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SYSTEMS REFERENCE DELIVERABLE

colour inside

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

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GENERIC SMART GRID REQUIREMENTS –

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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- withdrawn,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.

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

INTRODUCTION

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

– Part 1: *Specific application of the Use Case methodology for defining Generic smart grid requirements according to the IEC 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

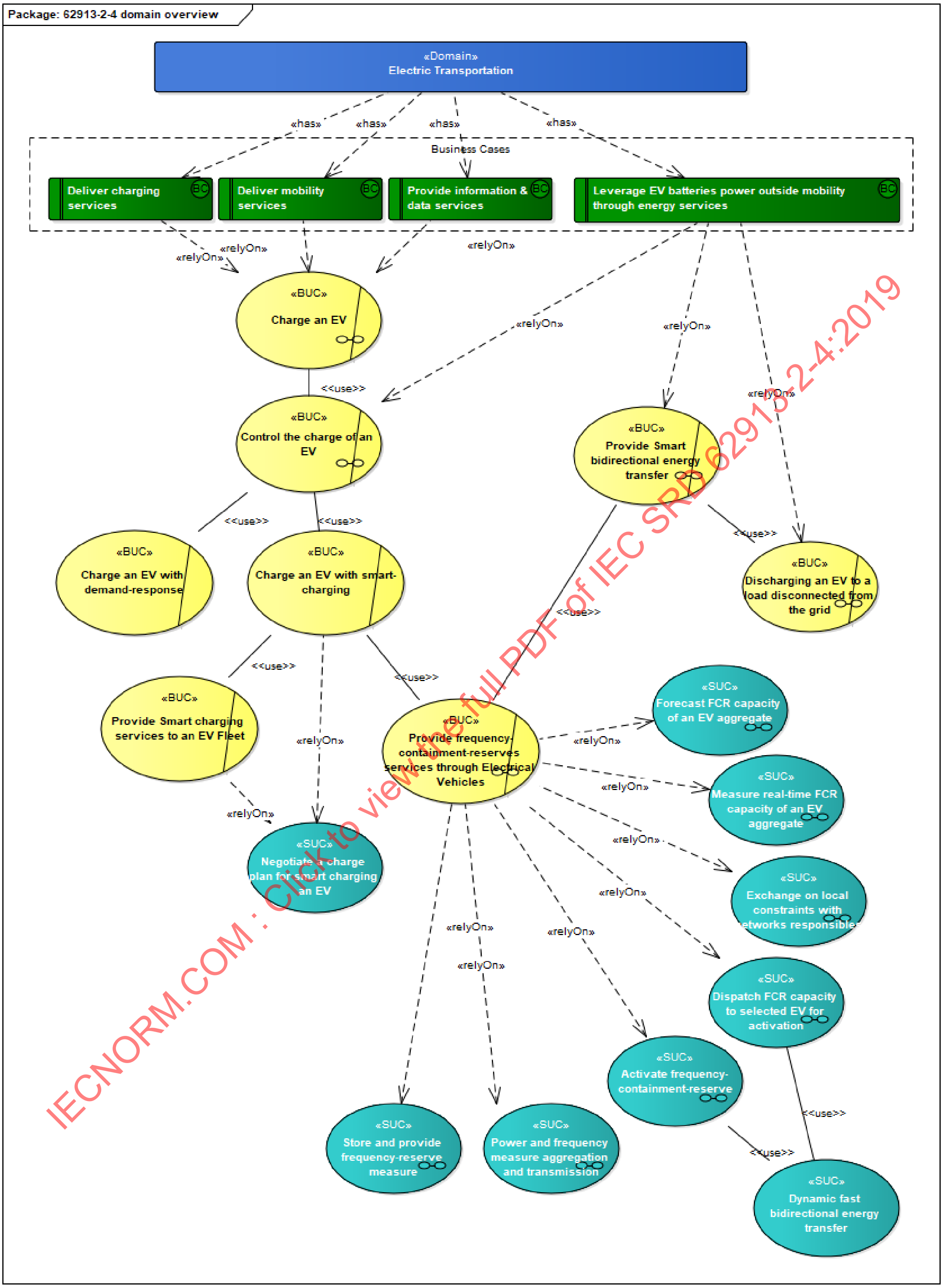


Figure 1 – Use Case domain overview of the electric transportation domain

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 restitute 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.

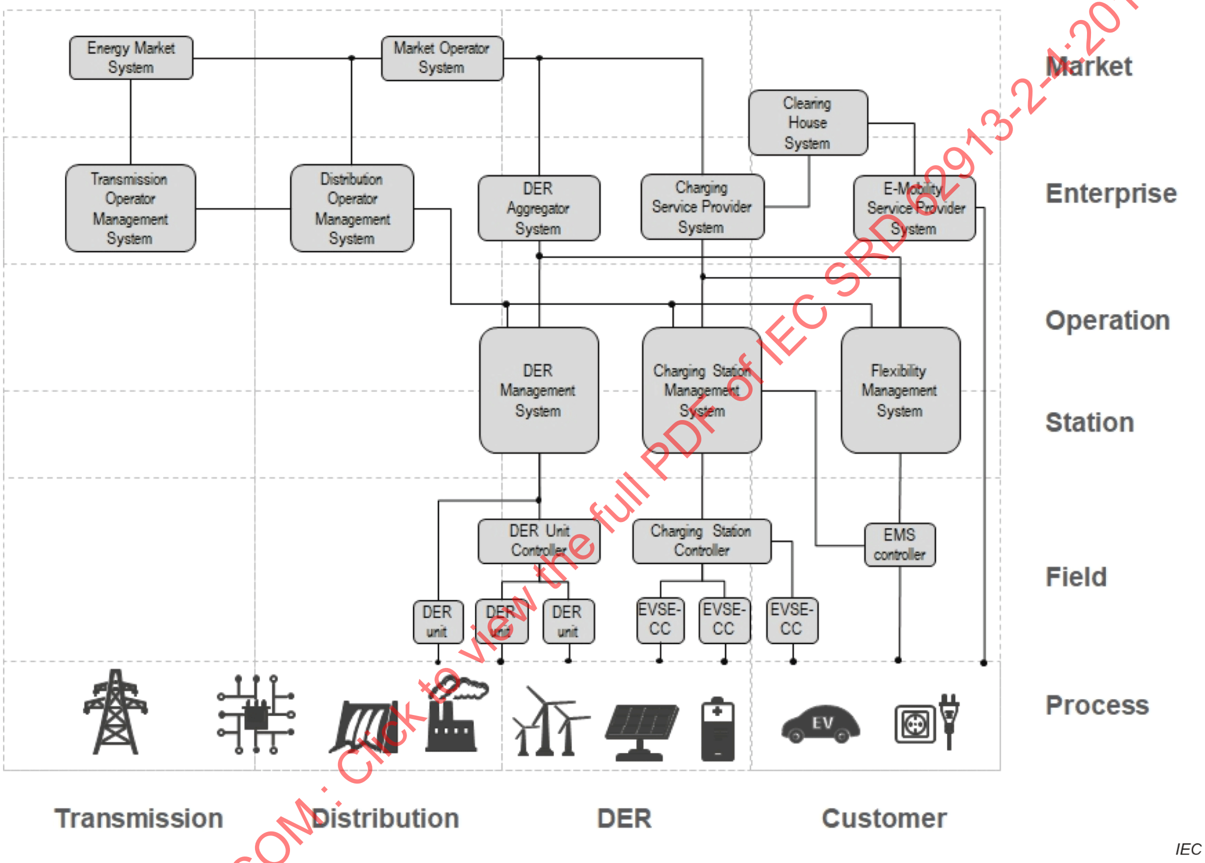


Figure 2 – Role model illustration mapped on SGAM

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

<table>
<tr><th>EV</th><th>EVSE/installation</th></tr>
<tr><td>Convert power (bidirectional) using an on-board charger</td><td>Store all grid code parameters (local)</td></tr>
<tr><td>Ensure active islanding detection</td><td>Provide decoupling protection</td></tr>
<tr><td></td><td>Measure V/f/calculate reactive power setpoint</td></tr>
<tr><td colspan="2">Enhanced immunity to voltage/frequency</td></tr>
</table>

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 level[1].

[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

Summary of use case

- **Connect or pair the EV to the EVSE**

  Description: 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**

  Description: 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**

  Description: 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

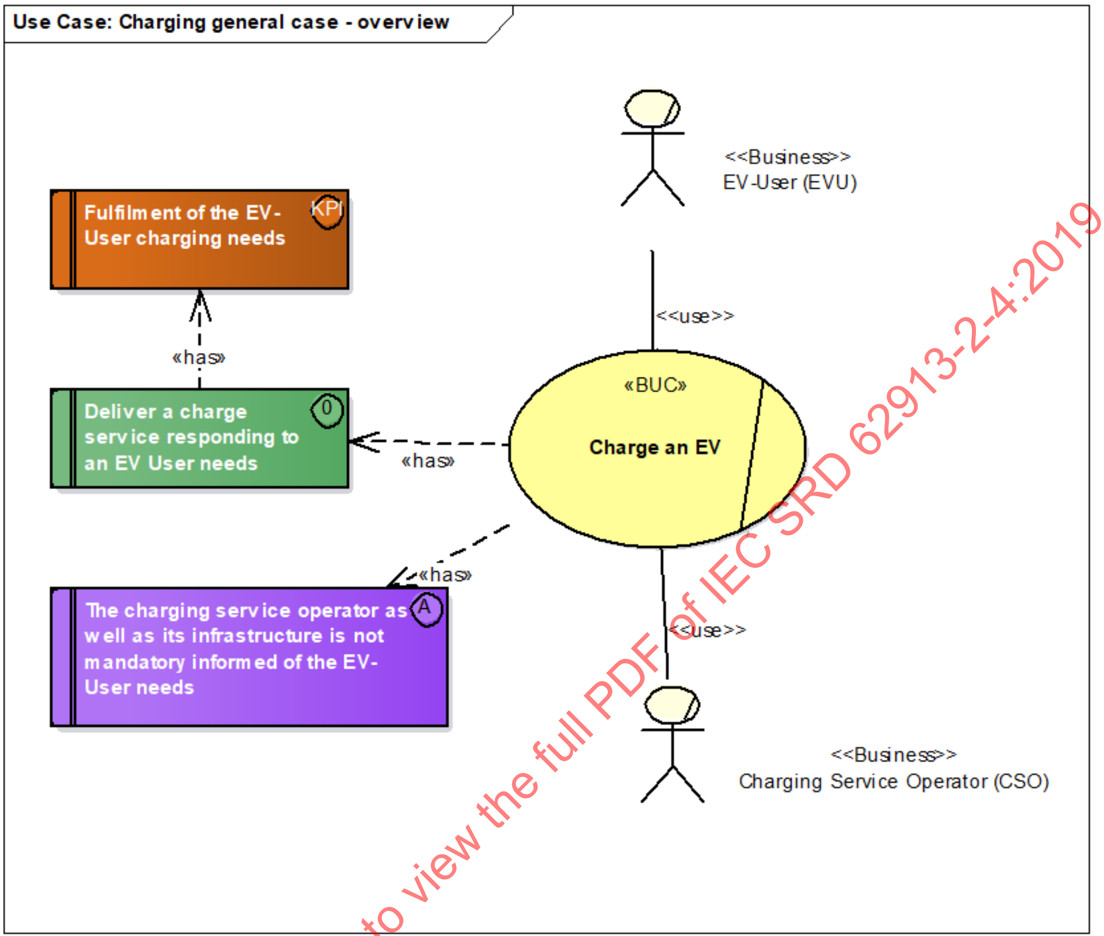
Prioritization

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

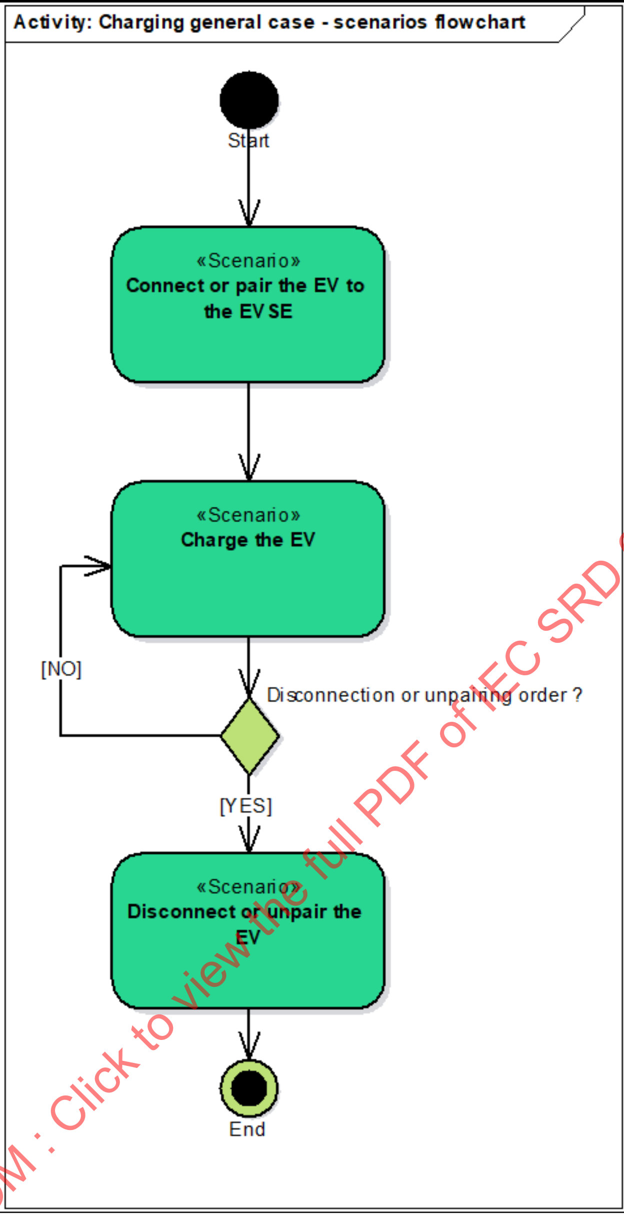
UC62913-2-4-B001 Charge an EV

2 Diagrams of use case

Diagram(s) of use case



UC62913-2-4-B001 Charge an EV



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

UC62913-2-4-B001 Charge an EV						
Scenario conditions						
No.	**Scenario name**	**Scenario description**	**Primary actor**	**Triggering event**	**Pre-condition**	**Post-condition**
1	Connect or pair the EV to the EVSE	**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.	EV user (EVU)			EV is electrically connected to the EVSE: Energy transfer from EVSE to EV is possible
2	Charge the EV	**Complete charging** The most important property of this scenario is that charging behaviour of the EV user 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.	Charging service operator (CSO)		EV is electrically connected to the EVSE	The time allowed for the charge by the EVU is reached

UC62913-2-4-B001 Charge an EV

3	Disconnect or unpair the EV	When the EVU decides to or when battery is full, charging stops and EVU 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.).	EV user (EVU)		The time allowed for the charge by the EVU is reached	The EV is disconnected or unpaired

4.2 Steps – Scenarios

4.2.1 Connect or pair the EV to the EVSE

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:

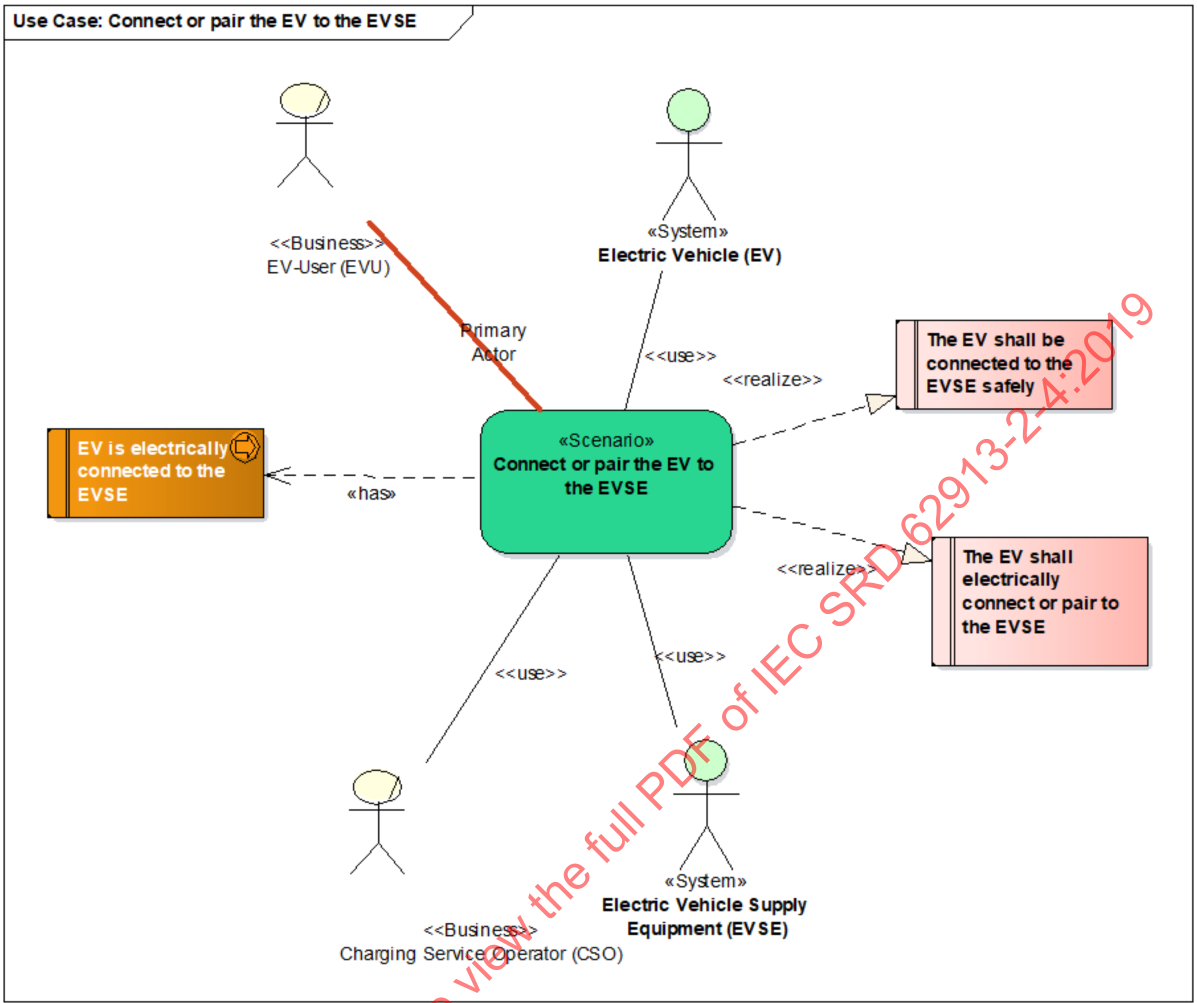
- individual domestic charging points using standard sockets;
- power charging at individual domestic charging points using sophisticated home EVSE;
- shared domestic charging points;
- private parking place;
- public parking place;
- etc.

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.

Requirement list (refer to "requirement" section for more information)

Requirement R-ID	Requirement name
Safety.Req1	The EV shall be connected to the EVSE safely
Functional.Req2	The EV shall electrically connect or pair to the EVSE

UC62913-2-4-B001 Charge an EV



Scenario step by step analysis

Scenario	
Scenario name	Connect or pair the EV to the EVSE.

