



BSI Standards Publication

Generic smart grid requirements

Part 2-4: Electric transportation related domain

National foreword

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SYSTEMS REFERENCE DELIVERABLE



**Generic smart grid requirements –
Part 2-4: Electric transportation related domain**

INTERNATIONAL
ELECTROTECHNICAL
COMMISSION

ICS 29.020; 29.240; 33.200

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GENERIC SMART GRID REQUIREMENTS –**Part 2-4: Electric transportation related domain****FOREWORD**

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IEC SRD 62913-2-4, which is a Systems Reference Deliverable, has been prepared by IEC systems committee Smart Energy.

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

Draft SRD	Report on voting
SyCSmartEnergy/85/DTS	SyCSmartEnergy/101/RVDTS

Full information on the voting for the approval of this Systems Reference Deliverable can be found in the report on voting indicated in the above table.

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

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

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

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- withdrawn,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

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

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INTRODUCTION

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

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

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

The purpose of this document is to define the generic smart grid requirements of electric transportation domain, i.e. electric transportation domain, based on the methods and tools developed in IEC SRD 62913-1.

The document for each domain is composed as follows.

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

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

GENERIC SMART GRID REQUIREMENTS –

Part 2-4: Electric transportation related domain

1 Scope

This part of IEC SRD 62913 initiates and illustrates the IEC's systems approach based on Use Cases and involving the identification of generic smart grid requirements for further standardization work for the electric transportation domain, based on the methods and tools developed in IEC SRD 62913-1.

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

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

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

Table 1 – Content of IEC SRD 62913-2-4:2019

Domain	Content	Scope
Electric transportation	Described with 6 business Use Cases and 1 system Use Case	EV Charging Smart charging and bidirectional power transfer Vehicle to grid

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

IEC 61851-1:2017, *Electric vehicle conductive charging system – Part 1: General requirements*

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>

NOTE Those definitions are consistent with ISO 15118 (all parts).

3.1.1

bidirectional power transfer

BPT

combination of forward or reverse power transfer transaction

3.1.2

charging session

collection of charging transactions at a charge point related only to the charging of an electric car assigned to a specific customer in a specific timeframe with a unique identifier

Note 1 to entry: The charging session is a subset of the service session.

3.1.3

charging transaction

smallest billable part of a charging session representing the transfer of energy in a specific timeframe

3.1.4

energy management system

EMS

system that controls electric power transfer among DER, premises appliances and the grid

3.1.5

electric vehicle communication controller

EVCC

embedded system, within the vehicle, that implements the communication between the vehicle and the SECC in order to support specific functions

3.1.6

e-mobility needs

needs expressed by the EV user in terms of departure time, minimum and maximum energy request and target energy request

3.1.7

forward power transfer

FPT

power transfer from external power supply to vehicle battery via EV supply equipment

3.1.8

reverse power transfer

RPT

power transfer from vehicle battery to home, loads or grid via EV supply equipment

3.1.9

identification

procedure for an actor/a system/a contract to provide its identifying information for the purpose of authorization, mostly to provide its capability for payments or a reference to a service contract

3.1.10**high level communication****HLC**

bi-directional digital communication using protocol and messages and physical and data link layers as specified for example in ISO 15118 (all parts)

3.1.11**roaming**

data interoperability process between e-mobility service providers and charging service operators in order to offer a continuity of services to a customer who travels outside the area of his or her original service provider

Note 1 to entry: IEC 63119 (all parts) provides a protocol specification for roaming.

Note 2 to entry: Roaming between mobile telephone operators illustrates best the concept. A given contract with an international option allows one to telephone in his or her home country and abroad. Mobile phone operators financially compensate the telecommunication made abroad.

Note 3 to entry: Charging facility could be provided with one unique RFID (Radio Frequency Identification Device) card (or mobile phone), either in one's home country or abroad. CSOs financially compensate the electricity and/or the charging service itself.

3.1.12**smart charging**

controlled charging process that meets the mobility constraints and requirements of the EV user while optimizing the use of the grid and the available electrical energy to minimize additional investments in the grid and facilitate the integration of DER

[SOURCE: Eurelectric and ESMG Smart Charging report]

3.1.13**wireless power transfer****WPT**

transfer of electrical energy from a power source to an electrical load via electric and/or magnetic fields or waves between a primary and a secondary device without current flow over a galvanic connection

Note 1 to entry: The receiver can be affixed to the vehicle's bottom or front and the transmitter on a parking lot surface or parking specific charging device.

[SOURCE: IEC 61980-1:2017, 3.10, modified – The words "without current flow over a galvanic connection" have been added to the definition, and the note to entry has been added.]

3.1.14**original equipment manufacturer****OEM**

original producer of a vehicle's components (such as cars, boats, buses and lorries), a company that manufactures spare parts, mainly on behalf of another company, the integrator or the assembler

3.1.15**pairing**

process by which a vehicle is correlated with the unique EVSE at which it is located and from which the power will be transferred either through a cable or through a wireless technology

3.1.16**service detail record****SDR**

data package containing all necessary information within one unique identification which is needed for billing or informing of/about a service session of a specific customer

3.1.17

service session

collection of services around a charge point mainly related to the charging of an electric car assigned to a specific customer in a specific timeframe with a unique identifier.

3.1.18

supply equipment communication controller

SECC

entity which implements the communication to one or multiple EVCCs and which may be able to interact with secondary actors

3.2 Abbreviated terms

DER Distributed Energy Resource

EMS Energy Management System

EV Electric Vehicle

EVSE Electric Vehicle Supply Equipment

RFID Radio-Frequency Identification Device

FCR Frequency Containment Reserve

SDR Service Detail Record

4 Electric transportation

4.1 Purpose and scope

4.1.1 Clause objective

The purpose of this document is to present a business analysis of the electric transportation domain, and more specifically to describe the smart grid requirements of the domain using the Use Case approach as defined in IEC SRD 62913-1.

This analysis is based on existing materials, including user stories, set of Use Cases, and architectures. It is also based on latest updates from IEC TC 69 experts working on communication protocols.

4.1.2 General context

This document considers non-guided electrical transportation using batteries, which require electricity charging through electric power grids (public and private), travelling on land (public streets, roads, motorways). It includes private or professional battery electric vehicles, plug-in hybrid electric vehicles, cars, lorries, buses and motorbikes. Planes, boats, trains and trams are out of the scope of this document.

