are cumulative. Said in other words, considering as an example the case of DER operated within H&B grid users, the interfaces presented in Annex A, Annex B and more specifically B.3.2, Annex C and Annex D apply.

In addition, performing such breakdown, should not lead to consider that there are no interactions between all these different constraints, and this is the limit of the current exercise. For example, applying the grid codes, as depicted in Annex A, has de facto important impacts on how DER should be operated as described in Annex B.

6.2 Interactions with the grid operators

Table 8 summarizes the main interactions considered for this group.

Table 8 – Main interactions between the grid user and the grid operators

No.	Title	From	To
1	Physical connection to the grid	Grid operator (DSO typically)	Grid user
6	IT Interaction between the grid users hosting DER units and the utility	Grid operator (may be TSO or DSO typically)	Grid user (hosting DER units), possibly through the service provider

Refer to 6.6 for further details.

As a result of this mapping summarized in Figure A.1 to Figure A.4, the involved IEC entities and main standards appear to be:

- IEC TC 57 WG 13/WG 14 with the IEC 61970 series [25] and IEC 61968 series [24]
- IEC TC 57 WG 17 with the IEC 61850 series [22]
- IEC TC 8/SC 8A/SC 8B with the IEC 62786 series [31], the IEC TS 62898 series [33] but also IEC 60038 , IEC 60059, IEC 60196
- IEC TC 64 with the IEC 60364 series [16]
- IEC TC 95 for protection/grid code functions and/or related measurements
- IEC TC 82 with IEC 61727 [20]
- IEC TC 88 with the IEC 61400 series [19]
- IEC TC 120 with the IEC 62933 series [40]
- IEC TC 69 with the IEC 61851 series [23] and ISO 15118 series [14]

TC 85 and SC 77A are not represented here because involved de facto on global topics such as measurements and EMC.

In addition, some points of interactions were identified.

1) Coordination between TC 57 WG 13/WG 14 and TC 57 WG 17 mostly around a common modelling approach of DER from both IEC CIM and IEC 61850 [22] sides. A joint TF is effectively already in place under IEC TC 57 WG 19 aiming at reaching that goal (results should be formalized in IEC 62361-102).
2) Coordination between TC 8/SC 8A/SC 8B and TC 95 on grid codes related functions, especially in frequency measurements. Already in place through the IEC TC 8/TC 85 JWG 12 (joint as well with TC 85 and SC 77A).
3) Coordination between TC 8/SC 8A/SC 8B and TC 57 WG 17 on grid codes functions. This would need a better formalization, although some informal exchanges have already taken place.
4) Coordination between TC 8/SC 8A/SC 8B. Already in place and formalized in the IEC TC 8 SBP.
5) Coordination between TC 8/SC 8A/SC 8B and TC 64, TC 82, TC 88, TC 120, TC 69 on Grid code implementation and other grid connexion requirements. This coordination process has started under the form of the IEC TC 8 JWG 10 joint with TC 120, TC 82, the other TCs being in the process of setting up equivalent liaisons.

6.3 Interactions related to DER operation

6.3.1 General

Table 9 summarizes the main interactions considered for this group.

Table 9 – Main interactions related to DER operation

Num	Title	From	To
4	Interaction between the DER units (located possibly at DER grid user or at Customer Premises grid users) and the DER unit operation	DER operator	DER units from DER grid users or Customer Premises grid users
5	Interaction between the DER operator and the Customer Premises energy management system	Customer energy manager from Customer Premises grid users	DER operator

Refer to Annex B for further details.

The assessment is conducted in four different situations and the assessment result is presented in 6.3.2 to 6.3.5.

- case of DER grid users (SGAM DER domain);
- case of DER units within Home and Building grid users (specific SGAM Customer Premises grid users);
- case of DER units within Industry grid users (specific SGAM Customer Premises grid users);
- case of DER units within a multi-owner microgrid (specific Customer Premises grid users).

6.3.2 In case of DER grid users

Refer to B.3.2 for further details.

As a result of this mapping summarized in Figure B.1 to Figure B.4, the involved IEC entities and main standards appear to be:

- IEC TC 57 WG 17 with the IEC 61850 series [22]
- IEC TC 57 WG 21 (and ex IEC PC 118) with the IEC 62746 series [30]

- IEC TC 88/TC 57 JWG 25 with the IEC 61400 series [19]
- IEC TC 69/TC 57 JWG 11 with the IEC 63110 series [41] and ISO 15118 series [14]

In addition, some points of interactions were identified:

1) Coordination between TC 57 WG 21, TC 57 WG 17 activities dealing with demand-response and flexibilities. In that respect the border between the usage of IEC CIM and the usage of IEC 61850 [22] seems very difficult to position, and thus it is more likely to have both modelling techniques supporting the same features. Joint meetings between these three bodies took place, however the consistency of their deliveries together with the points addressed in Annex A would need a real formalization.
2) Coordination between TC 88/TC 57 JWG 25 and TC 57 WG 17. Some joint meetings were set, and are still to be encouraged.
3) Coordination between TC 69/TC 57 JWG 11 and TC 57 WG 17. Quite active liaisons are already in place with cross reporting and contribution. However, JWG 11 still suffers from a lack of representative of TC 57 in their group.

6.3.3 In case of DER units within Home and Building grid users (specific Customer Premises grid users)

Refer to B.3.3 for further details.

As a result of this mapping summarized in Figure B.5 to Figure B.8 the involved IEC entities and main standards appear to be:

- IEC TC 57 WG 17 with the IEC 61850 series [22]
- IEC TC 57 WG 21 (and ex IEC PC 118) with the IEC 62746 series [30]
- IEC TC 69/TC 57 JWG 11 with the IEC 63110 series [41] and ISO 15118 series [14]
- IEC TC 23, SC 23K and ISO/IEC JTC 1/SC 25 with many standards
- IEC TC 64 with the IEC 60364 series [16]

In addition, some points of interactions were identified.

1) Coordination between IEC TC 57 WG 21 (and ex IEC PC 118), TC 57 WG 17 activities and the SC 23K and ISO/IEC JTC 1/SC 25 dealing with demand-response and flexibilities. This would need to be set-up.
2) Coordination between TC 69/TC 57 JWG 11 and SC 23K and ISO/IEC JTC 1/SC 25, to facilitate the integration of EV and its charging system into a HBAC/HBES.
3) Coordination between TC 69 and TC 64 to consider the connexion of EV internally to the Home or Building, especially in the case of V2G energy flows.

6.3.4 In case of DER units within Industry grid users (specific Customer Premises grid users)

Refer to B.3.4 for further details.

As a result of this mapping summarized in Figure B.9 to Figure B.12, the involved IEC entities and main standards appear to be:

- IEC TC 57 WG 17 with the IEC 61850 series [22]
- IEC TC 57 WG 21 (and ex IEC PC 118) with the IEC 62746 series [30]
- IEC TC 65 with many standards
- IEC TC 69/TC 57 JWG 11 with the IEC 63110 series [41] and ISO 15118 series [14]

6.3.5 In case of DER units within a multi-owner microgrid (specific Customer Premises grid users)

Refer to B.3.5 for further details

As a result of this mapping summarized in Figure B.13 to Figure B.16, the involved IEC entities and main standards appear to be:

- IEC SC 8B with the IEC TS 62898 series [33]
- IEC TC 57 WG 17 with the IEC 61850 series [22]
- IEC TC 57 WG 21 (and ex IEC PC 118) with the IEC 62746 series [30]
- IEC TC 88/TC 57 JWG 25 with the IEC 61400 series [19]
- IEC TC 69/TC 57 JWG 11 with the IEC 63110 series [41] and ISO 15118 series [14]
- IEC TC 64 with the IEC 60364 series [16]
- IEC TC 23, SC 23K and ISO/IEC JTC 1/SC 25 with many standards

6.4 Interactions to and from the service provider and energy metering

Table 10 summarizes the main interactions considered for this group.

Table 10 – Main interactions between the grid user and the service provider and energy metering

Num	Title	From	To
2	Service provider interaction	Service provider	Grid user
3	Energy metering interactions with grid users	Energy metering	Grid user
7	Service provider interaction with the grid operator	Service provider	Grid operator
8	Service provider interaction with the energy metering	Energy metering	Service provider
9	Energy metering interaction with the grid operator	Energy metering	Grid operator

Refer to Annex C for further details.

As a result of this mapping summarized in Figure C.1 to Figure C.4 the involved IEC entities and main standards appear to be:

- IEC TC 57 WG 16 with the IEC 62325 series [27]
- IEC TC 57 WG 13/WG 14 with the IEC 61970 series [25] and IEC 61968 series [24]
- IEC TC 57 WG 21 (and ex IEC PC 118) with the IEC 62746 series [30]
- IEC TC 13 with (among many) the IEC 62056 series [26]

6.5 Interactions with the energy market places

Table 11 summarizes the main interactions considered for this group:

Table 11 – Main interactions between the grid user and the energy market places

Num	Title	From	To
10	Interaction with the market places	Grid user, grid operator, Service provider	Market places

Refer to Annex D for further details.

As a result of this mapping summarized in Figure D.1 to Figure D.4, the involved IEC entities and main standards appear to be:

- IEC TC 57 WG 16 with the IEC 62325 series [27]
- IEC TC 57 WG 13/WG 14 with the IEC 61970 series [25] and IEC 61968 series [24]
- IEC TC 57 WG 21 (and ex IEC PC 118) with the IEC 62746 series [30]

6.6 Additional interactions applying to EV

Subclause 6.6 assesses the impacts resulting from the additional interactions to support EV as stated in Table 7.

Refer to Annex E for further details.

As a result of this mapping summarized in Figure E.1 to Figure E.4, the involved IEC entities and main standards appear to be:

- IEC TC 57 WG 17
- IEC TC 57 WG 21 (and ex IEC PC 118)
- IEC TC 69 WG 9 with the IEC 63119 series [43]
- IEC TC 69/TC 57 JWG 11 with the coming IEC 63110 series [41]
- IEC TC 68−ISO/TC 22 JWG 1 with the ISO 15118 series [14]
- IEC TC 23, SC 23K with IEC 62962 [44] [2]
- ISO/IEC JTC 1/SC 25
- IEC TC 64

In addition, the same Figure E.4 helps in identifying the needed point of interactions (in blue).:

1) Coordination between TC 57 WG 21 (and ex IEC PC 118 and TC 57 WG 17) and IEC TC 69 WG 9 on how roaming could impact flexibility management.
2) Coordination between IEC TC 69/TC 57 JWG 11, SC 23K and ISO/IEC JTC 1/SC 25, to facilitate the integration of EV and its charging system into a HBAC or HBES already mentioned in B.3.3.
3) Coordination between IEC TC 69 WG 9 and IEC TC 69/TC 57 JWG 11 on how energy contracts are handled, and information conveyed across the whole information architecture.
4) Coordination between IEC TC 64 and IEC TC 68/ISO TC 22 JWG 1 for any electrical issues related to the electrical connection or EV /EVSE into a private electrical network.

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2 IEC TC 23 is working on particular requirements for switching equipment to control power sources (SECPS), which can be considered between CEM and loads within a building. This project is being developed as IEC 62991, currently at CD stage.

In a near future, IEC TC 23 will also address Customer Energy Manager System and smart grid according to the scope of SC 23K, to ensure a consistent set of standards in that field.

At least IEC 62962 and the future IEC 62991 would/could be mentioned, as well as SC 23K in the DC N°99, within the interfacing figures and stakeholder.

Annex A
(informative)

Mapping of the interfaces between the grid operator with grid users hosting DER units

A.1 Interfaces under consideration

Subclause 6.6 focuses on the interactions listed in Table A.1.

Table A.1 – Interfaces under consideration between the grid users and the Utilities

No.	Title	From	To
1	Physical connection to the grid	Grid operator (DSO typically)	Grid user
6	IT interaction between the grid users hosting DER units and the grid operator	Grid operator (may be TSO or DSO typically)	Grid user (hosting DER units), possibly through the service provider

A.2 Main use cases

Subclause 6.6 focuses on the main use cases listed in Table A.2.

Table A.2 – Supported business processes and use cases when considering interfaces with utilities

Business process [a]	Use case
Long term Grid stability	Provide energy forecast
Short term Grid stability	Avoid increasing grid disturbance in staying connected even in possibly faulty/unstable conditions (fault ride through functions)
Contribute to grid user power quality – power balancing during extreme grid conditions	Frequency sensitive mode – possibly support remote disconnection/cease to energize
Contribute to grid user power quality – active feeder voltage management	Active voltage support in extreme grid conditions through providing reactive power or many other means

[a] This list is just a summary of some very common requirements expressed through grid codes and related to DERs.

A.3 Mapping standards to the SGAM architecture

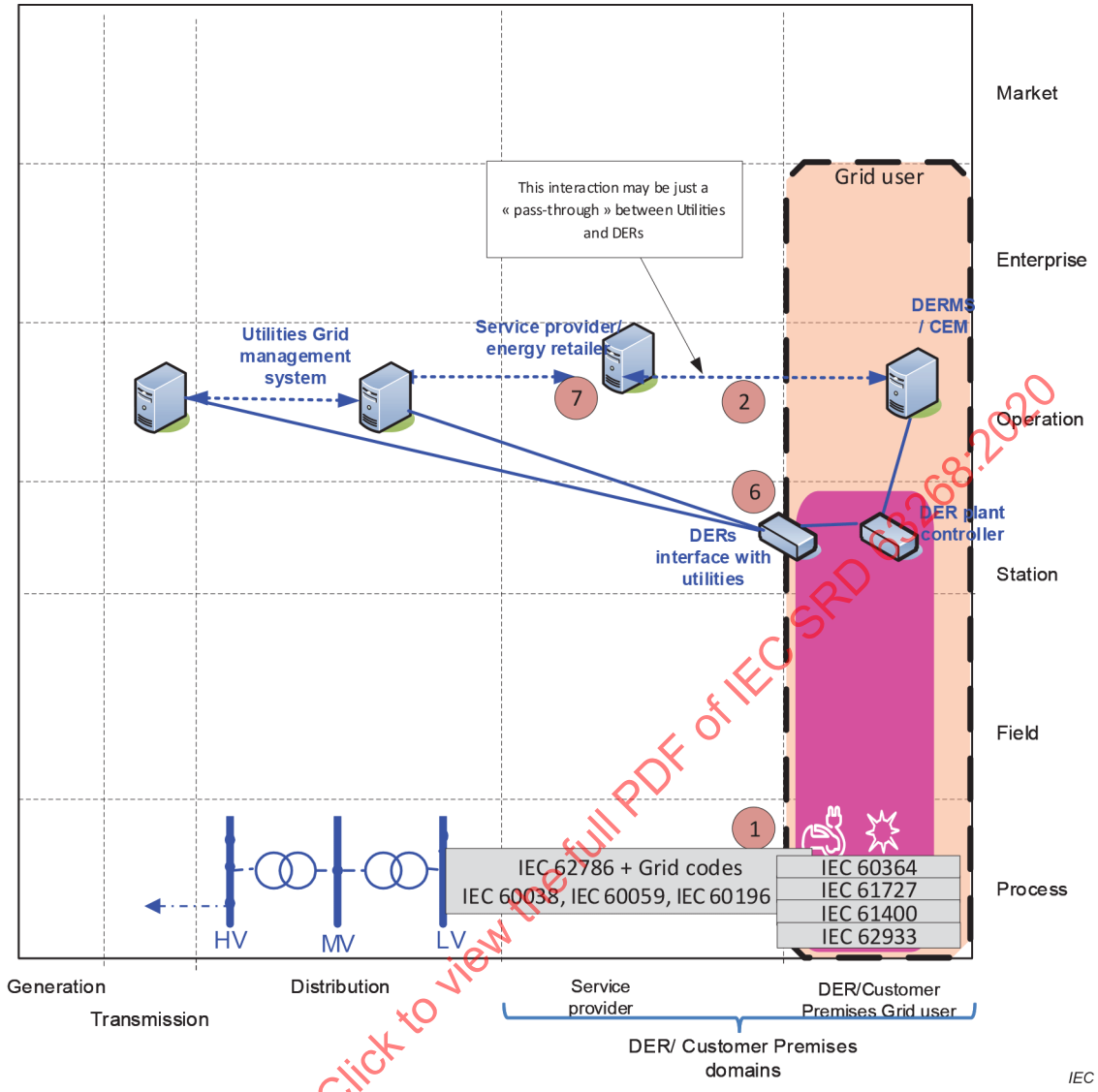
A.3.1 Preamble

As soon as a grid user hosts DER units, it may meet some specific requirements generally expressed through grid codes, normally related to the needed contribution of these DERs to frequency, possibly voltage, and generally stability of the grid. Attached to these requirements, observability and controllability by the grid operator may be required.

A typical architecture mapped onto the SGAM architecture is shown in Figure A.1.

A.3.2 Component layer

The components of the interface between utilities and grid users hosting DER units are depicted in Figure A.1.