Step No	Event	Name of process/ activity	Description of process/ activity	Service	Information producer (actor)	Information receiver (actor)	Information exchanged (IDs)	Requirement, R-IDs

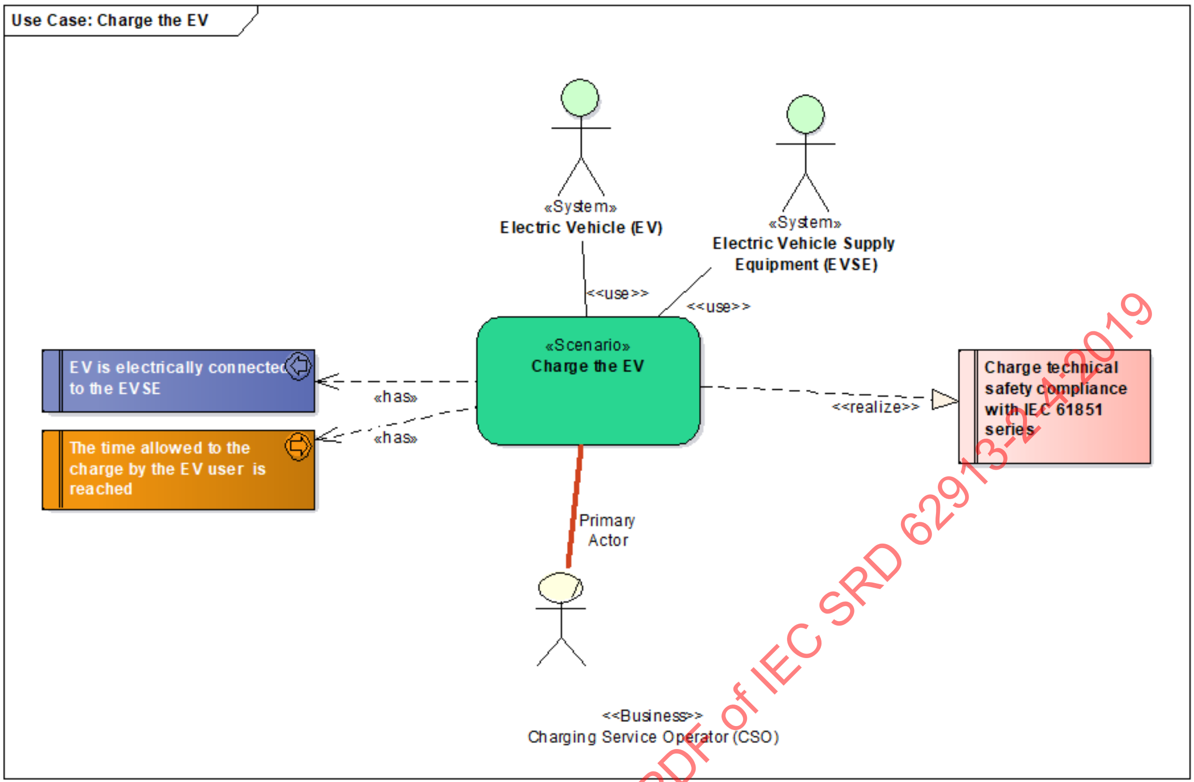
4.2.2 Charge the EV

Complete charging.

The most important property of this scenario is that charging behaviour of the EV user 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.

Requirement list (refer to "requirement" section for more information)	
Requirement R-ID	**Requirement name**
Req3	Charge technical safety compliance with the IEC 61851 series.

UC62913-2-4-B001 Charge an EV



Scenario step by step analysis

Scenario								
Scenario name	Charge the EV.							
Step No	Event	Name of process/ activity	Description of process/ activity	Service	Information producer (actor)	Information receiver (actor)	Information exchanged (IDs)	Requirement, R-IDs

4.2.3 Disconnect or unpair the EV

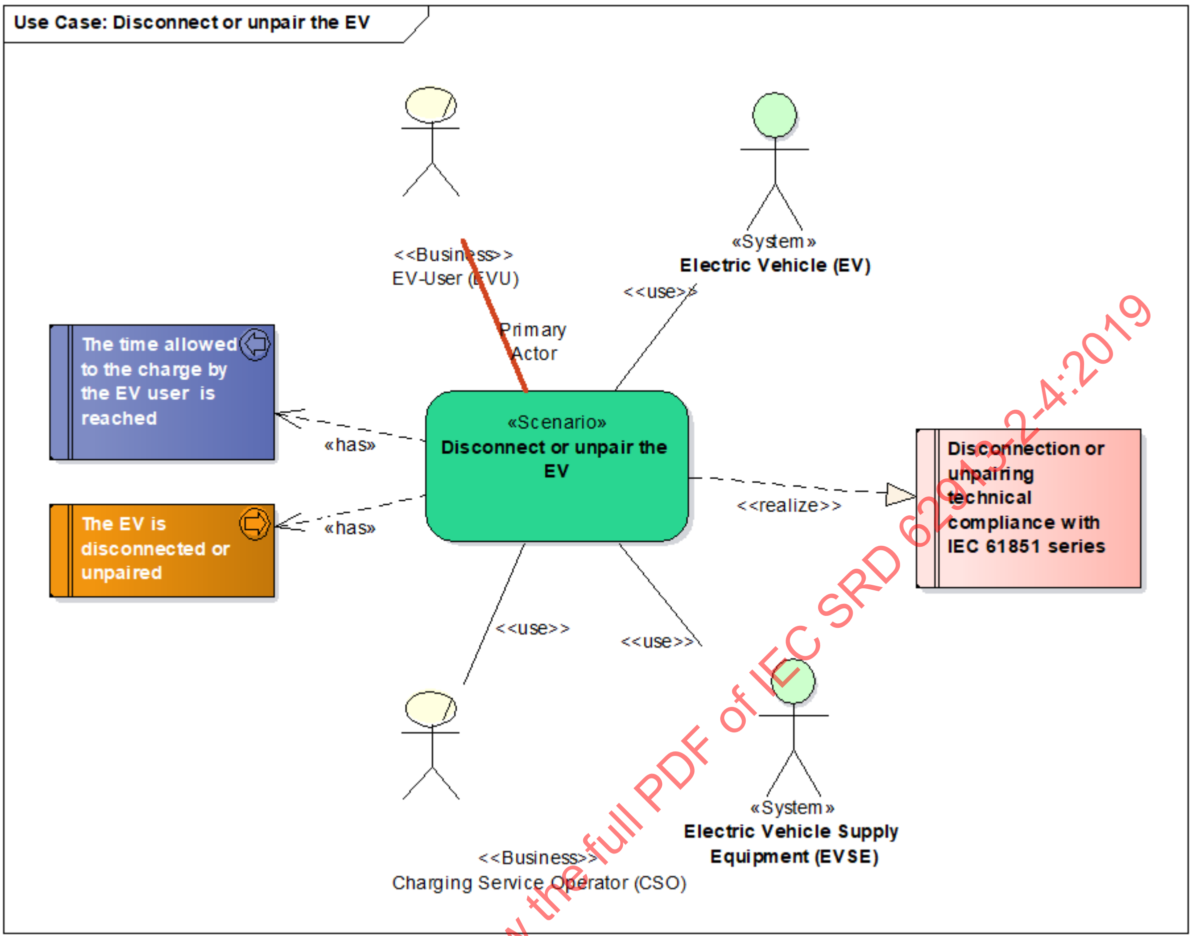
When the EVU decides to or when battery is full, charging stops and EVU unplugs or unpairs the EV from the charging station in order to finish the transaction.

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.).

Requirement list (refer to "requirement" section for more information)	
Requirement R-ID	**Requirement name**
Safety.Req4	Disconnection or unpairing technical compliance with the IEC 61851 series

UC62913-2-4-B001 Charge an EV



Scenario step by step analysis

Scenario								
Scenario name	Disconnect or unpair the EV							
Step No	Event	Name of process/ activity	Description of process/ activity	Service	Information producer (actor)	Information receiver (actor)	Information exchanged (IDs)	Requirement, R-IDs

5 Information exchanged

Information exchanged			
Information exchanged, ID	Name of information	Description of information exchanged	Requirement, R-IDs

6 Requirements

Requirements		
Categories ID	Category name for requirements	Category description
Cat1	Safety	
Requirement R-ID	Requirement name	Requirement description
Req1	The EV shall be connected to the EVSE safely	Electrical safety – IEC 61851 series
Req2	The EV shall electrically connect or pair to the EVSE	Socket or wire compatibility Inductive technology compatibility Charge technical safety compliance with the IEC 61851 series

UC62913-2-4-B001 Charge an EV		
Req3	Anytime during the charging sequence, the EVU may disconnect or unpair in safe conditions	Charge technical safety compliance with the IEC 61851 series
Common terms and definitions		
Term	**Definition**	
7 Custom information (optional)		
Custom information (optional)		
Key	**Value**	**Refers to section**

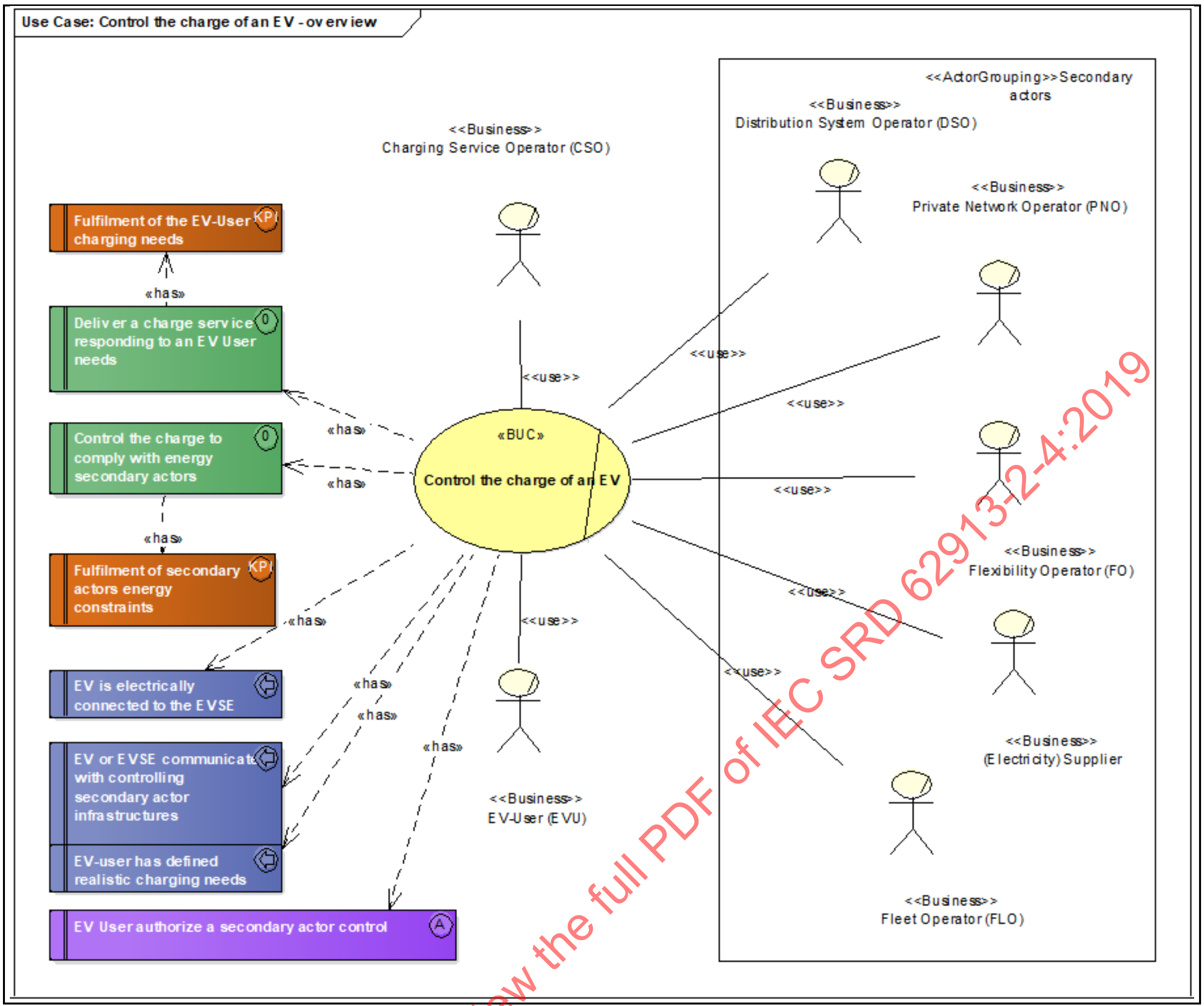
Table B.2 – UC62913-2-4-B002 Control the charge of an EV

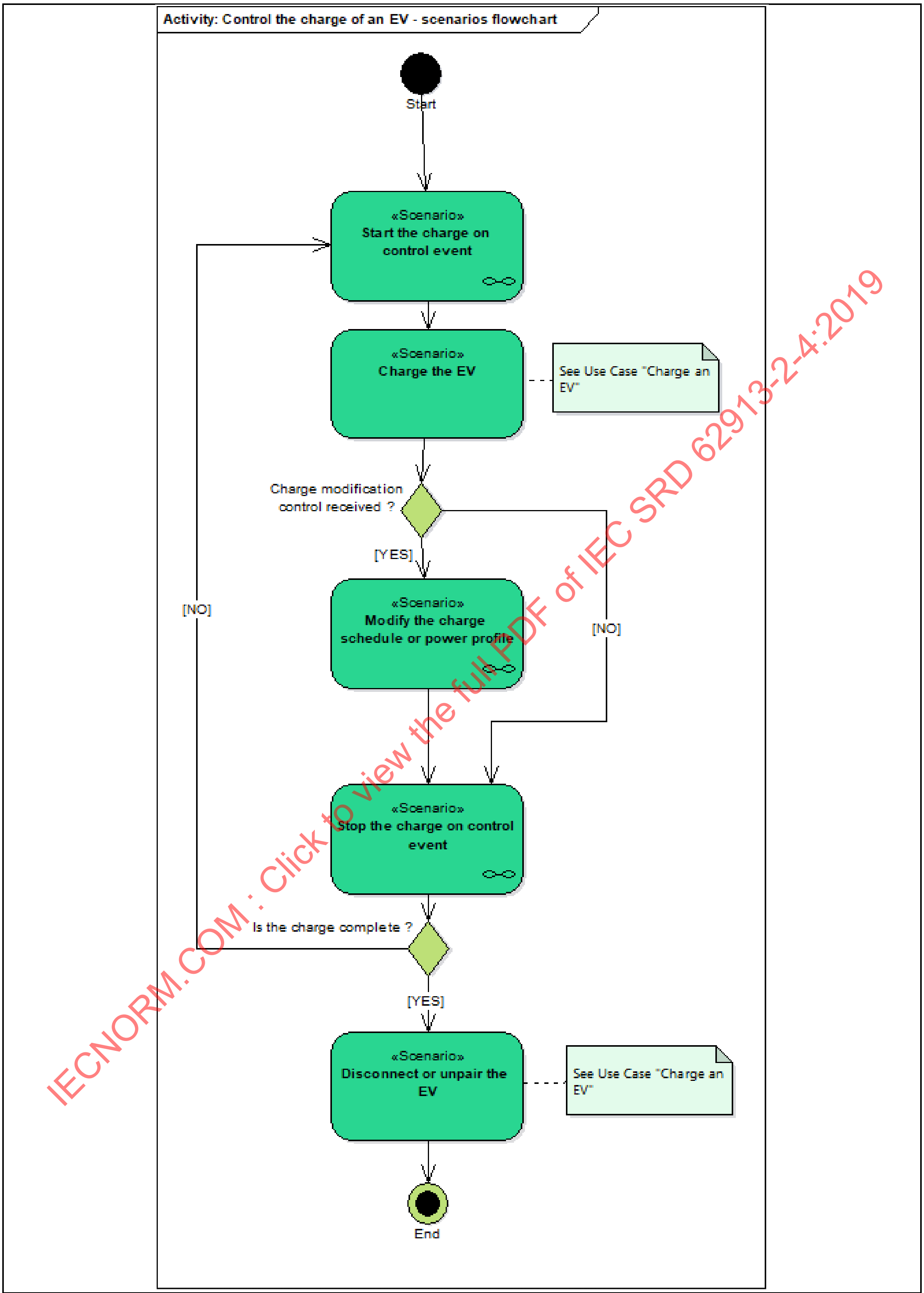
UC62913-2-4-B002 Control the charge of an EV				
1 Description of the use case				
1.1 Name of use case				
Use case identification				
ID	**Area(s)/Domain(s)/Zone(s)**		**Name of use case**	
	Electric transportation		Control the charge of an EV	
1.2 Version management				
Version management				
Version No.	**Date**	**Name of author(s)**	**Changes**	**Approval status**
1.3 Scope and objectives of use case				
Scope and objectives of use case				
Scope				
Objective(s)	Control the charge to comply with energy secondary actor's constraints and opportunities Deliver a charge service responding to an EVU's needs			
Related business case(s)	Deliver energy services			
1.4 Narrative of use case				
Narrative of use case				
Short description				
This 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 actor's constraints while responding to the EVU's needs.				
Complete description				
<u>Summary of use case</u> • **Start the charge on control event** • **Modify the charge schedule or power profile** • **Stop the charge on control event**				
1.5 Key performance indicators (KPIs)				
Key performance indicators				

ID	Name	Description	Reference to mentioned use case objectives
1	Fulfilment of secondary actor's energy constraints	The charge schedule and the power profile may be influenced by secondary actors	Control the charge to comply with energy secondary actors

2	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	EVU authorizes a secondary actor to take control on the charging process
Prerequisites	
1	EV or EVSE communicates with controlling secondary actor infrastructures
2	EV is electrically connected to the EVSE
3	EV user has defined realistic e-mobility needs
1.7 Further information to the use case for classification/mapping	
Classification information	
Relation to other use cases	
<<BUC>> Charge an EV <<BUC>> Charge an EV with demand-response <<BUC>> Provide Smart bidirectional energy transfer <<BUC>> Charge an EV with smart charging	
Level of depth	
Prioritization	
Generic, regional or national relation	
Nature of the use case	
BUC	
Further keywords for classification	
1.8 General remarks	
General remarks	
2 Diagrams of use case	


Use Case: Control the charge of an EV - overview
<<ActorGrouping>>Secondary actors
<<Business>> Distribution System Operator (DSO)
<<Business>> Charging Service Operator (CSO)
<<Business>> Private Network Operator (PNO)
Fulfilment of the EV-User charging needs
KPI
«has»
Deliver a charge service responding to an EV User needs
Control the charge to comply with energy secondary actors
Fulfilment of secondary actors energy constraints
EV is electrically connected to the EVSE
EV or EVSE communicate with controlling secondary actor infrastructures
EV-user has defined realistic charging needs
EV User authorize a secondary actor control
«BUC»
Control the charge of an EV
<<use>>
<<Business>> Flexibility Operator (FO)
<<Business>> (Electricity) Supplier
<<Business>> EV-User (EVU)
<<Business>> Fleet Operator (FLO)


Activity: Control the charge of an EV - scenarios flowchart
Start
«Scenario»
Start the charge on control event
«Scenario»
Charge the EV
See Use Case "Charge an EV"
Charge modification control received ?
[YES]
[NO]
«Scenario»
Modify the charge schedule or power profile
[NO]
«Scenario»
Stop the charge on control event
Is the charge complete ?
[YES]
«Scenario»
Disconnect or unpair the EV
See Use Case "Charge an EV"
End

3 Technical details

3.1 Actors

Actors			
Grouping (e.g. domains, zones)		**Group description**	
Secondary actors			
Actor name	**Actor type**	**Actor description**	**Further information specific to this use case**
Private network operator (PNO)	Business	See Table 3	
Flexibility operator (FO)	Business	See Table 3	
(Electricity) supplier	Business	See Table 3	
Distribution system operator (DSO)	Business	See Table 3	
Fleet operator (FLO)	Business	See Table 3	

