INTERNATIONAL STANDARD

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Second edition
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Road vehicles — Vehicle to grid communication interface —

Part 1: General information and use-case definition

Véhicules routiers — Interface de communication entre véhicule et réseau électrique —

Partie 1: Informations générales et définition de cas d'utilisation

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Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular, the different approval criteria needed for the different types of ISO documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights. Details of any patent rights identified during the development of the document will be in the Introduction and/or on the ISO list of patent declarations received (see www.iso.org/patents).

Any trade name used in this document is information given for the convenience of users and does not constitute an endorsement.

For an explanation of the voluntary nature of standards, the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT) see www.iso.org/iso/foreword.html.

This document was prepared jointly by Technical Committee ISO/TC 22, *Road vehicles*, Subcommittee SC 31, *Data communication*, and Technical Committee IEC/TC 69, *Electric road vehicles and electric industrial trucks.* The draft was circulated for voting to the national bodies of both ISO and IEC.

This second edition cancels and replaces the first edition (ISO 15118-1:2013) which has been technically revised. The main changes compared to the previous edition are as follows:

— new use cases and requirements for wireless communication, wireless power transfer, automatic connection devices and bidirectional power transfer have been added; and

— as usage of private data and cyber security are becoming an important concern for users, requirements for more traceability and data privacy have also been added.

A list of all parts in the ISO 15118 series can be found on the ISO website.

Any feedback or questions on this document should be directed to the user's national standards body. A complete listing of these bodies can be found at www.iso.org/members.html.

Introduction

The pending energy crisis and the necessity to reduce greenhouse gas emissions have led vehicle manufacturers to make a very significant effort to reduce the energy consumption of their vehicles. They are presently developing vehicles partly or completely propelled by electric energy. Those vehicles will reduce the dependency on oil, improve global energy efficiency and reduce the total CO_2 emissions for road transportation if the electricity is produced from renewable sources. To charge the batteries of such vehicles, specific charging infrastructure is required.

Much of the standardisation work on dimensional and electrical specifications of the charging infrastructure and the vehicle interface is already treated in the relevant ISO or IEC groups. However, the question of the interoperability of information transfer between the vehicle, the local installation and the grid is also of the upmost importance.

Such communication is beneficial for the optimisation of energy resources and energy production systems as vehicles can charge or discharge at the most economic or most energy-efficient instants. It is also required to develop efficient and convenient payment systems in order to cover the resulting micro-payments. The necessary communication channel can serve in the future to contribute to the stabilisation of the electrical grid as well as to support additional information services required to operate electric vehicles efficiently.

The requirements of this document form the basic framework for all use cases descriptions and related documents in the ISO 15118 series. This document is the result of a large consensus among all the actors of the electro mobility and is a guideline for implementers of the ISO 15118 series.

Road vehicles — Vehicle to grid communication interface —

Part 1: General information and use-case definition

1 Scope

This document, as a basis for the other parts of the ISO 15118 series, specifies terms and definitions, general requirements and use cases for conductive and wireless HLC between the EVCC and the SECC.

This document is applicable to HLC involved in conductive and wireless power transfer technologies in the context of manual or automatic connection devices.

This document is also applicable to energy transfer either from EV supply equipment to charge the EV battery or from EV battery to EV supply equipment in order to supply energy to home, to loads or to the grid.

This document provides a general overview and a common understanding of aspects influencing identification, association, charge or discharge control and optimisation, payment, load levelling, cybersecurity and privacy. It offers an interoperable EV-EV supply equipment interface to all e-mobility actors beyond SECC.

The ISO 15118 series does not specify the vehicle internal communication between battery and other internal equipment (beside some dedicated message elements related to the energy transfer).

NOTE 1 Electric road vehicles specifically are vehicles in categories M (used for carriage of passengers) and N (used for carriage of goods) (compare ECE/TR ANS/WP.29/78 ev.2). This does not prevent vehicles in other categories from adopting the ISO 15118 series as well.

NOTE 2 This document is destined to orientate the message set of ISO 15118-2 and ISO 15118-20[1]. The absence of any particular use case in this document does not imply that it will not be put into practice, with the required messages.

NOTE 3 This document, ISO 15118-2 and ISO 15118-20 are designed to work independent of data transfer medium used. However, the ISO 15118 series is made for fitting the specified data link layers in the corresponding documents in this series.

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.

ISO/TR 8713, *Electrically propelled road vehicles — Vocabulary*

ISO 15118-2, *Road vehicles — Vehicle to grid communication interface — Part 2: Network and application protocol requirements*

ISO 15118-3, *Road vehicles — Vehicle to grid communication interface — Part 3: Physical and data link layer requirements*

1) Under preparation. Stage at the time on publication: ISO/DIS 15118-20:2019.

ISO 15118-8, *Road vehicles — Vehicle to grid communication interface — Part 8: Physical layer and data link layer requirements for wireless communication*

ISO 15118-20[2)], *Road vehicles — Vehicle to grid communication interface — Part 20: 2nd generation network and application protocol requirements*

EN 50549-1, *Requirements for generating plants to be connected in parallel with distribution networks — Part 1: Connection to a LV distribution network — Generating plants up to and including Type B*

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

IEC 61980-2, *Electric vehicle wireless power transfer (WPT) systems — Part 2 specific requirements for communication between electric road vehicle (EV) and infrastructure with respect to wireless power transfer (WPT) systems*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO/TR 8713 and the following apply.

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

— ISO Online browsing platform: available at https://www.iso.org/obp

— IEC Electropedia: available at http://www.electropedia.org/

3.1 General terms

3.1.1
actor
entity which characterizes a role played by a user or any other system that interacts with the subject

3.1.2
ancillary services
services necessary for the operation of an electric power system provided by the system operator and/or by power system users

[SOURCE: IEC IEV Electropedia, 617-3-9, modified — The Note has been removed.]

3.1.3
association
procedure to establish the wireless communication between the *SECC* (3.1.68) controlling the charging infrastructure [e.g. coils for *WPT* (3.1.76)] and the *EVCC* (3.1.31)

3.1.4
authentication
procedure between the *EVCC* (3.1.31) and the *SECC* (3.1.68) or between the USER and the *EV* (3.1.30) supply equipment or the SA, to prove that the provided information [see *identification* (3.1.49)] is either correct, valid, or it belongs to the EVCC, the USER or the SECC

3.1.5
authorization
procedure to verify if an *EV* (3.1.30) is allowed to *charge* (3.1.12) or *discharge* (3.1.22)

3.1.6
automatic connection device
ACD
components supporting the automatic connection and disconnection process for conductive energy transfer between an *EV* (3.1.30) and the *EV supply equipment* (3.1.33 and 3.1.34)

2) Under preparation. Stage at the time of publication: ISO/DIS 15118-20:2019.

3.1.7
basic signalling
physical signalling according to the *pilot function* (3.1.55)

Note 1 to entry: This definition is provided by IEC 61851-1:2017, Annex A.

3.1.8
battery management system
BMS
electronic device that controls or manages the electric and thermal functions of the battery system and that provides communication between the battery system and other vehicle controllers

3.1.9
bidirectional power converter
BPC
stabilized power supply device which delivers *BPT* (3.1.10) functions

3.1.10
bidirectional power transfer
BPT
combination of forward or reverse power transfer sequences

3.1.11
certificate
electronic document which uses a digital signature to bind a public key with an identity

Note 1 to entry: The ISO 15118 series describes several certificates covering different purposes, e.g. the contract certificate including the EMAID and *OEM* (3.1.52) provisioning certificates.

3.1.12
charge
store electrical energy in the vehicle battery

Note 1 to entry: In the first edition of this document, the words “charge” or “charging” were used intensively as a generic term. In this edition, in order to be more precise and to cover with one word *forward* (3.4.1) and *Reverse Power Transfer* (3.4.2) the terms “charge” and its declinations have been replaced by “energy transfer” when appropriate. When energy transfer is used in a sentence, this means that both directions of power flow are possible.

Note 2 to entry: The term “charge” (and the associated verb) has in this text a precise definition in relation to the amount of energy stored in the *EV* (3.1.30) battery which can be different than the total energy transferred to the EV.

Note 3 to entry: In some sentences, the word “charging” is still used. For example, the words “charging site” are still used.

3.1.13
charger
power converter that performs the necessary functions for charging a battery

3.1.14
charging station operator
CSO
EV supply equipment operator
secondary actor (3.1.64) responsible for the installation and operation of a charging infrastructure (including charging sites) and the management of electricity to provide the requested energy transfer services

Note 1 to entry: The term CPO (Charge Point Operator) is also used in the ISO 15118 series. This term is not recommended for trademark reasons.

3.1.15
communication session
sequence of time where the *EVCC* (3.1.31) and the *SECC* (3.1.68) interactively exchange digital information in order to manage charging or discharging the *EV* (3.1.30) battery

Note 1 to entry: A communication session can be paused and resumed later several times. The communication session encapsulates zero or more *energy transfer periods* (3.1.37).

3.1.16
contactor
electrically controlled switch used for switching a power circuit

Note 1 to entry: Unlike a circuit breaker, a contactor is not intended to interrupt a short circuit current.

Note 2 to entry: As far as communication is concerned, the contactor occurs as a *trigger* (3.1.70) for the power supply.

3.1.17
credential
document attesting the permission of the *EV* (3.1.30) to be *charged* (3.1.12) or to *discharge* (3.1.22)

3.1.18
demand and prognosis
function that covers the collection of grid and local installation conditions which applies to the actual energy transfer process

EXAMPLE The *sales tariff table* (3.1.63) containing a price, CO_2 content and percentage of renewable energy information vs. time based on grid, energy production, energy demand and customer contract information, along with an optional contract-based current limitation. The *grid schedule* (3.1.46) containing a current vs. time limitation at the specific *EV* (3.1.30) supply equipment due to local installation and local electricity demand situation.

3.1.19
demand clearing house
DCH
entity for grid negotiation that provides information on the load of the grid

Note 1 to entry: The demand clearing house mediates between two clearing partners: an *SECC* (3.1.68) and the part of the power grid connected to this SECC. Most likely this function will be served by a system operator.

Note 2 to entry: Demand clearing house and *meter operator* (3.1.51) may exchange information with each other as well as with other *actors* (3.1.1).

EXAMPLE A DCH typically fulfils the following tasks:

— Collect all necessary information from all parts of the power grid, e.g. current or forecasted load of local transformers, distribution grid, power substation, transmission grid, transmission substation, power plants (including renewable energies) and predicted *energy transfer schedules* (3.1.39) submitted by *EVCCs* (3.1.31).

— Consolidate the collected grid information to a “grid profile” and offer it to SECCs/EVCCs.

— Provide energy transfer schedule proposal for the connected *EV* (3.1.30) to the requesting SECC based on the collected grid profile.

— Inform the SECC as to the necessity for an updated energy transfer schedule if the grid profile has changed.

— On the contrary, the SECC will inform the demand clearing house if the EV's energy transfer schedule has changed.

3.1.20
distributed energy resources
DER
distributed set of one or more energy service resources, including generators, energy storage and controllable load, that can be used to deliver *ancillary services* (3.1.2)

3.1.21
departure time
point in time when the user intends to unplug the car and/or leave the charging site

3.1.22
discharge
release the electric charge of the vehicle battery

3.1.23
discovery
phase in which an *EV* (3.1.30) obtains a list of available *SECCs* (3.1.68) in its wireless communication range

3.1.24
distribution system operator
DSO
entity responsible for the voltage stability in the distribution grid

Note 1 to entry: Electricity distribution is the final stage in the physical delivery of electricity to the delivery point, e.g. end user, EV supply equipment (3.1.33 and 3.1.34) or parking operator.

Note 2 to entry: A distribution system network carries electricity from the transmission grid and delivers it to consumers. Typically, the network would include medium-voltage power lines, electrical substations and low-voltage distribution wiring networks with associated equipment.

3.1.25
e-mobility needs
mobility needs expressed by the *EV* (3.1.30) user in terms of *departure time* (3.1.21), *minimum* (3.5.1) and *maximum energy request* (3.5.2) and target energy request

3.1.26
e-mobility operator clearing house
EMOCH
entity mediating between two clearing partners to provide validation services for roaming regarding contracts of different *EMSPs* (3.1.27)

Note 1 to entry: EMOCH mediates for the purpose of:

— collecting all necessary contract information like the EMAID, the EMSP, the communication path to the EMSP, roaming fees, begin and end dates of the contract, etc.;

— providing the *SECC* (3.1.68) with confirmation that an EMSP will pay for a given EMAID [*authorization* (3.1.5) of valid contract]; and

— transferring an *SDR* (3.1.66) after each *energy transfer period* (3.1.37) to connect the EMSP and the *EP* (3.1.29) of the identified contract.

Note 2 to entry: The EMOCH, EMSP and *meter operator* (3.1.51) may exchange information with each other as well as other *actors* (3.1.1).

3.1.27
e-mobility service provider
EMSP
entity with which the customer has a contract for all services related to the *EV* (3.1.30) operation

Note 1 to entry: Typically, the EMSP will include some of the other *actors* (3.1.1), like the spot operator or *EP* (3.1.29), and has a close relationship with the *distribution system operator* (3.1.24) and *meter operator* (3.1.51). An *OEM* (3.1.52) or utility could also fulfil such a role.

Note 2 to entry: The EMSP validates EMAIDs from his customers, which were received either from the *EMOCH* (3.1.26), other EMSPs or spot operators the customer is in relation with.

Note 3 to entry: The EMSP issues EMAIDs to his customers.

3.1.28
electric energy meter
EEM
equipment for measuring electrical energy by integrating power with respect to time

Note 1 to entry: The equipment complies with IEC 62052-11 and IEC 62053-21, IEC 62053-52.

Note 2 to entry: Some *use cases* (3.1.71) need the amount of electric energy measured by the electric energy meter and communicated through the *SECC* (3.1.68) to the *EVCC* (3.1.31), while other scenarios do not need a separate electric energy meter. The *EV* (3.1.30) may get this information and use it according to the *OEM's* (3.1.52) intentions.