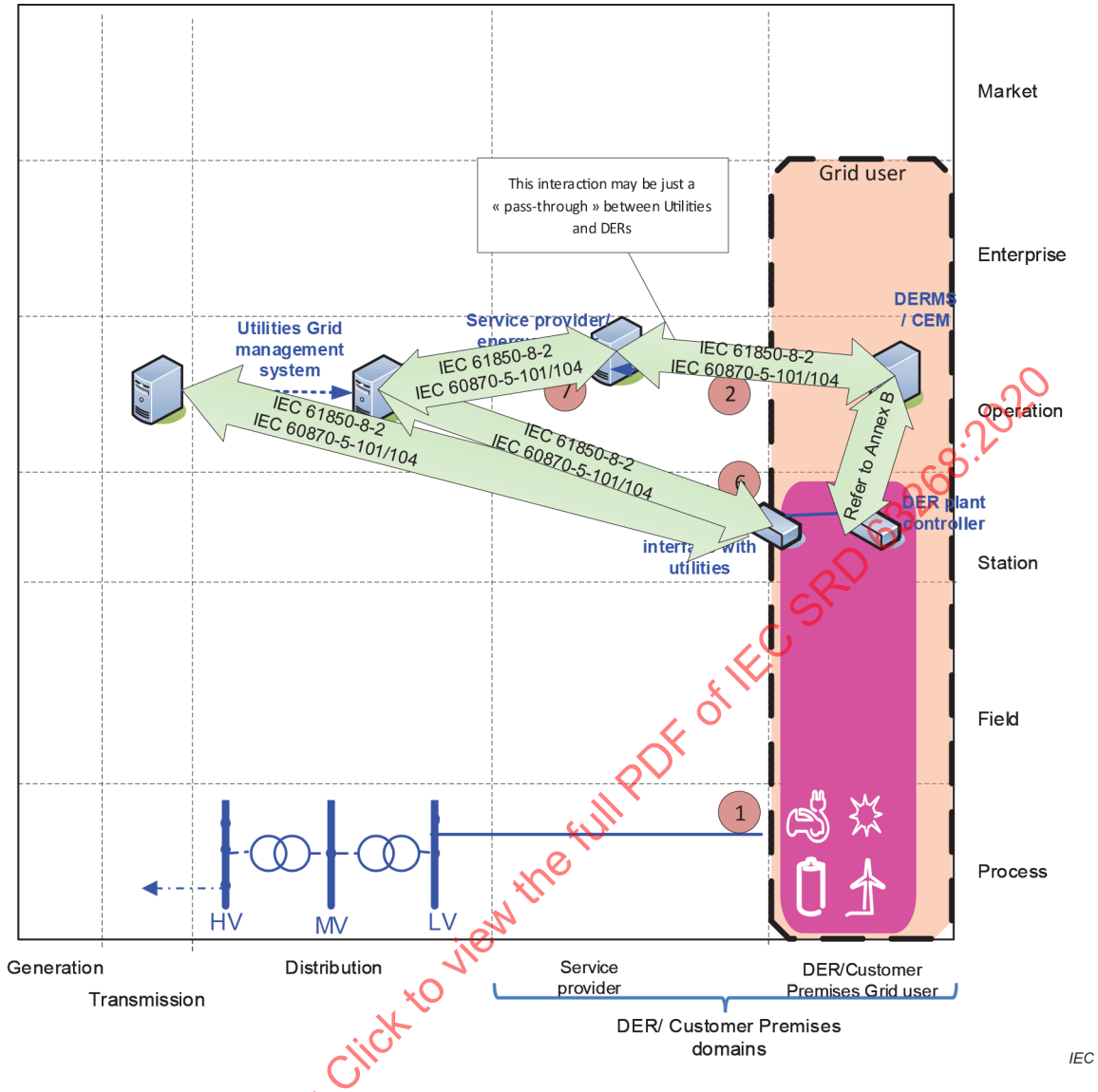
NOTE 1 For sake of simplicity, DER and Customer Premises domains have been merged into one, and the energy metering subdomain has been omitted.

NOTE 2 Only two paths are shown either direct through a specific interface or through the service provider and the top level DER management system/customer energy management system, but many other combinations are possible.

Figure A.1 – Interfacing the grid operator with grid users hosting DER units mapped to the SGAM component layer

A.3.3 Communications layer

The architecture in Figure A.2 identifies the main communication standards to be used for interfacing grid users hosting DER units with the grid operator and shows their mapping on the SGAM communication layer.



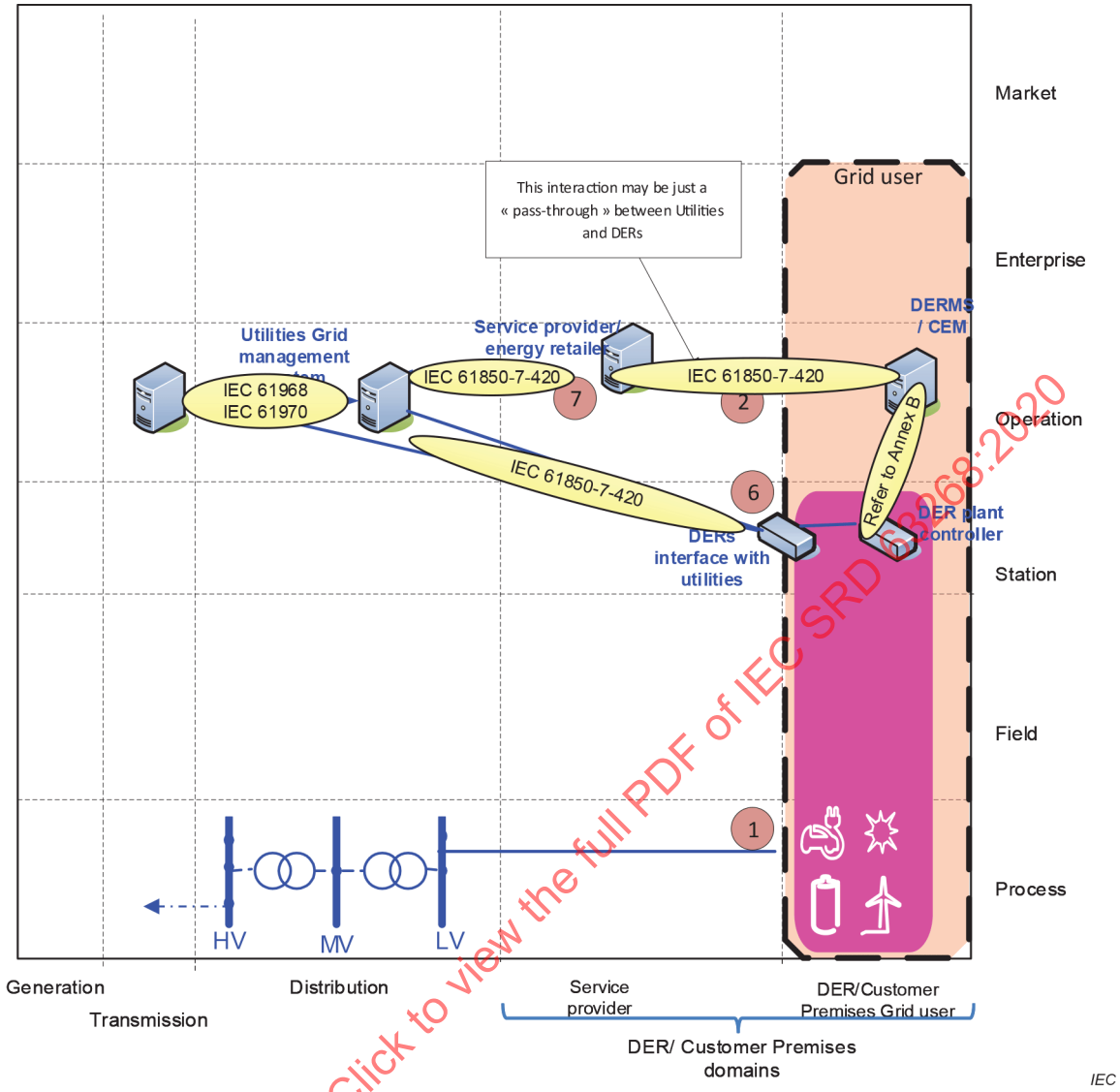
NOTE 1 For sake of simplicity, DER and Customer Premises domains have been merged into one, and the energy metering subdomain has been omitted.

NOTE 2 Only two paths are shown either direct through a specific interface or through the service provider and the top level DER management system/customer energy management system, but many other combinations are possible.

Figure A.2 – Interfacing the grid operator with grid users hosting DER units mapped to the SGAM communication layer

A.3.4 Information (Data) layer

Figure A.3 shows a mapping of interface of grid users hosting DER units to the Grid operator (DSO or TSO) into the SGAM information layer.



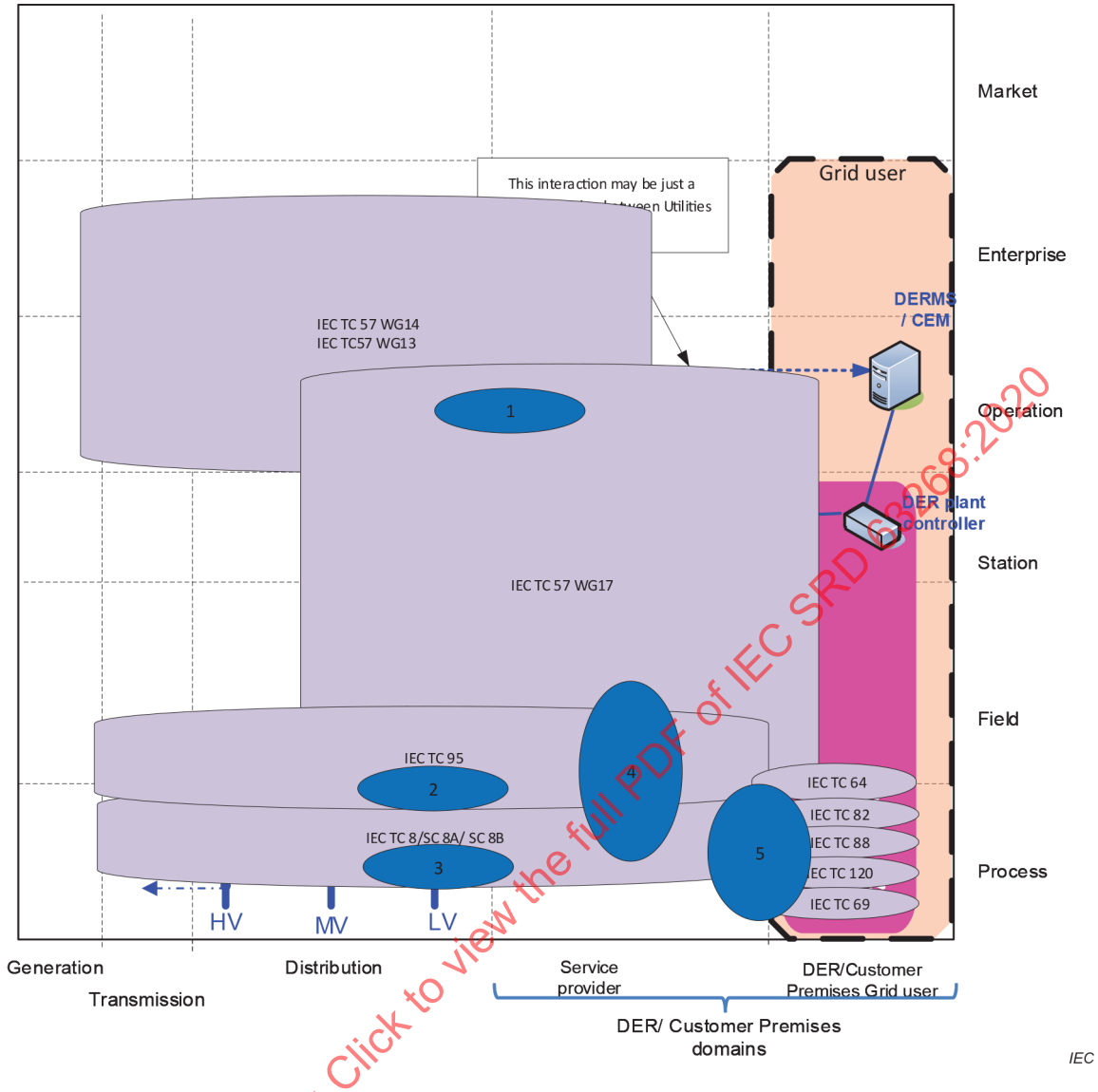
NOTE 1 For sake of simplicity, DER and Customer Premises domains have been merged into one, and the energy metering subdomain has been omitted.

NOTE 2 Only two paths are shown either direct through a specific interface or through the service provider and the top level DER management system/customer energy management system, but many other combinations are possible.

Figure A.3 – Interfacing the grid operator with grid users hosting DER units mapped to the SGAM information layer

A.3.5 Mapping IEC entities involved interfacing the grid operator with grid users

Figure A.4 shows the mapping of the IEC entities involved in supporting the standards listed in 6.6.



NOTE For sake of simplicity, DER and Customer Premises domains have been merged into one, and the energy metering subdomain has been omitted.

Figure A.4 – IEC entities involved in interfacing the grid operator with grid users hosting DER units

As shown in Figure A.4, the entities listed below were identified as handling these interactions:

- IEC TC 57 WG 13/WG 14 with the IEC 61970 series [25] and IEC 61968 series [24]
- IEC TC 57 WG 17 with the IEC 61850 series [22]
- IEC TC 8/SC 8A/SC 8B with the IEC 62786 series [31], the IEC TS 62898 series [33] but also IEC 60038, IEC 60059, IEC 60196
- IEC TC 64 with the IEC 60364 series [16]
- IEC TC 95 for protection/grid code functions and/or related measurements
- IEC TC 82 with IEC 61727 [20]
- IEC TC 88 with the IEC 61400 series [19]
- IEC TC 120 with the IEC 62933 series [40]
- IEC TC 69 with the IEC 61851 series [23] and ISO 15118 series [14]

TC 85 and SC 77A are not represented here because involved de facto on global topics such as measurements and EMC.

In addition, the same Figure A.4 helps in identifying the needed points of interactions (in blue).

1) Coordination between TC 57 WG 13/WG 14 and TC 57 WG 17 mostly around a common modelling approach of DER from both IEC CIM and IEC 61850 [22] sides. A joint TF is effectively already in place under IEC TC 57 WG 19 aiming at reaching that goal (results should be formalized in IEC 62361-102).
2) Coordination between TC 8/SC 8A/SC 8B and TC 95 on grid codes related functions, especially in frequency measurements. Already in place through the IEC TC 8/TC 85 JWG 12 (joint as well with TC 85 and SC 77A).
3) Coordination between TC 8/SC 8A/SC 8B and TC 57 WG 17 on grid codes functions. This would need a better formalization. Some informal exchanges have already taken place.
4) Coordination between TC 8/SC 8A/SC 8B. Already in place and formalized in the IEC TC 8 SBP.
5) Coordination between TC 8/SC 8A/SC 8B and TC 64, TC 82, TC 88, TC 120, TC 69 on Grid code implementation and other grid connexion requirements. This coordination process has started under the form of the IEC TC 8 JWG 10 with TC 120, TC 82, the other TCs being in the process of setting up equivalent liaisons.

Annex B
(informative)

Mapping the interfaces related to DER operation

B.1 Interfaces under consideration

Annex B focuses on the interactions listed in Table B.1.

Table B.1 – Interfaces related to DER operation

No.	Title	From	To
4	Interaction between the DER units (located possibly at DER grid user or at Customer Premises grid users) and the DER unit operation	DER operator	DER units from DER grid users or Customer Premises grid users
5	Interaction between the DER operator and the Customer Premises energy management system	Customer energy manager from Customer Premises grid users	DER operator

B.2 Main use cases

Annex B focuses on the main use cases listed in Table B.2.

Table B.2 – Supported business processes and use cases when considering DER operation

Business process	Use case
Protecting the grid assets	Protect a single equipment (Incomer/feeder, Transformer, Generator)
	Protect a zone outside of the substation boundary
	Perform networked protection logic (intertripping, logic selectivity, etc.)
	Perform networked security logic (interlocking, local/remote)
	Set/change protection parameters
Monitoring the grid flows	Monitoring electrical flows
	Monitoring power quality for operation (locally)
	Producing, exposing and logging time-stamped events
	Supporting time-stamped alarms management at all levels
	Capture, expose and analyse disturbance events
	Archive operation information
Maintaining grid assets	Monitoring assets conditions
	Supporting periodic maintenance (and planning)
	Optimize field crew operation
	Archive maintenance information
Managing power quality	VAr regulation
	Frequency support

Business process	Use case
Operate DER(s)	DER process management
	DER process management with reduced power output
	DER performance management
	DER remote control (dispatch)
	Registration/deregistration of DER in VPP
	Aggregate DER as technical VPP
	Aggregate DER as commercial VPP
Connect an active actor to the grid	Managing micro-grid transitions
	Managing generation connection to the grid
Blackout management	Restore power after blackout
Demand and production (generation) flexibility	Receiving metrological or price information for further action by consumer or CEM
	Generation forecast (from remote)
	Generation forecast (from local)
	Participating in electricity market
	Managing energy consumption or generation of DERs via local DER energy management system bundled in a DR program
	Managing energy consumption or generation of DERs and EVSE via local DER energy management system to increase local self-consumption
	Registration/deregistration of DER in DR program
System and security management	Discover a new component in the system
	Configure newly discovered device automatically to act within the system
	Distributing and synchronizing clocks

B.3 Mapping standards to the SGAM architecture

B.3.1 General

Addressing the considered interfaces will lead to different mappings depending whether DER domain is considered or Customer Premises; and even within Customer Premises, it appears important to distinguish Home and Building grid users from Industry grid users. And we have a kind of "ultimate" case related to multi-owner microgrid grid users, comprising instances of any kinds from DER domains (typically DER owners) and Customer Premises domains (typically home, buildings and industry owners) connected to such a microgrid, itself being connected "possibly" to the grid but possibly running off-grid.

Thus, four subclauses will address the four different cases:

1) DER domain grid users (B.3.2);
2) Home and Building grid users (B.3.3);
3) Industry grid users (B.3.4);
4) Multi-owner microgrid grid users (B.3.5);

B.3.2 Mapping standards to the SGAM architecture in case of DER grid users

B.3.2.1 Preamble

Subclause B.3.2 deals with the particular case of DER grid users composed of sets of DER units, organized by plants and operated remotely from a DERMS. Operation may be directly influenced by the data exchange with an external aggregator and/or connection with the market places.