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**

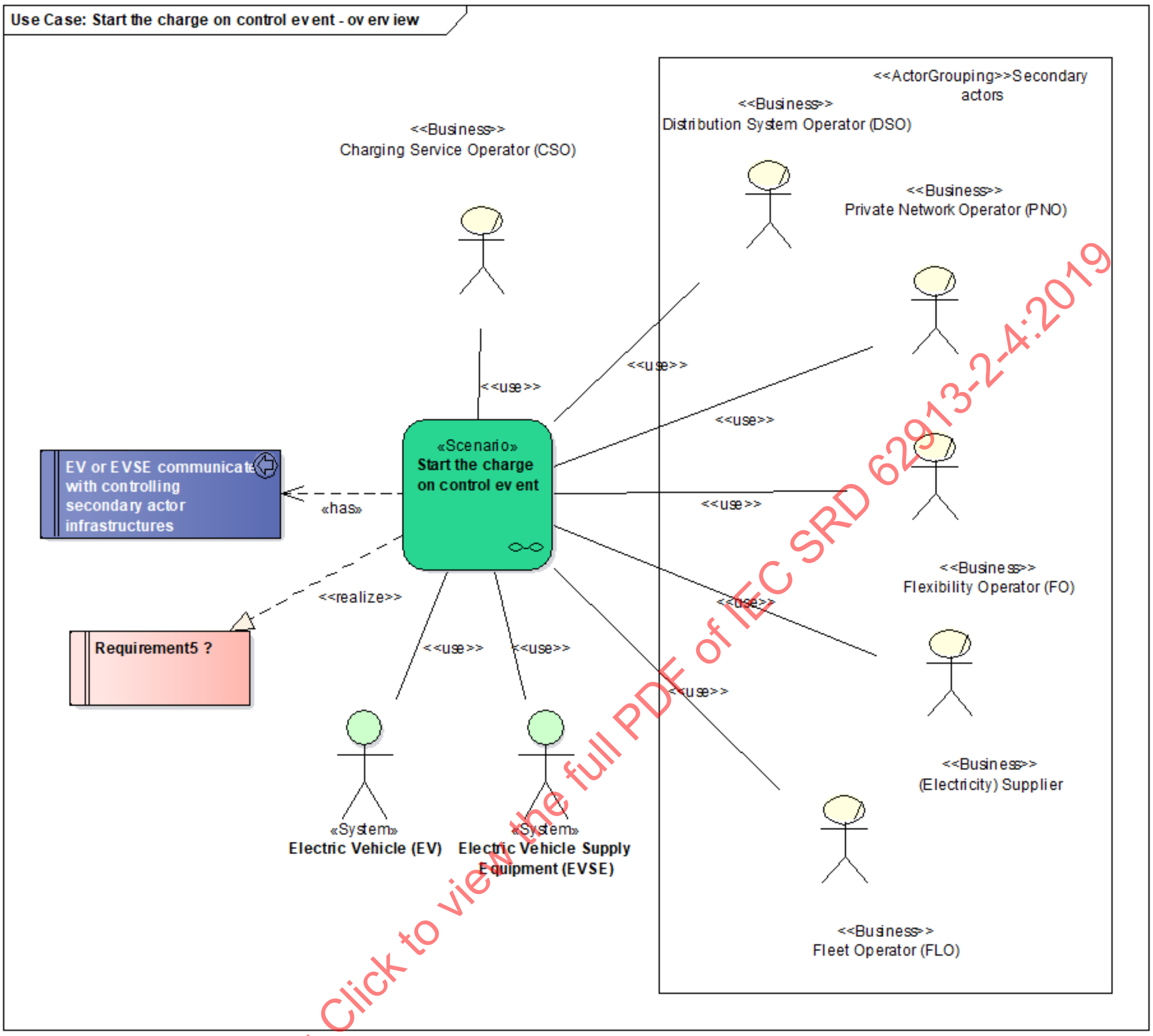
4 Step by step analysis of use case

4.1 Overview of scenarios

Scenario conditions						
No.	**Scenario name**	**Scenario description**	**Primary actor**	**Triggering event**	**Pre-condition**	**Post-condition**
1	Start the charge on control event				EV or EVSE communicates with controlling secondary actor infrastructures	
2	Modify the charge schedule or power profile	On control by a secondary actor the charge schedule or power profile can be modified			EV or EVSE communicates with controlling secondary actor infrastructures	
3	Stop the charge on control event				EV or EVSE communicate with controlling secondary actor infrastructures	

4.2 Steps – Scenarios

4.2.1 Start the charge on control event



Scenario step by step analysis

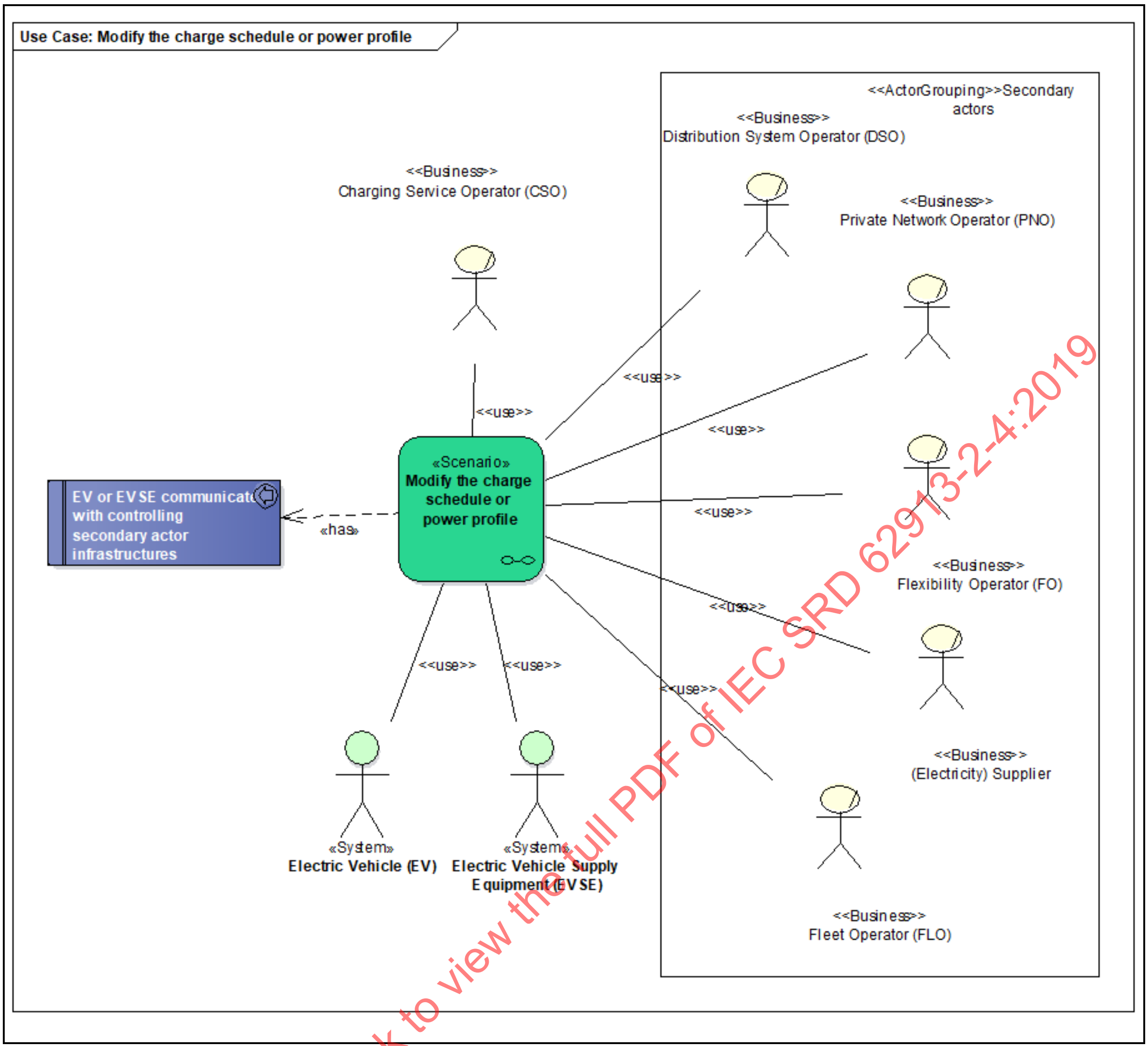
Scenario								
Scenario name	Start the charge on control event							
Step No	**Event**	**Name of process/ activity**	**Description of process/ activity**	**Service**	**Information producer (actor)**	**Information receiver (actor)**	**Information exchanged (IDs)**	**Requirement, R-IDs**
1.1		Start the charge						

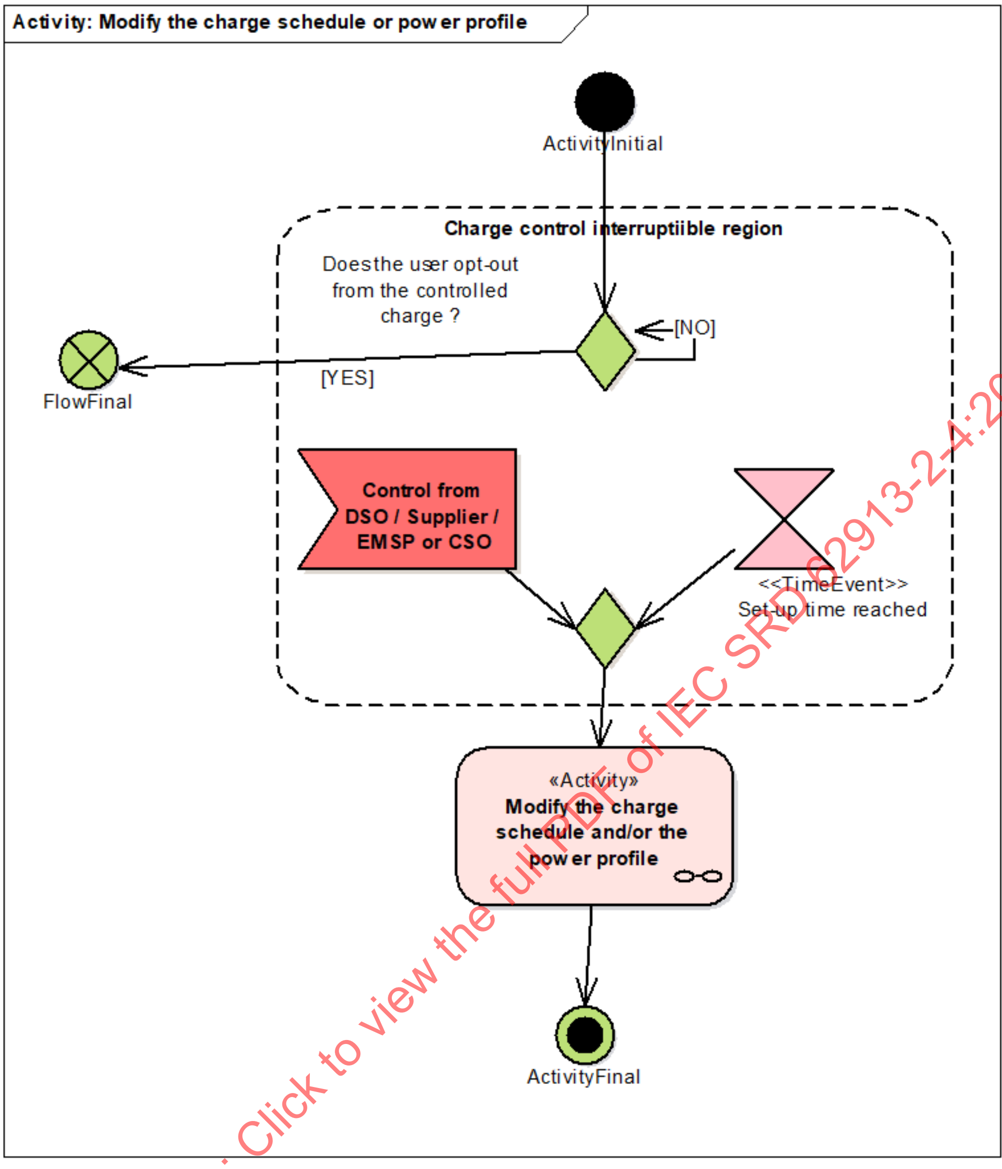
Start the charge

Start the charge on control event/Start the charge

4.2.2 Modify the charge schedule or power profile

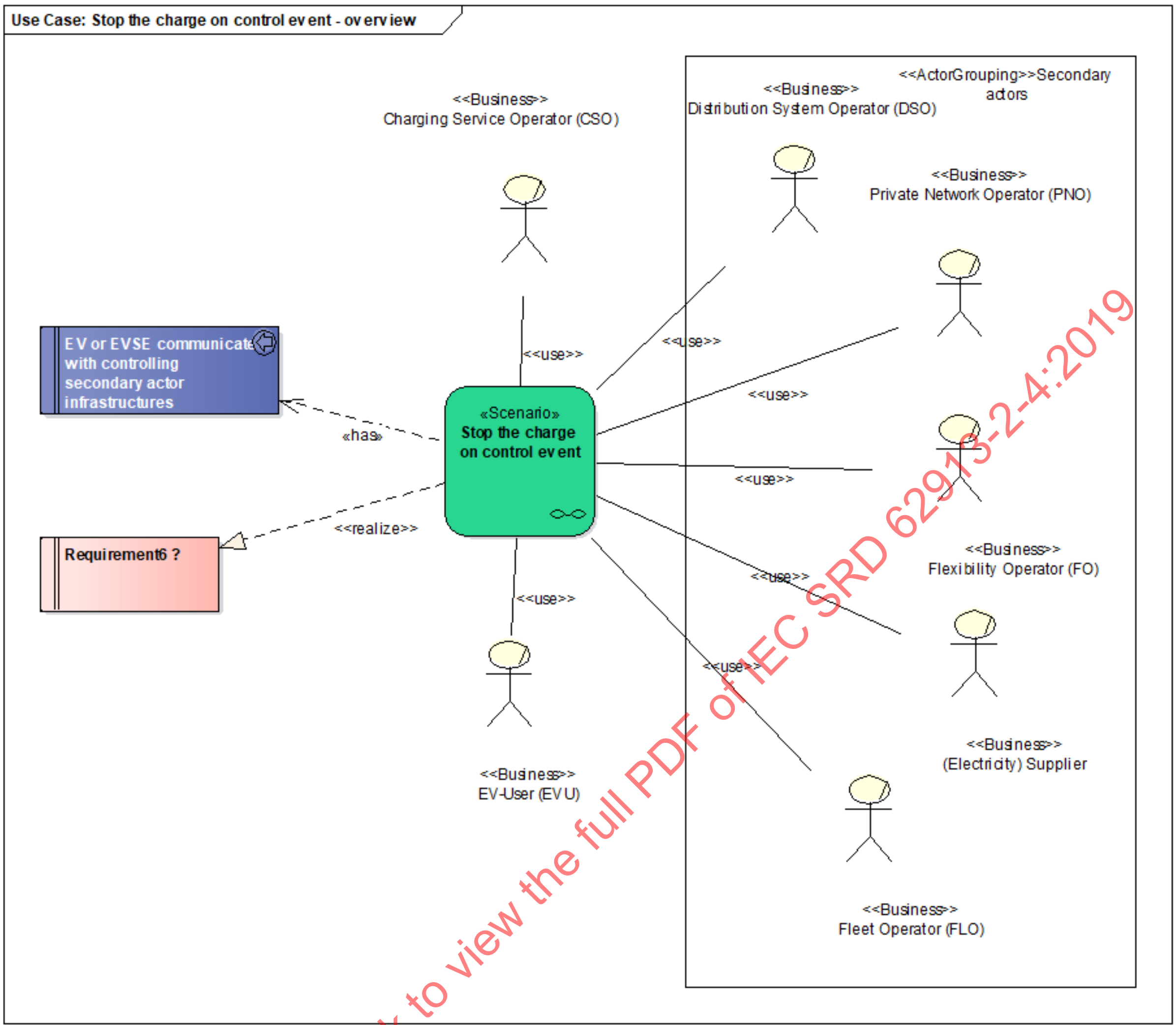
On control by a secondary actor the charge schedule or power profile can be modified

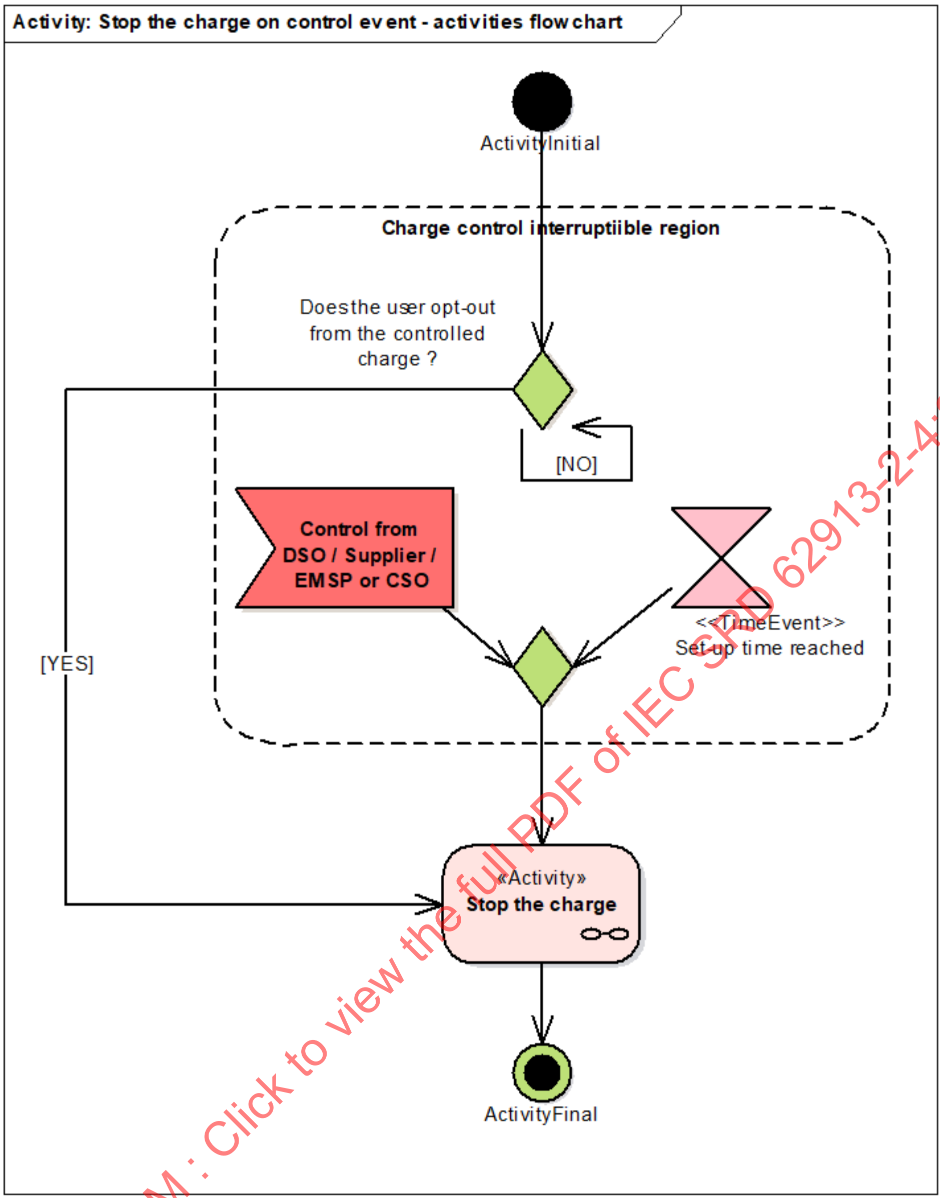

Use Case: Modify the charge schedule or power profile
<<ActorGrouping>>Secondary actors
<<Business>>
Distribution System Operator (DSO)
<<Business>>
Charging Service Operator (CSO)
<<Business>>
Private Network Operator (PNO)
<<use>>
<<use>>
<<use>>
<<use>>
«Scenario»
Modify the charge schedule or power profile
EV or EVSE communicate with controlling secondary actor infrastructures
«has»
<<use>>
<<use>>
<<use>>
<<use>>
<<Business>>
Flexibility Operator (FO)
<<Business>>
(Electricity) Supplier
«System»
Electric Vehicle (EV)
«System»
Electric Vehicle Supply Equipment (EVSE)
<<Business>>
Fleet Operator (FLO)



Scenario step by step analysis
Modify the charge schedule or power profile/Modify the charge schedule and/or the power profile

4.2.3 Stop the charge on control event





Scenario step by step analysis

Scenario								
Scenario name	Stop the charge on control event							
Step No	Event	Name of process/ activity	Description of process/ activity	Service	Information producer (actor)	Information receiver (actor)	Information exchanged (IDs)	Requirement, R-IDs
3.1		Stop the charge						

5 Information exchanged

Information exchanged			
Information exchanged, ID	Name of information	Description of information exchanged	Requirement, R-IDs

6 Requirements		
Requirements (optional)		
Categories ID	**Category name for requirements**	**Category description**
Cat1		
Requirement R-ID	**Requirement name**	**Requirement description**
Req1	Anytime during the charging sequence, the EVU may opt-out from any control by a secondary actor	
Req2	The EVSE indicates to the EV the status of the charge (charging, not charging due to control, not charging due to an issue)	
Req3	The EVSE can start/stop the charge on control by a secondary actor if no opt-out is activated by the EVU	

7 Common terms and definitions	
Common terms and definitions	
Term	**Definition**

8 Custom information (optional)		
Custom information (optional)		
Key	**Value**	**Refers to section**

Table B.3 – UC62913-2-4-B003 Charge an EV with demand-response

UC62913-2-4-B003 Charge an EV with demand-response		
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 with demand-response

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	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 EVU, grid, DER needs and e-mobility needs. This Use Case does not use HLC.
Objective(s)	1 Deliver a charge service responding to an EVU's e-mobility needs 2 Control the charge to comply with energy secondary actors
Related business case(s)	Deliver energy services Deliver charging services
1.4 Narrative of use case	

Narrative of use case

Short description

An EV is charged according to EVU e-mobility needs and secondary actor flexibility incentives.