There is a need to standardize the naming and definition of electric transportation domain roles in relation with the roles of the electrical system and markets, and smart grid Functions, bearing also in mind that they have to be articulated with non-electrical systems for mobility and associated services.

In order to ensure implementation of interoperability between roles in future e-mobility solutions, it is necessary to describe comprehensive business Use Cases defining their relationships and interactions, in view of satisfying needs of the final customers by adequate service provision.

Example of application of these Use Cases shall be given for the main common situations (charge or discharge an EV, provide service to the grid, etc.).

The couple EV-EVSE will be considered as a DER. DERs are described in IEC SRD 62913-2-3. However, the mobile and possible bidirectional natures of the EV, unusual for a classical DER, led to this document.

4.2 Business analysis

4.2.1 General overview

The transition towards a more sustainable economy is a key driver of the development of electric transportation, with a stronger political impetus to reduce carbon dioxide emissions and promote alternatives to fuel vehicles – both at regional and national levels. The number of electric vehicles in circulation has increased over the past years and will continue to grow as technologies are becoming more mature and new stakeholders are entering this new market. In the coming years smart charging and bidirectional power transfer will be key to allow a smooth transition for grid operators.

The development of electric vehicles therefore creates various opportunities and challenges for the actors of the electric power system, as well as for the actors of the Mobility Sector (OEM, service providers...).

The following actors will play a major role in the development of smart charging.

- a) Roles related to metering services will be concerned, as the bidirectional energy flowing from or to the EV will need to be measured and associated with a metering point for example for billing purposes – whether the charging station is public or private (commercial and tertiary offices, residential building, private parking, etc.).
- b) For system and grid operators, the charging or discharging of electric vehicles, for which location, timing and load profile is by nature variable and not easily predictable and can have a significant impact on the planning, operation, and maintenance of the grids. It will contribute to the growth of possible multiple peak loads – at wholesale system and at local levels – leading to increased network investment needs. Grid operators will have to take into account EV charging and discharging in their network operations business processes, but also develop operational planning and Demand Response models and tools to anticipate its effects on the grid at minimum cost.
- c) EV, potentially considered as a flexible DER, will be enrolled in electricity markets by flexibility operators.
- d) According to local regulations on flexibilities, the EV user will be able to choose a charge plan/schedule depending on price signals for instance (based on charging time, power, energy, renewable energy mix according to local regulations) but also other demand response signals in addition to local constraints managed by an EMS.

Furthermore, other roles are emerging with the development of electrical transportation.

- e) Installation, maintenance, operation and monitoring of charging station (charging service operators, CSO) or the operations of electric vehicle supply equipment and the charging of EV.
- f) E-mobility service providers will provide high-value services related to the use of EV, such as the identification of the closest currently operational charging station(s) or the charging station(s) in a given area, the calculation of the route between two charging stations, the reservation of a parking spot equipped with a charging station, access to charging stations of different charging service operators with a single contract and payment, etc.
- g) E-mobility clearing house operators will ensure the exchange of data between charging service operators and e-mobility service providers, and therefore allow an interoperable easy and open access to the market.
- h) Users of the vehicles (EV user, fleet operators, public transportation operators, etc.) will have access to high value services, through interactions with the roles listed above using smart cards, smartphones and IT solutions.

The evolutions implied by the development of electric vehicles tend to change the way the vehicle is considered by EV users, from an object that can be owned to a service or set of services that can be purchased. Different models of services may be considered for the electric transportation domain:

- infrastructure or charging services, with the possibility to charge any EV on any public or private charging station;
- mobility services, with the rental of EV/batteries, the reservation of a charging and parking spot for instance;
- energy services, with the purchase of electricity, but also the management of power demand peaks, BPT, ancillary services, frequency regulation, reserves services;
- data and communication services, with the exchange of various data between the different roles (tariffs, energy imported to charge the EV, etc.).

In this context, the development of interoperability becomes crucial to ensure communication between the different infrastructures (EV, EVSE, etc.) and information systems related to infrastructure and energy services (charging station operations, network operations, etc.), as well as mobility and data services.

4.2.2 List of business Use Cases and business roles of the domain

The business Use Cases listed are a result of the business analysis carried out previously – the list is not exhaustive, and it is likely to grow as new Use Cases come to light.

The business Use Cases are associated with one or several of the business objectives of the domain, which include: deliver charging, bidirectional and ancillary services.

Table 2 lists and provides a brief description of the business Use Cases that have been identified so far (they do not cover the entire domain business Use Cases). Figure 1 describes the Use Cases a hierarchical organization proposal.

Table 2 – Identified business Use Cases of the domain

Index of the business Use Case	Identified business Use Case	Brief description	Level of maturity
UC62913-2-4-B001	Charge an EV	During a timeframe, energy is exchanged between an EV and an EVSE. This Use Case describes the information exchanges between roles involved in this process and requirements associated with it.	Already implemented
UC62913-2-4-B002	Control the charge of an EV	This business Use Case describes the information exchanges between roles involved in controlling the energy transfer to charge an EV in order to comply with energy secondary actors while responding to the EV User needs.	Already implemented

Index of the business Use Case	Identified business Use Case	Brief description	Level of maturity
UC62913-2-4-B003	Charge an EV with Demand Response	The scope of this business Use Case is EV charging based on flexibility incentives coming from the market. These incentives can be for example price signals and renewable mix signals. The objective is to optimize customer, grid, DER and e-production needs.	Already implemented
UC62913-2-4-B004	Charge an EV with smart charging	The business Use Case describes the smart charging process of an electric vehicle in a private network (public car-park, residential condominium, etc.). This Use Case is based on ISO 15118 mechanism.	Incomplete due to uncertainty
UC62913-2-4-B005	Provide smart bidirectional energy transfer	Bidirectional power transfer into the grid based on messages sent by local energy management system.	Explorative
UC62913-2-4-B006	Provide smart charging services to an EV fleet	This business Use Case describes the information exchanges between roles involved in the process of optimizing users, fleet operator, grid and market constraints for the charge of an EV fleet.	Incomplete due to uncertainty
UC62913-2-4-B007	Provide frequency containment reserve services through EV	This business Use Case describes the process to provide primary frequency-regulation services using electric vehicles controllable charge and discharge possibilities. Frequency-restoration or replacement reserve are out of scope. Primary frequency-regulation services can be provided through injection or consumption power transfer and this contribution to frequency regulation can be symmetric or dissymmetric (only positive or negative regulation).	Explorative
UC62913-2-4-B008	Discharging an EV to a load disconnected from the grid	This business Use Case describes the information exchanges between roles involved in an energy transfer between an EV and a load (other EV, battery, home appliances, etc.) disconnected from the grid (main distribution grid, microgrid, etc.).	Explorative