A typical architecture mapped onto the SGAM architecture is shown in Figure B.1.

B.3.2.2 Component layer

The components of the interface DER units within DER grid users for operation purpose are depicted in Figure B.1.

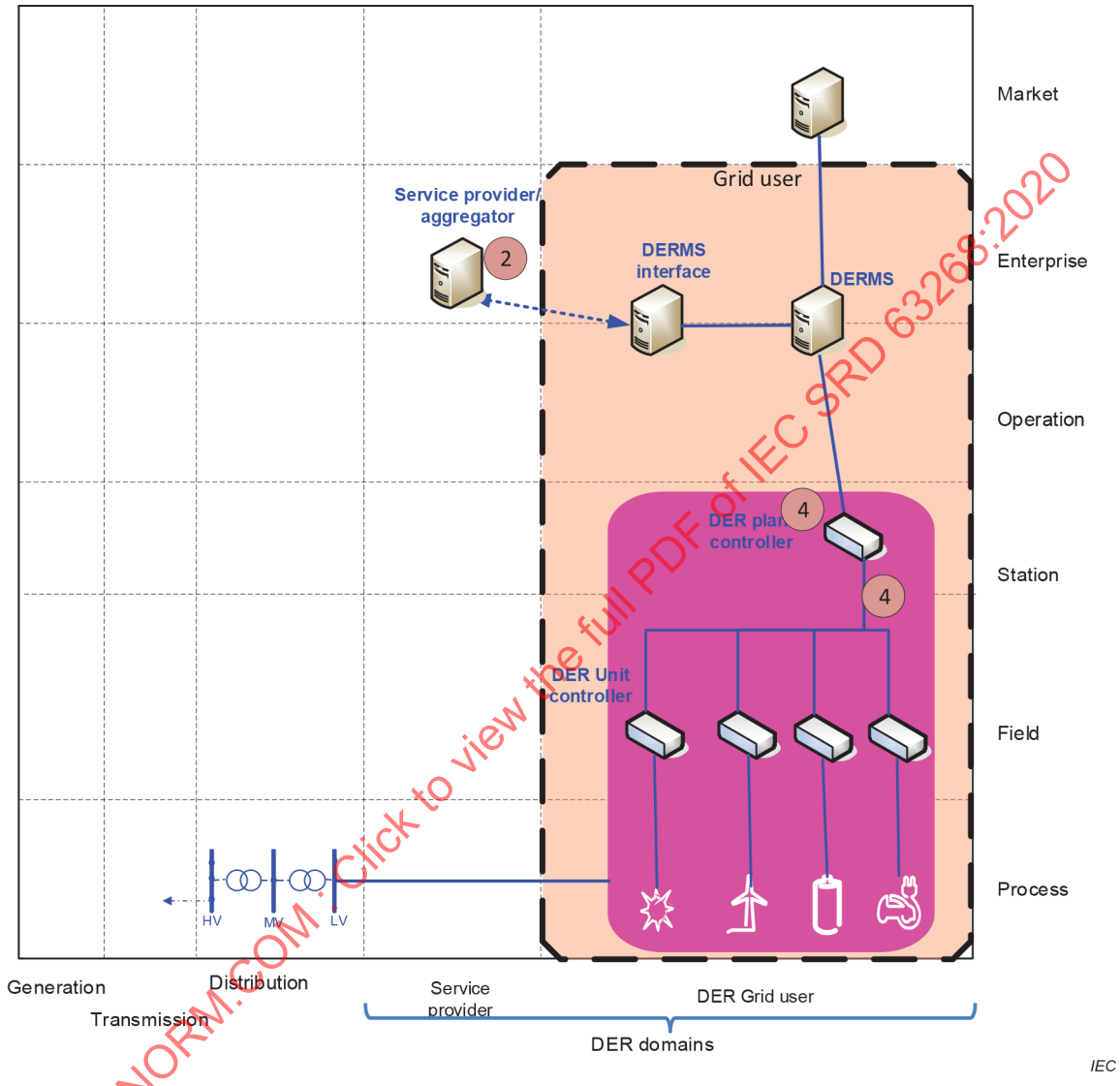
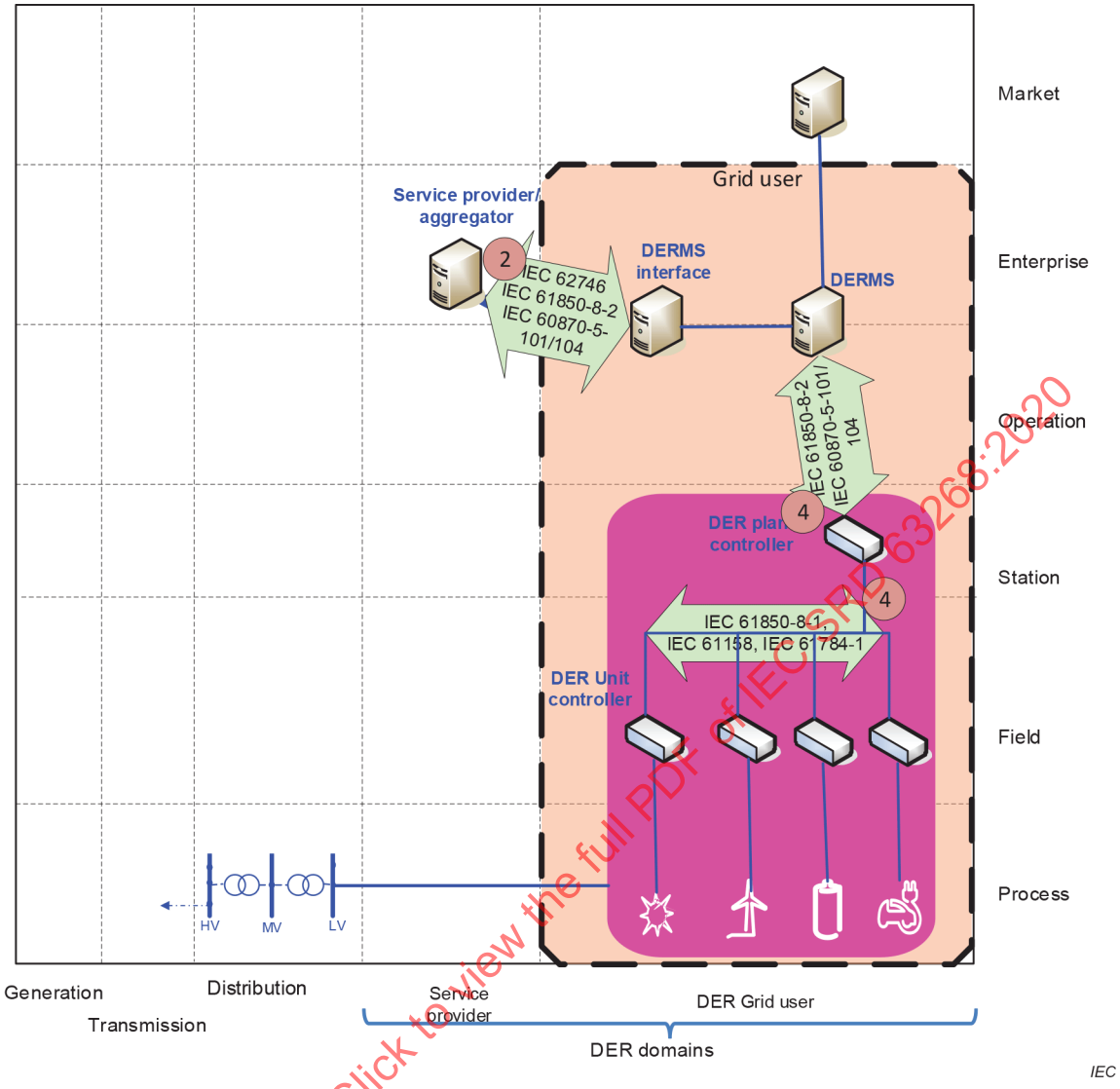


Figure B.1 – Interfacing DER units within DER grid users for operation purpose – component layer

B.3.2.3 Communications layer

The architecture in Figure B.2 identifies the main communication standards to be used for Interfacing DER units within DER grid users for operation purpose and shows their mapping onto the SGAM communication layer.



NOTE For sake of simplicity, Customer Premises domains and the energy metering subdomains have been omitted.

Figure B.2 – Interfacing DER units within DER grid users for operation purpose – communication layer

B.3.2.4 Information (Data) layer

Figure B.3 identifies the main communication standards to be used for interfacing DER units within DER grid users for operation purpose and shows their mapping onto the SGAM information layer.

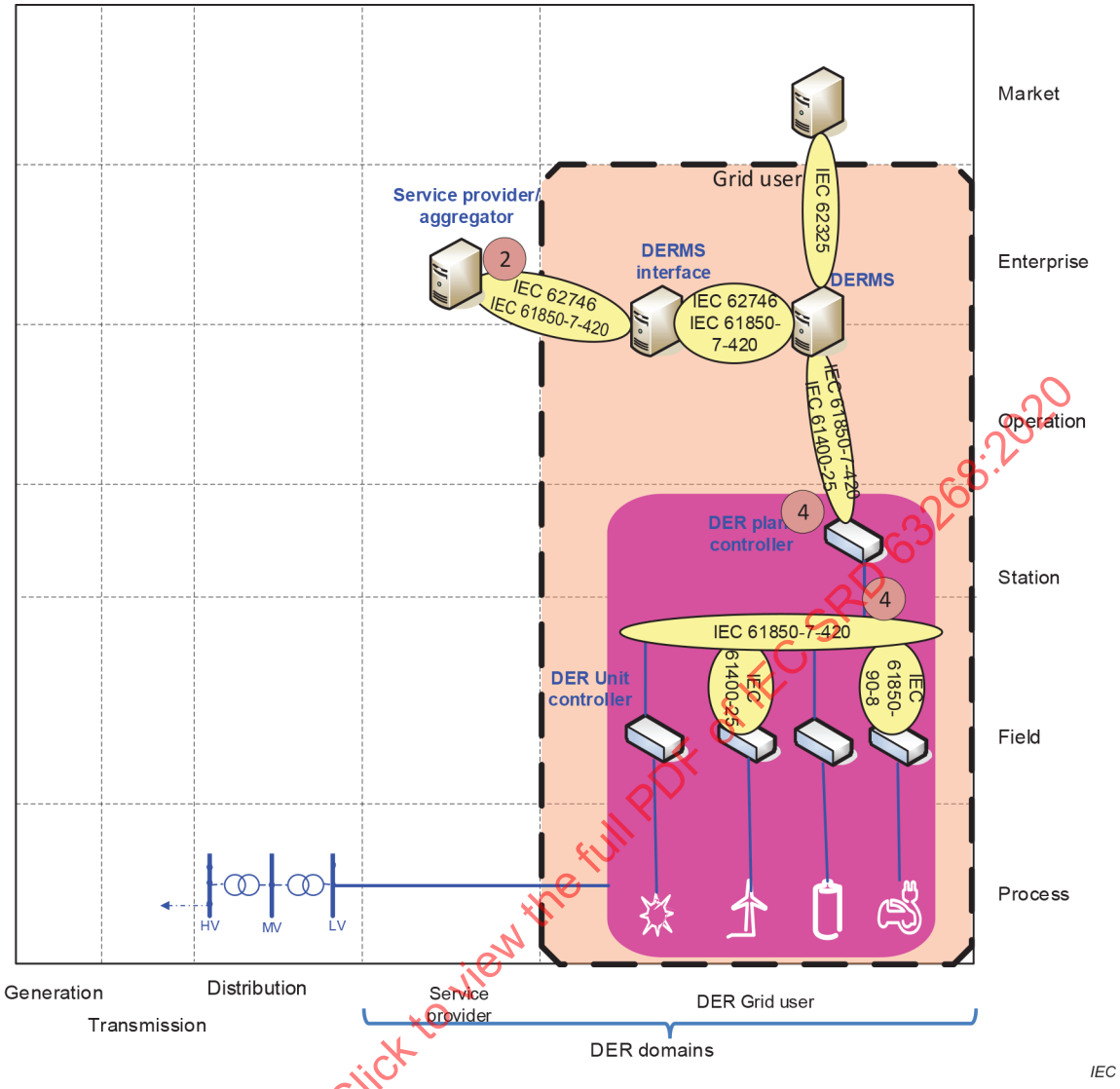


Figure B.3 – Interfacing DER units within DER grid users for operation purpose – information layer

B.3.2.5 Mapping IEC entities involved in interfacing DER units within DER grid users for operation purpose

Figure B.4 shows the mapping of the IEC entities whose standards are mentioned in B.3.2.1 to B.3.2.4.

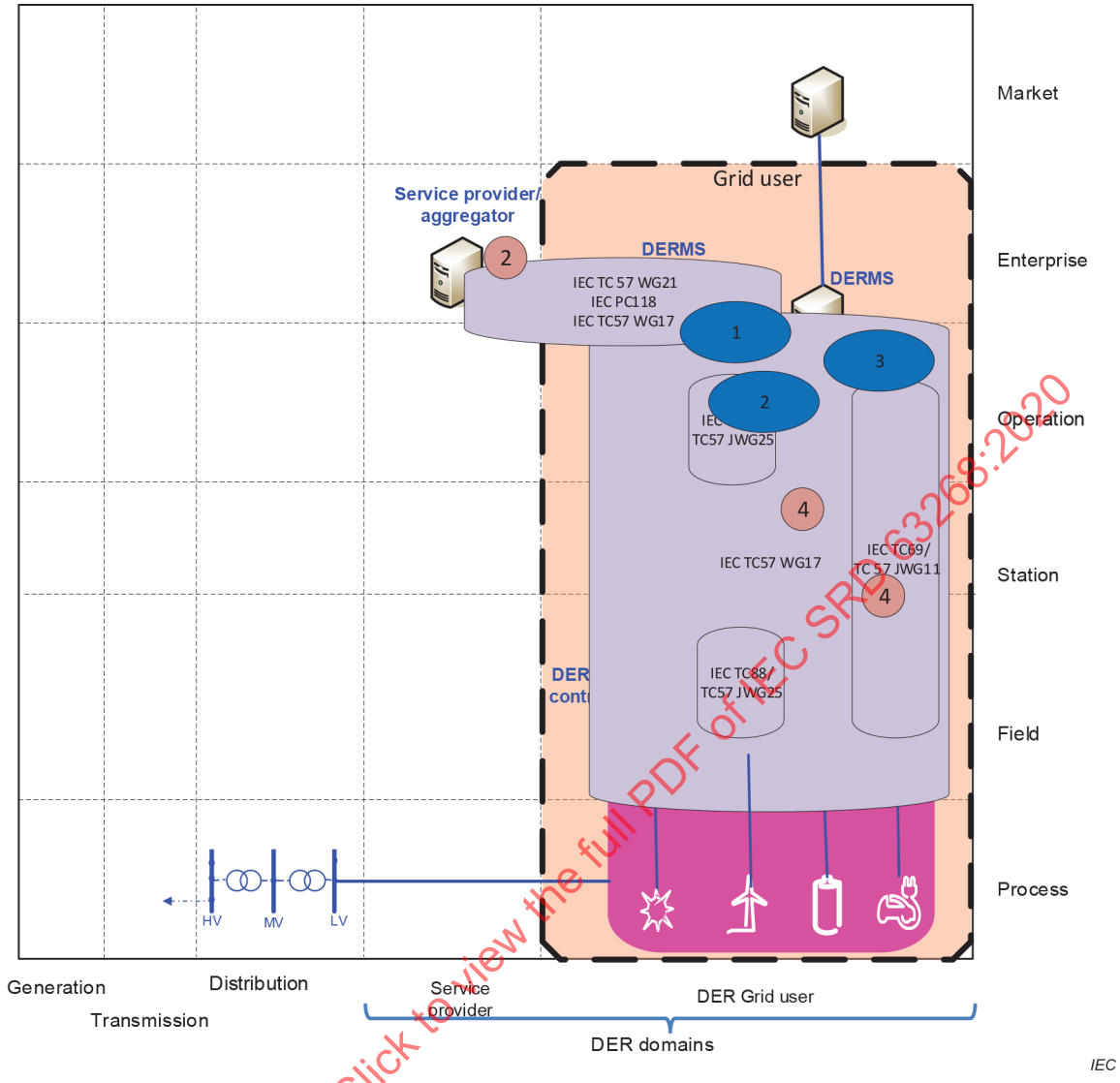


Figure B.4 – IEC entities involved in interfacing DER units within DER grid users for operation purpose

As a result of this mapping, the involved IEC entities appear to be:

- IEC TC 57 WG 17
- IEC TC 57 WG 21 (and ex IEC PC 118)
- IEC TC 88/TC 57 JWG 25
- IEC TC 69/TC 57 JWG 11

In addition, the same Figure B.4 helps in identifying the needed points of interactions (in blue).

1) Coordination between TC 57 WG 21, TC 57 WG 17 and the ex PC 118 activities dealing with demand-response and flexibilities. In that respect the border between the usage of IEC CIM and the usage of IEC 61850 [22] seems very difficult to position, and thus it is more likely to have both modelling techniques supporting the same features. Joint meetings between these three bodies took place; however the consistency of their deliveries together with the points addressed in Annex A would need a real formalization.
2) Coordination between TC 88/TC 57 JWG 25 and TC 57 WG 17. Some joint meetings were set up and are still to be encouraged.