Complete description

The EVU plugs or ensures EV pairing.

Depending on the flexibility conditions mandated by the flexibility operators, the charge may start immediately or not and after the charge has started can be interrupted.

The charge stops when the e-mobility needs have been fulfilled or when the user unplugs or when the EV leaves.

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 e-mobility needs
2	Fulfilment of secondary actor's energy constraints	The charge schedule and the power profile may be influenced by secondary actors	Control the charge to comply with energy secondary actors

1.6 Use case conditions

Use case conditions

Assumptions

Prerequisites

The EVSE is able to receive flexibility messages from secondary actors that may influence the charge schedule.

The EVU is informed and accepts that the charge may vary according to the flexibility messages.

The UV user may have defined his or her e-mobility needs (e.g. time of departure, target state of charge of the battery, etc.) to the EVSE, for example using a real or a mobile application.

If any identification is needed, it has been successfully achieved

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

Short description

Prioritization

Generic, regional or national relation

Generic

Nature of the use case

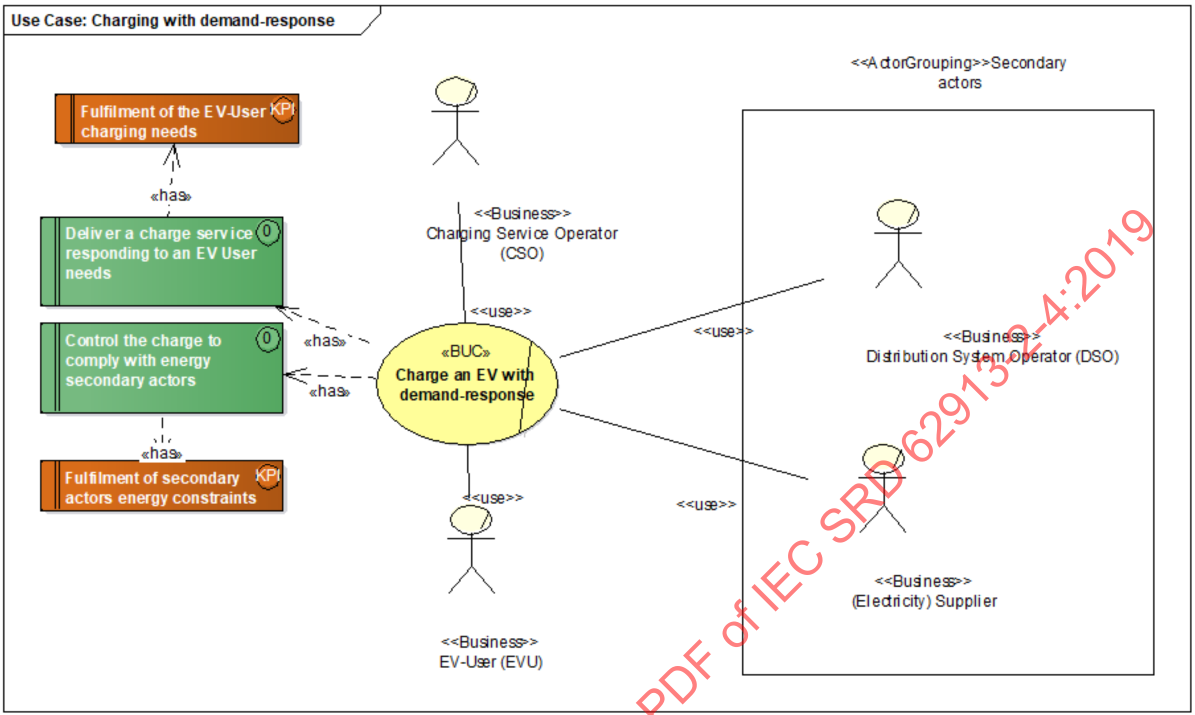
BUC

Further keywords for classification

1.8 General remarks

General remarks

2 Diagrams of use case

Diagram(s) of use case


3 Technical details

3.1 Actors

Actors			
Grouping (e.g. domains, zones)		**Group description**	
Secondary actors			
Actor name	**Actor type**	**Actor description**	**Further information specific to this use case**
Distribution system operator (DSO)	Business	See Table 3	DSO may send flexibility messages or tariffs through the smart meter.
(Electricity) supplier	Business	See Table 3	Supplier may send flexibility messages or tariffs through the smart meter or through any interface with the user.

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	CSO may receive messages directly from flexibility actors and sends them to the EVSE.

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

Scenario conditions						
No.	Scenario name	Scenario description	Primary actor	Triggering event	Pre-condition	Post-condition

4.2 Steps – Scenarios

5 Information exchanged

Information exchanged			
Information exchanged, ID	Name of information	Description of information exchanged	Requirement, R-IDs

6 Requirements (optional)

Requirements (optional)		
Categories ID	**Category name for requirements**	**Category description**
Requirement R-ID	**Requirement name**	**Requirement description**
Req1	Opt-out	Anytime during the charging sequence, the EVU may opt-out from any flexibility programme and start immediate charging
Req2	Status	The EVSE shall indicate to the EVU the status of the charge (ongoing charging, charge under control of a flexibility actor)
Req3	Mobility needs	The application of any flexibility programme shall not prevent the EVSE from fulfilling the mobility need.
Req4	PWM	When the EVSE receives a flexibility message, the EVSE shall use the PWM signal to control the maximum power level available for charging.

7 Common terms and definitions

Common terms and definitions	
Term	Definition

8 Custom information (optional)

Custom information (optional)		
Key	Value	Refers to section

Table B.4 – UC62913-2-4-B004 Charge an EV with smart-charging

UC62913-2-4-B004 Charge an EV with smart-charging

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 with smart-charging

1.2 Version management

Version management				
Version No.	**Date**	**Name of author(s)**	**Change**	**Approval status**

1.3 Scope and objectives of use case

Scope and objectives of use case	
Scope	The scope of this business Use Case is charging an EV based on schedules negotiated with secondary actors.
Objective(s)	Negotiate the charging services following user needs and energy secondary actor's constraints

UC62913-2-4-B004 Charge an EV with smart-charging	
Related business case(s)	Deliver energy services Deliver charging services

1.4 Narrative of use case

Narrative of use case
Short description
The business Use Case describes the smart charging process of an electric vehicle in a private network (public car-park, residential condominium, etc.). A charge is qualified as smart because it reflects user's e-mobility needs, grid and market constraints and opportunities in an optimal way for all parties. This Use Case is based on ISO 15118 smart charging mechanism.
Complete description
This Use Case covers charging process based on information about user mobility needs, local installation, grid schedule and market requirements. With this information, the EVSE and EV can dynamically react to changes in the charging conditions in a mutual optimal way by reducing or increasing demand plan along the charging schedule. Steps description: 1) The user informs the EV of its e-mobility needs (estimated time of departure, target state of charge). 2) The EV calculates the required amount of energy needed in order to reach the target state of charge at user-provided departure time. 3) The EV sends the required energy amount, departure time and charging capability of the EV to the EVSE, which might forward it to a secondary actor. 4) A secondary actor or the EVSE, if it has the required information, calculates a series of optimal maximum power schedules based on grid constraints and opportunities, market information, local power generation, user e-mobility needs and local current limitations. 5) The EVSE sends the maximum power schedules to the EV. 6) The EV selects one power schedule, calculates the charging profile that will be applied and sends it back to the EVSE. 7) The EV starts charging according to mode chosen. a) Scheduling: the EVSE sends available power and electricity prices, then the EV calculates its charging profile and sends it back to the EVSE. Re-negotiation is possible. b) Dynamic: the EV sends its physical limits and the EVSE sends back the setpoint. 8) During the charging sequence, EV or EVSE can stop the sequence and restart it with new parameters. If the EV decides it, this may be because the user has changed his or her e-mobility needs. If the EVSE stops it, this may be because of changes in charging conditions like: less power is available as a new EV has just plugged, or the energy price is now having a peak or more energy is now available. The EV can refuse to change current charging schedule. In that case, the previous charging schedule continues until its end.

1.5 Key performance indicators (KPIs)

Key performance indicators			
ID	**Name**	**Description**	**Reference to mentioned use case objectives**
1	Fulfilment of secondary actor's energy constraints	The charge schedule and the power profile may be influenced by secondary actors	Negotiate the charging services following user needs and energy secondary actor's constraints
2	Fulfilment of the EV user charging needs	Percentage of the charge reached in the allocated time (between connection and disconnection by the user)	Negotiate the charging services following user needs and energy secondary actor's constraints

1.6 Use case conditions

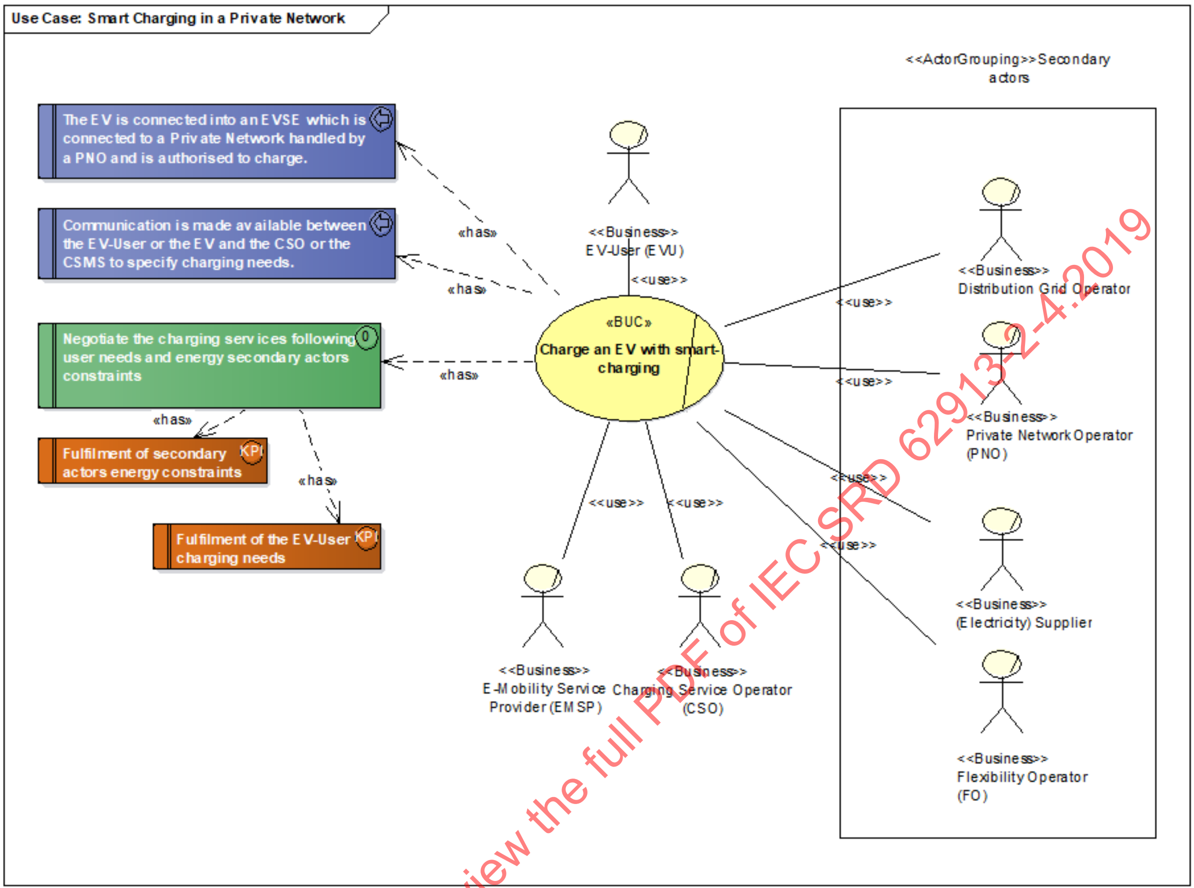
Use case conditions	
Assumptions	
Prerequisites	
1	The EV is plugged or paired to an EVSE which is connected to a CSO.
2	The EVSE is connected to the CSO.

UC62913-2-4-B004 Charge an EV with smart-charging	
3	HLC has successfully been established.
4	The EVU has been identified and authorized to charge. NOTE 1 The identification can be realized through the communication link (mode Plug and Charge in the ISO 15118 series) or through manual payment without identification at the EVSE (mode EIM in the ISO 15118 series). NOTE 2 CSO can have validated that the user is authorized to charge by contacting the EMSP or a clearing house.
1.7 Further information to the use case for classification/mapping	
Classification information	
Relation to other use cases	
<<BUC>> Provide frequency containment reserves services through electric vehicles <<BUC>> Deliver energy service to a private network through electric vehicles <<BUC>> Deliver energy service to a network through electric vehicles <<BUC>> Provide smart charging services to an EV fleet <<BUC>> Control the charge of an EV <<SUC>> Negotiate a charge plan for smart charging an EV	
Level of depth	
Short version	
Prioritization	
Generic, regional or national relation	
Generic	
Nature of the use case	
BUC	
Further keywords for classification	
Electric vehicle, smart charging, private network	
1.8 General remarks	
General remarks	

UC62913-2-4-B004 Charge an EV with smart-charging

2 Diagrams of use case

Diagram(s) of use case



3 Technical details

3.1 Actors

Actors			
Grouping (e.g. domains, zones)		**Group description**	
Secondary actors			
Actor name	**Actor type**	**Actor description**	**Further information specific to this use case**
(Electricity) supplier	Business	See Table 3	
Flexibility operator (FO)	Business	See Table 3	
Distribution grid operator	Business	See Table 3	
Private network operator (PNO)	Business	See Table 3	

Actors			
Grouping (e.g. domains, zones)		**Group description**	
Actor name	**Actor type**	**Actor description**	**Further information specific to this use case**
E-mobility service provider (EMSP)	Business	See Table 3	
EV user (EVU)	Business	See Table 3	
Charging service operator (CSO)	Business	See Table 2	

UC62913-2-4-B004 Charge an EV with smart-charging						
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						
Scenario conditions						
No.	**Scenario name**	**Scenario description**	**Primary actor**	**Triggering event**	**Pre-condition**	**Post-condition**
4.2 Steps – Scenarios						
5 Information exchanged						

Information exchanged			
Information exchanged, ID	**Name of information**	**Description of information exchanged**	**Requirement, R-IDs**
6 Requirements (optional)			

Requirements (optional)		
Categories ID	**Category name for requirements**	**Category description**
Requirement R-ID	**Requirement name**	**Requirement description**
Req1	Mobility need	The user may declare his mobility needs to the EV. In case the user does not declare them, the EV shall define default needs.
Req2	Power schedule proposition	The EVSE shall propose to the EV at least one maximum power schedule complying with secondary actor's requirements and user mobility needs.
Req3	Power schedule description	Schedule shall be described in any number of continuous periods of time where the maximum power available and market conditions are constant within the period.
Req4	Power schedule content	Schedule may contain market elements like tariffs tables, CO_2 levels, any other type of incentives.
Req5	Encryption	The EVSE shall encrypt all messages to secondary actors containing any user private data.
7 Common terms and definitions		

Common terms and definitions	
Term	**Definition**
8 Custom information (optional)	

Custom information (optional)		
Key	**Value**	**Refers to section**

Table B.5 – UC62913-2-4-B005 Provide smart bidirectional energy transfer

UC62913-2-4-B005 Provide smart bidirectional energy transfer		
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	Provide smart bidirectional energy transfer

UC62913-2-4-B005 Provide smart bidirectional energy transfer

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	
Objective(s)	Re-negotiate the charging services following a demand by grid actors of a bidirectional power transfer into the grid Leverage available and unused EV power reserve
Related business case(s)	Leverage EV batteries' power outside mobility

1.4 Narrative of use case

Narrative of use case

Short description

Complete description

Summary of use case

- **Inform the EVSE of a bidirectional power transfer demand**

  Description:

- **Renegotiation**

  Description:

- **Bidirectional power transfer**

  Description:

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)	Re-negotiate the charging services following a demand by grid actors of a bidirectional power transfer into the grid
2	Fulfilment of secondary actor's energy constraints	The charge schedule and the power profile may be influenced by secondary actors	Re-negotiate the charging services following a demand by grid actors of a bidirectional power transfer into the grid
3	Power reserve leveraging performance indicator	Ratio between the aggregated power available at EV level for the flexibility aggregator and the capacity contracted by the flexibility aggregator, when providing service.	Leverage available and unused EV power reserve