3.1.29
electricity provider
EP
entity whose activity is the wholesale purchase of electricity and the subsequent direct resale to a client through a contract

Note 1 to entry: The provider may also deliver energy related services.

Note 2 to entry: Provider can generate flexibilities through modulation of electricity prices (Time-of-Use, Critical Peak Prices...), flexibilities which can have value on energy markets and/or for network operations.

3.1.30
electric vehicle
EV
all road vehicles, including plug-in hybrid road vehicles (PHEV), that derive all or part of their energy from on-board rechargeable energy storage systems (RESS)

[SOURCE: IEC 61851-1:2017, 3.1.32]

3.1.31
electric vehicle communication controller
EVCC
embedded system, within the vehicle, that implements the communication between the vehicle and the *SECC* (3.1.68) in order to support specific functions

Note 1 to entry: Such specific functions could be e.g. controlling input and output channels, encryption or data transfer between the vehicle and the SECC.

3.1.32
electric vehicle power system
EV power system
equipment or combination of equipment providing dedicated functions to supply electric power in both directions:

— from an electrical installation or supply network to an *EV* (3.1.30) for the purpose of charging; and

— from a *DER* (3.1.20) in the EV to supply network or the grid for the purpose of discharging

Note 1 to entry: The former function is equal to the *EV supply equipment* (3.1.33 and 3.1.34), provided by IEC 61851-1.

3.1.33
electric vehicle supply equipment
EV supply equipment
<*conductive power transfer*> conductors, including the phase(s), neutral and protective earth conductors, the *EV* (3.1.30) couplers, attached plugs, and all other accessories, devices, *power outlets* (3.1.58) or apparatuses installed specifically for the purpose of delivering energy from the premises wiring to the EV and allowing communication between them as necessary

Note 1 to entry: This document will keep the wording "EV supply equipment" for any energy transfer process but the definition will depend on the technology used.

3.1.34
electric vehicle supply equipment
EV supply equipment
<*wireless power transfer*> off-board electronics that supply the electric power through the primary and secondary device to the *EV* (3.1.30) including all housings and covers

[SOURCE: IEC 61980-1:2015, 3.3]

3.1.35
electronic control unit
ECU
unit providing information regarding the vehicle

3.1.36
energy management system
EMS
system that controls the electric power transfer among the *DER* (3.1.20), premises appliances and the grid

Note 1 to entry: The EMS is similar to the HEMS or *PNEMS* (3.1.57).

3.1.37
energy transfer period
sequence of time between the beginning of energy transfer and the end of the energy transfer

EXAMPLE 1 One or many periods of charging or discharging the battery, doing pre-conditioning or post-conditioning.

EXAMPLE 2 Energy transfer can be achieved, for example, through a cable connection or though *WPT* (3.1.76).

EXAMPLE 3 End of energy transfer can be achieved, for example, with the disconnection of the cable or with leaving the parking place.

3.1.38
energy transfer scenario
combination of *use case* (3.1.71) elements to fulfil a specific energy transfer use case

3.1.39
energy transfer schedule
scheme which contains the power limits for charging or discharging the battery during an *energy transfer period* (3.1.37)

Note 1 to entry: The *EV* (3.1.30) should apply the negotiated limits as close as possible, to allow power balancing for the *EMS* (3.1.36) or the *DSO* (3.1.24).

EXAMPLE The schedule is calculated based on the *target setting* (3.1.69), *sales tariff table* (3.1.63) and *grid schedule* (3.1.46) information, respecting the corresponding current limitations, i.e. using the lowest current value.

3.1.40
energy transfer method
element which allows the *EV* (3.1.30) to select its desired energy transfer methods in case both the *EV supply equipment* (3.1.33 and 3.1.34) and the EV support multiple energy transfer methods and different plugs and sockets

Note 1 to entry: See IEC 62196.

3.1.41
EV supply equipment ID
EVSEID
unique *identification* (3.1.49) of the *EV supply equipment* (3.1.33 and 3.1.34)

3.1.42
external identification means
EIM
external means that authorized the coupled *EV* (3.1.30) to be served by services from the *EV supply equipment* (3.1.33 and 3.1.34)

EXAMPLE NFC, RFID, SMS credit/debit card, smartphone or web application, phone call.

Note 1 to entry: EIM also support "charging for free" (fair mode) to be given a positive *authorization* (3.1.5) every time.

3.1.43
fast responding services
services adapted to energy *secondary actors*' (3.1.64) real-time constraints leading to data exchanges limited to energy level boundaries

Note 1 to entry: Energy secondary actors' real-time constraints are in the order of a few seconds.

3.1.44
fleet operator
FO
person or legal entity operating several *EVs* (3.1.30) and who can have the contracts with the *EMSP* (3.1.27)

3.1.45
flexibility operator
party which aggregates flexibilities for its customers

3.1.46
grid schedule
function which sets the power level at a specific time based on the local grid situation

Note 1 to entry: Parameters to calculate the grid schedule are e.g. local grid demand and supply situation, actual and forecast.

3.1.47
high level communication
HLC
bidirectional digital communication using protocol and messages and physical and data link layers

Note 1 to entry: As specified in the ISO 15118 series.

Note 2 to entry: HLC in the ISO 15118 series is compliant with the term digital communication in SAE J1772, SAE 2836, SAE 2847 and SAE 2931.

3.1.48
human machine interface
HMI
interface allowing the *vehicle user* (3.1.75) to receive information relative to the energy transfer process and provide input to the energy transfer system

Note 1 to entry: All information from a user (input) or displayed to a user (output) will be performed through an HMI.

Note 2 to entry: The HMI could be implemented as a function of the *EV* (3.1.30), *EV supply equipment* (3.1.33 and 3.1.34), mobile phone, etc.

3.1.49
identification
procedure for the *EVCC* (3.1.31) or USER to provide its identifying information for the purpose of *authorization* (3.1.5), mostly to provide its capability for payments

EXAMPLE Contract *certificate* (3.1.11), credit card number, etc. and/or procedure for the *SECC* (3.1.68) to provide the *EV supply equipment ID* (3.1.41) to the EVCC.

Note 1 to entry: For simplicity reasons, within the ISO 15118 series, the term "identification" includes also the *authentication* (3.1.4) of the provided identifying information, i.e. this information is correct, or it belongs to the EVCC, the USER or the SECC.

3.1.50
level selector
function to select the lowest value among the data issued from the *demand and prognosis* (3.1.18) function, and then to feed the result to scheduling function

Note 1 to entry: This function may be implemented in the *EV* (3.1.30) or the *EV supply equipment* (3.1.33 and 3.1.34).

3.1.51
meter operator
MO
body having the legal responsibility for the installation and maintenance of the *EEM* (3.1.28)

3.1.52
original equipment manufacturer
OEM
producer who manufactures products or components that are purchased by a company and retailed under that purchasing company's brand name

Note 1 to entry: The OEM refers to the company that originally manufactured the product.

Note 2 to entry: When referring to automotive parts, the OEM designates a replacement part made by the manufacturer of the original part.

3.1.53
pairing
process by which a vehicle is correlated with the unique *EV supply equipment* (3.1.33 and 3.1.34) at which it is located and from which the power will be transferred either through a cable or through a wireless technology

Note 1 to entry: The pairing process is sometimes called the "*association* (3.1.3) problem".

3.1.54
paying unit
PU
device on the *EV supply equipment* (3.1.33 and 3.1.34) side that offers payment methods

EXAMPLE Payment methods: *EIM* (3.1.42), cash, credit cards, etc.

Note 1 to entry: If the *EVCC* (3.1.31) normally chooses a payment method, then the paying unit indicates to the *SECC* (3.1.68) whether the customer is authorized or not.

3.1.55
pilot function
means, electronic or mechanical, that ensures the conditions related to the safety or the transmission of data required for the mode of operation, compliant with IEC 61851-1

3.1.56
plug and charge
park and charge for WPT
PnC
identification (3.1.49) mode where the customer just has to plug or park, in case of *WPT* (3.1.76), their vehicle and all aspects of energy transfer are automatically taken care of with no further intervention from the driver

Note 1 to entry: The aspects of energy transfer may include load control, *authorization* (3.1.5) and billing.

3.1.57
private network energy management system
PNEMS
functional component responsible for managing equipment consuming, producing or storing electricity in the private network

Note 1 to entry: A PNEMS provides the expected services while fulfilling contracted conditions with the electricity supplier, the *DSO* (3.1.24), the *flexibility operator* (3.1.45) or any other system operators.

Note 2 to entry: A PNEMS negotiates with the *CSO* (3.1.14) the power available for the charging site and the cluster of *EV supply equipment* (3.1.33 and 3.1.34) within the frame of an operational planning function and a real time balance function.

Note 3 to entry: In this document the PNEMS is also called *EMS* (3.1.36).

3.1.58
power outlet
socket outlet or, in the case of a fixed cable, connector, that provides power to the *EV* (3.1.30), typically to be installed with the fixed wiring

3.1.59
power outlet ID
unique *identification* (3.1.49) of the *power outlet* (3.1.58) to the vehicle

3.1.60
power transfer control
function that confirms the maximum current which is allowed to be transferred from or to the *EV supply equipment* (3.1.33 and 3.1.34) based on the *energy transfer schedule* (3.1.39)

Note 1 to entry: Actual charge current to the battery should be controlled by the *BMS* (3.1.8). It is not in scope of the ISO 15118 series.

3.1.61
primary actor
entity involved directly in the energy transfer process

3.1.62
pulse width modulation
PWM
pulse control in which the pulse width or frequency, or both, are modulated within each fundamental period to produce a certain output waveform

3.1.63
sales tariff table
function of price related information over time

Note 1 to entry: The sales tariff table provides input for calculating an *energy transfer schedule* (3.1.39).

Note 2 to entry: The sales tariff table can be issued by a *secondary actor* (3.1.64), e.g. *EP* (3.1.29), *EMS* (3.1.36) or *EMSP* (3.1.27).

Note 3 to entry: The sales tariff table should reflect "supply and demand balance of the electricity provider" and "usage of green energy" (e.g. wind mill, photovoltaic).

Note 4 to entry: Information of the chosen tariff should be included in the service detail record.

Note 5 to entry: The sales tariff table can be updated periodically. It may differ by country or EP.

Note 6 to entry: There may be multiple sales tariff tables existing for one customer.

Note 7 to entry: The sales tariff table information should be constructed in such a way that normal fluctuations on the grid side will not lead to an insufficiently charged *EV* (3.1.30) or cost increase.

Note 8 to entry: The contract-based current limitation might vary over time, e.g. lower value during daytime and higher value during the night.

3.1.64
secondary actor
entity involved indirectly in the energy transfer process

Note 1 to entry: Secondary actors may exchange information between each other.

Note 2 to entry: Secondary actors could also be a single entity.

3.1.65
semi-online
status where the *SECC* (3.1.68) or any other device in general has the ability to go online, but being online is not required synchronously to the referring *use case(s)* (3.1.71)

3.1.66
service detail record
SDR
data package with all necessary information that an *EMSP* (3.1.27) needs for billing, informing the customer about the *V2G* (3.1.74) session and to ensure traceability of the transactions.

Note 1 to entry: Some data may be sent from the *EV supply equipment* (3.1.33 and 3.1.34). Some data may be originally owned by the *EMOCH* (3.1.26). Some data may be created at the EMOCH. Some records are sent to EMSP for billing or informing their customers.

3.1.67
service provider
secondary actor (3.1.64) which offers *value-added services* (3.1.72) to customers throughout the *CSO* (3.1.14)

Note 1 to entry: An EMAID may be used for activation.

3.1.68
supply equipment communication controller
SECC
entity which implements the communication to one or multiple *EVCCs* (3.1.31) and which may be able to interact with *secondary actors* (3.1.64)

Note 1 to entry: See ISO 15118-2.

Note 2 to entry: Further details regarding possible architectures are given in Annex A.

Note 3 to entry: Functions of a *supply equipment communication controller* (3.1.68) may control input and output channels, data encryption, or data transfer between the vehicle and the SECC.

3.1.69
target setting
function which covers the following user demand-related information:

— *departure time* (3.1.21);

— amount of energy required for charging or available for discharging;

— *energy transfer schedule* (3.1.39); and

— energy transfer type

3.1.70
trigger
event that will start or be a condition in the *use case* (3.1.71)

3.1.71
use case
description of a system's behaviour as it responds to a request that originates from outside that system

Note 1 to entry: In systems engineering, a use case describes "who" can do "what" with the system in question. The use case technique is used to capture a system's behavioural requirements by detailing scenario-driven threads through functional requirements.

Note 2 to entry: The term "*energy transfer scenario* (3.1.38)" is used simultaneously to the term "use case" within this document.

3.1.72
value-added services
VAS
elements not directly needed for the pure energy transfer between the *EV* (3.1.30) and the *EV supply equipment* (3.1.33 and 3.1.34)

3.1.73
vehicle coupler
means of enabling the manual connection of a flexible cable to an *EV* (3.1.30) for the purpose of charging or discharging the traction batteries, consisting of two parts: a vehicle connector and a vehicle inlet

3.1.74
vehicle to grid
V2G
plug-in *electric vehicle* (3.1.30) interaction with the electric grid, including charging as well as discharging and bi-directional communication interface

Note 1 to entry: The first part of this definition is excerpted from the scope of the V2G Domain Expert Working Group, SGIP, NIST.

3.1.75
vehicle user
person or legal entity using the vehicle and providing information about driving needs and consequently influencing energy transfer patterns

Note 1 to entry: Driving needs, such as range and time of availability, are necessary to achieve the most appropriate *energy transfer scenario* (3.1.38).

3.1.76
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

3.2 Control modes

3.2.1
scheduled mode
control mode where the *EVCC* (3.1.31) and *SECC* (3.1.68) have negotiated a power profile fulfilling the user's mobility needs and based on the energy target, power and tariff information

Note 1 to entry: In this control mode, the *EV* (3.1.30) is in charge of fulfilling the user's mobility needs.