3) Coordination between TC 69/TC 57 JWG 11 and TC 57 WG 17. Quite active liaisons are already in place with cross reporting and contribution. However, JWG 11 still suffers from a lack of representative of TC 57 in their group.

B.3.3 Mapping standards to the SGAM architecture in case of DER units within Home and Building grid users (specific Customer Premises grid users)

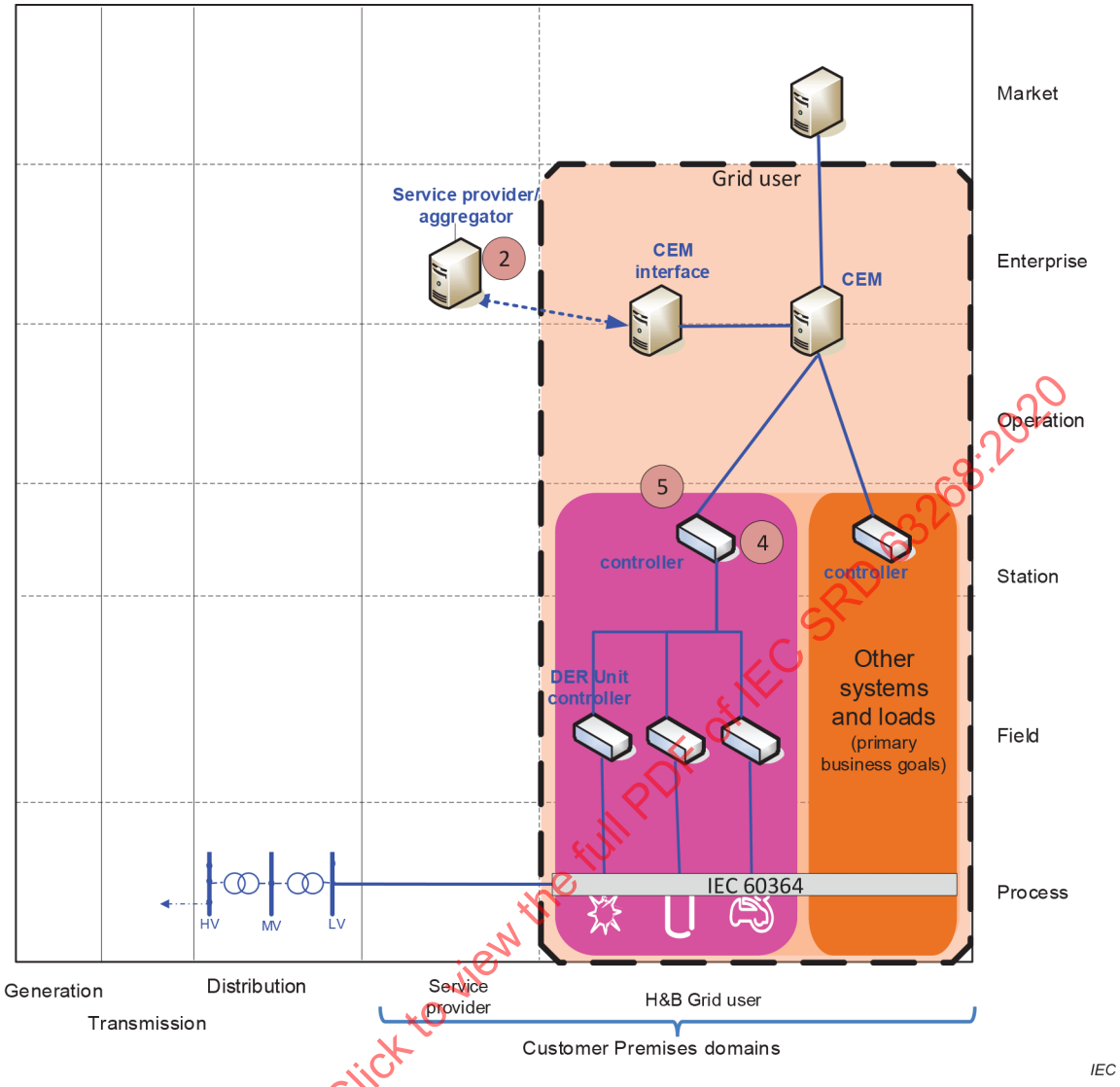
B.3.3.1 Preamble

Subclause B.3.3 deals with the particular case of sets of DER units, placed within a Home and Building grid user (specific Customer Premises grid user) and operated remotely from a customer energy manager (CEM). Operation may be directly influenced by the data exchange with an external aggregator and/or connection with the market places.

A typical architecture mapped onto the SGAM architecture is shown in Figure B.5.

B.3.3.2 Component layer

The components of the interface DER units within DER grid users for operation purpose are depicted in Figure B.5.

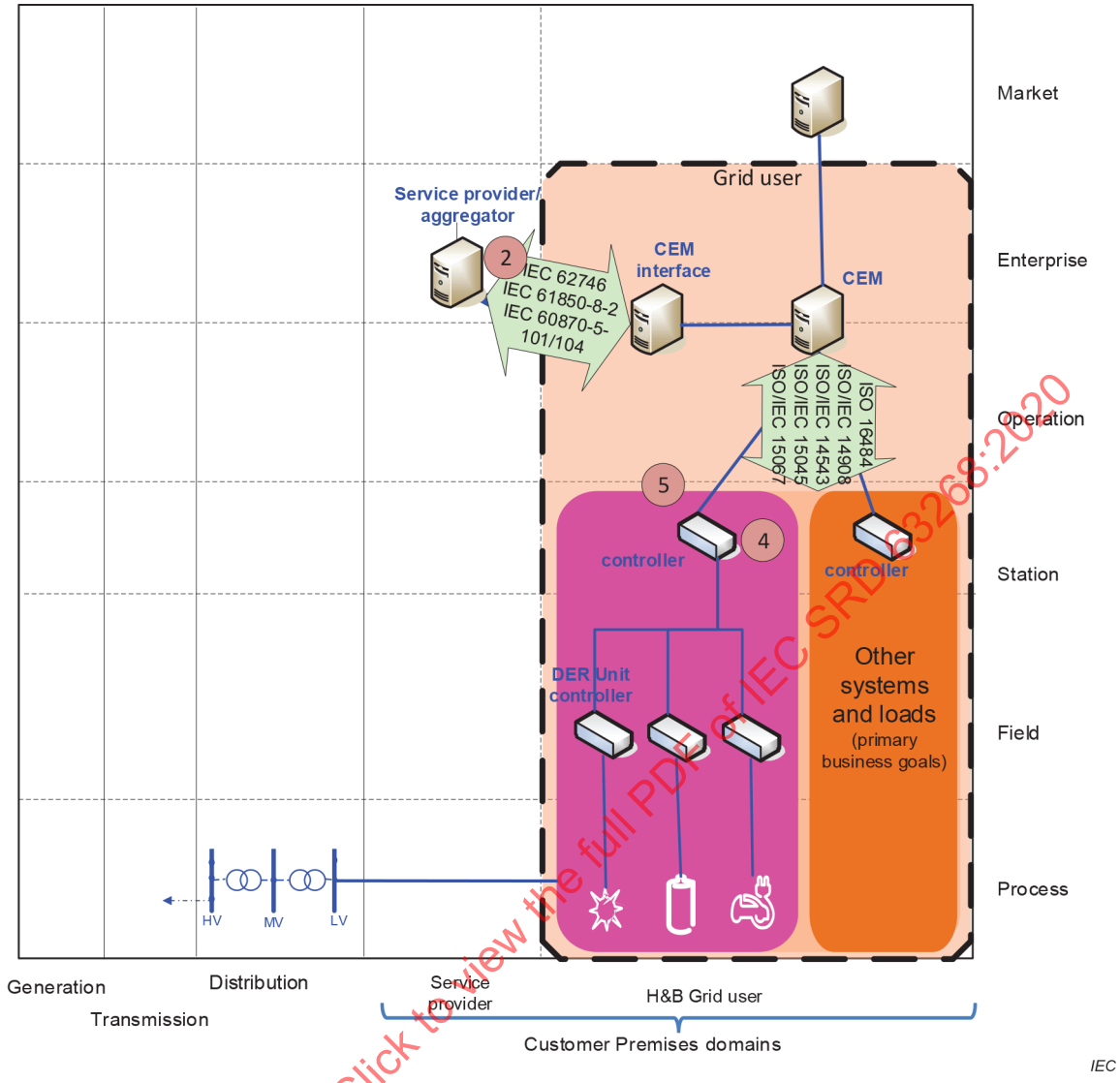


NOTE For sake of simplicity, DER domains and the energy metering subdomain have been omitted.

Figure B.5 – Interfacing DER units within Home and Building grid users for operation purpose – component layer

B.3.3.3 Communications layer

The architecture in Figure B.6 identifies the main communication standards to be used for interfacing DER units within DER grid users for operation purpose and shows their mapping onto the SGAM communication layer.

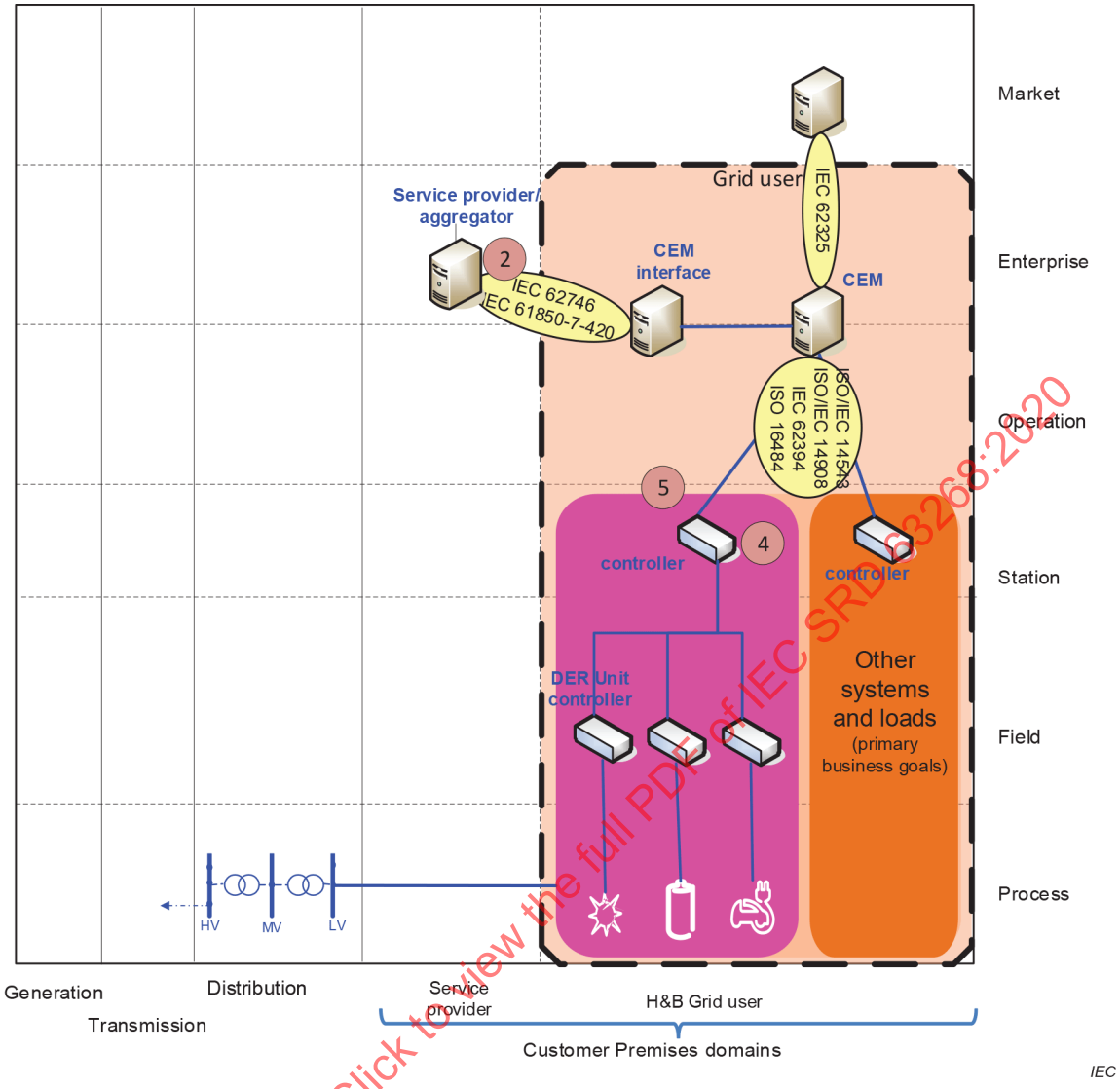


NOTE For sake of simplicity, the DER domain and the energy metering subdomain have been omitted.

Figure B.6 – Interfacing DER units within Home and Building grid users for operation purpose – communication layer

B.3.3.4 Information (Data) layer

Figure B.7 identifies the main communication standards to be used for interfacing DER units within DER grid users for operation purpose and shows their mapping onto the SGAM information layer.

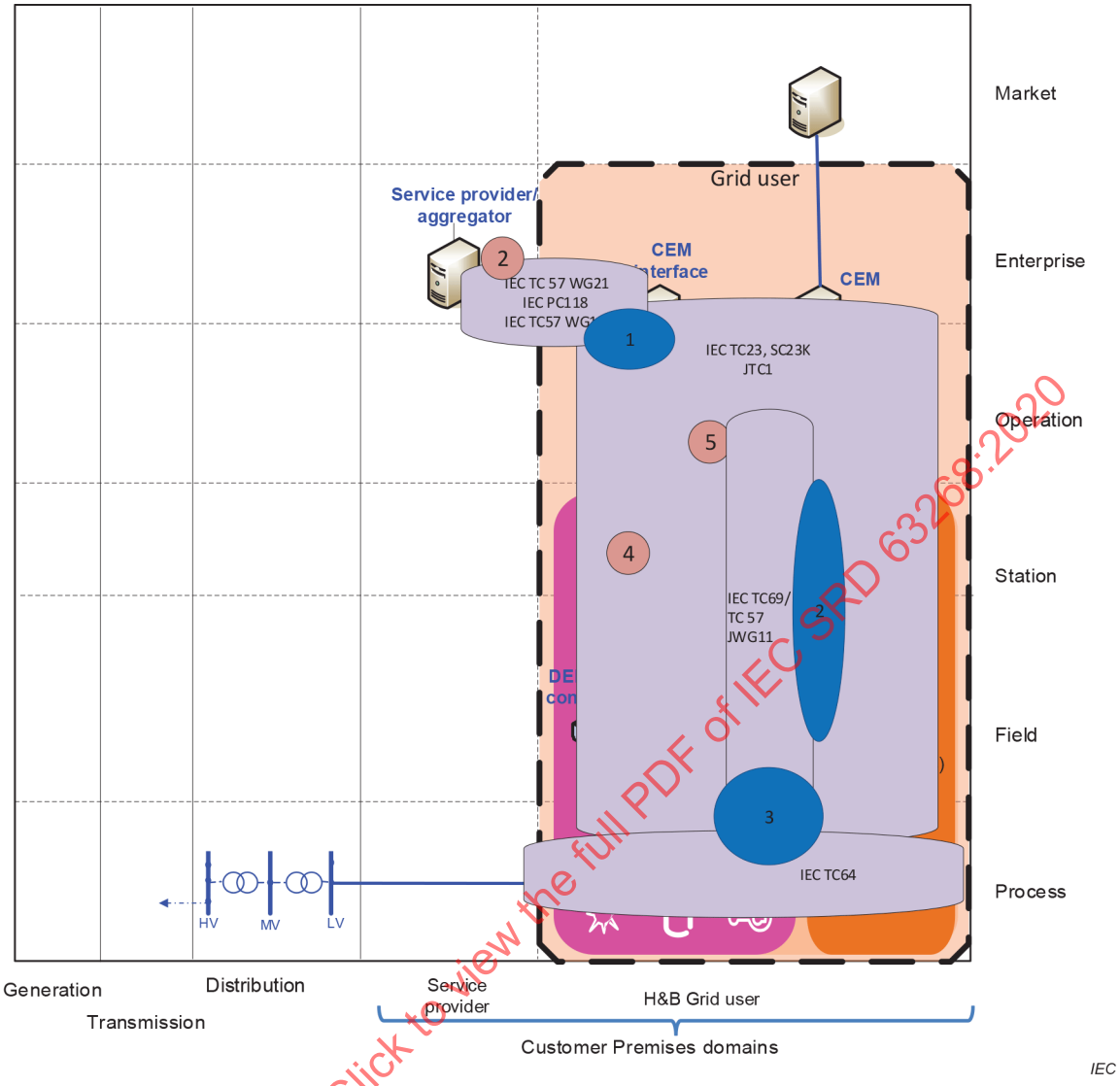


NOTE For sake of simplicity, the DER domain and the energy metering subdomain have been omitted.

Figure B.7 – Interfacing DER units within Home and Building grid users for operation purpose – information layer

B.3.3.5 Mapping IEC entities involved in interfacing DER units within Home and Building grid users for operation purpose

Figure B.8 shows the mapping of the IEC entities whose standards are mentioned in B.3.3.1 to B.3.3.4.



NOTE For sake of simplicity, the DER domain and the energy metering subdomain have been omitted.

Figure B.8 – IEC entities involved in interfacing DER units within Home and Building grid users for operation purpose

As a result of this mapping, the involved IEC entities appear to be:

- IEC TC 57 WG 17
- IEC TC 57 WG 21 (and ex IEC PC 118)
- IEC TC 69/TC 57 JWG 11
- IEC TC 23, SC 23K with IEC 62962 [44][3]

3 IEC TC 23 is working on particular requirements for switching equipment to control power sources (SECPS), which can be considered between CEM and loads within a building. This project is being developed as IEC 62991, currently at CD stage.