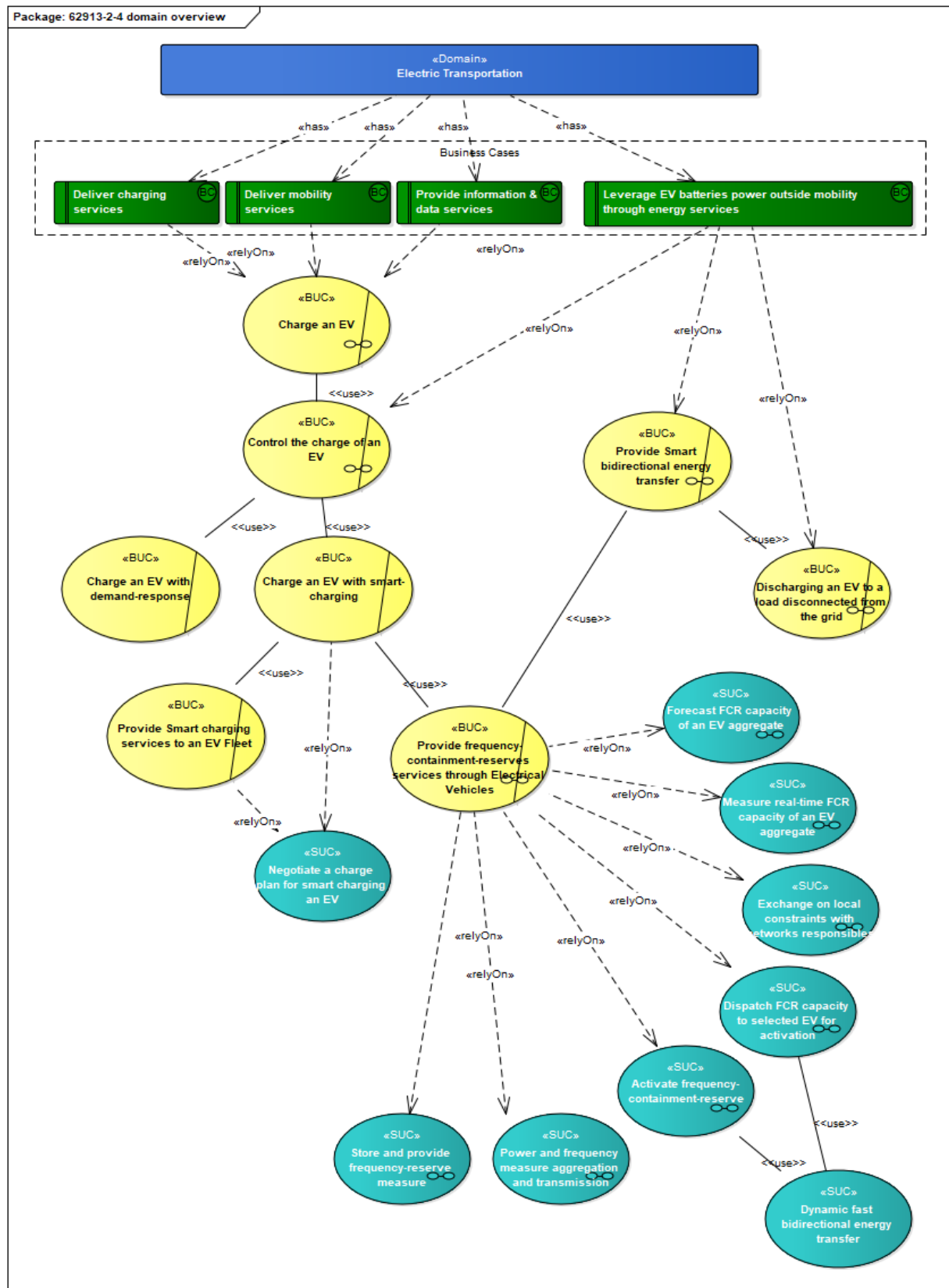


Figure 1 – Use Case domain overview of the electric transportation domain

The business Use Cases listed above are described in short version in Annex B.

In Figure 1, the general domain electric transportation defines five types of services linked to the general mobility activity. If needed, more services could be added.

The BUC associated to these services are organized in a hierarchical way and all the Use Cases inherit of the requirements defined in the parent's Use Case.

For example, the first BUC "Charge an EV" defines safety general requirements that are not repeated in children Use Cases.

E-mobility is a fast evolving domain and the vision in Figure 1 will have to be updated in the future to reflect those evolutions.

Table 3 lists the business roles that have been identified so far. This list is not exhaustive.

Table 3 – Business roles of the domain

Business roles	Definition
Charging service operator (CSO)	Party responsible for the provisioning and operation of a charging infrastructure (including charging sites), and managing electricity to provide requested energy transfer services. Also known as charging spot infrastructure operator (CSIO).
Distribution system operators (DSO)	Entity responsible for the planning, operation, maintenance, and the development in given areas of the electricity distribution network (LV, MV, and potentially HV), the quality of electricity supply (power delivery, voltage, etc.) and for customer access to energy supplier-retailer (ESR) market through his or her system under regulated conditions. Equivalent to distribution network operators (DNO) or distribution grid operators. In some countries, the distribution grid operator may also manage the metering system (e.g. France).
E-mobility clearing house operator (E-MCHO)	Entity that solves the relation between e-mobility service provider and charging service operators. Ensures exchange of data between operators allowing an open access to the market and provides a central management of data needed for smart charging to all stakeholders (collection, formatting, consolidation, dispatching).
E-mobility service provider (EMSP)	Party responsible for providing high-value service related to the use of an EV (renting an EV, reservation of parking service, navigation services, energy services which include charging service provider in relation with CSO, etc.).
E-mobility customer (EC)	Legal entity associated to an e-mobility service provider by the legal means of a contract. Requests easy access to e-mobility solutions at minimum cost.
EV-user (EVU)	The person or legal entity using the vehicle and providing information about its needs. EXAMPLE In case the EV does not support plug and charge, or if the plug and charge mode is not used, the EV user could manually use an ID tag (RFID card, NFC device, Smartphone, etc.) and its applications for identification on the EVSE.
Fleet operator (FLO)	Responsible for operating and managing a fleet of EVs. Takes into account the needs of operations and requests charging service from the CSO according to these needs, at best cost.
Flexibility operator (FO)	A party which aggregates flexibilities for its customers and activates flexibility sites. A party that aggregates a consistent amount of power capacity from several DERs and puts them at disposal for the interested DSO.
Meter operator (MO)	A party responsible for installing, maintaining, testing, certifying and decommissioning physical meters in compliance with the regulated conditions for contract between ESR and their customers. [SOURCE: ENTSO-E, EFET, and eBIX, 2010]
Private network operator (PNO)	Responsible for operating and managing a private electrical network (within a building, parking, etc.).