3.2.2
dynamic mode
control mode, without negotiation, where a *secondary actor* (3.1.64) system controls the power flow fulfilling the user's mobility needs and its own constraints

3.3 Architecture channel

3.3.1
dual architecture channel
electrical and information architecture in which two separate energy meters are used for the forward and reverse power flow

3.3.2
single architecture channel
electrical and information architecture in which one single energy meter is used for both the forward and reverse power flows

3.4 Forward and reverse power transfer

3.4.1
forward power transfer
FPT
power transfer from the external power supply to the vehicle battery via the *EV supply equipment* (3.1.33 and 3.1.34)

3.4.2
reverse power transfer
RPT
power transfer from the vehicle battery to home, loads or grid via the *EV supply equipment* (3.1.33 and 3.1.34)

3.5 Minimum and maximum energy request limits

3.5.1
minimum energy request
minimum energy stored in the battery requested by the *EV* (3.1.30) at any time during the *BPT* (3.1.10) period

Note 1 to entry: If the difference between the current state of charge and the minimum energy request is negative, immediate charging has to be performed.

3.5.2
maximum energy request
maximum energy stored in the battery requested by the *EV* (3.1.30) at any time during the *BPT* (3.1.10) period

Note 1 to entry: If the difference between the current state of charge and the maximum energy request is positive, immediate discharging can be required.

3.6 Source generator modes

3.6.1
voltage source generator mode
mode in which the system {*EV* (3.1.30) + *EV supply equipment* (3.1.33 and 3.1.34)} is able to power wires that would not be powered otherwise

3.6.2
current source generator mode
mode in which the system {*EV* (3.1.30) + *EV supply equipment* (3.1.33 and 3.1.34)} is able to supply current independently of the voltage

4 Abbreviated terms

ACD	automatic connection device
BMS	battery management system
CSO	charging station operator
DCH	demand clearing house
EBC	EV supply equipment booking confirmation
ECU	electronic control unit
EEM	electric energy meter
EIM	external identification means
EMAID	e-mobility authentication identifier
EMOCH	e-mobility operator clearing house
EMS	energy management system
EMSP	e-mobility service provider
EP	electricity provider
EV	electric vehicle
EVCC	electric vehicle communication controller
EVPS	electric vehicle power supply
EVSEID	electric vehicle supply equipment identifier
FO	fleet operator
FPT	forward power transfer
GW	gateway
HAN	home area network
HEMS	home energy management system
HLC	high level communication

HMI	human machine interface
LAN	local area network
MO	meter operator
OEM	original equipment manufacturer
PLC	power line communication
PnC	plug and charge or park and charge in case of WPT
PNEMS	private network energy management system
PU	paying unit
PWM	pulse width modulation
RCD	residual current device
RPT	reverse power transfer
SA	secondary actor
SDR	service detail record
SECC	supply equipment communication controller
USER	vehicle user
VAS	value-added services
V2G	vehicle to grid
WPT	wireless power transfer

5 Requirements

5.1 List of requirements

Implementers of this document shall comply with the requirements listed in Table E.1 of Annex E.

5.2 General communication requirements

Communication in the context of this document could be differentiated into two concepts called “basic signalling” and HLC. This document and ISO 15118-2 or ISO 15118-20[3)] specify only HLC.

HLC shall be used to enable features like identification, payment, load levelling, energy transfer control and value-added services. The relations between “basic signalling” and HLC are specified in ISO 15118-2, ISO 15118-3, ISO 15118-8 and ISO 15118-20. In the context of “basic signalling”, items such as vehicle states, control pilot handling for safety and initialization of the energy transfer process are defined (see also 3.1.30).

In case of AC energy transfer, the charger located in the EV shall perform the energy transfer control.

In case of DC energy transfer, the charger located in the EV supply equipment shall perform the energy transfer control.

3) Under preparation. Stage at the time of publication: ISO/DIS 15118-20:2019.

Information exchange with HLC only occurs if both the EV and the EV supply equipment are equipped with a HLC device.

Several options shall be considered. The interoperability between EVs and the EV supply equipment that implement the different options is described in 7.5.

— On the EV supply equipment side:

  — EV supply equipment does not support HLC;

  — EV supply equipment supports HLC; and

  — EV supply equipment requires HLC.

— On the EV side:

  — EV does not have any HLC means;

  — EV supports HLC; and

  — EV requires HLC.

There are some combinations requiring timeout handling due to the initial mismatch of communication capabilities. This timeout duration ensures that the overall initialization duration does not exceed a user-acceptable period of time. Timeouts are defined in ISO 15118-2, ISO 15118-3, ISO 15118-8 and ISO 15118-20.

The following general requirements build the basis for defining the use cases elements described in Clause 7:

— The mechanisms defined in ISO 15118-3 and/or ISO 15118-8 shall be used to establish the communication between the EVCC and the SECC.

— All data communication between the EV and the secondary actor is confidential. Appropriate cryptography shall be applied to protect the data exchanged between the EV and the secondary actor.

— Communication data shall be protected against modification or imitation (hacking).

— If separate billing is required, the electric energy transferred shall be measured in the EV supply equipment.

The billing principles, e.g. per hour, are defined by the EMSP and will be included in the contractual agreement between the operator and the customer.

NOTE 1 ISO 15118-2 describes the security threat scenarios against which protective measures are implemented.

NOTE 2 The electric energy offered can also be included in other fees (e.g. a parking fee).

NOTE 3 There is no direct communication from the EVCC to a smart meter defined within this document. Meter data will be exchanged between the EVCC and the SECC depending on the use case. The communication between the SECC and the smart meter is outside the scope of this document.

5.3 User-specific requirements

5.3.1 Reliability, availability, error handling and error reporting

The energy transfer shall

— be completed by a predetermined point in time; and

— in the case of any exceptional circumstances, i.e. if the energy transfer schedule cannot be met and if the total energy amount cannot be transferred by the announced point in time, a specified error reporting procedure to inform the user should be triggered as soon as possible (see ISO 15118-2 and ISO 15118-20[4]).

If there is a negotiation process for the energy transfer schedule e.g. because of the load levelling needs of the electrical grid, the protocol shall implement methods to indicate whether the target setting values could be fulfilled or not.

In the event that the requested energy transfer schedule cannot be fulfilled, a re-negotiation of the energy transfer schedule shall be initiated for alternatives.

EV manufacturers or EMSPs can choose suitable methods to inform their customers about unexpected differences from the negotiated energy transfer schedule.

Any communication error shall be detected and controlled either by the EV supply equipment or the EV. Error handling is performed according to the ISO 15118 series and IEC 61851-1.

5.3.2 Private data protection

Private information and user data shall only be readable by the intended recipient.

Private information shall be transferred to third parties only when necessary.

NOTE “When necessary” means that data is transferred to a party only if this party needs the private information data to comply with a requirement expressed in a use case or in the protocol.

Users shall be informed about who has access to their private data.

Users shall be able to transfer their personal data stored from their EV to another EV without being prevented from doing so by their EV.

5.3.3 Ease of use

Energy transfer scheduling processes may be complex and sophisticated. In order to ensure their involvement, solutions shall be presented in a clear and simple manner to the users. Similarly, the HMI shall be as easy to use as possible. However, this ease of use shall not prevent the user from accessing, before, during or after the V2G session, the information related to his e-mobility needs like target and current state of charge (SOC), energy transfer current state and efficiency.

The user shall have access to all private information stored in the EV without third parties’ intervention.

The user shall be able to remove all private information stored in the EV without third parties’ intervention.

5.4 OEM-specific requirements

An energy transfer schedule is calculated either by a secondary actor, the EV supply equipment or the EV, based on the information from the user, charging site and energy grid and is transferred back to the grid to allow the planning of other EVs.

The EVCC and SECC shall provide the possibility to adapt the energy transfer schedule from either side if required.

NOTE 1 It is possible to divide the energy transfer schedule into different phases like energy transfer postponement, energy transfer process interruption and energy transfer in progress.

NOTE 2 Electrical or physical limits of the installation (EV supply equipment and electrical wiring) have higher priority than the requested energy transfer schedule.

If the information is available, the EV may be able to send prices-related information to the EMS via the EV supply equipment (e.g. price per kilowatt hour or CO2 % or the last price the EV has paid for

4) Under preparation. Stage at the time of publication: ISO/DIS 15118-20:2019.

charging the battery). Then, the EMS may use this information to decide on any charging or discharging strategy for the future.

To store certificates or other user-/customer-specific information related to the charging process in the EV, the following requirements shall be fulfilled (for additional information see Annex B):

a) It shall be possible over the lifetime of the EV to change customer-specific information under the following circumstances:

   — at EV production;

   — at EV delivery to customer response start of EV usage;

   — when the energy contract is changed by the customer;

   — when the certificate expires;

   — if the EVCC or the component which stores the user-/customer-specific data will be replaced in a workshop;

   — when the vehicle is discarded;

   — when the vehicle is stolen;

   — when the vehicle is sold as a used car by the user.

b) Any type of customer-related data shall conform to the following requirements and process boundary conditions:

   — Limited storage and processing capacity available at a control unit for EV-specific data or certificates.

   — Since the production of the EV may happen months before delivery to a customer, no data specific to the future customer nor contract shall be written at production time.

   — OEM provisioning certificate may be changed during EV life time.

   NOTE It could be helpful to offer secure data storage in the EV for more than one OEM provisioning certificate and several contract certificates. Customer-related data stored in EVs may be used for more than 20 years.

   — Maintenance of an EV at independent workshops should be possible.

5.5 Utility-specific requirements

5.5.1 Power limiting for grid control or local energy control

The expected massive roll-out of EV will have a light impact at the transmission system operator (TSO) level, but a huge impact on the distribution system operator (DSO) level, especially on the medium and low-voltage lines and transformers. In order to minimise overloading situations and local perturbations due to a large number of EVs charging in the same time, external energy actors like DSO, EP, FO, or local actors like EMS will have to influence the energy transfer schedule and maximum power profile. The EMS will play a central role in this influence as external actors may not have natural direct access to the EV supply equipment communication infrastructure. The way the EMS is informed of the local or external constraints, and similarly the way the EMS will inform the SECC of those constraints are out of scope of the ISO 15118 series. The constraints can be expressed for example in term of maximum power during a certain period of time, positive for charging or negative for discharging, and also in financial or environmental terms.

The EV supply equipment, being informed of the energy constraints by energy SAs, shall prepare and communicate to the EVCC the elements necessary to establish the target setting (use cases F of Clause 7).

Target setting shall depend on the control mode selected.

The SECC shall inform the EVCC of the maximum available power level to optimize local grid energy usage.

Anytime during the energy transfer the EVCC or the SECC may trigger a change of the control mode or of the power schedule.

The support of the ISO 15118 series by EVs shall not prevent the usage of basic signalling in case the charging site does not support HLC (see Table 2 for details).

5.5.2 Current and voltage limits for EV supply equipment protection

The maximum nominal current circulating between the EV supply equipment and the EV shall not exceed the ratings of the supply rating installation and the ratings of the attached cable assembly.

The maximum nominal voltage between any wire of the cable shall not exceed the rating of the cable assembly.

The SECC shall indicate to the EVCC the maximum nominal current that can circulate between the EV and the EV supply equipment. The current indication shall correspond to the current that can circulate without overloading the local installation.

The SECC shall indicate to the EVCC the voltage rating of the cable assembly.

If the current or the voltage exceeds the limits indicated by the EV supply equipment during the energy transfer process, the EV supply equipment may interrupt the energy transfer process using predefined routines of ISO 15118-2 and, in case of an emergency, basic signalling routines.

5.5.3 Current and voltage limits for EV protection

The EVCC shall indicate to the SECC its voltage and current limitations (both maximum and minimum, charging and discharging) based on its component rated values, on the current operating conditions (including temperature) and on internal limitations.

If the current or the voltage exceeds the limits indicated by the EV, during the energy transfer process, the EV may interrupt the energy transfer process using predefined routines of ISO 15118-2, ISO 15118-20[5)] and, in case of an emergency, basic signalling routines.

5.5.4 Authorization of charging services

The EV supply equipment identifies itself to the EV and performs authorization to check if the EV is allowed to charge. Typically, the EV supply equipment allows charging if the EV or the USER provides the mechanism for payment. For this purpose, the EVCC may present the EMAID, or the USER may present some credit card/debit card or deposit some cash at the EV supply equipment or do authorization by a web- or smartphone-based service.

In case of authorization using the contract certificate, the protocol shall allow the exchange of contract relevant information between the EVCC and the SECC.

The validation of the contract-relevant information shall be achieved by an indication of acceptance or non-acceptance between the vehicle, the EV supply equipment and, if needed, the user. It shall be managed in a way that misuses are prevented.

In case of the USER presenting payment-relevant information at the EV supply equipment, such an exchange of information is not applicable.

EXAMPLES Parking information (to integrate charge into parking fees), EIM, debit/credit card, cash, mobile payment.

5) Under preparation. Stage at the time of publication: ISO/DIS 15118-20:2019.

5.5.5 Authorization of energy transfer from the EV to the EV supply equipment

The EV supply equipment shall allow energy transfer from the EV only if mandated by a validated SA or by the user. Typical RPT systems are providing AC by the EV with an on-board converter or providing DC by the EV with an off-board converter.

NOTE A validated SA is an actor having a valid contract with the user providing bidirectional or reverse power transfer services. Example of possible SAs are: EMS, EMSP, DSO, FO, EP...

The EV supply equipment shall provide local electricity quality requirements to the EV.

Before allowing energy transfer from the EV, the EV supply equipment shall check the validity of the SA mandating the energy transfer.

In case of EIM identification mode, the SA validity checking procedure shall be achieved by an explicit indication of acceptance or non-acceptance by the user of the energy transfer from the EV. This indication shall be managed in a way that misuses are prevented.

In case of authorization using an EMAID, the protocol shall allow the exchange of contract-relevant information between the SECC and the SA mandating the energy transfer from the EV.

In case of authorization using the contract certificate, the validation of the SA mandating energy transfer from the EV shall be achieved by checking the validity of the SA certificate.