In a near future, IEC TC 23 will also address Customer Energy Manager System and smart grid according to the scope of SC 23K, to ensure a consistent set of standards in that field.

At least IEC 62962 and the future IEC 62991 would/could be mentioned, as well as SC 23K in the DC N°99, within the interfacing figures and stakeholder.

- ISO/IEC JTC 1/SC 25
- IEC TC 64

In addition, the same Figure B.8 helps in identifying the needed points of interactions (in blue).

1) Coordination between TC 57 WG 21, TC 57 WG 17 the ex PC 118 activities and SC 23K and ISO/IEC JTC 1/SC 25 dealing with demand-response and flexibilities. This would need to be set up.
2) Coordination between TC 69/TC 57 JWG 11 and SC 23K and ISO/IEC JTC 1/SC 25, to facilitate the integration of EV and its charging system into a HBAC/HBES.
3) Coordination between TC 69 and TC 64 to consider the connexion of EV internally to the Home or Building, especially in the case of V2G energy flows.

B.3.4 Mapping standards to the SGAM architecture in case of DER units within Industry grid users (specific Customer Premises grid users)

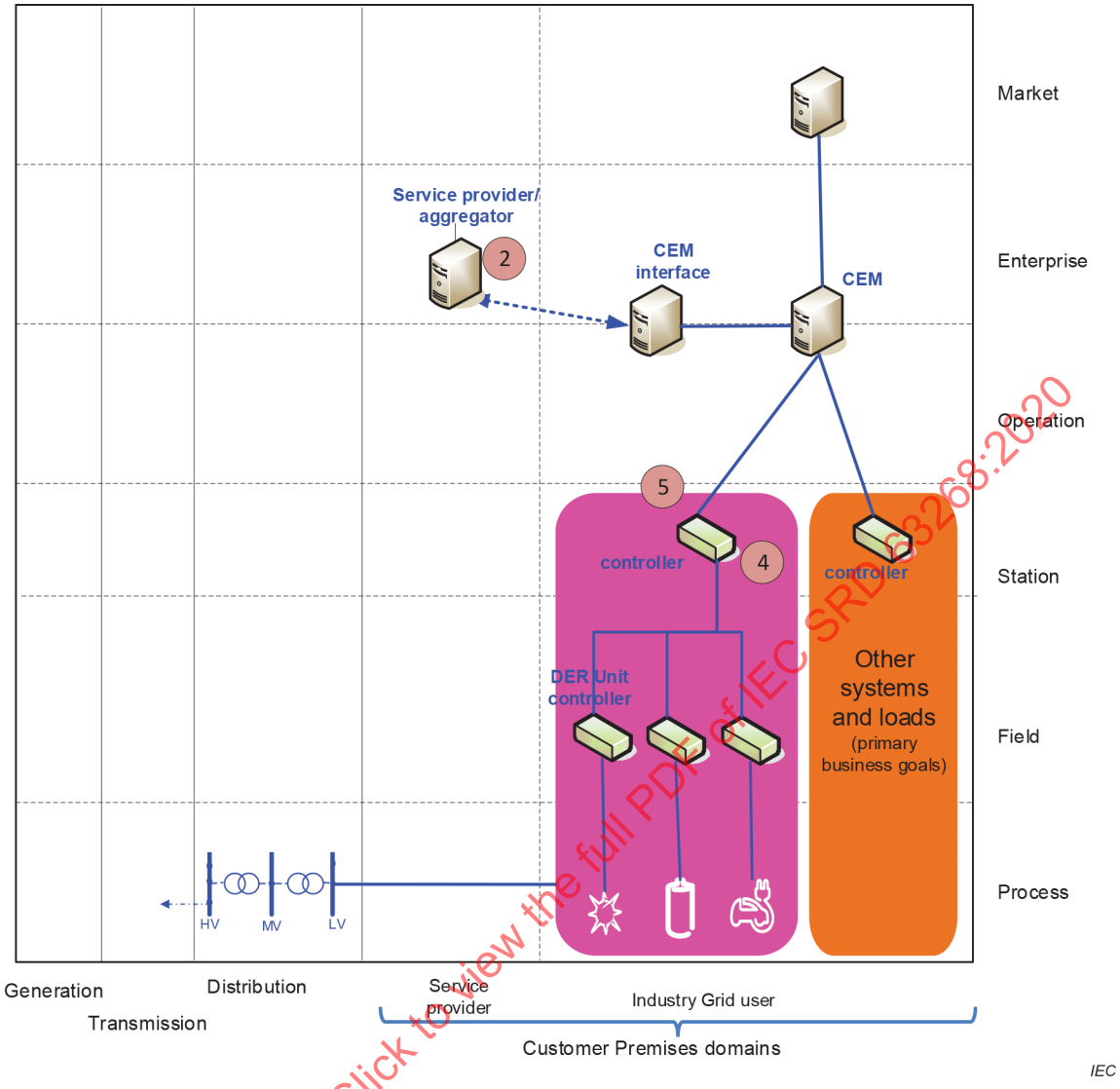
B.3.4.1 Preamble

Subclause B.3.4 deals with the particular case of sets of DER units, placed within an Industry grid user (specific Customer Premises grid user) and operated remotely from a customer energy manager (CEM). Operation may be directly influenced by the data exchange with an external aggregator and/or connection with the market places.

A typical architecture mapped onto the SGAM architecture is shown in Figure B.9.

B.3.4.2 Component layer

The components of the interface DER units within DER grid users for operation purpose are depicted in Figure B.9.

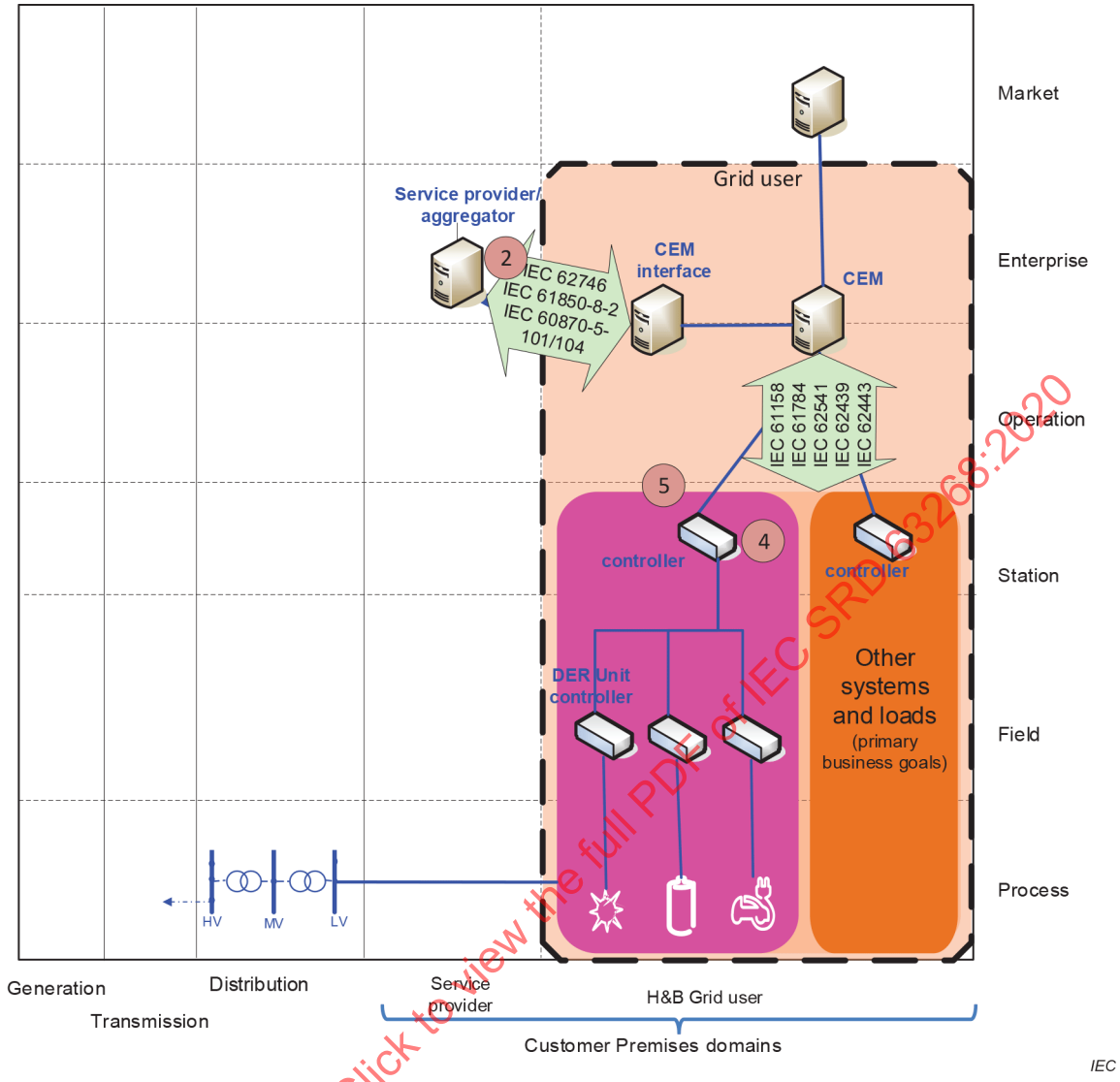


NOTE For sake of simplicity, Customer Premises domains and the energy metering subdomain have been omitted.

Figure B.9 – Interfacing DER units within Industry grid users for operation purpose – component layer

B.3.4.3 Communications layer

The architecture in Figure B.10 identifies the main communication standards to be used for Interfacing DER units within DER grid users for operation purpose and shows their mapping onto the SGAM communication layer.

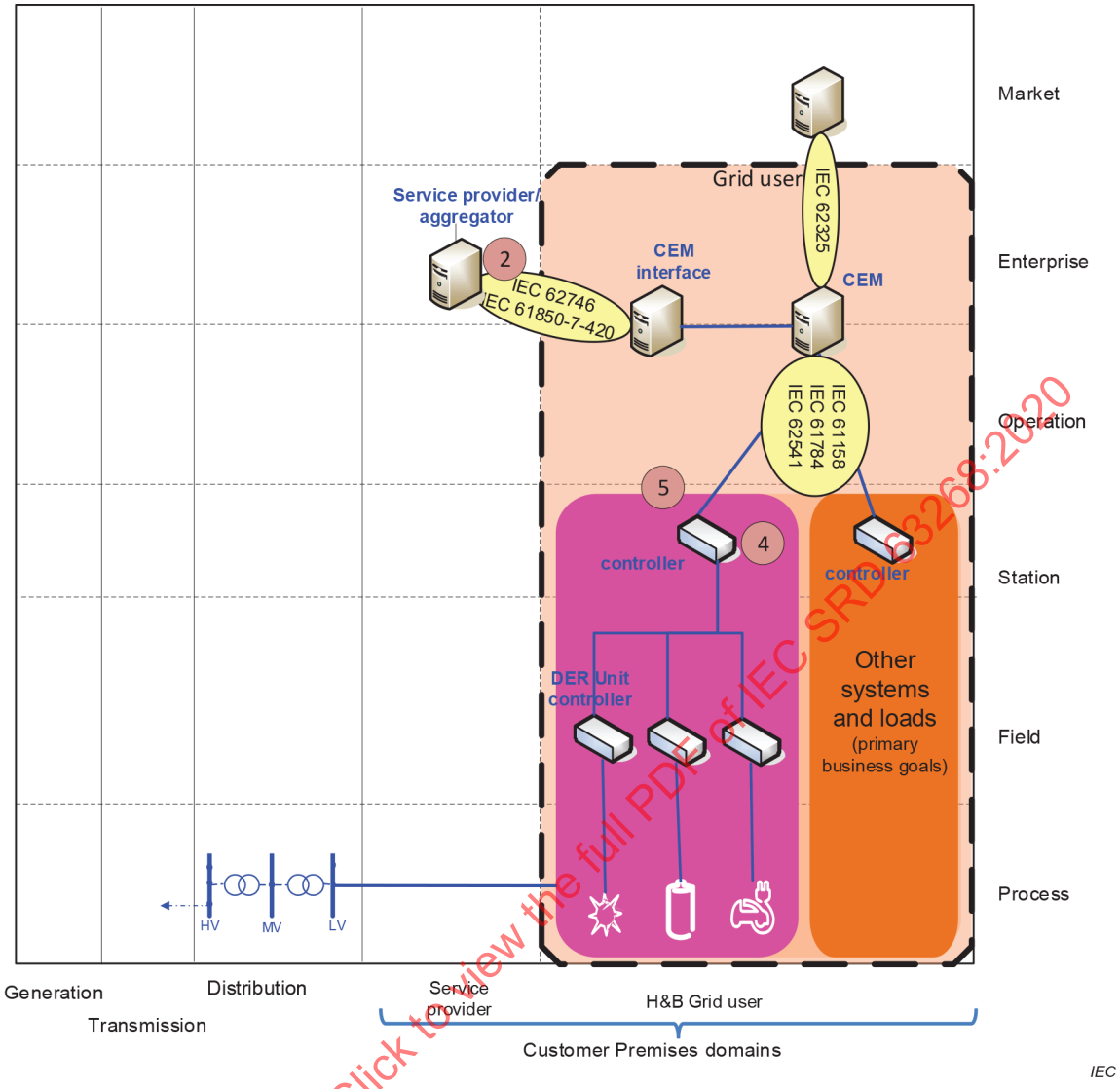


NOTE For sake of simplicity, the DER domain and the energy metering subdomain have been omitted.

Figure B.10 – Interfacing DER units within Industry grid users for operation purpose – communication layer

B.3.4.4 Information (Data) layer

Figure B.11 identifies the main communication standards to be used for Interfacing DER units within Industry grid users for operation purpose and shows their mapping onto the SGAM information layer.

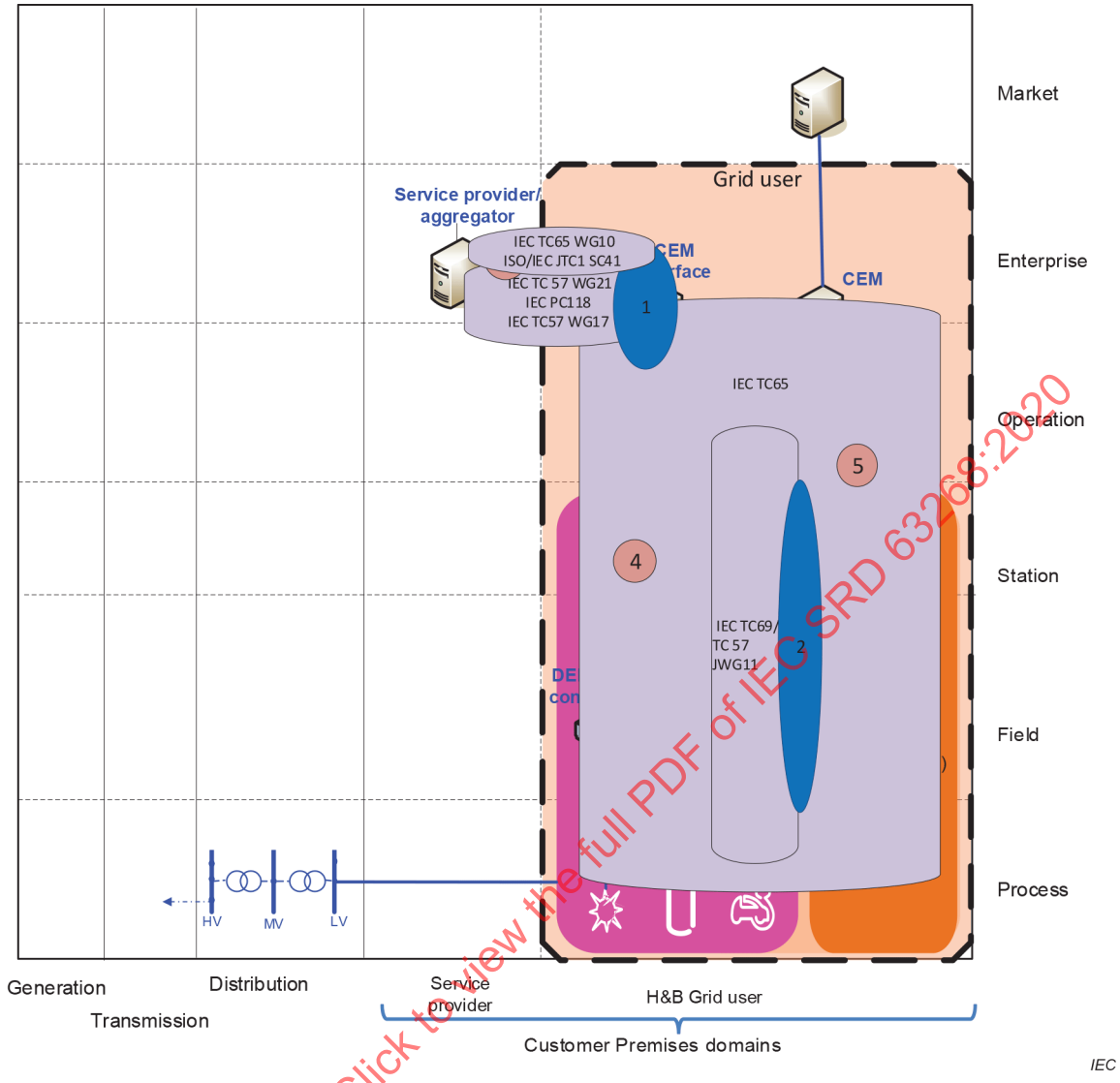


NOTE For sake of simplicity, the DER domain and the energy metering subdomain have been omitted.