Business roles	Definition
(Electricity) supplier/retailer	Entity whose activity is the wholesale purchase of electricity and the subsequent direct resale to client through a contract. The supplier may also deliver energy-related services such as providing flexibility through electricity price modulation, i.e. (time-of-use, critical peak prices...) or which can have value on energy markets and/or for network operations.
System operator (SO)	Party responsible for safe and reliable operation of a part of the electric power system in a certain area and for connection to other parts of the electric power system. [SOURCE: IEC 60050-617:2009, 617-02-09]

4.2.3 List of system Use Cases and system roles

4.2.3.1 System Use Cases and system roles of the domain

The purpose of this document is not to provide an exhaustive description of all SUC. This has to be done at the TC level with the appropriate level of expertise.

However, in order to start describing on set of SUC, Table 4 gives an overview of the SUC in relation with the BUCs "Provide frequency containment reserves services through electric vehicle" and "Charge an EV with smart-charging".

Table 4 describes the system Use Cases that have been identified so far to enable the business Use Cases described above to operate. The list is non-exhaustive and will be updated when new editions of this document are published.

Table 4 – Identified system Use Cases of the domain

Index of the system Use Case	Identified system Use Case	Brief description
UC62913-2-4-S001	Negotiate a charge plan for smart charging an EV	This Use Case describes the organization of exchange and computation of data between the CSMS and the other roles in order to settle the best possible charge plan for a new EV requesting to charge.
UC62913-2-4-S002	Manage bidirectional power transfer into the grid	This Use Case describes the organization of exchange and computation of data between the CSMS, the EVU and the other roles in order to settle a bidirectional plan.
UC62913-2-4-S003	Dynamic fast bidirectional energy transfer	This Use Case covers both AC and DC charging and discharging. It covers also dynamic adjustment of the AC or DC bidirectional power transfer considering complex grid situations and secondary actors for grid services. Using dynamic control mode, SECC is responsible for ensuring e-mobility needs (departure time; minimum and target energy request).
UC62913-2-4-S004	Power and frequency measure aggregation and transmission	This Use Case describes the systems exchanges to measure power and frequency of an EV aggregate and transmit them for forecast.
UC62913-2-4-S005	Activate frequency containment reserve	This Use Case describes the systems exchanges to activate bidirectional power transfer instructions to EVs.
UC62913-2-4-S006	Dispatch FCR capacity to selected EV for activation	This Use Case describes the systems exchanges to dispatch bidirectional power transfer instructions to EVs part of an aggregate.
UC62913-2-4-S007	Forecast FCR capacity of an EV aggregate	This Use Case describes the systems exchanges to be able to forecast the capacity of an EV aggregate to provide a FCR service

Index of the system Use Case	Identified system Use Case	Brief description
UC62913-2-4-S008	Store and provide frequency-reserve measure	This Use Case describes the systems exchanges to store measurements on the frequency-containment reserve service and to provide this information for control.
UC62913-2-4-S009	Measure real-time FCR capacity of an EV aggregate	This Use Case describes the systems exchanges to provide real time measures of the frequency-containment power-reserves of the flexibility aggregator. It covers the opt-out and re-negotiation process with EV user and EV charging environment roles. The aim is to provide real time measures of the frequency-containment power-reserves of the flexibility aggregator.
UC62913-2-4-S010	Exchange on local constraints with network responsible parties	This Use Case describes the systems exchanges to identify local constraints disabling the possibility to take part in a FCR service for EVs.

Table 5 describes the system roles that have been identified so far to enable the business Use Cases described in Table 3. The list is non-exhaustive and will be updated when new editions of this document are published.