In case of authorization using the contract certificate, and if the EV supply equipment is not able to check the SA certificate validity, then energy transfer from the EV shall not be allowed.

The EMAID of the validated SA shall be indicated in the SDR.

5.5.6 Retrofitting

In order to allow the upgrading of existing charging sites (the EV supply equipment) by adding a component, the HLC systems shall be defined in a way that an upgrade of the existing infrastructure in compliance with the ISO 15118 series is possible.

Furthermore, in case the new component does not fully integrate the existing components in the EV supply equipment (separated control pilot or SECC architecture), the newly installed SECC shall know and process the physical limits of the EV supply equipment as well.

5.6 Wireless communication requirements

5.6.1 General

Compared to conductive requirements, some additional requirements are introduced when using the wireless communication interface, since in the case of conductive power transfer, HLC may start before the driver has plugged-in. In the case of WPT, no action of plug-in is present and specific requirements also arise.

5.6.2 Communication infrastructure requirements

Wireless discovery and association is a process known by users of wireless mobile or WLAN devices. The same principle applies to EVs when using the wireless communication interface to connect to the SECC wireless interface.

When a large number of access points are in range, the discovery and association usually may require to select a particular service in a list of sometime more than 20 items. This situation can be acceptable for mobile users but is certainly not applicable for users driving their EVs. Currently in some countries, this kind of driver manipulation is forbidden if the EV is not stopped or parked.

In order to simplify and make the driver experience safer and considering that discovery should not lead to a long list of available SECCs, it is required that:

— On the SECC side:

  — SECCs may broadcast their identification and necessary information for discovery and association (e.g. unique id…).

  — Each SECC may control one or many EV supply equipment. The specification of this communication link is out of scope of this document, however, its data rate shall not degrade the overall system performance.

  — Each EV supply equipment shall have a communication link with one SECC only.

— On the EV side:

  — discovery and association shall be possible without any driver action.

NOTE The SECC's list in range received by the EVCC can be limited by the application (not in scope) provided by the OEM in order to make the driver experience more simple.

Figure 1 gives an example of infrastructure where a unique SECC controls 4 EV supply equipment. EV #1 is in communication only with the SECC.

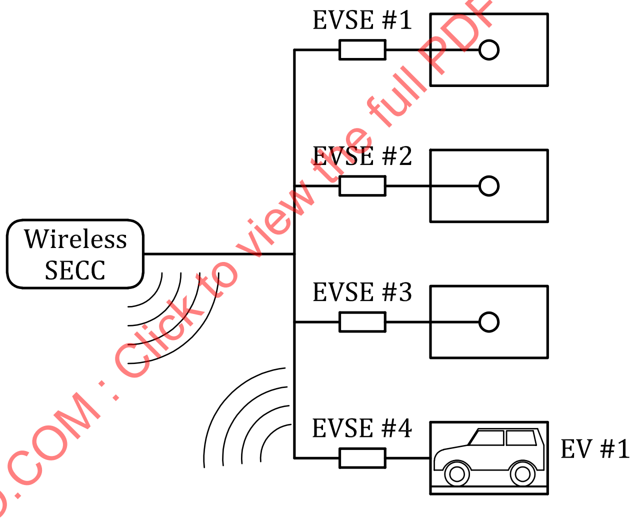


Figure 1 — Infrastructure with a unique SECC

For more wireless communication requirements, see ISO 15118-8.

5.7 RPT description

5.7.1 General

Some electric vehicles and other vehicles with electric propulsion drives can act as a power supply. These cars can use their internal energy storage system to provide electricity power to external loads.

In case of an EV with battery, an FPT is necessary to charge the vehicle battery.

The couple (EV - EV power system) is considered as DER during an RPT.

5.7.2 provides necessary information to define RPT use cases.

5.7.2 General information and requirements

— An EV designed to be able to discharge energy through an EV supply equipment shall comply with all relevant electrical safety requirements applicable to the electrical current or voltage source and DER.

— The EV and the EV power system shall be safely connected by the power transfer channel.

EXAMPLE The power transfer channel is provided by cable assembly between the EV and the EV power system.

— The power transfer system consists of the EV internal power management system, the power transfer channel of cable assembly etc. and connection between the power transfer channel and the local reverse main circuit of the power supply equipment.

— The communication system consists of the EVCC, the SECC and the communication channel between the EVCC and the SECC as described in ISO 15118-3 or ISO 15118-8. The communication system shall provide control functions and sequences for the RPT.

— The communication channel shall consist of basic signalling and/or HLC. Basic signalling provides minimum basic control with state agreement between the EV and the EV power system by a shaped voltage signal. On the other hand, HLC exchanges XML-based messages with TCP/IP protocol, to provide extended functions for the RPT. A typical example of basic signalling for the FPT is provided by IEC 61851-1:2017, Annex A, “Pilot function through a control pilot circuit using PWM modulation and a control pilot wire”.

— Single channel system

  This is the simplest RPT system. Charging and Discharging use the same power transfer channel. Channel control and messages are ensured by pilot control and HLC just like in Use Case A2.

— Dual channel system

  This is the general RTP system with two separated reverse power channels. This system is equipped with two power transfer channels, so channel control is shifted from pilot control to HLC control. In this document, AC and DC discharging and charging systems are described.

— Generator mode discharging system

  In islanding situation (for example if the grid connection is lost or when the home or building is not connected to the grid) a generator mode discharging system is acting as an electricity source and can start-up by itself and supply energy to the home or building.

Typical examples of these systems are described in Annex D.

5.8 Traceability requirements

In order to increase trust, reliability and traceability in energy transactions among all actors, it is necessary to introduce the following requirements. The scope of these requirements is limited to infrastructure where energy transfer between the EV and the EV supply equipment is monetized.

— During the energy transfer loop (use cases F0 to F4), the EV supply equipment shall measure active and reactive energy flowing from and to the grid (active charging, reactive charging, active discharging, reactive discharging).

— During the energy transfer loop (use cases F0 to F4), the SECC and the EVCC shall have the possibility to request information about the active and reactive energy meter indexes for approval. In case of failing plausibility check, the EVCC or the SECC shall return an error code indicating a failing check leading to terminating the V2G session.

— At the end of the energy transfer loop (use case H), the EV supply equipment may produce a service detail record containing, among other appropriate e-mobility related information, the following block of information:

1. Timestamp of the beginning of the energy transfer loop.
2. Control modes used (dynamic or scheduled).
3. Type of charge AC or DC, single phase or 3 phases.
4. Identification: EVID, EVSEID, Grid Delivery Point identification.
5. Total active and reactive energy transferred to the EV.
6. Total active and reactive energy transferred from the EV.
7. Timestamp at the end of the energy transfer loop.
8. EMAIDs and actors IDs involved (if any).

— V2G session interruption flag indicating that a negative plausibility check occurred during the energy transfer loop.

6 Actors

Figure 2 shows all primary and secondary actors that may be involved directly or indirectly in the energy transfer procedure of the ISO 15118 series. The use case element descriptions in Clause 7 will incorporate, where applicable, those actors and functions.

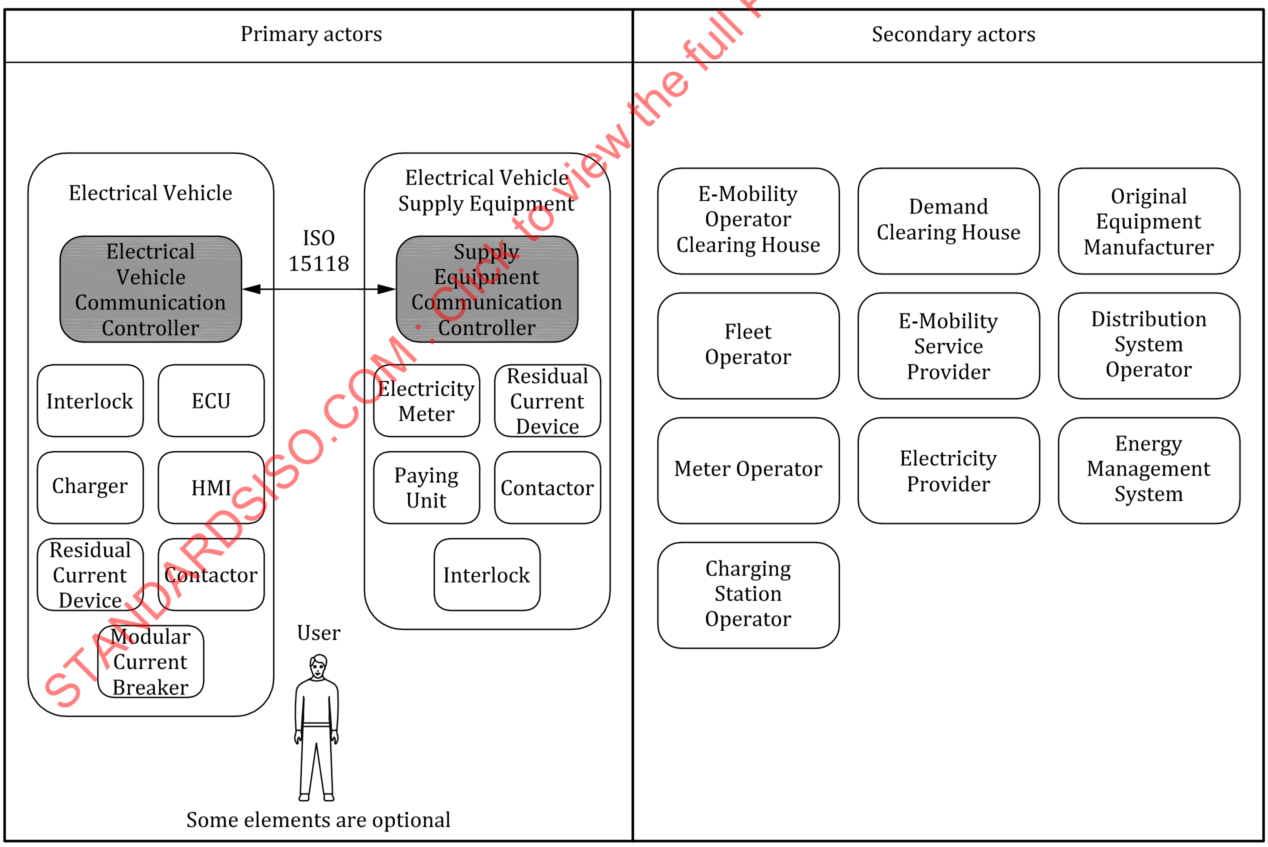


Figure 2 — Overview with examples of participating actors in the overall scenario

Primary actors are directly involved in the energy transfer process. The information flow between the EVCC and the SECC shall be specified according to all layers of the Open Systems Interconnection (OSI) reference model in accordance with ISO 7498.

The USER plays an important role in the full context of charging or discharging EVs using the charging infrastructure. For implementing the EV supply equipment, it is crucial to understand this role and the interactions between the energy transfer system and the vehicle USER. However, it is out of scope of this document to establish requirements relative to USER behaviour. If the term “USER” is used in this document as the subject of a requirement, it is more to provide guidance for the implementer of the document than to define the exact behaviour of the USER.

Although this document does not specify the protocol between the primary actors and a secondary actor, there are messages defined in ISO 15118-2 and ISO 15118-20 which include elements to exchange data between these actors.

NOTE 1 Secondary actors can be involved in the energy transfer process due to supplying information to the EVCC needed for the energy transfer process. Secondary actors can supply to the SECC any information needed for the energy transfer process. If needed, part of this information can be transferred to the EVCC by the SECC during the V2G communication session. Depending on the use case element, they can be involved but a specific relation is not described in the ISO 15118 series. Due to country-specific characteristics, the supply of information to the SECC can be done by centralised actors such as the financial and demand clearing house and meter operator, or directly by secondary actors i.e. EP, distribution system operator, EMS, EMSP.

NOTE 2 Not all primary actors are necessarily located within the EV supply equipment.

7 Use case elements

7.1 General

This clause describes the use case elements necessary for the communication between the EVCC and the SECC in order to authorize, start, manage and terminate the energy transfer before and during a V2G communication sequence. The communication to accomplish the identified use cases is defined in ISO 15118-2, ISO 15118-20[6], ISO 15118-3 and ISO 15118-8. If neither the EV nor the EV supply equipment have any HLC device, basic signalling applies.

Charging or discharging an EV is a process that requires ten functional groups of elementary use cases (see Table 2). For each functional group, several elementary use cases are possible. Each use case should be a combination of elementary use cases (see Annex C).

Compared to ISO 15118-1:2013, wireless communication introduces two new functional groups linked to pairing and fine positioning and ACD. In order to keep the existing functional letter [A-H] unchanged, a new letter [P] has been defined for pairing and fine positioning. Also letter [I] is used for ACD.

All possible elementary use cases are mentioned in the document:

a. Start of communication session: initiation of the EV and the EV supply equipment communication session. It sets the basis for the on-going sequences e.g. plug-in for PLC communication, discovery of the SECC for wireless communication, availability of PWM, HLC etc.;

b. Communication set-up: establishes the association and relevant connection between the EVCC and the SECC;

c. Certificate handling: everything related to certificates;

d. Identification and authorization: methods for identification and authorization;

p. Pairing and fine positioning: specific element needed for pairing and WPT;

e. Target setting and energy transfer scheduling: information needed from the EV as well as from the SECC and the secondary actor to start the energy transfer process;

f. Power flow controlling and re-scheduling: elements during the energy transfer;

6) Under preparation. Stage at the time of publication: ISO/DIS 15118-20:2019.

g. Value-added services;

h. End of energy transfer period: triggers for signalling the end of the energy transfer;

i. ACD connect/disconnect.

Variations of use case implementations exist, depending on the EV supply equipment, the EV or the business case used for the energy transfer process.

Table 1 provides an overview of all use case elements grouped by function. Examples are listed in Annex C.