Figure B.11 – Interfacing DER units within Industry grid users for operation purpose – information layer

B.3.4.5 Mapping IEC entities involved in interfacing DER units within Industry grid users for operation purpose

Figure B.12 shows the mapping of the IEC entities whose standards are mentioned in B.3.4.1 to B.3.4.4.



NOTE For sake of simplicity, the DER domain and the energy metering subdomain have been omitted.

Figure B.12 – IEC entities involved in interfacing DER units within Industry grid users for operation purpose

As a result of this mapping the involved IEC entities appear to be:

- IEC TC 57 WG 17
- IEC TC 57 WG 21 (and ex IEC PC 118)
- IEC TC 65–ISO/IEC JTC 1/SC 41 JWG 17 with the IEC 62872 (all parts) and many other TC 65 groups with the many communication and modelling standards
- IEC TC 69/TC 57 JWG 11

In addition, the same Figure B.12 helps in identifying the needed points of interactions (in blue).

1) Coordination between TC 57 WG 21, TC 57 WG 17 activities and the TC 65 JWG 17 and dealing with demand-response and flexibilities. This would need to be set up.
2) Coordination between TC 69/TC 57 JWG 11 and TC 65, to facilitate the integration of EV and its charging system into industrial process control systems.

B.3.5 Mapping standards to the SGAM architecture in case of a multi-owner microgrid (specific Customer Premises domain grid users)

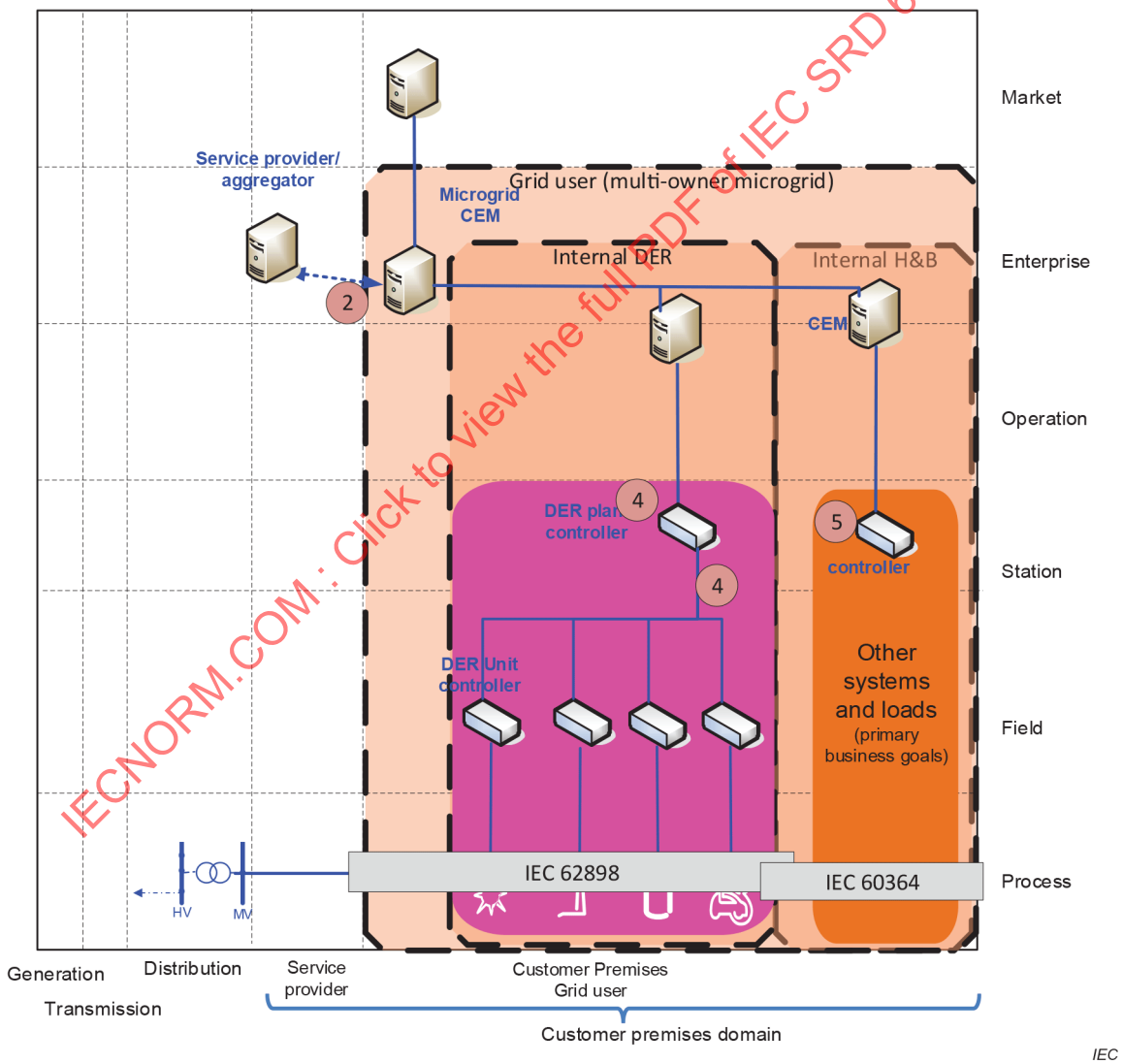
B.3.5.1 Preamble

Subclause B.3.5 deals with the particular case of sets of DER units, placed within a multi-owner microgrid. A multi-owner microgrid is defined as a combined DER composed of DERs and other elements such as homes, buildings or even industries, owned by different actors (i.e. having possibly different business objectives). As a microgrid, such an installation has the built-in capability to run off-grid, i.e. disconnected from the supplying grid (typically a distribution grid but possibly a transmission grid).

A typical architecture mapped onto the SGAM architecture is shown in Figure B.13.

B.3.5.2 Component layer

The components of multi-owner microgrid for operation purpose are depicted in Figure B.13.

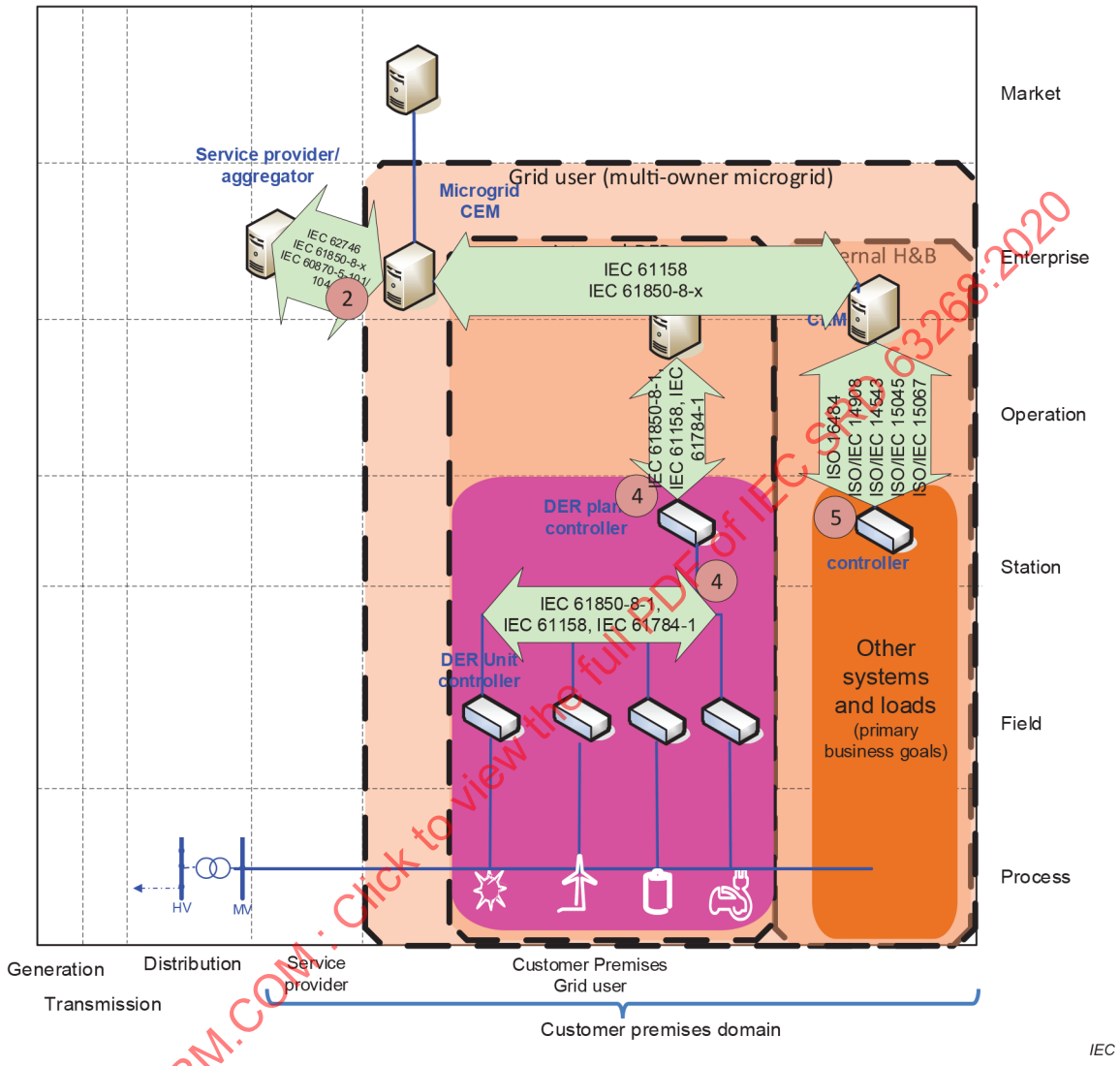


NOTE For sake of simplicity, the DER domain and the energy metering subdomain have been omitted.

Figure B.13 – Interfacing DER units within a multi-owner microgrid for operation purpose – component layer

B.3.5.3 Communications layer

The architecture in Figure B.14 identifies the main communication standards to be used for Interfacing DER units within a multi-owner microgrid for operation purpose and shows their mapping onto the SGAM communication layer.

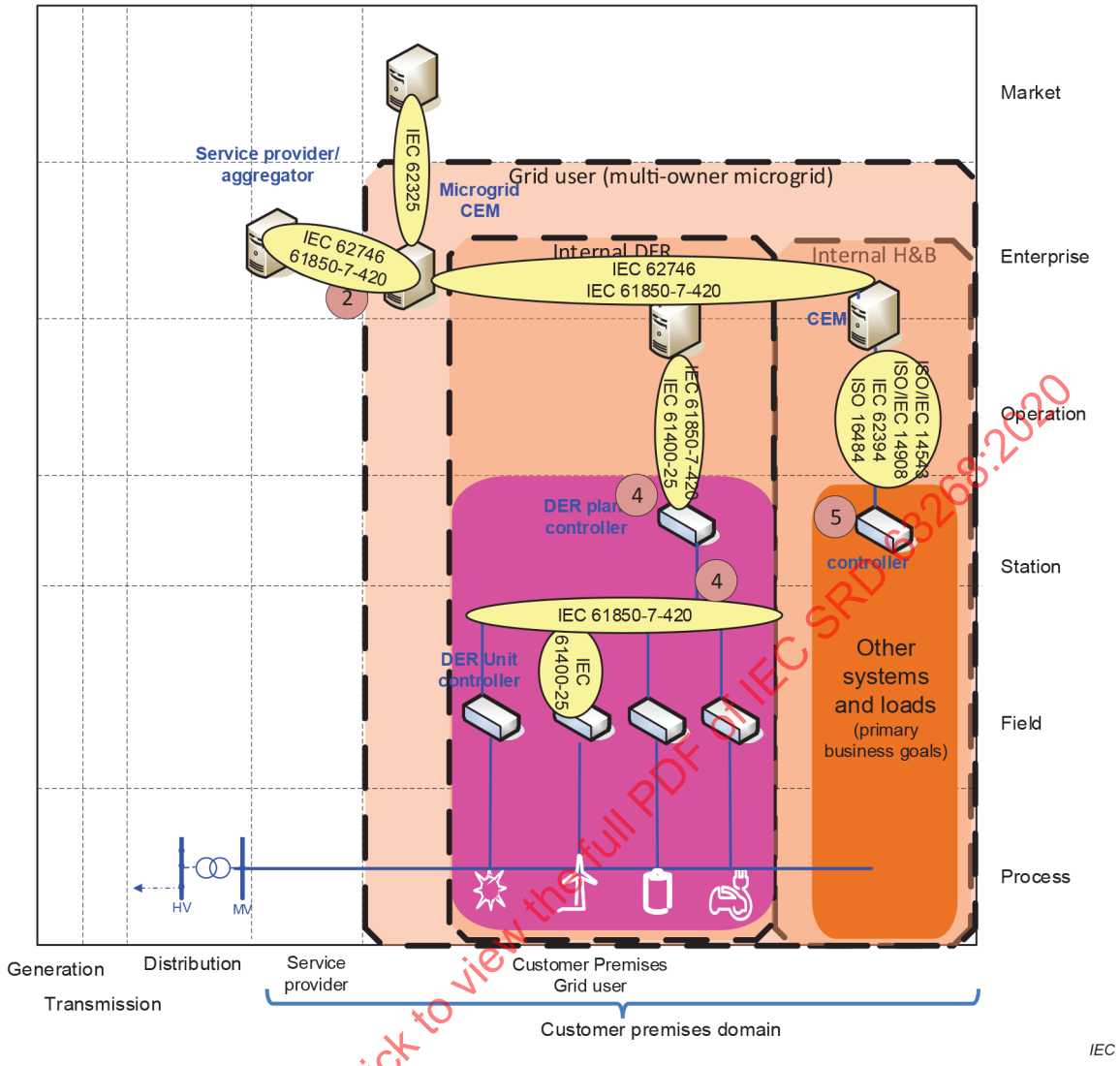


NOTE For sake of simplicity, the DER domain and the energy metering subdomain have been omitted.

Figure B.14 – Interfacing DER units within a multi-owner microgrid for operation purpose – communication layer

B.3.5.4 Information (Data) layer

Figure B.15 identifies the main communication standards to be used for Interfacing DER units within a multi-owner microgrid for operation purpose and shows their mapping onto the SGAM information layer.

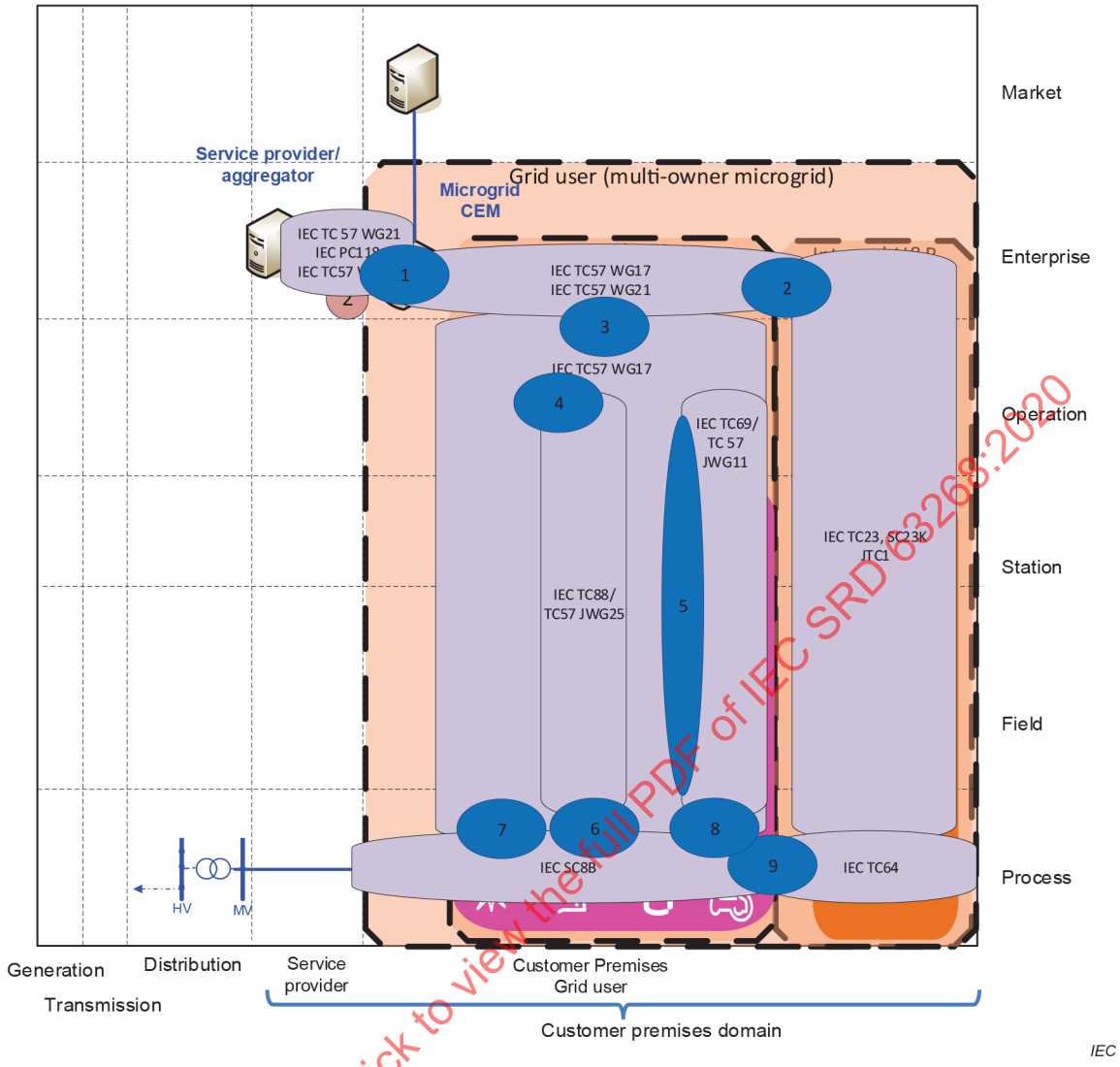


NOTE For sake of simplicity, DER domains and the energy metering subdomain have been omitted, and only one internal DER and one internal H&B are shown.