Table 5 – System roles of the domain

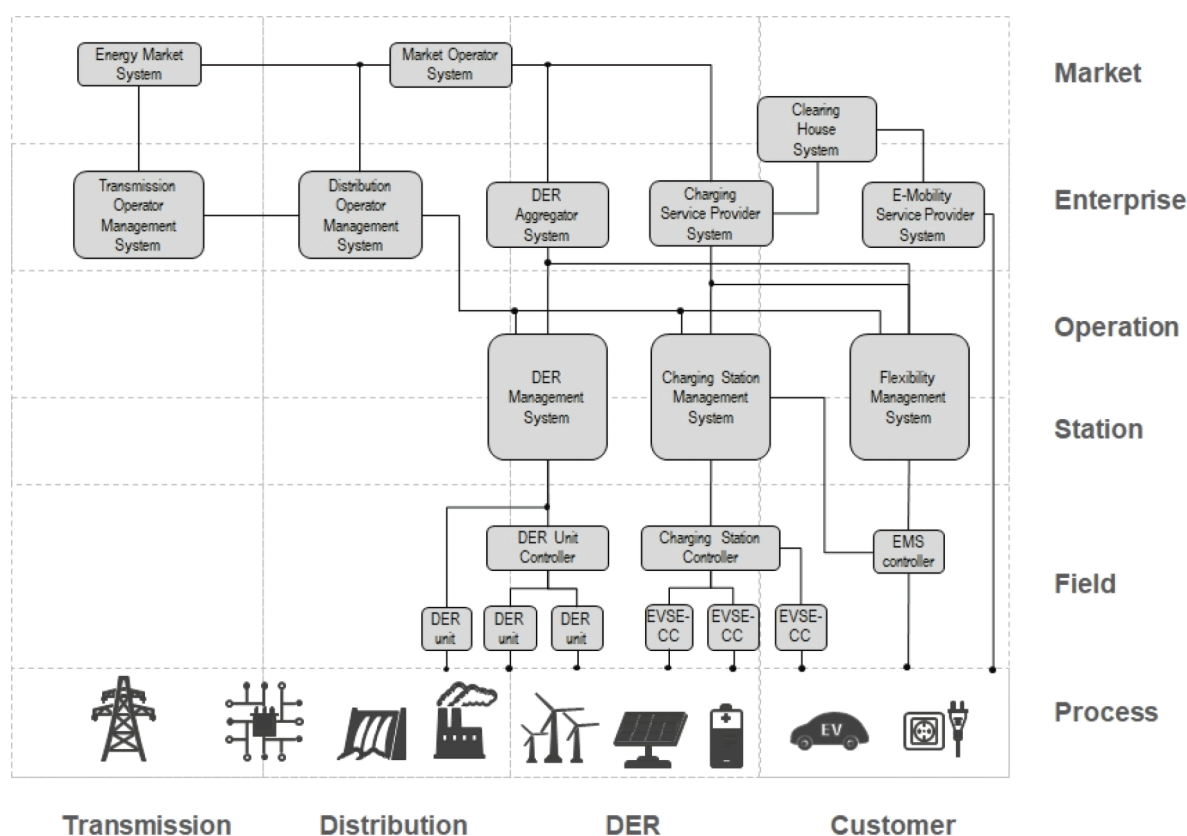
System roles	Definition
Battery	A physical on-board device that can store and reconstitute the electric energy.
Charging schedule	Maximum allowable charge power vs. time information, which the EV shall follow while charging the battery. See ISO 15118-1.
Charging service management system (CSMS)	System responsible for managing charging stations, typically operated by the CSO
Charging station (CS)	All equipment for delivering current to EVs, installed in an enclosure and with special supervisory and control functions. EVSE and charging station only differ in the fact that the charging station is an aggregation of EVSE's. EVSE can charge one EV and a charging station can have multiple EVSEs. See: IEC 61851-1.
Charging station area	A physical location with one connection to the distribution grid, in which a set of charging stations are installed and managed by one CSO. A charging station area has other usages of the electricity than for the recharge of electric vehicles, at least for auxiliary system, consumption and losses. Several charging station areas could be distinguished with specific standardization domain and regulation like • residential or home places; • block of flats; • tertiary building; • private campus or parking lot; • public parking lot; • public recharge location.

System roles	Definition
Charging station tariff (CST)	Definition of pricing by CSO calculated according to given parameters: time of use, period of the day, quantity of electricity, etc. Two cases can be encountered: - a global service pricing, including EVSE operation and maintenance, electricity and possible other services such as parking; or - a separated pricing for electricity selling by a specific electricity supplier on one hand, and charging service selling by CSO on the other hand. In this case, the organization shall be compliant with the regulations applying to electricity selling.
Customer identification device	Standardized identification of the EVU as customer of an EMSP. It might be included within a communication system. Since there are several possible ways of identification, these ways would be properly defined in the specific identification Use Cases.
E-mobility clearinghHouse system	Managing exchange of data between operators in relation with mobility services so as to ensure interoperability and open access of EVUs to these services. Alternative: Entity mediating between two clearing partners to provide validation services for roaming regarding contracts of different e-mobility service providers with the purpose to: - collect all necessary contract information like contract ID, EMSP, communication path to e-mobility service provider, roaming fees, begin- and end-date of contract, etc.; - provide CSO with confirmation that an e-mobility service provider (EMSP) will pay for a given contract ID (authentication of valid contract) and transfer a corresponding service detail record (SDR) after each charging session to the corresponding e-mobility service provider (EMSP).
E-mobility service management system	System supporting the e-mobility services.
Electric vehicle	EV or electric road vehicle (ISO). Any vehicle propelled by an electric motor drawing current from an a rechargeable storage battery (RESS), intended primarily for use on public roads. [SOURCE: IEC 61851-1:2017, 3.4.1]) The EVCC (EV communication controller) is included in the EV.
Electric vehicle supply equipment (EVSE)	Equipment or a combination of equipment, providing dedicated functions to supply electric energy from a fixed electrical installation or supply network to an EV for the purpose of charging [SOURCE: IEC 61851-1:2017, 3.1.1]
Electricity tariff	An information concerning the price of electricity according to given parameters (time periods, type of use, etc.) as fixed by the electricity supplier according to its contracting policy. In addition, the DSO fixes the distribution tariffs for energy delivery purposes.
Electricity meter	An electricity meter compliant with the regulations applicable to contracts between ESR on the market and their customers.
Private electrical network	An electricity network (home, building, factory, etc.) downstream of a smart grid connection point (SGCP). It is handled by the private network operator, who assumes the full responsibilities and coverage.
Private network energy management system (EMS)	A functional component responsible for managing equipment consuming, producing or storing electricity in the private network. It provides the expected services while fulfilling contracted conditions with the electricity supplier, the DSO, the flexibility operator or any other system operators. In addition, it negotiates with the charging spot infrastructure operator the power available for the charging station area and the cluster of EVSE within the frame of an operational planning function and a real time balance function.

System roles	Definition
Service detail record (SDR)	Data package of a charge or service related session with all necessary information that an E-mobility Service Provider needs for billing or for informing the customer about the session. [SOURCE: ISO 15118-1:2013, 3.50]

4.2.3.2 Role model

Figure 2 presents a possible role model corresponding to the above Use Cases.



IEC

Figure 2 – Role model illustration mapped on SGAM

Figure 2 shows a SGAM component layer role model version for charging electric vehicles where CSMS and EMS play a central role in the management of charging stations. Assuming that smart charging is applied, the CSMS has to balance the interest of the DSO, aggregators, the energy supplier, the customer and the influence of local consumption and local production optimized by the EMS.

4.3 Generic smart grid requirements

4.3.1 List of requirements

The electric transportation requirements in 4.3 have been extracted from the following Use Cases described in Annex B according to the IEC 62559-2 Use Case template.