Table 1 — Use case elements function groups

Use case element function	Description
A	Start of communication session
B	Communication set-up
C	Certificate handling
D	Identification, authentication and authorization
P	Pairing and fine positioning
E	Target setting and energy transfer scheduling
F	Energy transfer controlling and re-scheduling
G	Value-added services
H	End of energy transfer period
I	ACD connect/disconnect

NOTE The groups do not specify the order in which the use case elements will be implemented, or which elements are required or optional.

7.2 Task groups

The complete charging or discharging scenario is separated into task groups to allow the classification of the elementary use cases (see Table 2). For each task group, several elementary use cases are possible. Each use case can be a combination of elementary use cases. Task groups starting with "W" are specific to wireless communication (in grey in Table 2).

NOTE For compatibility reasons with ISO 15118-1:2013, E3 does not exist anymore. In all parts in the ISO 15118 series, use case E3 will refer to use case E2.

Table 2 — Overview of elements of use cases

Conductive task group	Wireless task group	Use case No.	Use case element name
A		A1	**Plug-in and forced high-level communication**
		A2	**Plug-in with concurrent IEC 61851-1 and high-level communication**
	WA	WA1	**discovery with reservation**
		WA2	**Manual or automatic discovery without reservation**
B		B1	**EVCC/SECC conductive communication set-up**
	WB	WB1	**EVCC/SECC wireless communication set-up**
C		C1	**Certificate update**
		C2	**Certificate installation**
D		D1	**Authorization using contract certificates performed at the EV supply equipment**

Table 2 *(continued)*

Conductive task group	Wireless task group	Use case No.	Use case element name
		D2	Authorization using contract certificates performed with the help of an SA
		D3	Authorization at EV supply equipment using external credentials performed at the EV supply equipment
		D4	Authorization at EV supply equipment using external credentials performed with the help of an SA
	WD	WD1	Authentication with prior reservation
P	WP		Pairing and fine positioning
		WP1	WPT fine positioning
		WP2	WPT fine positioning without communication support
		WP3	Conductive power transfer pairing
		WP4	WPT pairing
E		E1	AC charging with load levelling based on HLC
	WE	WE1	WPT target setting and energy transfer scheduling
		E2	Optimized charging with scheduling to secondary actor
		E3	Reserved
		E4	DC charging with load levelling based on high-level communication
		E5	Resume to authorized charge schedule
		E6	Reverse power transfer with load levelling based on HLC
		E7	Reverse power transfer on stand-alone operation
		E8	Fast responding energy transfer services based on dynamic control mode
		E9	Managed bidirectional power transfer into the grid
F		F0	Energy transfer loop
		F1	Energy transfer loop with metering information exchange
	WF	WF1	WPT charging loop
		F2	Energy transfer loop with interrupt from the SECC
		F3	Energy transfer loop with interrupt from the EVCC or user
		F4	Energy transfer control based on dynamic control mode
G		G1	Value added services
	WG	WG1	ACD system status check
		G2	Energy transfer details
H		H1	End of energy transfer period
	WH	WH1	WPT end of energy transfer
I	**WI**	**WI1**	ACD connect/disconnect

7.3 Task groups description

7.3.1 Start of communication process [A]

7.3.1.1 General

The first group of use case A refers to 4 elements detailed in Table 2.

The first two elements are for conductive communication:

— A1: Plug-in and forced high-level communication; and

— A2: Plug-in and concurrent IEC 61851-1 and HLC.

The last two are for wireless communication:

— WA1: discovery with reservation; and

— WA2: discovery without reservation.

7.3.1.2 Combinations and communication capabilities

The following two cases occur if an EV supply equipment implements HLC:

— A1) HLC required by the EV supply equipment, the PWM signal (according to IEC 61851-1) at 5 %, the EV supply equipment will not provide power to EVs that do not support HLC; and

— A2) HLC optional, the EV supply equipment will provide power even to those EVs that do not support HLC.

Table 3 shows the different combinations of the EV supply equipment and EVs that do, or do not, support HLC and how these cases are treated.

Table 3 — Combinations of EV and EV supply equipment communication capabilities

	EV ISO 15118 not implemented	EV ISO 15118 implemented, not required	EV ISO 15118 implemented and required
EV supply equipment ISO 15118 not implemented[a]	Charging according basic signalling – not inside the scope of the ISO 15118 series.	Failure end condition of use case element A1, A2, WA1 and WA2 on EV side. No establishment of HLC. Charging according basic signalling out of scope of the ISO 15118 series.	Failure end condition of use case element A1, A2, WA1 and WA2 on EV side. Energy transfer is not possible.
EV supply equipment ISO 15118 implemented, not required[b]	Failure end condition of use case element A1, A2, WA1 and WA2 on EV supply equipment side. No establishment of HLC. Charging according basic signalling – out of scope of the ISO 15118 series.	See use case element A1, A2, WA1,WA2.	See use case element A1, WA1 and WA2.
EV supply equipment ISO 15118 implemented and required[c]	Failure end condition of use case element A1, WA1 and WA2 on EV supply equipment side. Charging is not possible.	See use case element A1, WA1 and WA2.	See use case element A1, WA1 and WA2.

a The functionality is not available.

b The functionality is available; the usage applies, if the counterpart has the functionality implemented as well.

c The functionality is available, the usage enforced. If the functionality is not available at the counterpart, charging is not possible.

NOTE Sequence diagrams about message flow and interaction are described in ISO 15118-2 and ISO 15118-20. A timing diagram about the interconnection between IEC 61851-1 and the ISO 15118 series is described in ISO 15118-3.

7.3.2 Plug-in and forced HLC

Table 4 — Plug in and forced HLC

No.	Type	Description
1	Use case element name	Plug-in and forced HLC (the ISO 15118 series in compliance with IEC 61851-1)
2	Use case element ID	A1
3	Objectives	Establishing of HLC after the user plugs in.
4	Description	This use case covers the initial PWM signalling (IEC 61851-1) from the EV supply equipment, with a 5 % duty cycle in order to require HLC and mode 3/ mode 4 charging. The actors involved are: — Primary actors: EV, EV supply equipment, EVCC, SECC. Scenario description: — Connect the cable between the EV and EV supply equipment; — The EV supply equipment indicates a 5 % PWM duty cycle; — The EV interprets the PWM duty cycle; — The EVCC and the SECC establish the physical and data link layer connection (The detailed sequence is defined in ISO 15118-3); and — Communication set-up (use case function group B) is able to start.
5	Prerequisites	— The EV shall be connected physically to the EV supply equipment with the appropriate cable. — The EV and EV supply equipment require pilot function and basic signalling in accordance with IEC 61851-1. — The EV and EV supply equipment shall have a higher level communication device in accordance with ISO 15118-2 and ISO 15118-3.
6	Requirements	— Successful set-up of HLC at the data link layer. — Timing for the initialization process shall be according to ISO 15118-3. — Triggers: — for the EV supply equipment: The EV is connected properly to the EV supply equipment; and — for the EV: Plug present and PWM duty cycle indicating HLC required according to IEC 61851-1.
7	End conditions	Success end conditions: — Successful set-up of HLC at the data link layer. Failure end conditions: — No establishment of HLC at the data link layer or failure of the PWM signal. — No correct association of SECC and EVCC or timeout in the binding process occurs.

7.3.3 WA1: discovery with reservation

Table 5 — discovery with reservation

No.	Type	Description
1	Use case element name	Discovery with reservation
2	Use case element ID	WA1
3	Objectives	The goal of this use case is to automatically discover the SECC based on the information received by the operator in charge of reservation.
4	Description	The driver selects the right SECC ID according to the information linked to the reservation ID. If the SECC ID is already stored in the application memory, e.g. as it was included in the reservation response or assigned upon arrival at the site, the application automatically selects the right SECC ID on behalf of the driver. Primary actors involved are: USER, EVCC, SECC.
5	Prerequisites	An EV is approaching a charging site area. The EVCC wireless interface is in the range of the SECC wireless interface. The driver has reserved an EV supply equipment and has received a valid reservation ID. As an example, this reservation ID could have been obtained through a reservation protocol as specified in ETSI TS 101 556-3. The format of the reservation ID may be alphanumerical.
6	Requirements	EVCC and SECC feature active wireless interfaces complying with ISO 15118-8. When in range, the appropriate display (could be an on-board EV system or an independent system like a smartphone) shows the list of all local SECCs currently broadcasting their ID.
7	End conditions	Success end conditions: — Successful SECC discovery. Failure end conditions: — SECCs in the list do not correspond to the SECC ID received during reservation; — discovery aborted by the driver or application; and — reservation mismatch or expiration.

7.3.4 Plug-in with concurrent IEC 61851-1 and HLC

Table 6 — Plug-in with concurrent IEC 61851-1 and HLC

No.	Type	Description
1	Use case element name	Plug-in with concurrent IEC 61851-1 and HLC
2	Use case element ID	A2
3	Objectives	Establish HLC concurrently with IEC 61851-1 mode 3 charging.
4	Description	This use case covers the initial basic signalling (IEC 61851–1) from the EV supply equipment and high-level communication working concurrently and mode 3 charging. NOTE CSO can offer a fall-back solution if HLC fails by enabling charging according to IEC 61851–1. The actors involved are: — Primary actors: EV, EV supply equipment, EVCC, SECC. Scenario description:

Table 6 *(continued)*

No.	Type	Description
		— plug-in the cable between the EV and EV supply equipment; — the EV supply equipment sets a duty cycle of 5 % indicating that HLC is required; — the EV interprets the PWM duty cycle as a safety signal; — the EVCC and SECC establish the physical and data link layer connection (The detailed sequence is defined in ISO 15118-3); and — Communication set-up (use case function group B) is able to start.
5	Prerequisites	— The EV shall be plugged physically to the EV supply equipment with the appropriate cable. — The EV and EV supply equipment require basic signalling. — The EV and EV supply equipment shall have a higher level communication device in accordance with ISO 15118-2 and ISO 15118-3.

6	Requirements	— Successful set up of HLC at the data link layer.
		— Timing for the initialization process shall be according to ISO 15118-3.
		— Triggers:
		  — For the EV supply equipment: The EV is connected properly to the EV supply equipment; and
		  — For the EV: Plug present shall be according IEC 61851-1.

7	End conditions	Success end conditions: — Successful set-up of HLC at the data link layer. Failure end conditions: — no establishment of HLC at the data link layer; — failure of the PWM signal; and — no correct association of the SECC and the EVCC or timeout in the binding process occurs.

7.3.5 WA2: discovery without reservation

Table 7 — discovery without reservation

No.	Type	Description
1	Use case element name	Discovery without reservation
2	Use case element ID	WA2
3	Objectives	The goal of this element is to select manually or automatically an SECC.
4	Description	The driver selects one SECC ID in relation with its charging site choice (if the SECC's ID is already stored in the application memory, the application automatically selects the right SECC's ID on behalf of the driver). It is assumed that if a password is required, it is given to the driver locally by the CSO or by the EMSP. Primary actors involved are: USER, EV supply equipment, SECC. Secondary actors involved are: CSO, EMSP, DCH.
5	Prerequisites	An EV is approaching a charging site area. The EVCC wireless interface is in range of The SECC wireless interface.

Table 7 *(continued)*

No.	Type	Description
6	Requirements	EVCC and SECC feature active wireless interfaces complying with ISO 15118-8 requirements. When in range, the appropriate display (could be an on-board EV system or an independent system like a smartphone) shows the list of all local SECCs currently broadcasting their ID.
7	End conditions	Success end conditions:
		— Successful SECC discovery. Failure end conditions: — SECCs in the list do not correspond to the driver's preferred choice; and — discovery aborted by the driver or application.

7.4 Communication set-up [B]

7.4.1 EVCC/SECC conductive communication set-up

Table 8 — EVCC/SECC communication set-up

No.	Type	Description
1	Use case element name	EVCC/SECC conductive communication set-up
2	Use case element ID	B1
3	Objectives	The goal of this use case element is to establish a communication link between the EVCC and the SECC and a correct association.
4	Description	The primary actors are the SECC and the EVCC. There is no information exchange between the EVCC and the SECC at the application layer. The actors involved are: — Primary actors: EVCC, SECC.
5	Prerequisites	— Plug-in process according to use case elements A1 or A2 shall be established successfully.
6	Requirements	— The SECC and EVCC shall be capable of being associated one-to-one. — The EVCC shall be bound to the SECC by the protocol described in ISO 15118-2 or ISO 15118-20. — The timing of this binding shall be in line with the requirements given by ISO 15118-2 or ISO 15118-20. — The EVCC and the SECC shall exchange information about the supported ISO 15118-2 or ISO 15118-20 protocol versions and use the latest common protocol version.
7	End conditions	Success end conditions: — The SECC and the EVCC are associated and bound correctly, i.e. the EVCC is able to send the first request to the SECC on the application layer according to the negotiated ISO 15118-2 or ISO 15118-20 protocol version. Failure end conditions: — Negotiation of the ISO 15118-2 or ISO 15118-20 protocol version failed.

7.4.2 WB1: EVCC/SECC wireless communication set-up

Table 9 — EVCC/SECC wireless communication set-up

No.	Type	Description
1	Use case element name	EVCC/SECC wireless communication set-up
2	Use case element ID	WB1
3	Objectives	The goal of this use case element is to establish a wireless communication link between the EVCC and the SECC and a correct association.
4	Description	Establishment of the wireless communication link between the EVCC and the SECC is detailed in ISO 15118-8. Primary actors involved are: EVCC, SECC.
5	Prerequisites	Discovery according to WA1 or WA2 shall be established successfully.
6	Requirements	— The SECC and EVCC shall be capable of being associated. — The EVCC shall be bound with the SECC by the protocol and timings described in ISO 15118-20 and ISO 15118-8. — EVCC and SECC shall exchange information about the supported ISO 15118-8 protocol version and use the latest common protocol version.
7	End conditions	Success end conditions: — The SECC and the EVCC are associated and bound correctly, i.e. the EVCC is able to send the first request to the SECC on the application layer according to the ISO 15118-20 protocol. Failure end conditions: — Negotiation of the ISO 15118-20 protocol failed.