Figure B.15 – Interfacing DER units within a multi-owner microgrid for operation purpose – information layer

B.3.5.5 Mapping IEC entities involved in interfacing DER units within a multi-owner microgrid for operation purpose

Figure B.16 shows the mapping of the IEC entities whose standards are mentioned in B.3.5.1 to B.3.5.4.



NOTE For sake of simplicity, DER domains and the energy metering subdomain have been omitted, and only one internal DER and one internal H&B are shown.

Figure B.16 – IEC entities involved in interfacing DER units within a multi-owner microgrid for operation purpose

As a result of this mapping, the involved IEC entities appear to be:

- IEC TC 8/SC 8B
- IEC TC 57 WG 17
- IEC TC 57 WG 21 (and ex IEC PC 118)
- IEC TC 88/TC 57 JWG 25
- IEC TC 69/TC 57 JWG 11
- IEC TC 23, SC 23K
- ISO/IEC JTC 1/SC 25
- IEC TC 64
- IEC TC 120

In addition, the same Figure B.16 helps in identifying the needed points of interactions (in blue). It shows that this situation is the superposition of most of the situations already described above. The additional elements, compared to what has already been shown, are highlighted below.

1) Coordination between TC 57 WG 21, TC 57 WG 17 to consider hierarchical approach of DERs/microgrids.
2) Coordination between TC 57 WG 21, TC 57 WG 17 and SC 23K and ISO/IEC JTC 1/SC 25 dealing with operating flexibilities inside the building. This would need to be set up.
3) As already depicted in B.3.2.5.
4) As already depicted in B.3.2.5.
5) As already depicted in B.3.2.5.
6) Coordination between SC 8B and TC 88/TC 57 JWG 25 on operating wind farms in microgrids.
7) Coordination between SC 8B and TC 57 WG 17 on operating DERs in microgrids.
8) Coordination between SC 8B and TC 69/TC 57 JWG 11 on operating EVs in microgrids.
9) As already depicted in A.3.5.

Annex C
(informative)

Mapping the interfaces between grid users and service providers and energy metering

C.1 Interfaces under consideration

Annex C focuses on the interactions listed in Table C.1.

The main reason for merging service providers and energy metering is that energy metering actors exist principally to serve the service providers in buying or selling energy or energy-related services, thus the real requirements for energy metering directly come from the services to be supported.

Table C.1 – Interfaces under consideration to and from the service providers and energy metering

No.	Title	From	To
2	Service provider interaction	Service provider	Grid user
3	Energy metering interactions with grid users	Energy metering	Grid user
7	Service provider interaction with the utility	Service provider	Utility
8	Service provider interaction with the energy metering	Energy metering	Service provider
9	Energy metering interaction with the utility	Energy metering	Utility

C.2 Main use cases

Annex C focuses on the main use cases listed in Table C.2.

Table C.2 – Supported business processes and use cases when considering interfaces with service providers and energy metering

Business process	Use case
Demand and production flexibility	Sending/receiving metrological information for further action by consumer or CEM
Demand and production flexibility	Sending price information for further action by consumer or CEM
Demand and production flexibility	Direct load/generation control signals
Demand and production flexibility	Convey requests for ancillary services
Demand and production flexibility	Convey forward power usage projections
Demand and production flexibility	Convey user information
Demand and production flexibility	Managing energy consumption or generation of DERs via local DER energy management system bundled in a DR program
System and security management	Registration/de-registration of smart devices
System and security management	Enabling remote control of smart devices
Contracting and billing	Obtain meter readings on request

Business process	Use case
Contracting and billing	Obtain scheduled meter reading
Contracting and billing	Set and maintain contractual[a] parameters in the meter
Contracting and billing	Execute supply control
Contracting and billing	Execute load control
Customer support	Provide information back to the grid user
Infrastructure maintenance	Meter commissioning and registration
Infrastructure maintenance	Meter supervision
Infrastructure maintenance	Maintenance of the security system
Infrastructure maintenance	Manage events and alarms
Infrastructure maintenance	Firmware update
Infrastructure maintenance	Clock synchronization
Infrastructure maintenance	Disconnection and re-connection of the consumer's premises
Infrastructure maintenance	Quality of supply supervision
[a] Considering credit mode or debit mode (pre-payment) operation of the meter.	

C.3 Mapping standards to the SGAM architecture

C.3.1 Preamble

The service providers communication interfaces, as well as the energy metering interfaces, in relation with grid users are shown in Figure C.1. They are mapped over the SGAM.

Note in the diagrams of C.3.2, that the split of the "DER/Customer Premises grid users" domain on the right is intended to illustrate typical market model roles where assets in the home/building are not owned/operated by the actor having the role of electricity service supplier. However, from an implementation point of view the same actor could play multiple roles. Market models vary, for example regarding meter ownership and operation, and are subject to national structures and regulation, so this representation should not be reflecting a specific role organization.

C.3.2 Component layer

The components of such interfaces are depicted diagrammatically in Figure C.1.

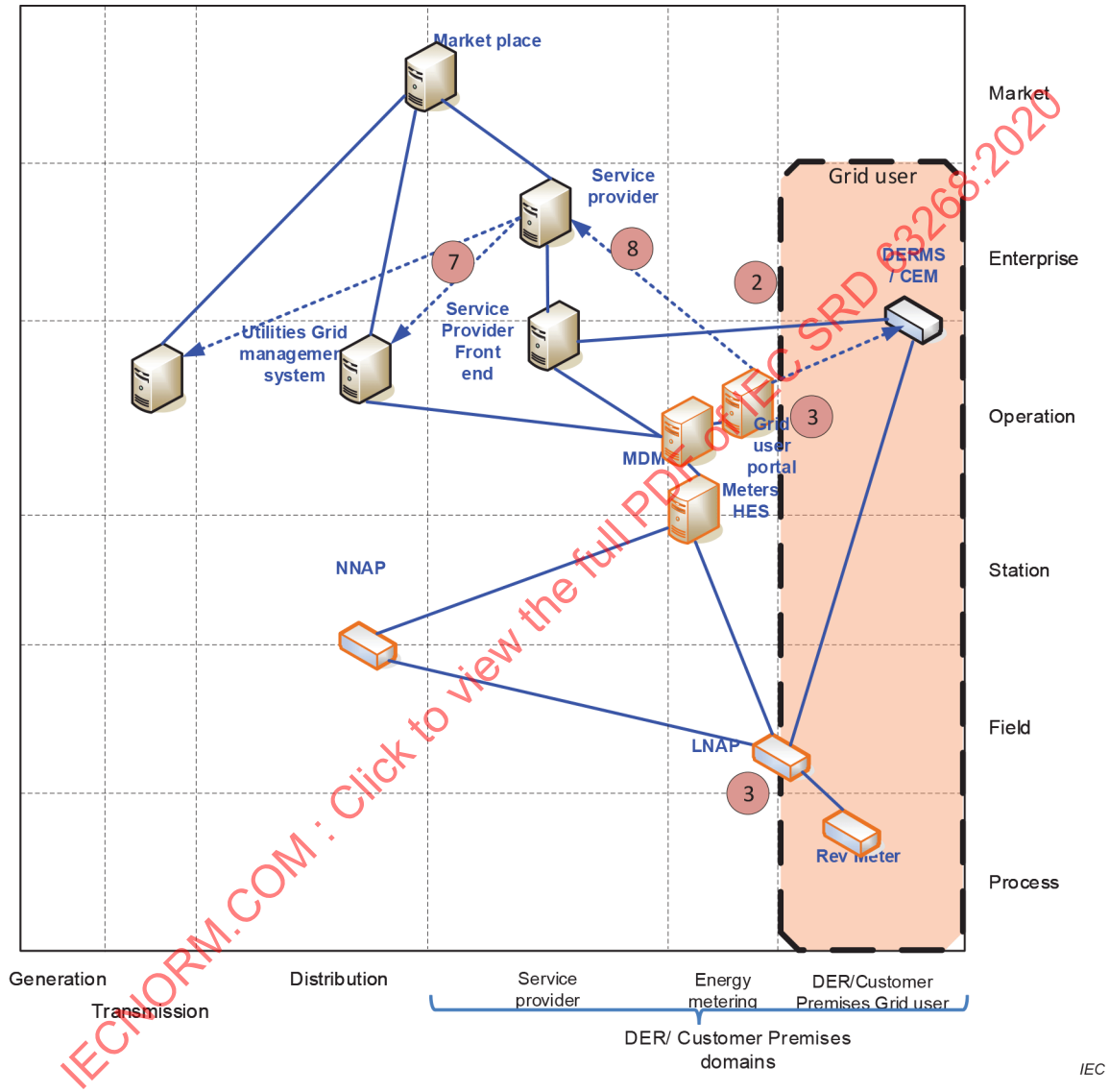
The exact composition of the energy metering architecture and interface to grid users will depend on the configuration chosen. Figure C.1 shows the components that may be part of the Energy Metering Infrastructure. Meters for different flows (Electricity, Gas, Heat and Water) represent the end devices on field level. Revenue meters at (residential) Customer Premises (which are subject to national metrological approvals) are distinguished from meters used in industrial, commercial environments or for grid automation purposes. The meter may have an interface to a simple display unit, or it may be interfaced to a proper home automation system.

Meters and home/building automation end devices may be interconnected via LNAPs (local network access points).

The NNAP (neighbourhood network access point) is typically located at distribution station level. The NNAP may be part of a simple communication gateway or of a data concentrator offering comprehensive data processing features.

The meters are connected (directly or via LNAP and/or NNAP) to the head end system (HES). The HES manages the data exchange with the meters and supervises the WAN/LAN communication.

The MDM (meter data management) system interfaces to the ERP systems and to the market systems. In particular, the MDM accepts metering tasks (data acquisition, command distribution, etc.) from the "superior" systems and returns the validated results. The communication with the automatic metering infrastructure (AMI) endpoints is done via the HES.



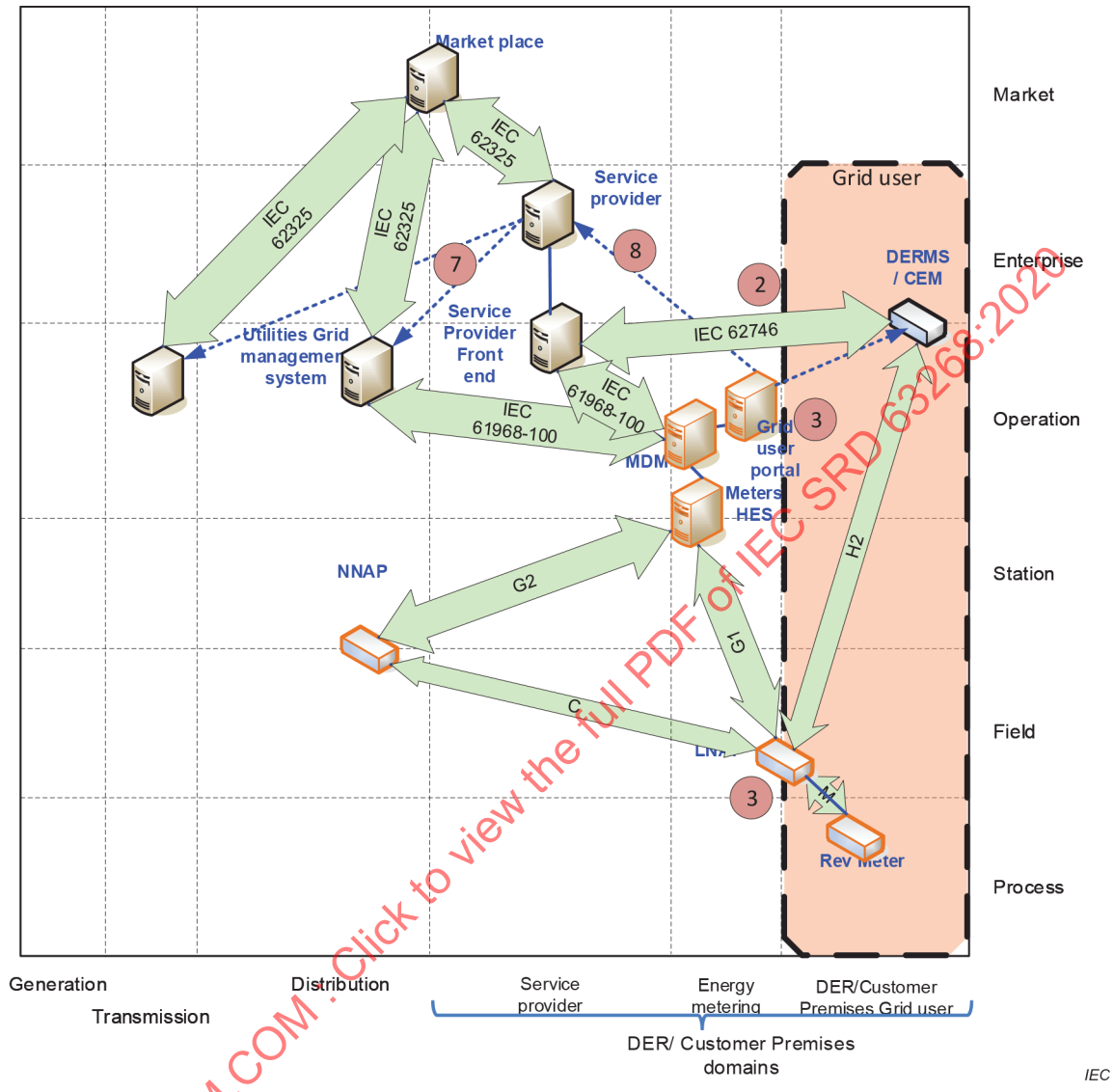
NOTE The components marked in orange are related to the energy metering and serve to support service provider interface in two ways: provide access to the grid users through the smart meters for handling the service (as a pure communication channel) – interface 2, and/or provide back the metered values of the energy flow – interface 8.

Figure C.1 – Interfacing the service providers and energy metering – in relationship with grid users (example) mapped to the SGAM component layer

C.3.3 Communications layer

The service providers communication interfaces, as well as the energy metering interfaces, in relation with grid users are identified in Figure C.2 with the principal interfaces as M, C, G and H as more precisely defined in the IEC TR 63097 [1].

Figure C.2 shows a mapping of these interfaces into the SGAM communication layer. The standards referenced as G1, G2, C, H2, M are so numerous that it does not make real sense to give the details here. Details are provided in Annex G.

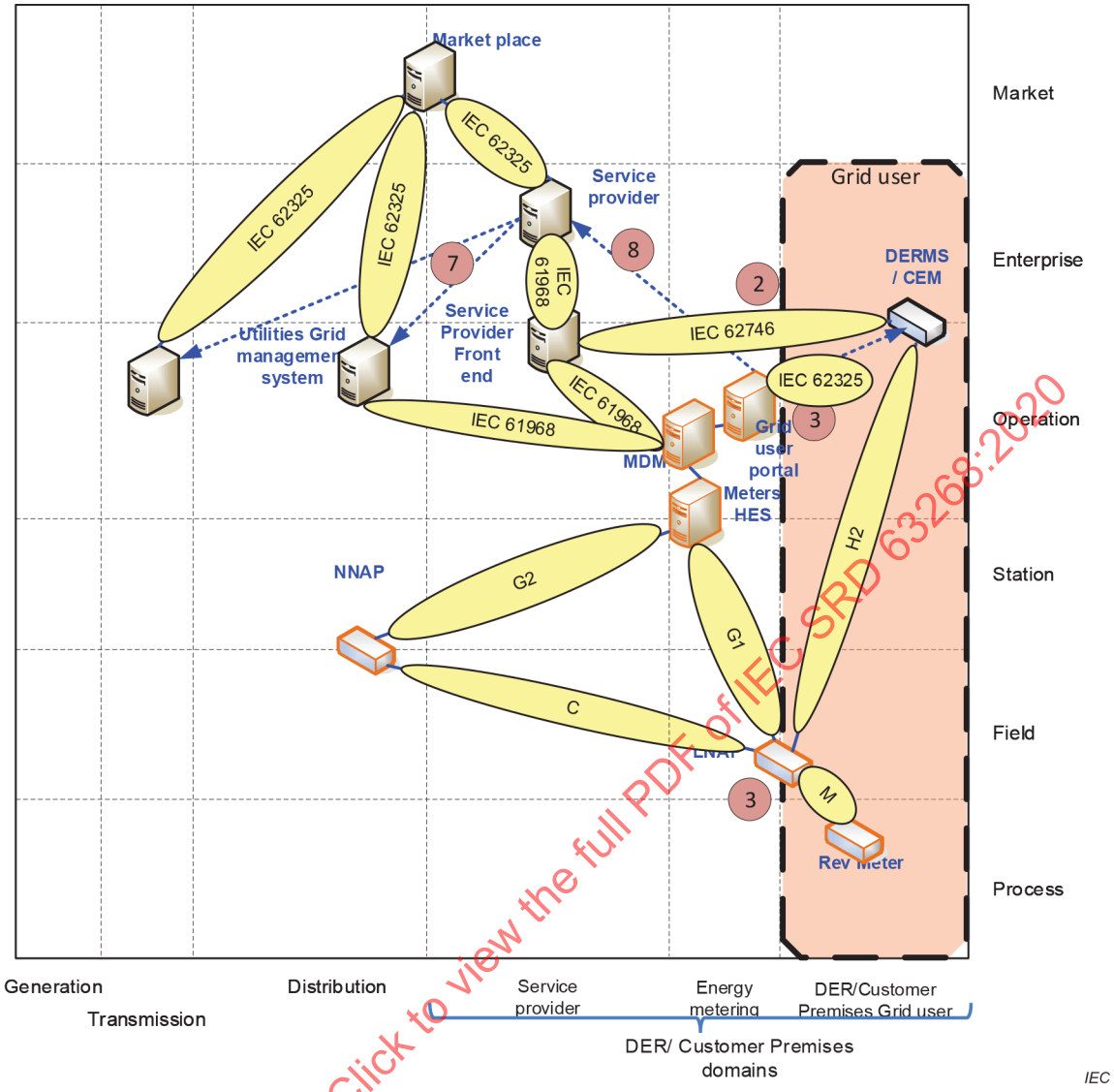


NOTE The components marked in orange are related to the energy metering and can serve to support service provider interface in two ways: provide access to the grid users through the smart meters for handling the service (as a pure communication channel) – interface 2, and/or provide back the metered values of the energy flow – interface 8.