The IEC core standards shall support the needs and requirements listed in Table 6. The UCs inherit the requirements defined in their parent UC as described in Figure 1.

Table 6 – Requirements identified

Requirement ID	Requirement description	Link to Use Cases
R62913-2-4-001	The EV electrically connects or pairs to the EVSE.	UC62913-2-4-B001
R62913-2-4-002	The EV is connected to the EVSE safely and stays safely connected until disconnection/unpairing, in case of conductive charging, the plug shall be locked in the socket during the charge if socket does not support disconnection under defined current	UC62913-2-4-B001
R62913-2-4-003	Anytime during the charging sequence, the EVU may disconnect or unpair in safe conditions.	UC62913-2-4-B001
R62913-2-4-004	Anytime during the charging sequence, the EVU may opt-out from any control by a secondary actor.	UC62913-2-4-B002
R62913-2-4-005	The EVSE indicates to the EV the status of the charge (charging, not charging due to control, not charging due to an issue).	UC62913-2-4-B002
R62913-2-4-006	The EVSE can start/stop the charge on control by a secondary actor. In case of conductive charging, the cable shall then be locked.	UC62913-2-4-B002
R62913-2-4-007a	At any time during the charging sequence, the EVU may opt in a flexibility program	UC62913-2-4-B003
R62913-2-4-007b	If the EVU has opted in a flexibility program, at any time during the charging sequence, the EVU may opt-out from this flexibility program and ask for immediate charging	UC62913-2-4-B003
R62913-2-4-008	The EVSE indicates to the EVU the status of the charge (ongoing charging) and may indicate to the EVU charge under control of a flexibility actor	UC62913-2-4-B003
R62913-2-4-009	The application of any flexibility programme does not prevent the EVSE from fulfilling the mobility need.	UC62913-2-4-B003
R62913-2-4-010	When the EVSE receives a flexibility message, and if HLC is not available, the EVSE uses the PWM signal to control the maximum power level available for charging.	UC62913-2-4-B003
R62913-2-4-011	The user may declare his mobility needs to the EV and, if not, assumptions should be taken by the EV.	UC62913-2-4-B004
R62913-2-4-012	The EVSE proposes to the EV at least one maximum power schedule complying with secondary actor's requirements and EVU mobility needs.	UC62913-2-4-B004
R62913-2-4-013	Schedule is described in any number of continuous periods of time where the maximum power available and market conditions are constant within the period. The minimal requirement for a schedule is the "max. power from now on" (without time limit or other condition).	UC62913-2-4-B004
R62913-2-4-014	Schedule may contain market elements like tariffs tables, CO ₂ levels, any other type of incentives.	UC62913-2-4-B004
R62913-2-4-015	The EVSE encrypts all messages to secondary actors containing any user private data.	UC62913-2-4-B004
R62913-2-4-016	EVCCs and SECCs exchange information about their bidirectional physical limitations.	UC62913-2-4-B005
R62913-2-4-017	EVCCs send information about their flexibility contract to the SECC in order for the EMS to check their validities and, if needed, roam to its flexibility operator through an e-mobility clearing house.	UC62913-2-4-B005
R62913-2-4-018	EVs can check the energy measured by EVSEs.	UC62913-2-4-B005
R62913-2-4-019	EVSEs measure the energy effectively transferred to the grid according local grid codes and flexibility contract measurement requirements.	UC62913-2-4-B005
R62913-2-4-020	If required, EVSE produces an SDR indicating the date, duration, energy transferred from and to the battery, and all other measurements required by the flexibility contract (e.g. load curves, active and/or reactive energy, quality of current, frequency). The SDR is sent to the EMSP and to EMS. The SDR is signed and encrypted by the EVSE. It may be checked by EV.	UC62913-2-4-B005

Requirement ID	Requirement description	Link to Use Cases
R62913-2-4-021	The SDRs are sent to the EMSP and to EMS. The SDR is signed and encrypted by the EVSE. It may be checked by EV.	UC62913-2-4-B005

4.3.2 Other requirements

4.3.2.1 Business rules (grid codes, market rules)

The charging installation shall comply with the local grid regulation rules.

- In case of DC energy transfer, the EVSE has to comply with all local regulations including specific grid codes relating to energy production and injection into the grid.
- Grid codes vary along countries and even regions in the same country. It is agreed that it is difficult for the EV to comply to many different codes depending on the location of the EVSE. On the other hand, the EVSE is fixed and shall comply to any local grid code. However, in AC session as the converter is in the EV, which is the source of the energy, it is clear that it is also up to the vehicle to comply to any local rules. So it is the responsibility of the EV supply equipment and the OEM to comply with local grid codes.
- The electricity purchase process and service offer process shall comply with electricity market organization and rules.
- In case of for AC bidirectional power transfer, the EV has to comply on its own with grid code requirements; it will embed a bidirectional on-board charger that can work in four-quadrants, i.e., either pure resistive, or pure current source, or with the simulation of an additional reactive load (capacitive or inductive). As mentioned before, it will host also an active anti-islanding function. As this function consists of generating a disturbed sinewave, it can only be done by the power electronic, i.e. the B-OBC. The EVSE will host the decoupling protection and the necessary protective devices. Its configuration will depend on the ability to work grid-connected, or islanded, or both. For example, in islanded mode, it will have to generate a new earthing system. The EVSE will also be responsible for storing the local grid code parameters and generating the active and reactive power setpoints requested to the EV, using local voltage and frequency measurements. The list of the functions required to safely feed current back to the grid need to be allocated both in the EV and the EVSE are described in Table 7.

Table 7 - Function allocation between EV and EVSE

EV	EVSE/installation
Convert power (bidirectional) using an on-board charger	Store all grid code parameters (local)
Ensure active islanding detection	Provide decoupling protection
	Measure V/f/calculate reactive power setpoint
Enhanced immunity to voltage/frequency	

4.3.2.2 Performances

EVU mobility needs have to be satisfied at the best economical condition and minimized risks of failure. Transparency of quality and price of service shall not only be fulfilled by the operators in direct relationship with the EVU, but also spread within the processes and conditions between roles in the Use Cases.

4.3.2.3 Safety

Safety requirements are described in IEC 61851-1.

DSOs and TSOs may be subject to locally applied requirements with regard to ensuring secure operation of the power system. References to such requirements are not included in Use Cases in Annex B.