7.5 Certificate handling [C]

7.5.1 Certificate update

Table 10 — Certificate update

No.	Type	Description
1	Use case element name	Certificate update
2	Use case element ID	C1
3	Objectives	Replace the invalid or expired certificate in the EV with a new and valid certificate from the secondary actor.
4	Description	This use case covers the update of an invalid certificate in the EV. Therefore, the EVCC is initiating a certificate update process using the established HLC with the SECC to retrieve a new certificate from the issuing secondary actor. NOTE 1 There can be alternative communication paths to do a certificate update. However, these are outside the scope of this document. NOTE 2 Whether an expired certificate is subject to be updated depends on the business decision of the SA. NOTE 3 If there is no permission from the SA to update the certificate, use case element C2 can apply. The certificate update process from the SECC to the secondary actor and back is outside the scope of this document. The actors involved are:

Table 10 *(continued)*

No.	Type	Description
		— Primary actors: EVCC, SECC. — Secondary actors: EMOCH, FO, EMSP. Scenario description:
		— The EVCC requests a certificate update by the SECC, providing information about the secondary actor who has issued the certificate. — SECC enables a communication link to the secondary actor or provide the certificates to be updated as a local copy. — SECC requests a certificate update for the EVCC from the secondary actor containing EVCC-specific information. — The issuing entity provides a new certificate to the requesting SECC. — The SECC forwards the new certificate to the EVCC.
5	Prerequisites	— Communication set-up according to use case element B1 or WB1 shall be established successfully. — The EV (i.e. EVCC) shall possess a valid certificate for an energy contract (contract certificate). — Semi-online connection between the SECC and the secondary actor shall be possible or certificates to be updated shall be available on the SECC.
6	Requirements	The EVCC shall support the certificate update process. The SECC shall support the certificate update process. Trigger: — The EVCC/SECC detects that the certificate of the EV has expired. — Limited remaining lifetime.
7	End conditions	Success end conditions: — The valid certificate (contract certificate) from the secondary actor shall be stored in the EVCC. Failure end conditions: — Certificate update failed due to a communication issue. — Certificate update failed due to rejection by the secondary actor.

7.5.2 Certificate installation

Table 11 — Certificate installation

No.	Type	Description
1	Use case element name	Certificate installation
2	Use case element ID	C2
3	Objectives	Installation of a new certificate from the secondary actor in the EV.

Table 11 *(continued)*

No.	Type	Description
4	Description	This use case covers the installation of a certificate (contract certificate) into the EV if no such certificate is available yet or if it has expired or is invalid. Therefore, the EVCC is initiating a certificate installation process using the established HLC with the SECC to retrieve a certificate from the issuing secondary actor. The EV is identified by using a certificate (OEM provisioning certificate) that was installed by the OEM earlier (e.g. at EV production). NOTE There can be alternative communication paths for doing a certificate installation. However, these are outside the scope of this document. The certificate installation/transfer process from the SECC to the secondary actor and back is outside the scope of this document. The actors involved are:
		— Primary actors: EVCC, SECC. — Secondary actors: EMOCH, FO, EMSP. Scenario description: — The EVCC requests a certificate installation by the SECC. — The SECC enables a communication link to the secondary actor or provides the certificates to be installed as local copy. — For this purpose, the SECC has to identify the secondary actor which has a contract with the owner of the EV. Therefore, it has to send the OEM provisioning certificate (or its ID) to: — the clearing house / all known clearing houses; and — the preferred secondary actor / all known secondary actors. The corresponding contract may be identified by the secondary actor, for instance, via the certificate ID of the Bootstrap certificate. This ID is transferred from the customer to the secondary actor at contract creation. (First, the OEM has to transfer this ID to the customer e.g. at EV delivery). — The SECC requests a certificate installation for the EVCC from the secondary actor found containing EVCC-specific information (OEM provisioning certificate). — The issuing entity shall provide a certificate and the corresponding private key to the requesting SECC. At least the private key has to be encrypted using the old EVCC OEM provisioning certificate. — The SECC shall forward the new certificate and the corresponding (encrypted) private key to the EVCC.
5	Prerequisites	— Communication set-up according to use case element B1 shall be established successfully. — No contract certificate resp. no valid contract certificate is available in the EV. — A Bootstrap certificate created by the OEM is available in the EV. — Online connection between the SECC and the secondary actor shall be possible or certificates to be updated shall be available on the SECC.
6	Requirements	The SECC supports the certificate installation process. The SECC shall enable a communication link to the secondary actor or provide the contract certificate being installed as local copy. Trigger: The EVCC detects resp. SECC signals that the certificate of the EV either

Table 11 *(continued)*

No.	Type	Description
		— has expired. — is invalid. — is still valid but only has a limited lifetime (instead of applying C1).
7	End conditions	Success end conditions:
		— The valid certificate (contract certificate) from the secondary actor shall be stored in the EVCC. — The Bootstrap certificate (created by the OEM) is still available in the EV. Failure end conditions: — Certificate installation failed due to a communication issue. — Certificate installation failed due to rejection by the secondary actor. — Certificate installation failed because no secondary actor with a matching contract can be found.

7.6 Identification and authorization [D]

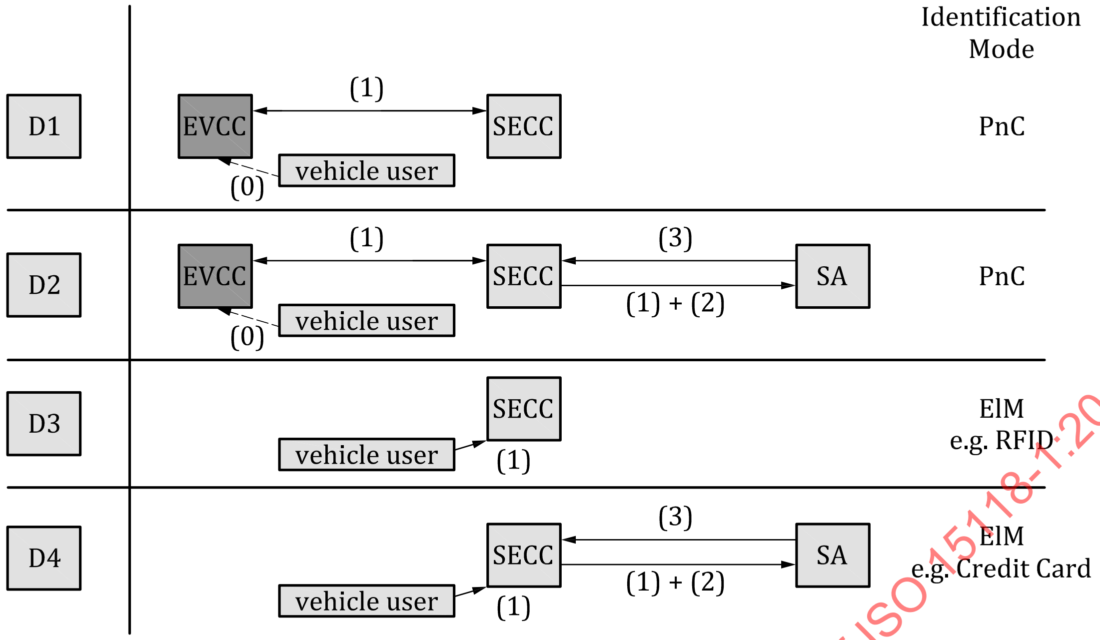
7.6.1 Overview

The EV supply equipment identifies itself to the EV and performs authorization to check if the EV is allowed to be charged. Typically, the EV supply equipment allows charging if an EV or USER provides the mechanism for payment. For this purpose, the EVCC may present the contract certificate, or the USER may present some credit card/debit card, or deposit some cash at the EV supply equipment.

Depending on the EV supply equipment infrastructure and the capabilities of the EV, the methods of authorizing a user differ. Figure 3 classifies the possible scenarios, in general there are two major groups: PnC where contract certificates are used and EIM where the identification/authorization is performed without using contract certificates. Although the ISO 15118 series does not specify requirements for the implementation of external identification methods (EIM – D3 and D4)), the message sets defined in ISO 15118-2 and ISO 15118-20[7] support both identification types. In case of EIM, ISO 15118-3 outlines the necessary synchronisation requirements between HLC and basic signalling.

Figure 3 may be taken as the graphical overview of the possible identification/authorization means and their location.

7) Under preparation. Stage at the time of publication: ISO/DIS 15118-20:2019.



Key

————	mandatory
— — — —	optional
(0)	activation
(1)	credential(s) (e.g. EMAID)
(2)	e.g. EVSEID
(3)	e.g. authorization

Figure 3 — Graphical overview of scenarios for identification

These authorization options are an indicator of possible implementations in the field. For the ISO 15118 series, only those options are listed as use case elements, which require informational exchange on the message level between the EVCC and the SECC.

No authorization for charging or discharging is required if the authorization to transfer energy is done by a third party.

EXAMPLE At a car park where parking fees could include the energy consumption of the vehicle or charging or discharging at domestic household socket.

7.6.2 Authorization using contract certificates performed at the EV supply equipment

Table 12 — Authorization using contract certificates performed at the EV supply equipment

No.	Type	Description
1	Use case element name	Authorization using contract certificates performed at the EV supply equipment
2	Use case element ID	D1
3	Objectives	Verify the validity of the contract by using the ISO 15118-2 or ISO 15118-20 message set at the EV supply equipment.
4	Description	This use case covers the authorization process using contract certificates at the EV supply equipment. The identification should be made with an ID (contract certificate) as stipulated in ISO 15118-2 or ISO 15118-20 PnC identification mode. The actors involved are:

Table 12 *(continued)*

No.	Type	Description
		— Primary actors: EVCC, EV, SECC, EV supply equipment, HMI. — Secondary actors: EMOCH, EMSP. Scenario description: — The USER connects the car with the station and activates the service offering the ID. This could also be done automatically. — The SECC and the EVCC exchange their IDs (EMAID and EV supply equipment ID). — The SECC may decide to forward the IDs from the EVCC associating its own IDs to the secondary actors. — Service should start after successful verification of the IDs.
5	Prerequisites	— Communication set-up according to use case element B1 shall be established successfully. — All required information for authorization shall be stored in the SECC in case the SECC does not establish online connections synchronously to the charging event.
6	Requirements	— If the authorization is not automatically launched, the USER shall activate the authorization through the HMI (in the car) within a specific time after connecting the EV to the EV supply equipment. — The SECC shall exchange its IDs (EV supply equipment ID) to the EVCC. — The EVCC shall exchange its IDs (EMAID) to the SECC. — Trigger: — Initialization of the authorization process from the EVCC. — Reply or acceptance of the payment (ID) shall be done within a specific time. This timing is stipulated in ISO 15118-2 or ISO 15118-20.
7	End conditions	Success end conditions: — The authorization process is successful; a session ID is defined and the required service (charging or value added) starts. Failure end conditions: — The authorization process fails. — The required service does not start. — The user might be informed about the reason for failure (i.e. contract has expired, contract has been blocked – stolen car, stolen contract, procedure to be restarted, authorization server not available).

7.6.3 Authorization using contract certificates performed with the help of an SA

Table 13 — Authorization using contract certificates performed with the help of an SA

No.	Type	Description
1	Use case element name	Authorization using contract certificates performed with the help of an SA
2	Use case element ID	D2
3	Objectives	Verify the validity of the contract with a validation from a secondary actor by using the ISO 15118-2 or ISO 15118-20 message set.

Table 13 *(continued)*

No.	Type	Description
4	Description	— This use case covers the authorization process using contract certificates with the help of an SA. The identification should be made with an ID (contract certificate) as stipulated in ISO 15118-2 or ISO 15118-20 PnC identification mode. The actors involved are: — Primary actors: EV, EVCC, EV supply equipment, SECC, HMI. — Secondary actors: EMOCH, EMSP. Scenario description: — The USER connects the car to the station and activates the service offering the ID. This could also be done automatically. — The SECC and the EVCC exchange their IDs (EMAID and EV supply equipment). Those are forwarded to the secondary actor for validation. — The secondary actor replies with an agreement or non-agreement. — Service starts after successful authorization of the IDs.
5	Prerequisites	— Communication set-up according to use case element B1 or WB1 shall be established successfully. — Online connection between the SECC and the secondary actors is required.
6	Requirements	— If the authorization is not automatically launched, the USER has to activate the authorization through the HMI (in the car) within a specific time after connecting the EV to the EV supply equipment. — The SECC shall exchange its IDs (EV supply equipment ID) to the EVCC. — The EVCC shall exchange its IDs (EMAID) to the SECC. — The SECC shall forward the IDs (EMAID from the EVCC associating its own IDs) (EV supply equipment ID) to the secondary actors. — Trigger: Initialization of the authorization process from the EVCC. Reply or acceptance of the payment (ID) shall be done within a specific time. This timing is stipulated in ISO 15118-2 or ISO 15118-20.
7	End conditions	Success end conditions: — The authorization process is successful, a session ID is defined and the required service (charging, discharging or value added) starts. Failure end conditions: — The authorization process fails, no authorization given by the secondary actor. — The required service does not start. — The user might be informed about the reason for failure (i.e. contract has expired, contract has been blocked, stolen car or contract, procedure to be restarted, authorization server not available).

7.6.4 Authorization at the EV supply equipment using external credentials performed at the EV supply equipment

Table 14 — Authorization at the EV supply equipment using external credentials performed at the EV supply equipment

No.	Type	Description
1	Use case element name	Authorization at the EV supply equipment using External Credentials performed at the EV supply equipment
2	Use case element ID	D3
3	Objectives	Authorization at the EV supply equipment with credentials, which are external to the vehicle as described in ISO 15118-2 or ISO 15118-20 EIM identification mode.
4	Description	The USER identifies himself/herself at the EV supply equipment by using one of the identification methods offered. NOTE Depending on the identification type, the CSO could not have the possibility to authenticate the IDs and therefore might not authorize the service. The SECC can decide to forward the IDs (EMAID) associating its own IDs (EV supply equipment ID) to the secondary actors. Service should start after successful verification of the Ids. The actors involved are: — Primary actors: USER, EV supply equipment, HMI, SECC. — Secondary actors: EMOCH, EMSP.
5	Prerequisites	Communication set-up according to use case element B1 or WB1 shall be established successfully.
6	Requirements	— The USER shall activate the authorization within a specific time after connecting the EV to the EV supply equipment or the EV supply equipment shall have an HMI or any other method to authorize the restart of the authorization process. — The USER shall, for example, use an HMI to type in the identification code or any other authorization method offered at the EV supply equipment. — The SECC shall evaluate the authorization and, if accepted, proceed with the communication flow. — Trigger: — The authorization shall be made at the EV supply equipment and activated by the USER.
7	End conditions	Success end conditions: — The authorization process is successful, a session ID is defined and the required service (charging, discharging or value-added) starts. Failure end conditions: — The authorization process fails. — The required service does not start. — The user might be informed about the reason for failure (i.e. identification means has expired, contract has been blocked – stolen car, stolen contract, procedure to be restarted, identification means out of order).