1.6 Use case conditions

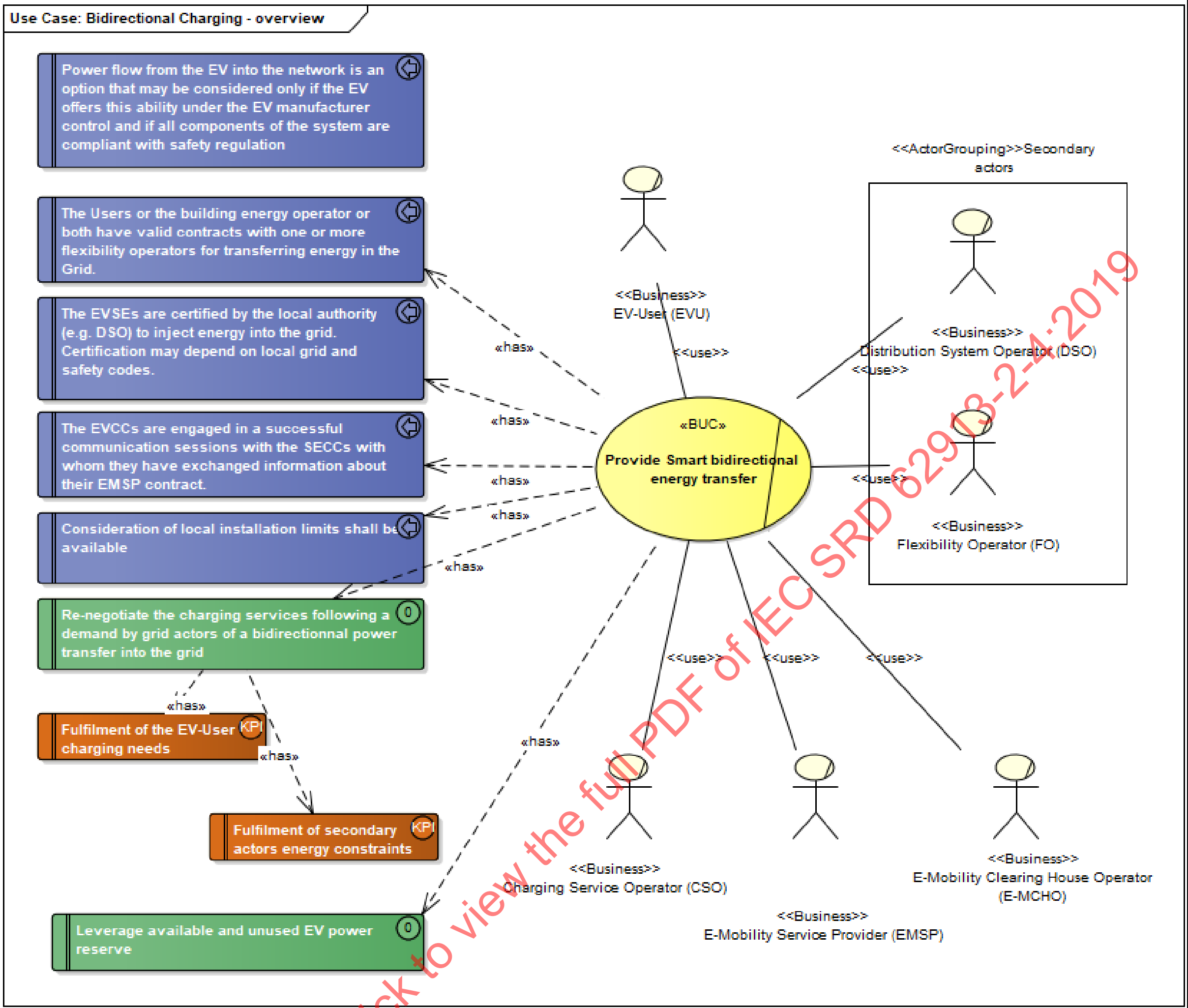
Use case conditions

Assumptions

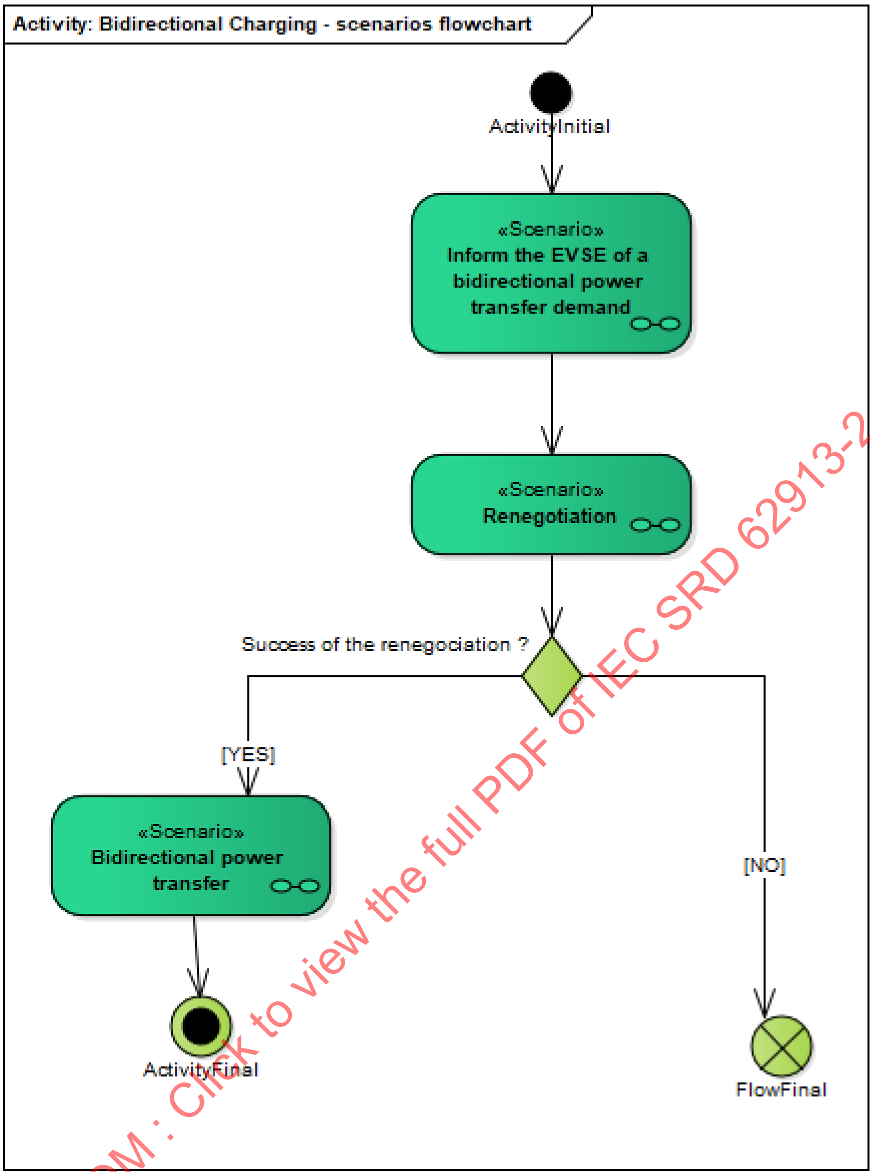
Prerequisites	
1	Consideration of local installation limits shall be available
2	The EVCCs are engaged in successful communication with the SECCs with whom they have exchanged information about their EMSP contract.
3	The EVSEs are certified by the local authority (e.g. DSO) to inject energy into the grid. Certification may depend on local grid and safety codes.

UC62913-2-4-B005 Provide smart bidirectional energy transfer	
4	The users or the building energy operator or both have valid contracts with one or more flexibility operators for transferring energy in the grid.
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 <<BUC>>Provide frequency containment reserves services through electric vehicles <<BUC>>Supply electricity for a local energy storage through EV <<BUC>>Deliver energy service to a network through electric vehicles <<BUC>> Deliver energy service to a private network through electric vehicles	
Level of depth	
Prioritization	
Generic, regional or national relation	
Nature of the use case	
BUC	
Further keywords for classification	
1.8 General remarks	
General remarks	
2 Diagrams of use case	

UC62913-2-4-B005 Provide smart bidirectional energy transfer
Diagram(s) of use case



UC62913-2-4-B005 Provide smart bidirectional energy transfer



3 Technical details

3.1 Actors

Actors			
Grouping (e.g. domains, zones)		**Group description**	
Secondary actors			
Actor name	**Actor type**	**Actor description**	**Further information specific to this use case**
Distribution system operator (DSO)	Business	See Table 3	
Flexibility operator (FO)	Business	See Table 3	

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	

UC62913-2-4-B005 Provide smart bidirectional energy transfer			
E-mobility clearing house operator (e-MCHO)	Business	See Table 3	
E-mobility service provider (EMSP)	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

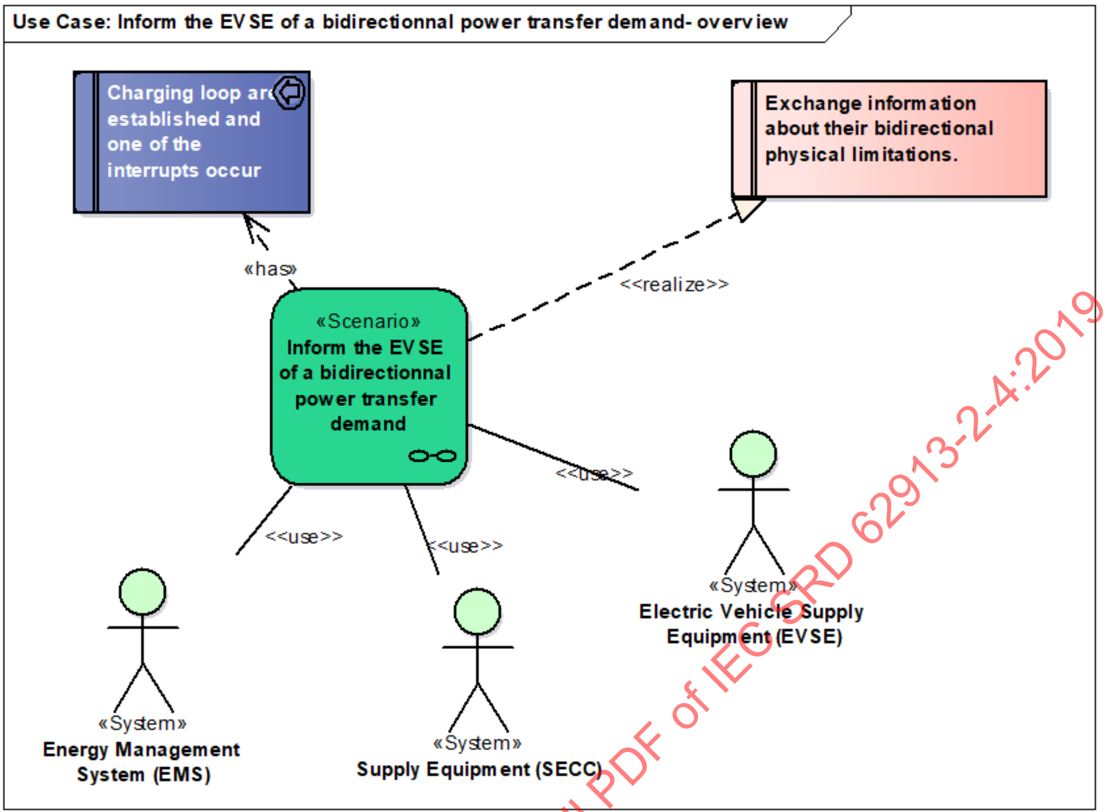
4.1 Overview of scenarios

Scenario conditions						
No.	**Scenario name**	**Scenario description**	**Primary actor**	**Triggering event**	**Pre-condition**	**Post-condition**
1	Inform the EVSE of a bidirectional power transfer demand				Charging loops are established and one of the interrupts occurs and SECC or EVCC have the necessity to renegotiate. If the result of the renegotiation is a bidirectional service, then this Use Case can start.	
2	Renegotiation					

UC62913-2-4-B005 Provide smart bidirectional energy transfer						
3	Bidirectional power transfer				Authorization of discharging has been completed and EVs are ready to transfer energy.	EVs will be charged according the mobility needs of the Users. Failure end conditions: – The EVSE is not able to transfer power due to contactor failure. – Negotiation between EV and EVSE failed. – No power transfer between EVSE and EV. – Flexibility contracts cannot be assessed as valid by the secondary actors. The EVSEs are transferring power within the maximum local limits of installaion and according to the conditions agreed during the renegotiations.

4.2 Steps – Scenarios	
Inform the EVSE of a bidirectional power transfer demand	
Requirement list (refer to "requirement" section for more information)	
Requirement R-ID	**Requirement name**
Req1	Exchange information about their bidirectional physical limitations.

UC62913-2-4-B005 Provide smart bidirectional energy transfer

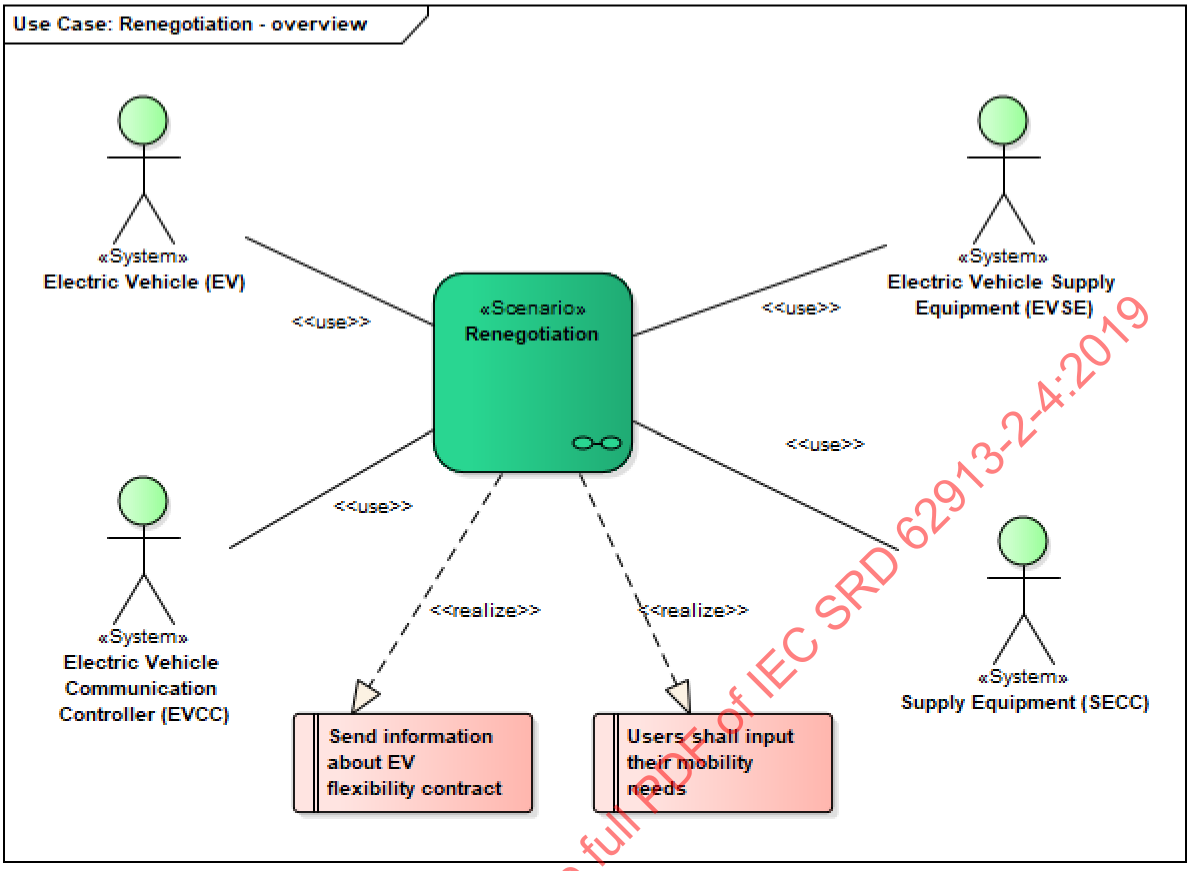


Scenario step by step analysis

Scenario								
Scenario name	Inform the EVSE of a bidirectional power transfer demand							
Step No	Event	Name of process/ activity	Description of process/ activity	Service	Information producer (actor)	Information receiver (actor)	Information exchanged (IDs)	Requirement, R-IDs
Renegotiation								

Requirement list (refer to "requirement" section for more information)	
Requirement R-ID	**Requirement name**
Req2	Users shall input their e-mobility needs
Req3	Send information about EV flexibility contract

UC62913-2-4-B005 Provide smart bidirectional energy transfer

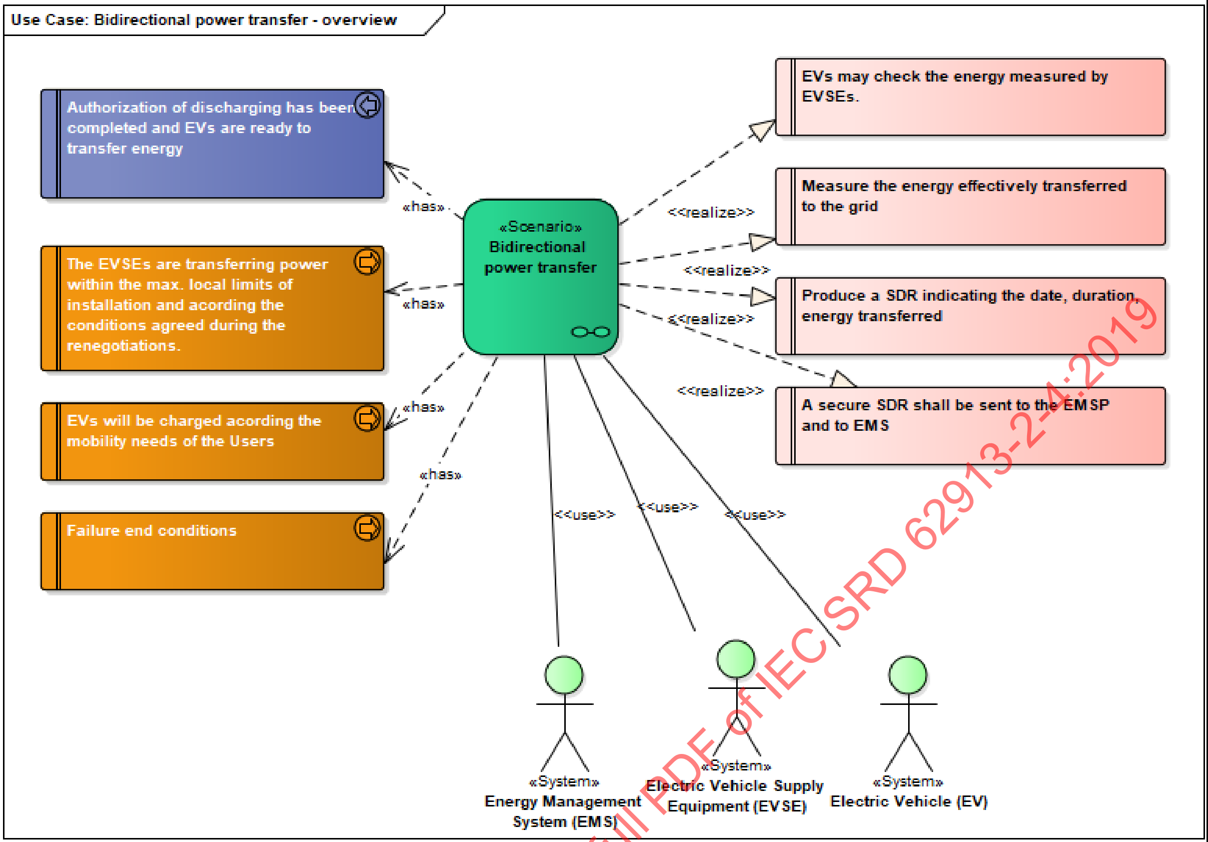


<u>**Scenario step by step analysis**</u>

Scenario								
Scenario name	Renegotiation							
Step No.	**Event**	**Name of process/ activity**	**Description of process/ activity**	**Service**	**Information producer (actor)**	**Information receiver (actor)**	**Information exchanged (IDs)**	**Requirement, R-IDs**
Bidirectional power transfer								

Requirement list (refer to "requirement" section for more information)	
Requirement R-ID	**Requirement name**
Req4	EVs may check the energy measured by EVSEs.
Req5	Measure the energy effectively transferred to the grid.
Req6	Produce an SDR indicating the date, duration, energy transferred.
Req7	A secure SDR shall be sent to the EMSP and to EMS.