4.3.2.4 Data security

Data security is ensured by transport layer security (example TLS in the ISO 15118 series) and by application layers through encrypted links.

Private data protection is also an increasing concern for all users and actors.

For EV circulating in Europe, for example, the General Data Protection Regulation (GDPR) (Regulation (EU) 2016/679) shall be applied.

4.3.2.5 Interoperability

Interoperability of equipment and services are needed for a competitive and open market of equipment supply and market of mobility and charging services. ISO 15118 (all parts) and IEC 63119-1 are in charge of ensuring interoperability of services at the communication level¹.

¹ A further International Standard (IEC 63110 series) is currently under consideration.

Annex A (informative)

Links with other TCs and gathered materials

A.1 General

In order to capture generic smart grid requirements for their domain, the domain's leader needs to establish contact with the technical committees working on topics related to their domain, to gather existing materials (standardization documents, user stories, Use Cases, and functional architectures), and from this starting point coordinate the further work on generic smart grid requirements.

A.2 Electric transportation

A.2.1 Identified TCs

A.2.1.1 General

Below are listed the relevant TCs working on smart grid requirements of the domain.

- IEC TC 57, Power systems management and associated information exchange; WG 17, WG 14/WG 13:
 - IEC 61850-7-420, Communication networks and systems for power utility automation – Part 7-420: Basic communication structure – Distributed energy resources logical nodes
 - IEC TR 61850-90-8, Communication networks and systems for power utility automation - Part 90-8: Object model for E-mobility
 - IEC 61968-11, Application integration at electric utilities – System interfaces for distribution management – Part 11: Common information model (CIM) extensions for distribution
 - IEC TR 61850-90-7 Communication networks and systems for power utility automation - Part 90-7: Object models for power converters in distributed energy resources (DER) systems
- IEC TC 69–ISO/TC 22/SC 3 JWG 1: Vehicle to grid communication interface (V2G CI):
 - ISO 15118-1:2013, Road vehicles – Vehicle to grid communication interface – Part 1: General information and use-case definition
 - IEC 61851 (all parts), Electric vehicle conductive charging system
- IEC TC 69–IEC TC 57 JWG 11: Management of electric vehicles charging and discharging infrastructures
- IEC TC 64: Electrical installations and protection against electric shock
- SAE:
 - J 2836/1 Use Cases for Communication between Plug-in Vehicles and the Utility Grid
 - J 2836/2 Use Cases for Communication between Plug-in Vehicles and the Supply Equipment (EVSE)
 - J 2836/3 Use Cases for Communication between Plug-in Vehicles and the Utility Grid for Reverse Power Flow

A.2.1.2 Existing functional architectures

Name	Author or organization	Publication date	Source
European Distribution system operators for smart grids – Position paper on electric vehicle charging	EDSO for smart grids	2012-04-10	http://www.edsoforsmartgrids.eu/index.php?page=edso-s-publications
Smart Charging report Edition 2.00	CEN-CENELEC eMobility Coordination Group	2015-05-08	https://www.cencenelec.eu/standards/Sectors/Transport/ElectricVehicles/Pages/default.aspx

Functional architectures may be used in Use Cases only if they are generic enough.

Annex B (informative)

Electric transportation Use Cases

B.1 Business Use Cases

See Table B.1 to B.6.

Table B.1 – UC62913-2-4-B001 Charge an EV

UC62913-2-4-B001 Charge an EV				
1 Description of the use case				
1.1 Name of use case				
Use case identification				
ID	Area(s)/Domain(s)/Zone(s)		Name of use case	
	Electric transportation		Charge an EV	
1.2 Version management				
Version management				
Version No.	Date	Name of author(s)	Changes	Approval status
1.3 Scope and objectives of use case				
Scope and objectives of use case				
Scope	This Use Case is the most basic form of EV charging, where the process is not externally controlled. As a result, it does not take into account special charging capabilities of the EV or EVSE local grid constraints nor the availability of RES for charging purposes. This Use Case reflects the 2017 situation of most charging points and it is the basic service level solution for individual domestic charging. It is not intended to be taken as an example of good practice for future public infrastructure. Actors responsible for public charging infrastructure development should use the Use Case "Control the charge of an EV". This Use Case considers both inductive and conductive charging.			
Objective(s)	Deliver a charge service responding to an EVU's needs to charge at the maximum level allowed by the EVSE during all the time the EV is connected or paired.			
Related business case(s)	Provide information and data services Deliver mobility services Deliver charging services			