7.6.5 Authorization at the EV supply equipment using external credentials performed with the help of an SA

Table 15 — Authorization at the EV supply equipment using external credentials performed with the help of an SA

No.	Type	Description
1	Use case element name	Authorization at the EV supply equipment using external credentials performed with the help of an SA
2	Use case element ID	D4
3	Objectives	Authorization at the EV supply equipment with credentials, which are external to the vehicle, with the help of a secondary actor.
4	Description	This use case covers the process of how identification should be validated by a secondary actor. The USER identifies himself/herself at the EV supply equipment by using one of the EIM identification methods offered. NOTE Depending on the identification type, the CSO could not have the possibility to authenticate the IDs and therefore might not authorize the service. The actors involved are:
		— Primary actors: USER, EV supply equipment, SECC, HMI. — Secondary actors: EMOCH, EMSP. Scenario description: — The SECC forwards the IDs (EV supply equipment ID and EMAID) to the secondary actor for validation. — The secondary actor replies with an agreement or non-agreement. — Service starts after successful verification of the IDs.
5	Prerequisites	— Communication set-up according to use case element B1 shall be established successfully. — Online connection between the SECC and secondary actors is required.
6	Requirements	— The USER shall activate the authorization within a specific time after connecting the EV to the EV supply equipment or the EV supply equipment shall have an HMI to authorize the restart of the identification process. — The USER shall use the identification method at the EV supply equipment (e.g. HMI). — The SECC shall send the identification to the secondary actor for validation. — Trigger: — The authorization shall be made at the EV supply equipment and activated by the USER.
7	End conditions	Success end conditions: — The authorization process is successful, a session ID is defined and the required service (charging, discharging or value-added) starts. Failure end conditions: — The authorization process fails. — The identification performed by the USER at the EV supply equipment is not validated by the secondary actor. — The required service does not start. — The user might be informed about the reason for failure (i.e. contract has expired, contract has been blocked, stolen car or contract, procedure to be restarted, identification server not available).

7.6.6 WD1: Authentication with prior reservation

Table 16 — Authentication with prior reservation

No.	Type	Description
1	Use case element name	Authentication with prior reservation
2	Use case element ID	WD1
3	Objectives	The goal of this use case element is to authenticate that a reservation is valid and then to indicate to the driver the appropriate EV supply equipment corresponding to the charging requirements as confirmed during the reservation process.
4	Description	After a successful wireless association, the SECC may require a confirmation that the reservation is valid to continue further steps. This element allows the CSO to validate the transaction with third parties (in particular the EMSP responsible of the reservation). — The CSO backend checks the EV or EV user's reservation and related data, and the contract of service with its EMSP covering reservation service payment. If checking is not possible, other way of identification/payment should be proposed to the driver (EIM mode, pre-payment, credit card...) after parking and pairing. — If the reservation is validated, the SECC may indicate to the EV where the appropriate EV supply equipment is located. “Appropriate EV supply equipment” means adapted to the EV requirements as confirmed during the reservation process. — If the reservation validation fails, the SECC notifies it to the EVCC and, if possible, assigns it an available EV supply equipment as without reservation. The way the driver indicates the reservation number to the SECC is out of scope of this document. Also, SECC upstream communications and means used by the SECC to indicate to the EVCC where the allocated EV supply equipment is, is out of scope of the ISO 15118 series. EXAMPLE Real-time maps, flashing light on the EV supply equipment, unique number that can be visualized in the EV when approaching the EV supply equipment. The primary actors involved are: USER, EV supply equipment, EVCC, SECC. The Secondary actors involved are: CSO, EMSP.
5	Prerequisites	Association described in WB1 is successful. A reservation has been validated by the EMSP responsible of reservations.
6	Requirements	— The SECC shall ask the EVCC the reservation number. — The EVCC shall indicate to the SECC the reservation number indicated in the EBC. — The SECC shall notify rejection or acceptance of the reservation to the EVCC. — The SECC may allocate an appropriate EV supply equipment.
7	End conditions	Success end conditions: — The reservation has been validated. — An EV supply equipment has been allocated to EV. Failure end conditions: — ISO 15118-2 or ISO 15118-20 protocol failed. — The reservation is declared invalid by the EMSP and there is no available EV supply equipment.

7.7 Pairing and fine positioning

7.7.1 WP1: WPT fine positioning

The technical definition of fine positioning is out of scope of this document (see IEC 61980 for the definition), but it is the responsibility of the ISO 15118 series to define the messages and signal to support fine positioning. Fine positioning shall be successful before the EV triggers pairing. There are different mechanisms for fine positioning being proposed in IEC 61980.

Table 17 — WPT fine positioning

No.	Type	Description
1	Use case element name	WPT fine positioning
2	Use case element ID	WP1
3	Objectives	The goal of this element is to trigger the sequence of alignment of primary and secondary devices.
4	Description	The EV selects a fine positioning method out of the list offered by the SECC. The EVCC triggers the start of the positioning process by sending a message to the SECC. The EV and/or EV supply equipment check their relative position until the appropriate position is reached and the fine positioning process is finished. The EV and EV supply equipment inform each other of the fine positioning status. The actors involved are: Primary actors: USER, EV supply equipment, SECC, EV, EVCC.
5	Prerequisites	— The EV is at the appropriate distance of the primary device. — Information on available positioning technologies has been exchanged.
6	Requirements	— Wireless communication (WB) shall be successfully established. — The compatibility with respect to the fine positioning technologies shall be checked just after the establishment of the wireless communication (WB).
7	End conditions	Success end conditions: — Primary and secondary devices are correctly aligned. Failure end conditions: — ISO 15118-20 fine positioning protocol failed. — EV supported fine positioning mechanisms don’t match the available EV supply equipment fine positioning mechanism. — Fine positioning failed.

7.7.2 WP2: WPT fine positioning without communication support

If the EV uses stand-alone positioning system e.g. stand-alone optical positioning by the vehicle, then fine positioning messages defined in ISO 15118-20 are exchanged but do not aid the fine positioning. Even in this case, confirmation about successful positioning status between the EVCC and the SECC is necessary.

Table 18 — WPT fine positioning without communication support

No.	Type	Description
1	Use case element name	WPT fine positioning without communication support
2	Use case element ID	WP2
3	Objectives	Share the result of the stand-alone positioning without communicating positioning parameters, between the EVCC and the SECC. Make an agreement about the status of the system.

Table 18 *(continued)*

No.	Type	Description
4	Description	To avoid instability or interferences of communication while the vehicle is moving, stand-alone fine positioning of the vehicle to the park space and WPT device is successfully finished before communication set-up. This control does not have communication delay in the control loop, response time of the feedback control is improved to be satisfied and used. If stand-alone optical fine positioning is successfully finished, the communication set-up shall be started. After the communication set-up and before the pairing process, the result of optical positioning shall be sent from the EVCC to the SECC. The involved actors are: — Primary actors: EVCC, SECC.
5	Prerequisites	— Optical stand-alone fine positioning is successfully finished before communication set-up. — Communication set-up is successfully finished.
6	Requirements	— The EVCC send to the SECC the results of optical stand-alone positioning. — The SECC respond to the EVCC with “OK” if the result is acceptable.
7	End conditions	Success end conditions: — The EVCC and the SECC share the status that primary and secondary devices are correctly aligned. Failure end conditions: — The result of fine positioning sent from the EVCC is not acceptable for the SECC.

7.7.3 WP3: Conductive energy transfer pairing

Wireless communication cannot ensure by itself that EVs are correctly parked. Pairing is then necessary to avoid wrong parking.

The pairing shall use the existing IEC 61851-1 pilot line to modulate specific state variations. Pairing-specific messages are described in ISO 15118-20[8].

Table 19 — Conductive energy transfer pairing

No.	Type	Description
1	Use case element name	Conductive power transfer pairing
2	Use case element ID	WP3
3	Objectives	The goal of this element is to start the pairing sequence in case of conductive energy transfer.
4	Description	The EVCC and the SECC exchange authorization to start a pairing sequence. After a positive answer from the SECC specifying the number of toggles, pairing starts. EV starts the sequence of BCB states toggle (BCB state toggle are defined in ISO 15118-3). The EV supply equipment that detects the correct sequence of toggles informs the SECC of the pairing toggles detection. The SECC informs the EVCC of the correct toggles reception. Depending on whether the location detected is convenient or not, the SECC may decide to ask the EVCC to change the location. The actors involved are: Primary actors: EVCC, SECC, EV, EV supply equipment.

8) Under preparation. Stage at the time of publication: ISO/DIS 15118-20:2019.

Table 19 *(continued)*

No.	Type	Description
5	Prerequisites	— The EV is plugged and parked. — The EVCC and the SECC are in state B (see IEC 61851-1). — Wireless communication (WB) shall be successfully established.
6	Requirements	— The SECC may accept only one conductive pairing at a time. — Toggle sequence is defined in ISO 15118-20.
7	End conditions	Success end conditions: — The EV and the EV supply equipment are correctly paired. Failure end conditions: — ISO 15118-20 pairing protocol failed. — The EVCC does not receive any pairing authorization from the SECC. — The EV supply equipment doesn't receive the correct number of toggles. — Pairing failed.

7.7.4 WP4: WPT pairing

EV triggers pairing through messages described in ISO 15118-20[9]. Pairing mechanisms, out of scope of this document, are described in IEC 61980-2.

Table 20 — WPT pairing

No.	Type	Description
1	Use case element name	WPT pairing
2	Use case element ID	WP4
3	Objectives	The goal of this use case element is to start the pairing sequence in case of WPT.
4	Description	The EV and the EV supply equipment start to exchange synchronisation messages until both parties are ready to start the pairing sequence. Depending on the technology used, the pairing signal can be sent either by the EV or by the EV supply equipment. The receiving party processes the pairing signal and informs the emitting party whether the pairing signal processing is successful or not. The actors involved are: Primary actors: EV supply equipment, SECC, EV, EV supply equipment.
5	Prerequisites	— Fine positioning has been successfully done. — The EV is stopped and parked. — Wireless communication (WB) shall be successfully established. — Information on available pairing technologies has been exchanged.
6	Requirements	The compatibility with respect to the pairing technologies shall be checked just after the establishment of the wireless communication (WB).
7	End conditions	Success end conditions:

9) Under preparation. Stage at the time of publication: ISO/DIS 15118-20:2019.

Table 20 *(continued)*

No.	Type	Description
		— The EV and the EV supply equipment are correctly paired. Failure end conditions: — ISO 15118-20 paring protocol failed. — The EV or the EV supply equipment are not ready for pairing. — Pairing failed.

7.8 Target setting and energy transfer scheduling [E]

7.8.1 AC charging with load levelling based on HLC

Table 21 — AC charging with load levelling based on HLC

No.	Type	Description
1	Use case element name	AC charging with load levelling based on HLC
2	Use case element ID	E1
3	Objectives	This use case covers only charging (and not discharging) within a local charging site. Dynamic adjustment of the maximum AC current to be transferred to the EV within the limits of the local installation.
4	Description	The SECC and the EVCC exchange information about the AC current limits using HLC. The SECC communicates the maximum power that can be drawn from the outlet, in order to protect the EV supply equipment, to the EVCC. EXAMPLE Simple load levelling can be in a car park or at home, where not all AC power outlets can deliver full AC current and, therefore, need to dynamically adjust the maximum AC current that the EV can draw. The actors involved are: — Primary actors: USER, EV supply equipment, SECC.
5	Prerequisites	If the authorization according to use case elements D is applied, it shall be established successfully.
6	Requirements	— The EVCC shall ask for the maximum AC current limit from the SECC. — The SECC shall reply with the maximum allowed AC current per phase. — The EV shall not exceed the AC current limit. Trigger: — The charging authorization shall be completed and the EV shall be ready to retrieve energy.
7	End conditions	Success end conditions: — The EV supply equipment delivers the AC current within the maximum local installation limits. — The EV charges within the given local limits of the EV supply equipment. Failure end conditions: — The EV supply equipment does not deliver AC power due to contactor failure. — The current exceeds the max values of the EV supply equipment.

7.8.2 WE1: WPT target setting and charge scheduling

Table 22 — WPT target setting and charge scheduling

No.	Type	Description
1	Use case element name	WPT target setting and charge scheduling
2	Use case element ID	WE1
3	Objectives	This use case covers only charging within local charging site. Dynamic adjustment of the maximum wireless power transfer to be drawn by the EV within the limits of the local installation.
4	Description	The SECC and the EVCC exchange information about the wireless power transfer limits using HLC. The SECC communicates the maximum power that can be drawn from the WPT, in order to protect the EV supply equipment, to the EVCC. EXAMPLE Simple load levelling can be in a car park or at home, where not all WPT can deliver full wireless power and, therefore, need to dynamically adjust the maximum wireless power that the EV can draw. The actors involved are: USER, EV supply equipment, SECC.
5	Prerequisites	— If the authorization according to use case elements WD1 is applied, it shall be established successfully.
6	Requirements	— The EVCC shall ask for the maximum wireless power limit from the SECC. — The SECC shall reply with the maximum allowed wireless power. — The EV shall not exceed the wireless power limit. — Trigger: The charging authorization shall be completed and the EV shall be ready to retrieve energy.
7	End conditions	Success end conditions: — The EV supply equipment delivers wireless power within the maximum local installation limits. — The EV charges within the given local limits of the EV supply equipment. Failure end conditions: — The EV supply equipment does not deliver wireless power due to WPT failure.