UC62913-2-4-B005 Provide smart bidirectional energy transfer



Scenario step by step analysis

Scenario								
Scenario name	Bidirectional power transfer							
Step No.	Event	Name of process/ activity	Description of process/ activity	Service	Information producer (actor)	Information receiver (actor)	Information exchanged (IDs)	Requirement, R-IDs

5 Information exchanged

Information exchanged			
Information exchanged, ID	Name of information	Description of information exchanged	Requirement, R-IDs

6 Requirements (optional)

Requirements (optional)		
Categories ID	Category name for requirements	Category description
Cat1		
Requirement R-ID	Requirement name	Requirement description
Req1	Exchange information about their bidirectional physical limitations	EVCCs and SECCs shall exchange information about their bidirectional physical limitations.
Req2	Users shall input their mobility needs	The users shall input their mobility needs (minimum, maximum and target SOC, ToD, etc.)
Req3	Send information about EV flexibility contract	EVCCs shall 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.
Req4	EVs may check the energy measured by EVSEs.	EVs may check the energy measured by EVSEs.

UC62913-2-4-B005 Provide smart bidirectional energy transfer		
Req5	Measure the energy effectively transferred to the grid	EVSEs shall measure the energy effectively transferred to the grid according to local grid codes and flexibility contract measurement requirements.
Req6	Produce an SDR indicating the date, duration, energy transferred	If required, EVSE shall produce 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 SDRs shall be sent to the EMSP and to EMS. The SDR shall be signed and encrypted by the EVSE. It may be checked by EV.
Req7	A secure SDR shall be sent to the EMSP and to EMS	The SDRs shall be sent to the EMSP and to EMS. The SDR shall be signed and encrypted by the EVSE. It may be checked by EV.
7 Common terms and definitions		
Common terms and definitions		
Term	**Definition**	
8 Custom information (optional)		
Custom information (optional)		
Key	**Value**	**Refers to section**

Table B.6 – UC62913-2-4-B007 Provide frequency containment reserve services through EV

UC62913-2-4-B007 Provide frequency containment reserve services through 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	Provide frequency containment reserves services through electric vehicles

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 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. In this Use Case, we consider only electric vehicles (PHEV, BEV, vehicle with range extenders) at charging spot. Vehicles such as lorries, buses and boats are included but stationary batteries, trains and trams are excluded from the 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).
Objective(s)	Ensure frequency containment reserves availability at best economic cost Contribute to grid resilience improvement Leverage available and unused EV power reserve
Related business case(s)	Leverage EV batteries' power outside mobility

1.4 Narrative of use case

Narrative of use case

Short description

This Use Case describes the electric vehicles contribution process to the frequency containment process of stabilizing the system frequency by compensating imbalances through its power reserves (injection or consumption).

Complete description

The frequency containment reserves are the operational reserves activated to contain system frequency after the occurrence of an imbalance; they are the reserves considered in this Use case. Frequency restoration reserves (FRR – active power reserves activated to restore system frequency to the nominal frequency and power balance for the scheduled value in a synchronous area) or replacement reserves (used to restore/support the FRR for additional imbalances) are out of scope.

The electric vehicle's contribution to the frequency containment process of stabilizing the system frequency by compensating imbalances through its power reserves can be realized differently depending on the imbalance nature and the injection/consumption capability of the EV.

The EV's state of charge (SOC) is a key parameter to choose which subcase is most appropriate or feasible, in order to ensure that mobility needs are fulfilled, for example:

– low SOC: consumption only would be feasible;
– high SOC: injection only would be feasible.

The local regulation framework is also key to this Use Case (reverse flow allowed, frequency reserve grid codes, Power and frequency measures resolution and sampling defined by regulation).

The frequency containment process can be split in several steps:

First, the flexibility aggregator responds to the transmission system operator (TSO) dimensioning and allocation of frequency containment reserves to providers with its own capacity.

Then, periodically, the flexibility aggregator communicates its frequency containment reserve capacity to the TSO according to its contract and the rules defined with the TSO.

On a frequency measure threshold (frequency increase or decrease), the flexibility aggregator activates its frequency containment reserve. The TSO live controls the aggregated frequency reserve availability of the flexibility aggregator.

Ex-post TSO controls the power and energy measures of the flexibility aggregator (aggregated or by units).

<u>Summary of use case</u>

– **The flexibility aggregator respond to the allocation of frequency containment reserves by the TSO**

  <u>Description</u>: The flexibility aggregator responds to the Transmission system operator tenders or mandatory offers (dimensioning and allocation of frequency containment reserves) through its contract with a frequency reserve responsible party.

  Tenders, offers, provisions and contracts mode are dependent on the procurement scheme defined by regulation (for example: in Germany, it is an open market with voluntary participation and bidding; in France, it is a mandatory provision scheme with fixed prices).

  During programming (for example: the day before in France, or the week before in Belgium), the TSO allocates primary reserve capacity services to the frequency reserve responsible party he or she contracted with and to whom the flexibility aggregator responded with a capacity proposition. This collaboration can happen through diverse market mechanisms.

  The programming of the allocations and propositions of frequency reserve capacities are achieved at a programming step $[t; t + T]$ for a defined product resolution P (in MW) defined in regulations (for example, at the moment in France, Belgium, Switzerland, P is 1 MW and T is 0,5 h; in Netherlands, T is 0,25 h and 5 MW $\geq P \geq$ 1 MW).

– **The flexibility aggregator communicates periodically its frequency containment reserve capacity**

  <u>Description</u>: The flexibility aggregator communicates its frequency reserve capacity to the TSO at step of programming in preparation the next time slot.

  Example: At the moment the step is 0,5 h in France and 0,25 h in Germany or Netherlands, but this depends on the local regulation.

– **Frequency containment reserve activation**

  <u>Description</u>: Activation, from a frequency measurement over/under a threshold, of frequency reserve capacity on the contracted level (power, increase or decrease) and on the contracted response time (< 1 s).

  The activation can come from a central dispatch of the TSO, or a self-dispatch (portfolio or unit based).

– **TSO live control of aggregated frequency reserve availability**

  <u>Description</u>: The TSO controls a periodic aggregated power measurement provided by the flexibility aggregator at a step compliant with the setting dynamic (for example 10 s in France or 4 s in Germany or Belgium).

– **Ex-post control of the power and energy measures (aggregated or by units)**

  <u>Description</u>: The frequency reserve responsible party shall provide proof of its frequency containment reserve service providing at unit and aggregate level. This proof contracted with the TSO requires measures (aggregated and by unit) from the flexibility operator.

  Power and frequency measures resolution and sampling are defined by regulation.

1.5 Key performance indicators (KPIs)

Key performance indicators

ID	Name	Description	Reference to mentioned use case objectives
1	Margin to fulfil FCR services and 100 % end-user mobility needs	Margin of security (%) used in the dispatching of the FCR service onto EV aggregate to cover for the end-user opt-outs.	Ensure frequency containment reserves availability at best economic cost
2	Flexibility aggregator FCR quality of service performance indicator	Depending on TSO and local regulations (number of opt-outs, percentage of service delivery failures, respond times, etc.).	Contribute to grid resilience improvement
3	Power reserve leveraging for FCR performance indicator	Ratio between the aggregated power available at EV level for the flexibility aggregator and the capacity contracted by the flexibility aggregator, when providing frequency containment reserve service.	Leverage available and unused EV power reserve

1.6 Use case conditions

Use case conditions

Assumptions

Prerequisites

1	A contract exists between the flexibility aggregator and the frequency reserve responsible party
2	Local and national regulations shall allow frequency containment reserves service
3	Flexibility aggregator shall be pre-qualified by the transmission system operator through the frequency reserve responsible party: the transmission system operator shall certify the flexibility aggregator's ability to provide frequency containment reserves services through its commitment with the frequency reserve responsible party.
4	A contract exists between the frequency reserve responsible party and the TSO.
5	Flexibility aggregator shall comply to local networks constraints and national networks constraints (grid-codes): – private network constraints; – distribution network constraints; – TSO grid codes (national and supra-national).
6	EVs are connected to compatible charging spots (i.e. reversibility-enabled, communication-enabled, or metering enabled, if required)
7	Grid operator has informed the flexibility aggregator on grid availability (planned work, congestions in relation with random events as faults, etc.)

1.7 Further information to the use case for classification/mapping

Classification information

Relation to other use cases

<<BUC>> [] Provide smart bidirectional energy transfer

<<BUC>> [] Charge an EV with smart-charging

<<SUC>> [] Power and frequency measure aggregation and transmission

<<SUC>> [] Activate frequency containment reserve

<<SUC>> [] Dispatch FCR capacity to selected EV for activation

<<SUC>> [] Forecast FCR capacity of an EV aggregate

<<SUC>> [] Store and provide frequency-reserve measure

<<SUC>> [] Measure real-time FCR capacity of an EV aggregate

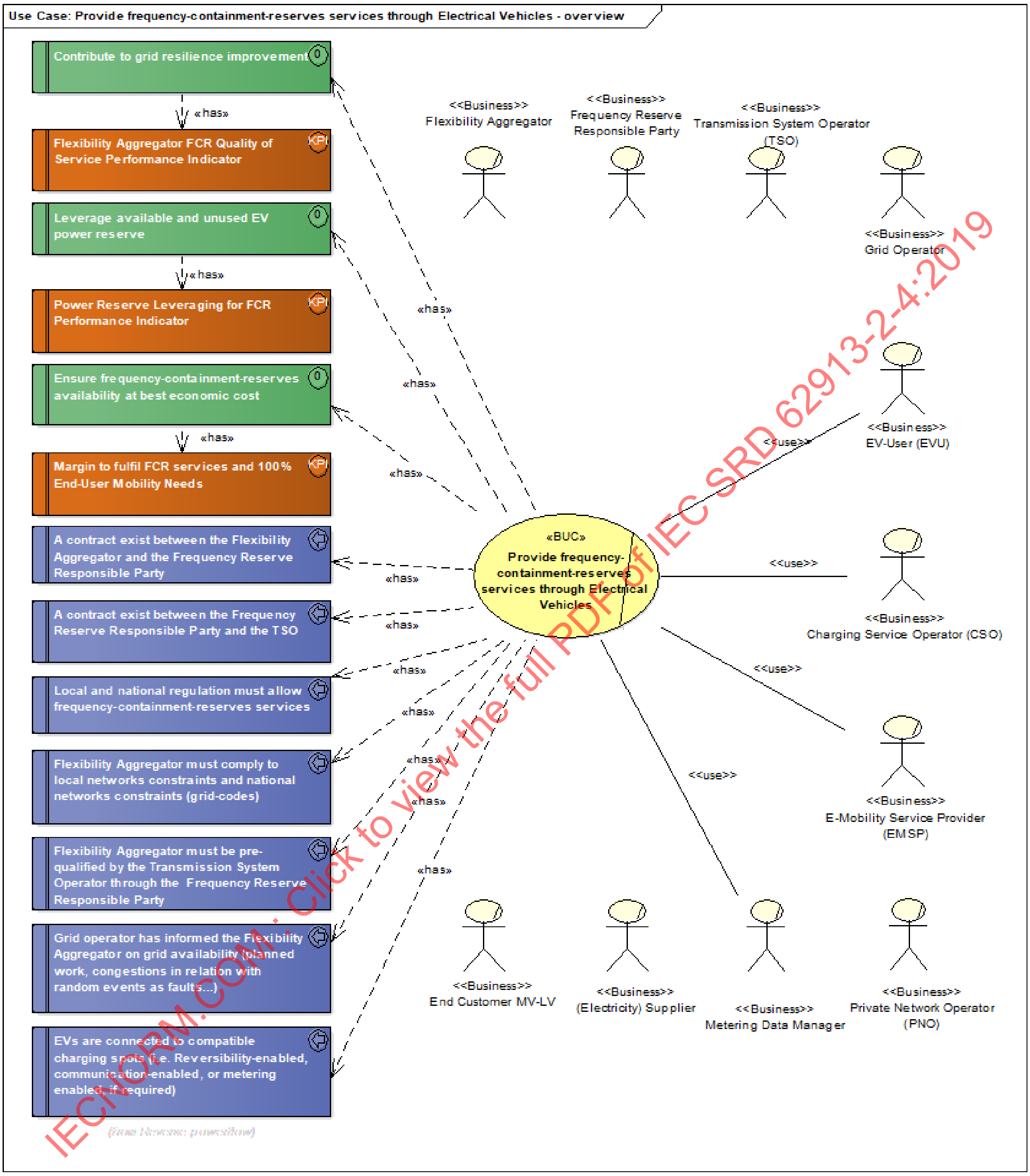
<<SUC>> [] Exchange on local constraints with network responsible parties

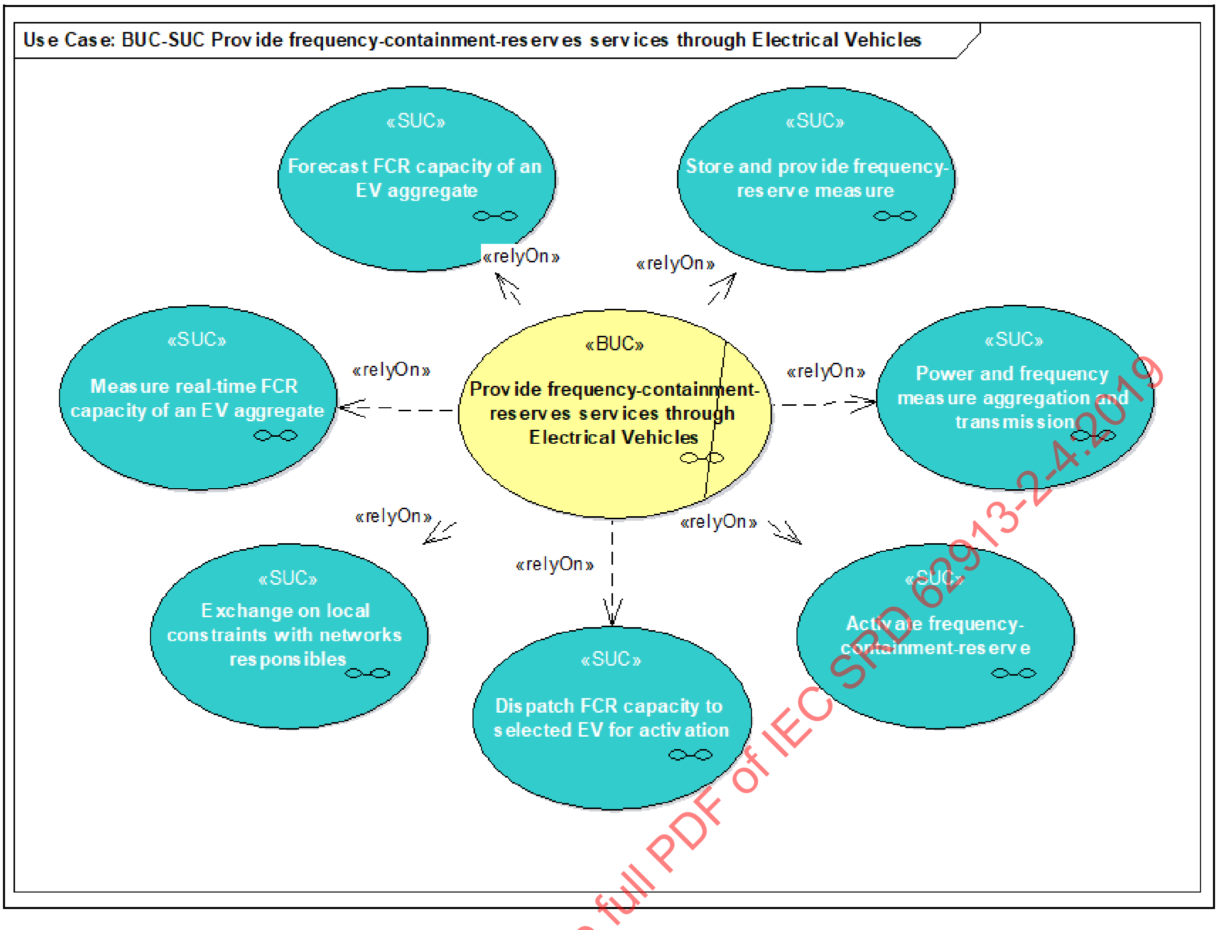
Level of depth

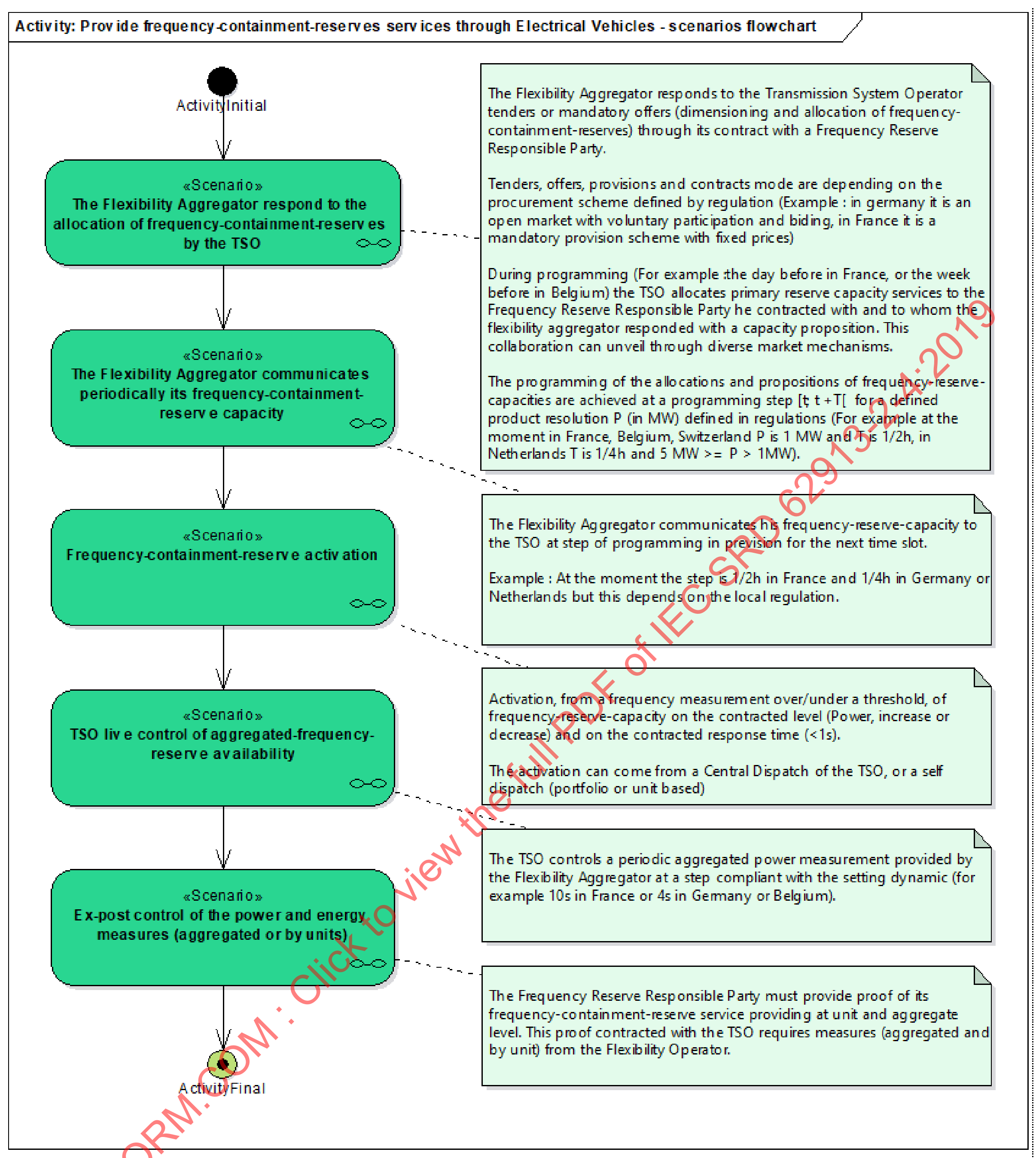
Prioritization
Generic, regional or national relation
Nature of the use case
BUC
Further keywords for classification
1.8 General remarks
General remarks