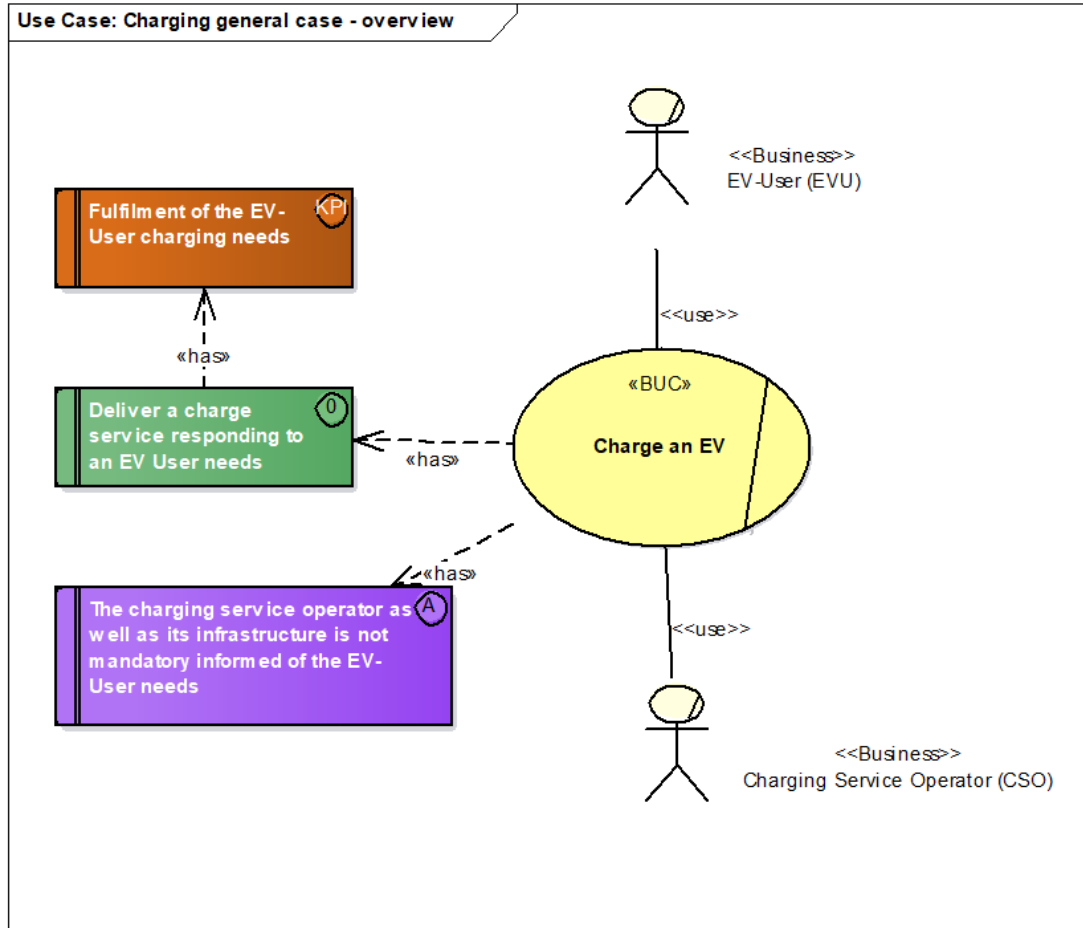
UC62913-2-4-B001 Charge an EV			
1.4 Narrative of use case			
Narrative of use case			
Short description			
During a timeframe, energy is exchanged between an EV and an EVSE. This Use Case describes the information exchanges between roles involved in this process and requirements associated with it.			
Complete description			
<u>Summary of use case</u>			
Connect or pair the EV to the EVSE <u>Description:</u> Connect or pair the EV to a charging station An EVU arrives at a charging station which can be located at many different places and uses one of the EVSE available: - individual domestic charging points using standard sockets; - power charging at individual domestic charging points using sophisticated home EVSE; - shared domestic charging points; - private parking place; - public parking place; - etc. In all these cases, after arriving at the charging station, the EV-user plugs in the socket or pairs its EV with the inductive EVSE and starts charging. Charge the EV <u>Description:</u> Complete charging In this scenario, charging behaviour is not externally influenced. The only influence on charging is the technical safeguard to keep charging within safe limits (given by the IEC 61851 series) and the user decision to disconnect. Disconnect or unpair the EV <u>Description:</u> When the EVU decides to or when battery is full, charging stops and EV user unplugs or unpairs the EV from the charging station in order to finish the transaction. End of the charging process due to interference It can be due to an interruption by the user stopping the charge before the end of the process or due to any unexpected event (basic communication interruption, outage, etc.).			
1.5 Key performance indicators (KPIs)			
Key performance indicators			
ID	Name	Description	Reference to mentioned use case objectives
1	Fulfilment of the EV user charging needs	Percentage of the charge reached in the allocated time (between connection and disconnection by the user)	Deliver a charge service responding to an EVU's needs
1.6 Use case conditions			
Use case conditions			
Assumptions			
1	The charging service operator as well as its infrastructure is not mandatorily informed of the EV user needs.		
Prerequisites			
1.7 Further information to the use case for classification/mapping			
Classification information			
Relation to other use cases			
<<BUC>> [] Control the charge of an EV			
Level of depth			
Prioritization			

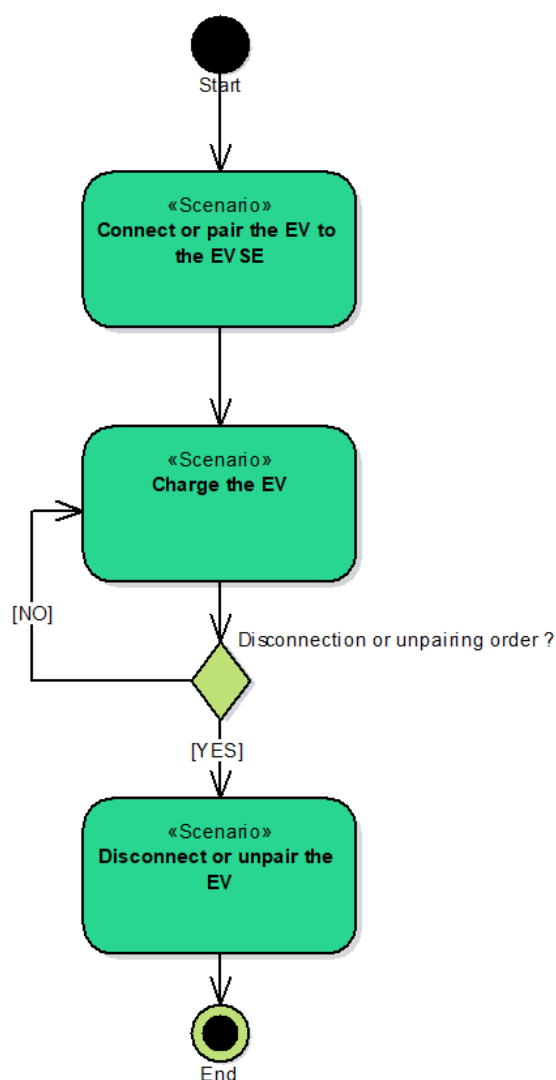
UC62913-2-4-B001 Charge an EV	
Generic, regional or national relation	
Nature of the use case	
BUC	
Further keywords for classification	
1.8 General remarks	
General remarks	

UC62913-2-4-B001 Charge an EV

2 Diagrams of use case

Diagram(s) of use case



UC62913-2-4-B001 Charge an EV**Activity: Charging general case - scenarios flowchart****3 Technical details****3.1 Actors**

Actors			
Grouping (e.g. domains, zones)		Group description	
Actor name	Actor type	Actor description	Further information specific to this use case
EV user (EVU)	Business	See Table 3	
Charging service operator (CSO)	Business	See Table 3	

3.2 References

References						
No.	Reference Type	Reference	Status	Impact on use case	Originator/organization	Link

4 Step by step analysis of use case**4.1 Overview of scenarios**