Figure C.2 – Service providers and energy metering interfaces – in relationship with grid users (example) mapped to the SGAM communication layer

C.3.4 Information (Data) layer

The service providers communication interfaces, as well as the energy metering interfaces, in relation with grid users are identified in Figure C.3, which shows such a mapping onto the SGAM information layer. The standards referenced as G1, G2, C, H2, M are so numerous that it does not make real sense to give the details here. Details are provided in IEC TR 63097:2017 [1], Tables 45 and 46.

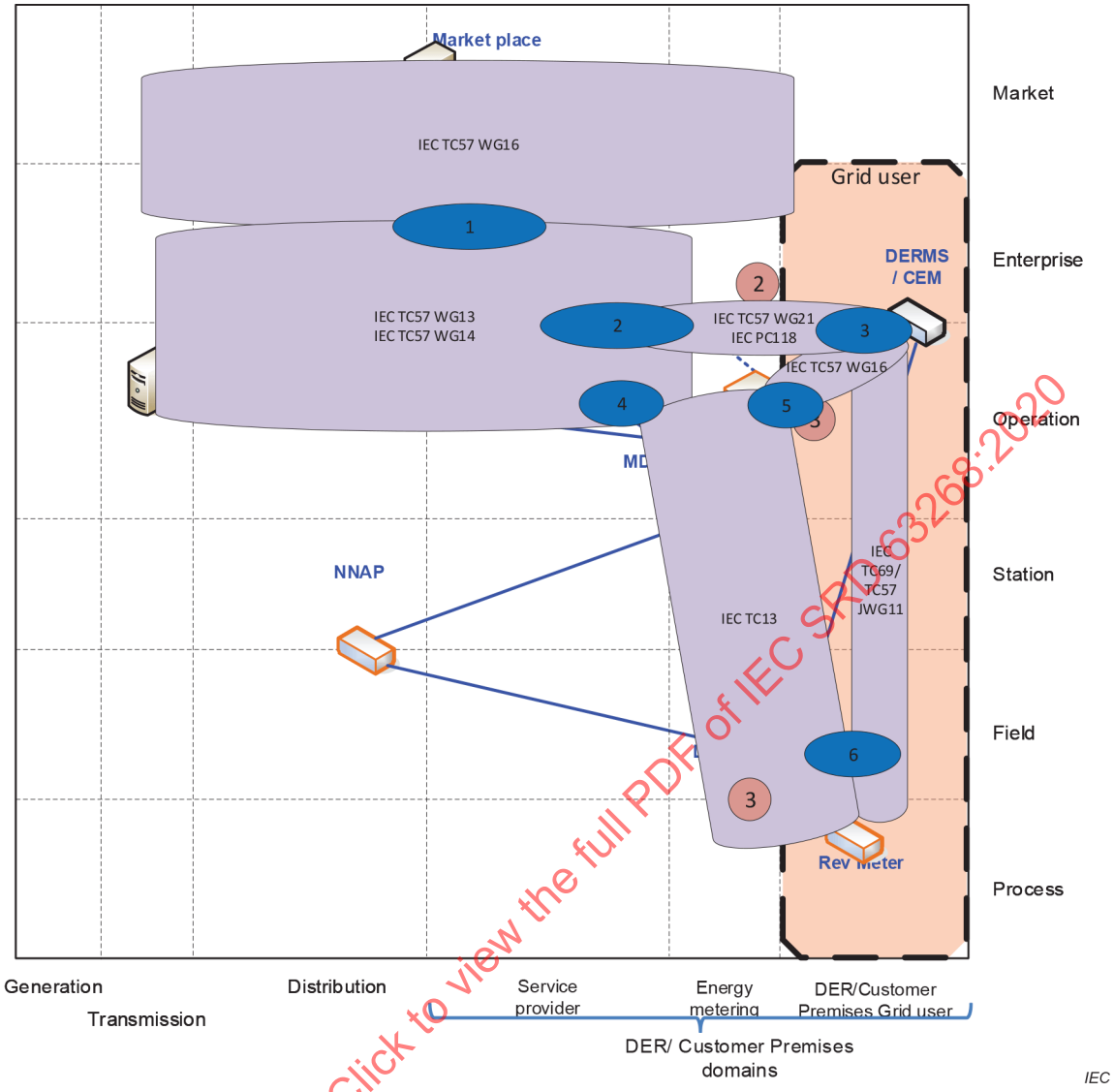


NOTE The components marked in orange are related to the energy metering and can serve to support service provider interface in two ways: provide access to the grid users through the smart meters for handling the service (as a pure communication channel) – interface 2, and/or provide back the metered values of the energy flow – interface 8.

Figure C.3 – Service providers and energy metering interfaces – in relationship with grid users (example) mapped to the SGAM information layer

C.3.5 Mapping involved IEC entities to the SGAM architecture

Figure C.4 shows the mapping of the standard exposed in C.3.1 to C.3.4.



NOTE The components marked in orange are related to the energy metering and can serve to support service provider interface in two ways: provide access to the grid users through the smart meters for handling the service (as a pure communication channel) – interface 2, and/or provide back the metered values of the energy flow – interface 8.

Figure C.4 – IEC entities involved in supporting service providers and energy metering interfaces

As a result of this mapping, the involved IEC entities appear to be:

- IEC TC 57 WG 16 with the IEC 62325 series [27]
- IEC TC 57 WG 13/WG 14 with the IEC 61968 series [24]
- IEC TC 57 WG 21 (and ex IEC PC 118) with the IEC 62746 series [30]
- IEC TC 13 with the IEC 62056 series [26] (and many others)
- IEC TC 69/TC 57 JWG 11 with the IEC 63110 series [41]

In addition, the same Figure C.4 helps in identifying the needed points of interactions (in blue).

1) Coordination between TC 57 WG 13/WG 14 and WG 16 on metering and market related services.
2) Coordination between TC 57 WG 13/WG 14 and WG 21 on metering and market related services.

3) Coordination between TC 57 WG 16 and WG 21 on metering and market related services, with in addition the handling of the specificities of the smart charging of EV from IEC TC 69/TC 57 JWG 11.
4) Coordination between TC 57 WG 16 and TC 13 on metering related services.
5) Coordination between TC 57 WG 13/WG 14 and TC 13 on metering related services.
6) Coordination between IEC TC 69/TC 57 JWG 11 and TC 13 for handling energy and market related services.

Annex D
(informative)

Mapping the interfaces with the market places

D.1 Interfaces under consideration

Annex D focuses on the interactions listed in Table D.1.

Table D.1 – Interfaces under consideration to and from the market places

Num	Title	From	To
10	Interaction with the market places	Grid user, utility, service provider	Market places

D.2 Main use cases

Annex D focuses on the main use cases listed in Table D.2.

Table D.2 – Supported business processes and use cases when considering interfaces with market places

Business process	Use case
Operate wholesale electricity market	Receive energy offers and bids
Operate wholesale electricity market	Clear day-ahead market
Operate wholesale electricity market	Clear intraday market
Operate wholesale electricity market	Clear real-time market
Operate wholesale electricity market	Publish market results
Support grid reliability using market-based mechanisms	Manage (auction/resale/curtailment) transmission capacity rights on interconnectors
Support grid reliability using market-based mechanisms	Consolidate and verify energy schedules
Support grid reliability using market-based mechanisms	Operate (register/bidding/clearing/publishing) ancillary services markets
Support grid reliability using market-based mechanisms	Solve balancing issues through balancing market
Support grid reliability using market-based mechanisms	Solve grid congestion issues through balancing market
Support market settlements	Perform measurement and validation
Support market settlements	Perform settlements
Secure adequacy of supply	Operate capacity markets
Support flexibility markets	Register flexibility markets

Further insights can be found in references [5] to [8]:

D.3 Mapping standards to the SGAM architecture

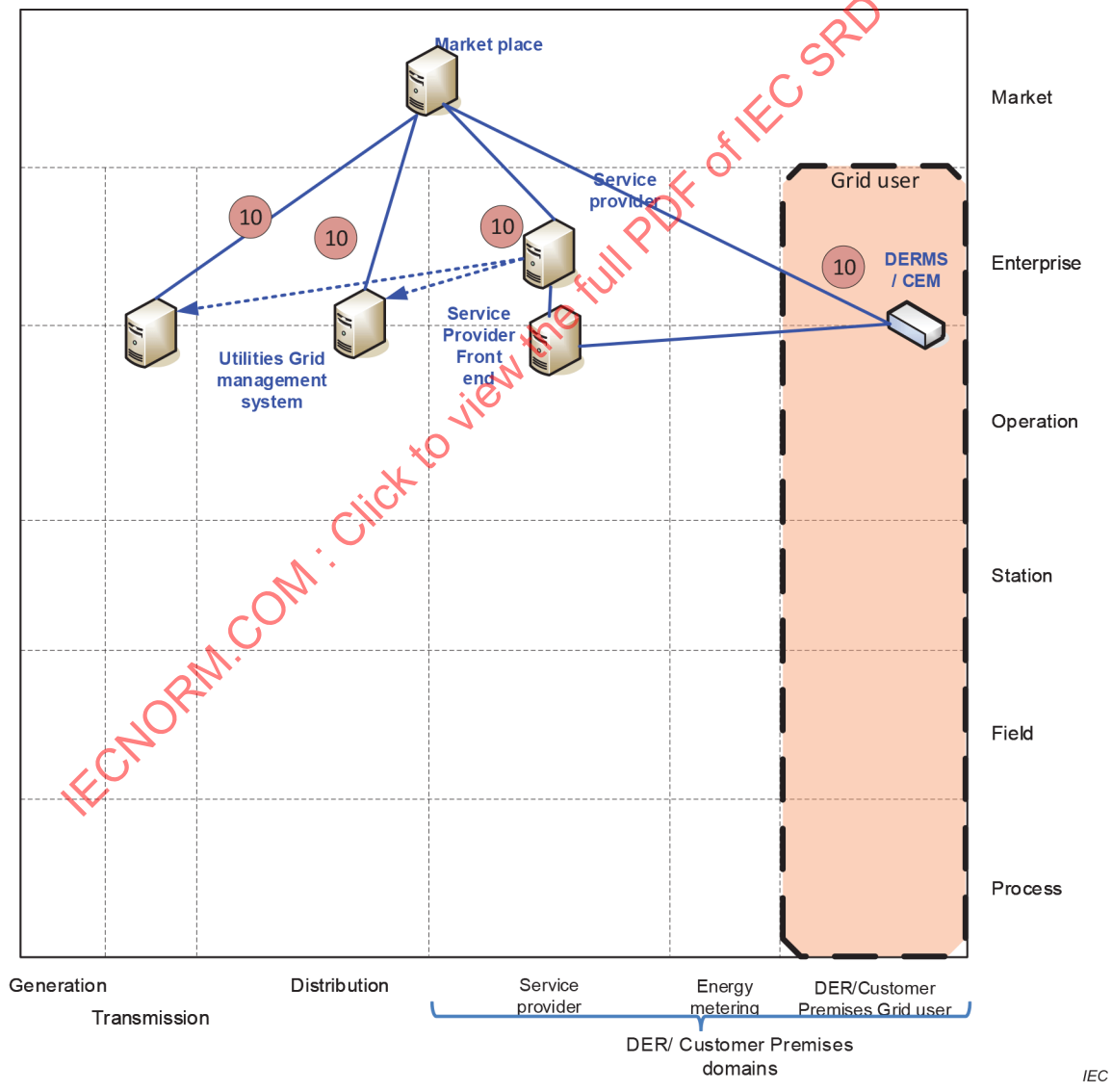
D.3.1 Preamble

The market places interfaces mapped over the SGAM are shown in Figure D.1.

Note in Figure D.1, Figure D.2, Figure D.3 and Figure D.4 that the split of the "DER/Customer Premises grid users" domain on the right is intended to illustrate typical market model roles where assets in the home/building are not owned/operated by the actor having the role of electricity service supplier. However, from an implementation point of view the same actor could play multiple roles. Market models vary, for example regarding meter ownership and operation, and are subject to national structures and regulation, so this representation should not be seen as reflecting a specific role organization.

D.3.2 Component layer

The components of such interfaces are depicted diagrammatically in Figure D.1.



NOTE Domain breakdown at market (place) zone level has been taken out from the drawing because not relevant here.

Figure D.1 –Interfacing market places – mapped to the SGAM component layer

D.3.3 Communications layer

Figure D.2 shows a mapping of these interfaces into the SGAM communication layer.

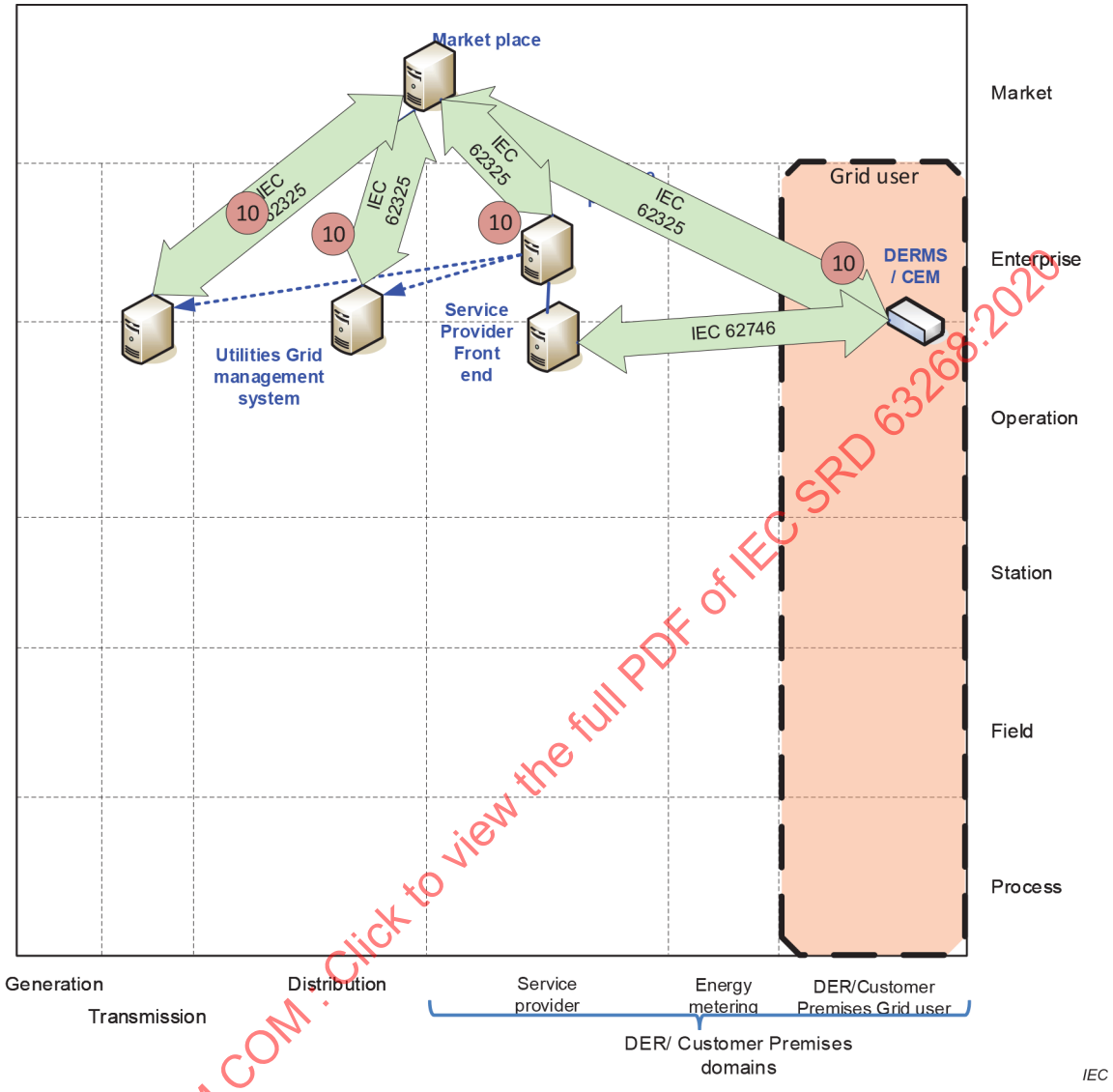


Figure D.2 – Market places interfaces mapped to the SGAM communication layer

D.3.4 Information (Data) layer

The market places communication interfaces are identified in Figure D.3, which shows such a mapping onto the SGAM information layer.