2 Diagrams of use case

Diagram(s) of use case




Use Case: BUC-SUC Provide frequency-containment-reserves services through Electrical Vehicles
«SUC»
Forecast FCR capacity of an EV aggregate
«SUC»
Store and provide frequency-reserve measure
«relyOn»
«relyOn»
«SUC»
Measure real-time FCR capacity of an EV aggregate
«relyOn»
«BUC»
Provide frequency-containment-reserves services through Electrical Vehicles
«relyOn»
«SUC»
Power and frequency measure aggregation and transmission
«relyOn»
«relyOn»
«relyOn»
«SUC»
Exchange on local constraints with networks responsibles
«SUC»
Dispatch FCR capacity to selected EV for activation
«SUC»
Activate frequency-containment-reserve



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**
Metering system operator	Business	See Table 3	
Metering data manager	Business	See Table 3	
Charging spot infrastructure operator (CSIO)	Business	See Table 3	
EV user (EVU)	Business	See Table3	
Charging service operator (CSO)	Business	See Table 3	
E-mobility service provider (EMSP)	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

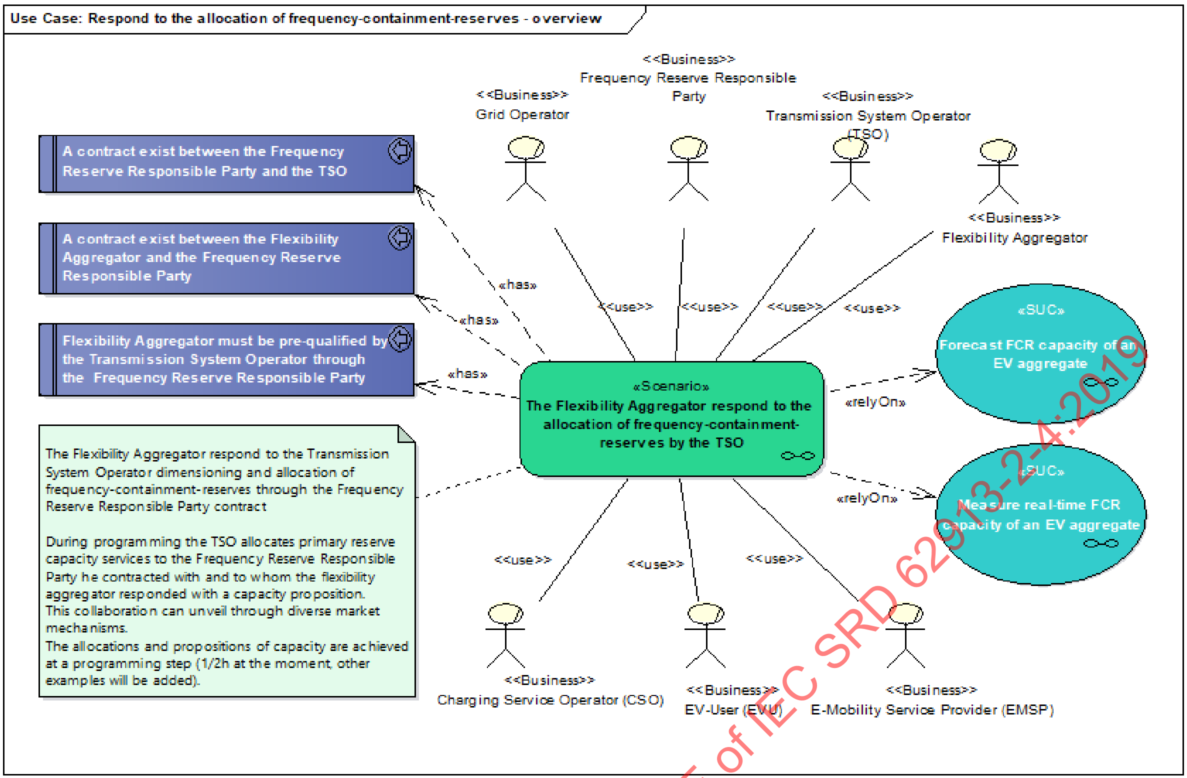
4.1 Overview of scenarios

Scenario conditions							
No.	Scenario name	Scenario description	Primary actor	Triggering event	Pre-condition	Post-condition	
1	The flexibility aggregator responds to the allocation of frequency containment reserves by the TSO	The flexibility aggregator responds to the transmission system operator tenders or mandatory offers (dimensioning and allocation of frequency containment reserves) through its contract with a frequency reserve responsible party. Tenders, offers, provisions and contracts mode are dependent on the procurement scheme defined by regulation (For example: in Germany, it is an open market with voluntary participation and bidding; in France, it is a mandatory provision scheme with fixed prices). During programming (for example: the day before in France, or the week before in Belgium), the TSO allocates primary reserve capacity services to the frequency reserve responsible party he or she contracted with and to whom the flexibility aggregator responded with a capacity proposition. This collaboration can unveil through diverse market mechanisms. The programming of the allocations and propositions of frequency reserve capacities are achieved at a programming step [t; t +T] for a defined product resolution P (in MW) defined in regulations (for example, at the moment in France, Belgium, Switzerland, P is 1 MW and T is 0,5 h; in Netherlands, T is 0,25 h and 5 MW ≥ P ≥ 1MW).			The flexibility aggregator shall be pre-qualified by the transmission system operator through the frequency reserve responsible party: The transmission system operator shall certify the flexibility aggregator's ability to provide frequency containment reserves services through its commitment with the frequency reserve responsible party. A contract exists between the flexibility aggregator and the frequency reserve responsible party A contract exists between the frequency reserve responsible party and the TSO.		

2	The flexibility aggregator communicates periodically its frequency containment reserve capacity.	The flexibility aggregator communicates his frequency reserve capacity to the TSO at step of programming in prevision for the next time slot. EXAMPLE At the moment, the step is 0,5 h in France and 0,25 h in Germany or Netherlands but this depends on the local regulation.			The flexibility aggregator shall comply to local networks constraints and national networks constraints (grid-codes): – private network constrains; – distribution networks constraints; – TSO grid codes (national and supra-national). EVs are connected to compatible charging spots (i.e. reversibility-enabled, communication-enabled, or metering enabled, if required) Grid operator has informed the flexibility aggregator on grid availability (planned work, congestions in relation with random events as faults, etc.)	
3	Frequency containment reserve activation	Activation, from a frequency measurement over/under a threshold, of frequency reserve capacity on the contracted level (power, increase or decrease) and on the contracted response time (< 1 s). The activation can come from a central dispatch of the TSO, or a self-dispatch (portfolio or unit based).			EVs are connected to compatible charging spots (i.e. reversibility-enabled, communication-enabled, or metering enabled, if required) The flexibility aggregator shall comply to local networks constraints and national networks constraints (grid-codes): – private network constrains; – distribution networks constraints; – TSO grid codes (national and supra-national).	
4	TSO live control of aggregated frequency reserve availability	The TSO controls a periodic aggregated power measurement provided by the flexibility aggregator at a step compliant with the setting dynamic (for example 10 s in France or 4 s in Germany or Belgium).			EVs are connected to compatible charging spots (i.e. reversibility-enabled, communication-enabled, or metering enabled, if required)	
5	Ex-post control of the power and energy measures (aggregated or by units)	The frequency reserve responsible party shall provide proof of its frequency containment reserve service providing at unit and aggregate level. This proof contracted with the TSO requires measures (aggregated and by unit) from the flexibility operator. Power and frequency measures resolution and sampling are defined by regulation				

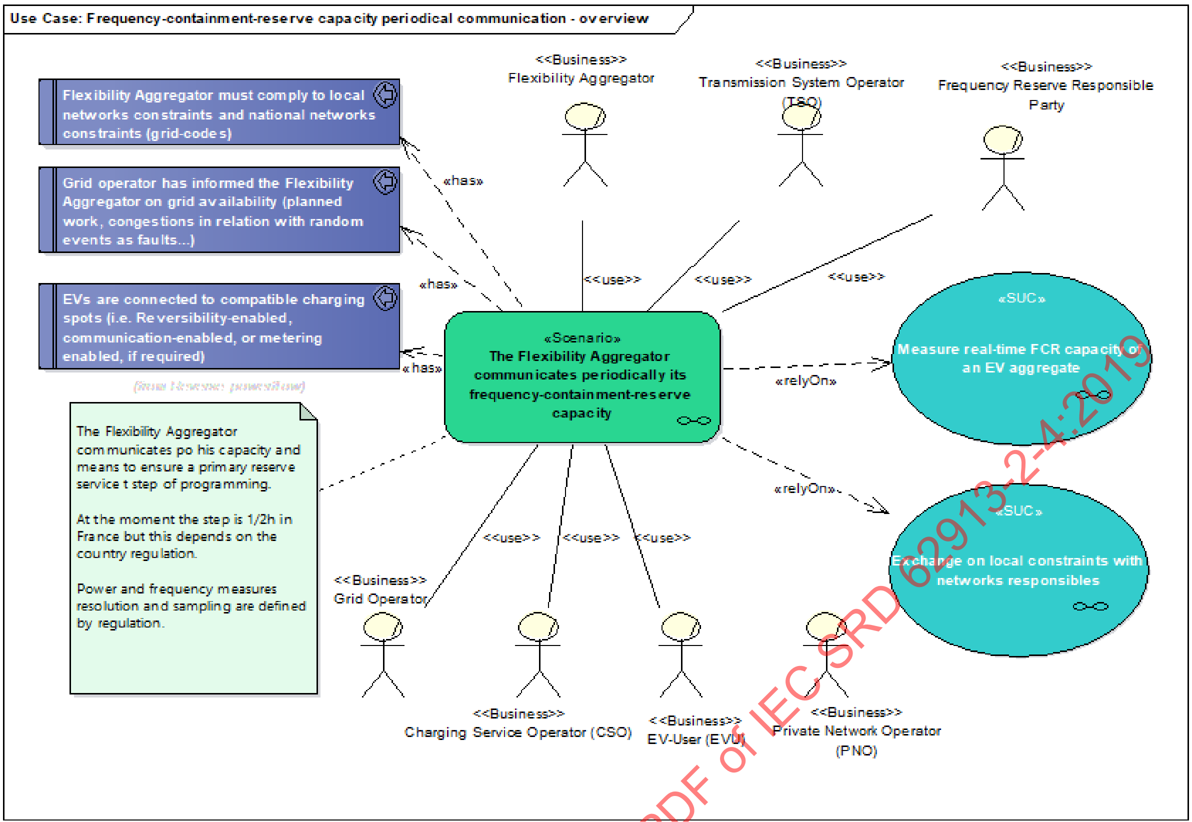
4.2 Steps – Scenarios

The flexibility aggregator responds to the allocation of frequency containment reserves by the TSO

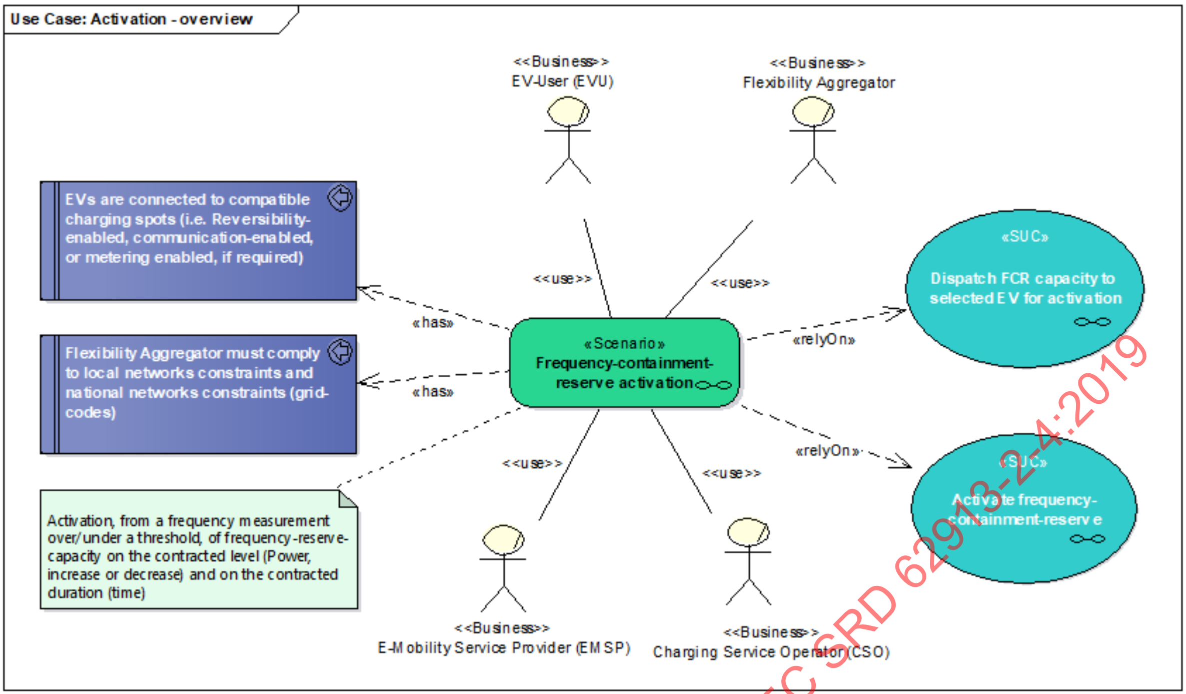


Scenario step by step analysis

Scenario								
Scenario name	The flexibility aggregator responds to the allocation of frequency containment reserves by the TSO							
Step No	Event	Name of process/ activity	Description of process/ activity	Service	Information producer (actor)	Information receiver (actor)	Information exchanged (IDs)	Requirement, R-IDs
The flexibility aggregator communicates periodically its frequency containment reserve capacity								

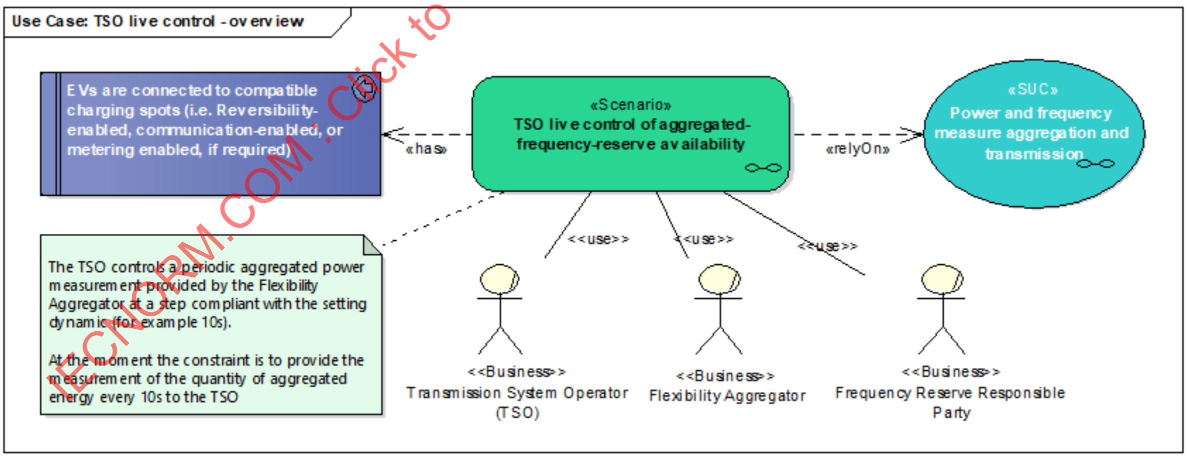


Scenario step by step analysis									
Scenario									
Scenario name	The flexibility aggregator communicates periodically its frequency containment reserve capacity								
Step No	**Event**	**Name of process/activity**	**Description of process/activity**	**Service**	**Information producer (actor)**	**Information receiver (actor)**	**Information exchanged (IDs)**	**Requirement, R-IDs**	
Frequency containment reserve activation									

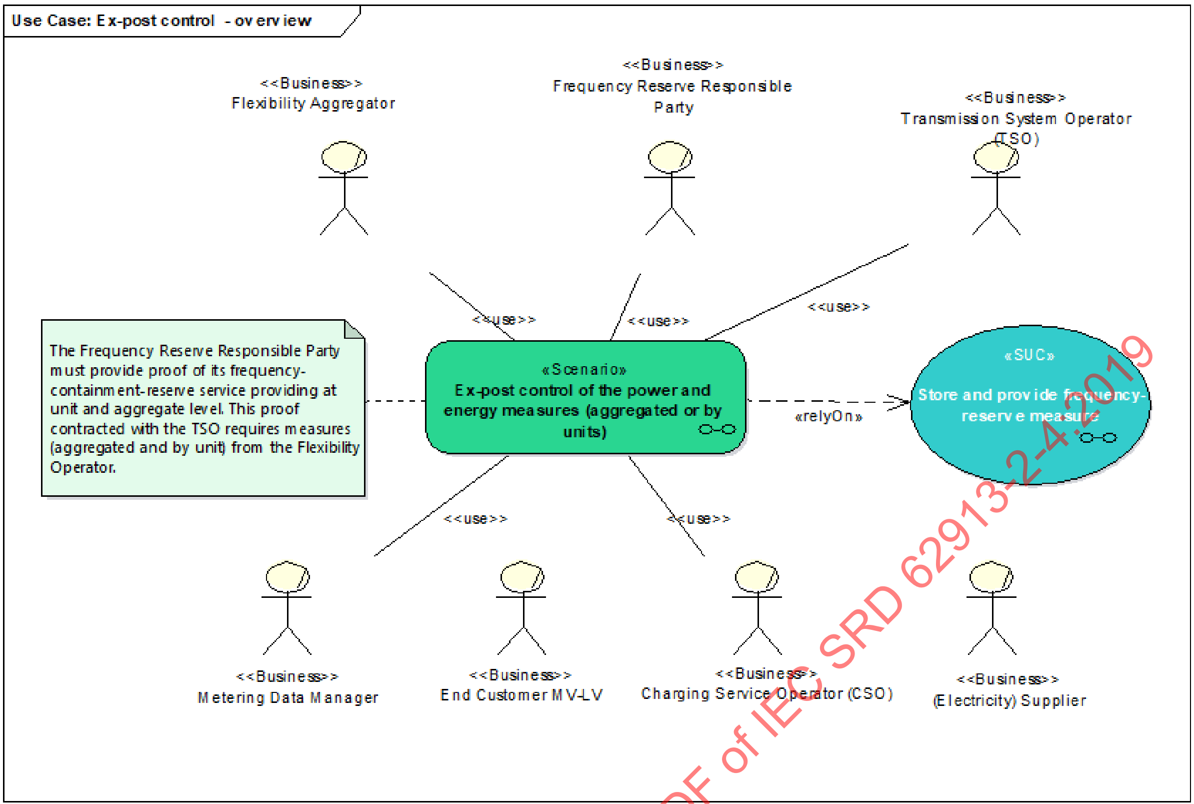


Scenario step by step analysis								
Scenario								
Scenario name	Frequency containment reserve activation							
Step No	**Event**	**Name of process/ activity**	**Description of process/ activity**	**Service**	**Information producer (actor)**	**Information receiver (actor)**	**Information exchanged (IDs)**	**Requirement, R-IDs**

TSO live control of aggregated frequency reserve availability



Scenario step by step analysis								
Scenario								
Scenario name	TSO live control of aggregated frequency reserve availability							
Step No	**Event**	**Name of process/ activity**	**Description of process/ activity**	**Service**	**Information producer (actor)**	**Information receiver (actor)**	**Information exchanged (IDs)**	**Requirement, R-IDs**
Ex-post control of the power and energy measures (aggregated or by units)								



Scenario step by step analysis

Scenario								
Scenario name	Ex-post control of the power and energy measures (aggregated or by units)							
Step No	Event	Name of process/ activity	Description of process/ activity	Service	Information producer (actor)	Information receiver (actor)	Information exchanged (IDs)	Requirement, R-IDs

Information exchanged

Information exchanged			
Information exchanged, ID	Name of information	Description of information exchanged	Requirement, R-IDs

Requirements (optional)

Requirements (optional)		
Categories ID	Category name for requirements	Category description
Requirement R-ID	Requirement name	Requirement description

Common terms and definitions

Common terms and definitions	
Term	Definition

Custom information (optional)

Custom information (optional)		
Key	Value	Refers to section

B.2 System Use Cases

See Table B.7.

Table B.7 – UC62913-2-4-S001 Negotiate a charge plan for smart charging an EV

UC62913-2-4-S001 Negotiate a charge plan for smart charging 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		Negotiate a charge plan for smart charging 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	Describe the functions operated by the charging service management system (CSMS) to determine the charging-discharging profile of an EV. In the most general situation considered, the CSMS handles several EVSEs connected to a same specific private network, and there may be already several other EVs engaged in a charging process, when the new EV arrives. Moreover, expectation of future EV arrival in the considered period of time may be taken into account. An EMS allocates power to the various uses of electricity, and possibly manages production or storage means, within the private network.				
Objective(s)	Describe information exchanges between CSMS and the other roles needed to fix the smart charging-discharging process				
Related business case(s)					
1.4 Narrative of use case					
Narrative of use case					
Short description					
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.					

Complete description
NOTE In the following, we call "max. power allocation profile (MPAP)" a series of consecutive P_{max} blocks function periods. P_{max} is positive for EV charging, and negative for EV discharging. MPAP may also be called "charge plan envelope". When a MPAP is allocated to an EV through the EVSE, the actual instantaneous power drawn by the EV, function of time, called "charge profile", is controlled by its battery management system. It is assumed to be lower than P_{max}. Preliminary situation: An EV is connected to an EVSE and the CSMS is requested to satisfy its charging needs, providing a quantity of energy until its time of departure. This EVSE is one among a set of EVSEs, within a given private network handled by an EMS. **Negotiation to settle the charging profile taking into account the power available from the EMS** To settle the MPAP and notify it to the EVSE, the CSMS follows the steps below. 1) EVs charge profiles: The CSMS has already stored the other charging EV charge profile. It could possibly ask for an EV charge profile update from the other EVSEs charging an EV. Whenever actual charge profile is not available, charge plan envelopes are collected. The CSMS may also have a forecast of future charge plan envelopes as requested in advance by EVs that have made a reservation. Moreover, or alternatively, it may take into account additional MPAP for possible new coming EVs without reservation in the considered period of time. Therefore, the required total power with time for all EVSEs is calculated. 2) Request of the global MPAP for EVs charge. The CSMS asks the EMS for the global MPAP available for charging services in the considered period of time. The EMS has two dimensions to manage and optimize: – energy, taking into account electricity tariff from the electricity supply retailer(s), and possible capacity adjustment requests from the market through flexibility operator(s); – power, according to the capacity of the private network and the maximum instantaneous power available at the delivery point of the DSO. There may be a possibility for the EMS to request a temporary adjustment of this maximum power. The EMS takes into account other consumptions and possibly production and storage means connected to the private network to determine the available power for EVs charge. 3) Power and energy analysis: the CSMS analyses the available power and the needed energy for the EV charge. The two following steps can be followed in any order. – Power re-assignment: if the available energy is not sufficient, the CSMS re-calculates the allocated power to the other EVSEs without any impact on the final SoC. For instance, the power allocated to EVSEs charging an EV with a lower priority could be decreased in order to be able to charge uppermost the EV. If it has an impact on the final SoC, then the CSMS will have to notify the e-mobility service provider or the EV user [see 4)]. – Re-negotiation with EMS: if the available energy to charge the EV is not sufficient, the CSMS asks for a power excess agreement with the EMS. 4) Best offer notification: if the available energy is still not sufficient to charge the EV, the CSMS has to notify the EVSE and/or the e-mobility service provider of the EVU, if existing, that the EV will not be charged as required and gives the best possible offer. The e-mobility service provider or the EV user takes the decision to accept this offer. 5) MPAP notification: the CSMS sends the MPAP to the EVSE for the specified time slot, according to the negotiated profile and EVSE characteristics. 6) Change during charging-discharging process: At any time during the process, the charge plan may be re-negotiated at the request of EV user (e.g. change regarding the parking time or requested energy amount), or of the EMS (in relation with the situation within the private network, or within secondary roles such as DSO or capacity market). Such request of temporary change may decrease maximum power or increase it. NOTE The DSO can request temporary change of the maximum instantaneous power available at the delivery point to the private network, either decreasing it (e.g. because of local public network overflow) or increasing it (e.g. because of availability of local renewable production). Other signals of the same kind may come from upstream adjustments (TSO or flexibility operator).

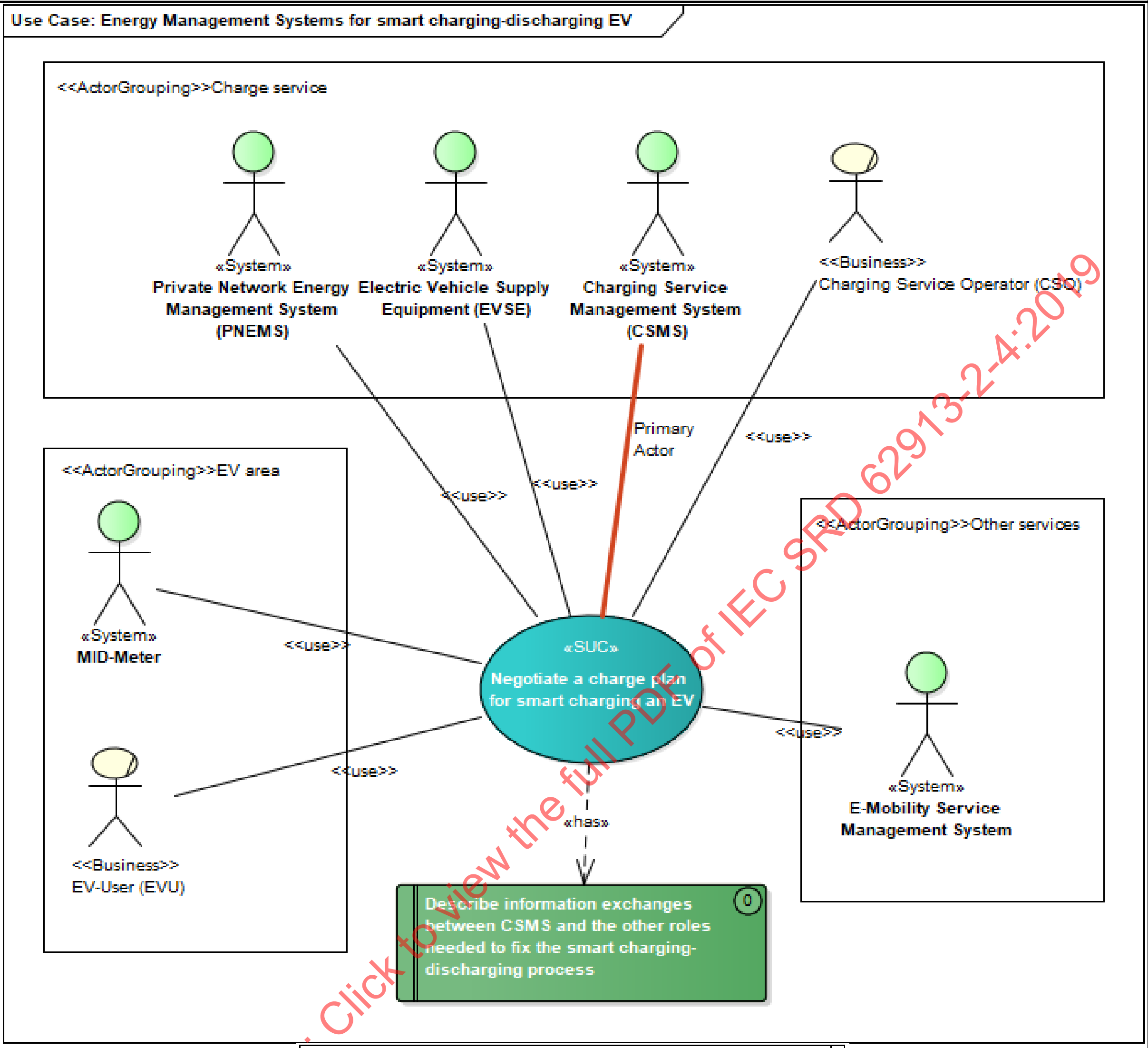
1.5 Key performance indicators (KPIs)

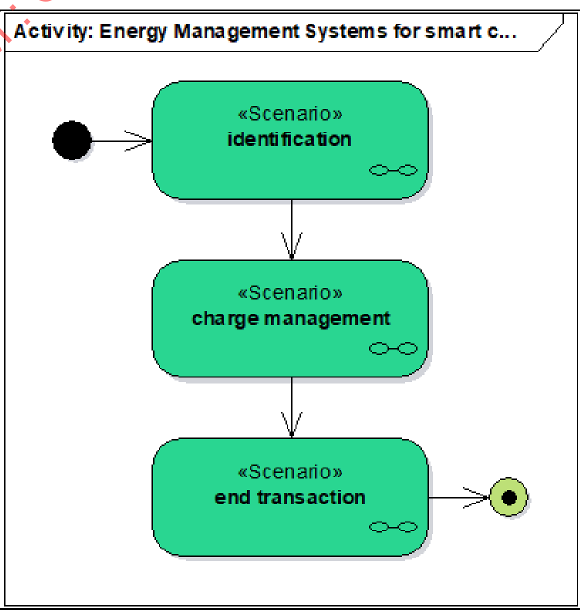
Key performance indicators			
ID	Name	Description	Reference to mentioned use case objectives

1.6 Use case conditions

Use case conditions
Assumptions
Prerequisites
1.7 Further information to the use case for classification/mapping
Classification information
Relation to other use cases
<<BUC>> Provide smart charging services to an EV fleet <<BUC>> Charge an EV with smart-charging <<BUC>> Application to smart charging on public parking <<BUC>> Application to smart charging on residential parking
Level of depth
Short version
Prioritization
Generic, regional or national relation
Generic
Nature of the use case
SUC
Further keywords for classification
1.8 General remarks
General remarks

2 Diagrams of use case
Diagram(s) of use case





3 Technical details			
3.1 Actors			
Actors			
Grouping (e.g. domains, zones)		**Group description**	
EV area			
Actor name	**Actor type**	**Actor description**	**Further information specific to this use case**
MID-Meter	System	See Table 4	
EV user (EVU)	Business	See Table 2	
Actors			
Grouping (e.g. domains, zones)		**Group description**	
Charge service			
Actor name	**Actor type**	**Actor description**	**Further information specific to this use case**
Charging service operator (CSO)	Business	See Table 2	
Electric vehicle supply equipment (EVSE)	System	See Table 4	
EMS	System	See Table 4	
Charging service management system (CSMS)	System	See Table 4	
Actors			
Grouping (e.g. domains, zones)		**Group description**	
Other services			
Actor name	**Actor type**	**Actor description**	**Further information specific to this use case**
E-mobility service management system	System	System supporting the e-mobility services	

3.2 References

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

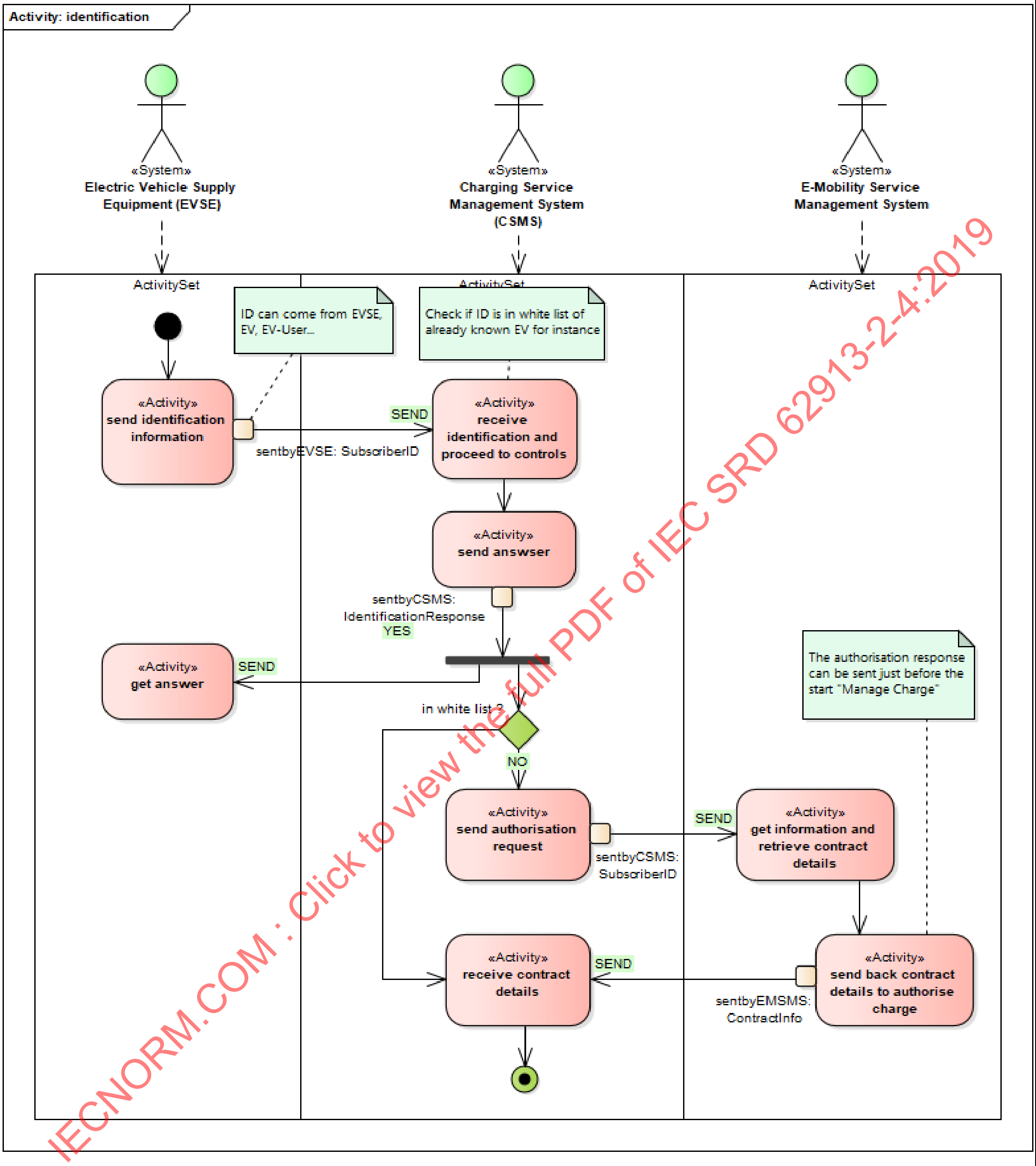
4 Step by step analysis of use case

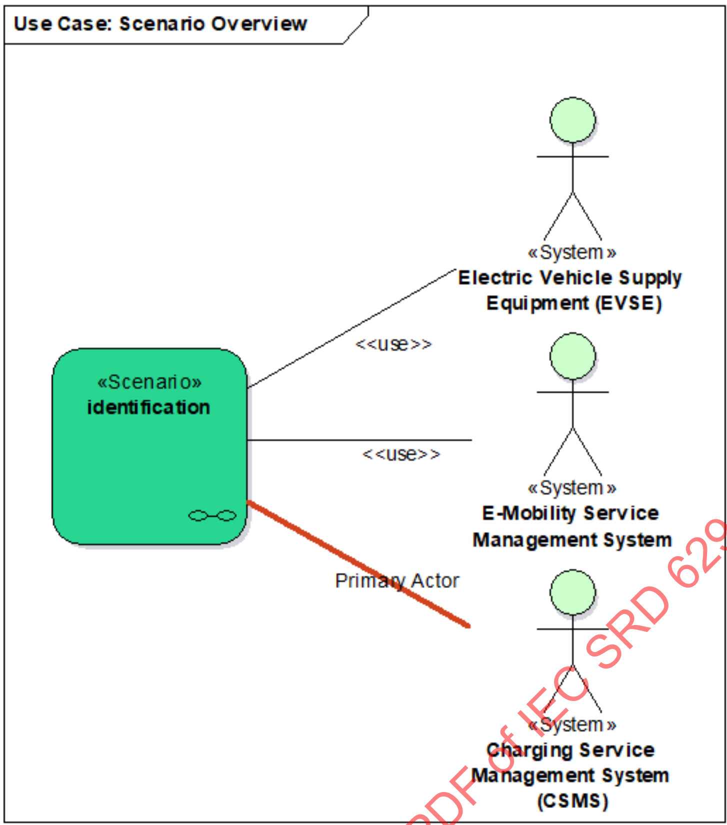
4.1 Overview of scenarios

Scenario conditions						
No.	**Scenario name**	**Scenario description**	**Primary actor**	**Triggering event**	**Pre-condition**	**Post-condition**
1	Identification		Charging service management system (CSMS)			
2	Charge management		Charging service management system (CSMS)			
3	End transaction		Charging service management system (CSMS)			

4.2 Steps – Scenarios

identification





Scenario step by step analysis

Scenario								
Scenario name		Identification						
Step No.	**Event**	**Name of process/ activity**	**Description of process/ activity**	**Service**	**Information producer (actor)**	**Information receiver (actor)**	**Information exchanged (IDs)**	**Requirement, R-IDs**
1.1		Send identification information		SEND	Electric vehicle supply equipment (EVSE)	Charging service management system (CSMS)	Info1-SubscriberID	
1.2		Receive identification and proceed to controls			Charging service management system (CSMS)			
1.3		Send answswer			Charging service management system (CSMS)	Electric vehicle Supply Equipment (EVSE), charging service management system (CSMS),	Info2-Identification Response	
1.4		Get answer			Electric vehicle supply equipment (EVSE)			