7.8.3 Optimized charging with scheduling from secondary actors

Table 23 — Optimized charging with scheduling based on information from secondary actors

No.	Type	Description
1	Use case element name	Optimized charging with scheduling based on information from secondary actors
2	Use case element ID	E2
3	Objectives	Charging according to a schedule that was calculated by the EV based on information from secondary actors to optimize charging. Prognosis of the power drawn by the EV which can be dynamically adjusted.

Table 23 *(continued)*

No.	Type	Description
4	Description	This use case covers the charging process with information about local installation, grid schedule and sales tariff table. With this information, the EV supply equipment can dynamically react to changes in the supply chain to reduce peak demand or oversupply situations and communicate the new boundary conditions to the EV with the intention to calculate or change the charging schedule accordingly. Additionally, the predicted energy transfer schedule becomes accessible to secondary actors in order to enhance electricity supply scheduling. The secondary actors need to communicate to the SECC the actual information about the local installation (e.g. power limits, local power generation), grid schedule and sales tariff table. The involved actors are: — Primary actors: EV, EVCC, EV supply equipment, SECC. — Secondary actors: DCH, EMSP, EMS.
		Scenario descriptions: — The USER inputs e-mobility needs at the EV. — The EV calculates the required amount of energy needed in order to fully charge (kWh) the battery for the user-provided departure time. — The EVCC sends the required energy amount, departure time and charging capability of the EV to the SECC, which might forward it to a secondary actor. — The EV will calculate a charging plan and communicate it back to the EV supply equipment — The EV will start charging according to the actual limitation if it received the message content to enter the charging loop. NOTE 1 A secondary actor collects “Demand and prognosis”. (e.g. Local physical limits from the EV supply equipment, local power generation, grid schedule from the DCH, Sales tariff table from the EP or EMSP, local power optimisation from the EMS). This action might be performed prior to the charging event. NOTE 2 The relevant boundary conditions for each EV supply equipment are calculated by a secondary actor or the SECC.
5	Prerequisites	— If the authorization according to use case elements D is applied, it shall be established successfully.” — The SECC shall be able to forward information from/to the secondary actor. — Consideration of local installation limits shall be available.
6	Requirements	— The USER shall input his e-mobility needs to be included in the schedule. — The EVCC, the SECC and secondary actors can trigger a re-scheduling of the charging schedule. Trigger: — the authorization of charging has been completed and the EV is ready to retrieve energy; — the charging loop is established and one of the interrupts occurs; or — the EV is in a charging pause, e.g. state B according to IEC 61851-1, and the SECC has the necessity to renegotiate the charging schedule.

Table 23 *(continued)*

No.	Type	Description
7	End conditions	Success end conditions: — The EV will start charging according to the negotiated schedule. Failure end conditions: — The calculator does not calculate the required amount of charging (kWh) to meet the target. — A secondary actor does not collect the "Target set" and "Demand and prognosis" information. — A secondary actor or the SECC does not provide (new) boundary conditions. — The EV will not start charging.

7.8.4 DC charging with load levelling based on HLC

Table 24 — DC charging with load levelling based on HLC

No.	Type	Description
1	Use case element name	DC charging with load levelling based on HLC.
2	Use case element ID	E4
3	Objectives	Charging without considering complex grid situations and secondary actors. Dynamic adjustment of the maximum DC power to be drawn by the EV within the limits of the local installation.
4	Description	The EV supply equipment and the EV will exchange information about the DC power limits using HLC. The EV supply equipment will communicate the maximum DC power that can be drawn from the outlet in order to protect the supply equipment to the EV. The EV and the EV supply equipment exchange control information for the battery management system. The actors involved are: — Primary actors: EV, EVCC, EV supply equipment, SECC.
5	Prerequisites	— If the authorization according use case elements D is applied, it shall be established successfully. — Mode 4 charging (according to IEC 61851-1) shall be selected.
6	Requirements	— The EV shall ask for the maximum DC power, voltage and current limits from the EV supply equipment. — The EV supply equipment shall reply with the limits. — The EV shall provide information about demanded voltage and current. — The energy transfer loop will begin.
7	End conditions	Success end conditions:

Table 24 *(continued)*

No.	Type	Description
		— The EV supply equipment shall deliver DC power within the maximum local limits of installation. — The EV shall be charged within the given local limits of the EV supply equipment. — The EV supply equipment shall be able to deliver power until the user disconnects. Failure end conditions: — The EV supply equipment will not deliver DC power, due to contactor failure. — Negotiation between the EV and the EV supply equipment failed. — No power delivery from the EV supply equipment to the EV.

7.8.5 Resume to authorized charging schedule

Table 25 — Resume to authorized charging schedule

No.	Type	Description
1	Use case element name	Resume to authorized charging schedule
2	Use case element ID	E5
3	Objectives	Restart sleeping charging schedule.
4	Description	This use case covers the resume process to the once authorized and sleeping charging schedule. The actors involved are: — Primary actors: EV, EVCC, EV supply equipment, SECC. Scenario description: — Optimizing charging schedule often lead to pause or went-to-sleep status within the schedule. In case of a sleep status, the EVCC and the SECC are, in general, neither able to communicate to each other nor can be woken up by the counterpart. This depends on the communication technology used. Therefore, ISO 15118-3 provides means and concepts as to how the communication can be re-established from sleep mode, either from the EV or EV supply equipment side, depending on the physical layer used and IEC 61851-1-based concepts and requirements. — The wake-up trigger could be initiated either on the EV or EV supply equipment side. The entity which receives this initial trigger shall be able to wake up the counterpart according to ISO 15118-3. — HLC will be re-established and identification and authorization resumed securely. — The EVCC and/or SECC will recognise/receive information about the suspended charging schedule from the internal memory or the EMSP to share it between them. If both accept this suspended charging schedule, it will be resumed from the interrupted point.
5	Prerequisites	— The optimized charging schedule is already authorized in use cases E2. — The charging schedule is paused according use case element H1. — The EV and the EV supply equipment indicate sleep mode according to ISO 15118-3.

Table 25 *(continued)*

No.	Type	Description
6	Requirements	— Either the EV or the EV supply equipment gets an initial wake-up trigger at the restart time of the charging schedule. a. If the EV supply equipment gets the initial wake-up trigger, it shall wake up the EV/EVCC according to ISO 15118-3. b. If the EV gets the initial wake-up trigger, it shall wake up the EV supply equipment/SECC according to ISO 15118-3. — HLC shall be re-established and identification, authentication, authorization shall be ended successfully. — E2 shall be executed and lead to the same charging schedule as original agreed if the boundary conditions remain unchanged. — The charging process shall be re-started from the resume point.
7	End conditions	Success end conditions:
		— Information of the former suspended charging session is accepted by both the SECC and the EVCC and they agree to resume it. — The EVCC goes back to the suspended point of the charging schedule and restarts charging. Failure end conditions: — Wake up of counterpart was unsuccessful. — Information of the former session is not accepted by either the SECC, the EVCC or both. a. Negotiation of the charging schedule leads to different results and charging can be resumed according to the changed schedule. b. It is not possible to resume the charging process because one of the required intermediate use case elements leads to a failure end condition.

7.8.6 Reverse power transfer with load levelling based on HLC

Table 26 — Reverse power transfer with load levelling based on HLC

No.	Type	Description
1	Use case element name	Reverse power transfer with load levelling based on HLC
2	Use case element ID	E6
3	Objectives	This use case covers both AC and DC reverse power transfer. Dynamic adjustment of the maximum AC or DC current to be delivered by the EV within the limits of the local installation, and according to the request from the EMS through the EV power system.
4	Description	The SECC and the EVCC exchange information about the AC or DC current limits using high-level communication. The SECC communicates to the EVCC the maximum current that can be drawn from the outlet in order to protect the EV power system. The SECC also communicates to the EVCC the necessary current based on the request from the HEMS. Reverse power transfer will be scheduled including EMS requirements or demand request from the grid. NOTE High-level information cannot be in contradiction to the safety requirements defined in IEC 61851-1. This basic policy cannot have changes in any use cases, including reverse power transfer. The involved actors are:

Table 26 *(continued)*

No.	Type	Description
		— Primary actors: USER, EV supply equipment, SECC. — Secondary actors: EMS.
5	Prerequisites	— Control state agreement of C or D, given by IEC 61851-1:2017, Annex A, between EV and EV power system shall be established successfully.
6	Requirements	— The EVCC and the SECC exchange information about necessary AC or DC current and their limitations. — The EVCC and the SECC get a schedule of reverse power transfer. — In AC case the EVCC checks that the frequency of AC current flowing from the EV and the AC current frequency coming from grid are equal and synchronised. — Trigger: Control state agreement of C or D between the EV and the EV power system, including necessary preparation within the EV, the EV power system and the HEMS.
7	End conditions	Success end conditions: — The EV discharges AC or DC current within the maximum local limits of installation. — The EV discharges the requested AC or DC current within the local limits of the EV power system. Failure end conditions: — In case of AC the EVCC can't ensure that frequencies are synchronised between the grid and the EV. — The EV does not discharge AC or DC power due to no agreement of the RPT schedule.

7.8.7 Reverse power transfer on stand-alone operation

Table 27 — Reverse power transfer on stand-alone operation

No.	Type	Description
1	Use case element name	Reverse power transfer on stand-alone operation disconnected from the grid
2	Use case element ID	E7
3	Objectives	This use-case covers both AC and DC reverse power transfer on stand-alone operation, disconnected from the grid. In this type of situation information from the HEMS or the grid might be not available. In that case the EV will be considered as a voltage generator.
4	Description	The SECC and the EVCC exchange information about the AC or DC current limits using high-level communication. The SECC communicates to the EVCC the maximum power that can be drawn from the outlet in order to protect the EV power system. NOTE The high-level information cannot be in contradiction to the safety requirements defined in IEC 61851-1. This basic policy can have no changes in any use cases, including reverse power transfer. The involved actors are: — Primary actors: USER, EV supply equipment, SECC.
5	Prerequisites	— Control state agreement of C or D, given by IEC 61851-1:2017, Annex A, between the EV and the EV power system shall be established successfully. — The EV supply equipment shall be supplied by its own power supply independent of the grid (e.g. with an internal battery).

Table 27 *(continued)*

No.	Type	Description
6	Requirements	— The SECC, although not supplied by the grid, is able to operate safely and to communicate with the EVCC. — The EVCC and the SECC exchange information about the maximum AC or DC current and voltage. — For AC connections the SECC shall provide all necessary information to the EVCC to ensure that the technical requirements of the local grid code can be met. Where necessary this information will be updated dynamically during the charging loop. Trigger: — Control state agreement of C or D between EV and EV power system, including necessary preparation within EV, EV power system and HEMS.
7	End conditions	Success end conditions:
		— The EV discharges AC or DC current within the maximum local limits of installation. — The EV discharges within its own limitations. Failure end conditions: — The EV does not discharge AC or DC power due to no agreement of the RPT schedule.

7.8.8 Fast responding energy transfer services based on dynamic control mode

Table 28 — Fast responding energy transfer services based on dynamic control mode

No.	Type	Description
1	Use case element name	Fast responding services based on dynamic control mode
2	Use case element ID	E8
3	Objectives	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. Although using dynamic control mode, the SECC is also responsible for ensuring e-mobility needs (departure time; minimum and target energy request).
4	Description	The EV supply equipment and the EV will exchange information about the AC or DC power limits using HLC. The EV provides its mobility needs to the EV supply equipment before energy transfer. The EV will also provide the maximum and minimum energy request. The minimum and maximum energy requests define the usable/allowed battery range to ensure BPT services. The EVCC and the SECC will exchange their charging and discharging physical limitations (voltage, current, power). In case of AC, the EV supply equipment will communicate the nominal value of voltage and frequency of the local grid in order for the EV to verify its compatibility. NOTE High-level information cannot be in contradiction to the safety requirements defined in IEC 61851-1. The actors are: — Primary actors: EV, EVCC, EV supply equipment, SECC, USER. — Secondary actor: EMS, flexibility operator.

Table 28 *(continued)*

No.	Type	Description
		Scenario description: — The EVCC and the SECC exchange their physical limitations. — The EVCC sends to the SECC the user mobility needs. — The SECC transfers the user mobility needs to the EMS which will either take it into consideration or forward this information to the flexibility operator.
5	Prerequisites	— The EV and the EV supply equipment are able to support dynamic control mode. — The SECC has proposed dynamic control mode. — The EVCC has chosen dynamic control mode. — A valid contract exists between the user and the flexibility operator. — The user has configured the EV to select this dynamic control mode service either at this location or when offered. — If needed, the EV and the charging station, or the EV and the charging stations in contract with the flexibility operator, may have been certified as grid reserve providers. — The EV and the charging station, or the EV and the charging stations in contract with the flexibility operator, abide by the market rules.
6	Requirements	— The EVCC and the SECC shall exchange information about their physical limitations. — For AC connections the SECC shall provide all necessary information to the EVCC to ensure that the technical requirements of the local grid code can be met. Where necessary this information will be updated dynamically during the charging loop. — The SECC shall transfer the mobility needs to the appropriate SA. — The SECC and SAs shall give preference to user mobility needs over system and grid services. — The SECC and SAs shall comply with physical limitations and energy minimum/maximum range defined by the user or the EV. — If a contract with a flexibility operator has been mentioned during identification phases, then the contract shall be validated by the flexibility operator before the energy transfer starts.
7	End conditions	<u>Success conditions:</u> — The EV will start charging and/or discharging AC or DC current abiding by the SECC power request. — The EV will start charging and/or discharging AC or DC current within the maximum limits of local installation and EV conditions <u>Failure end conditions:</u> — Based on the voltage and frequency nominal value of the local grid, the EVCC will evaluate its compatibility and end session if it is not compatible. — The EV will not start charging or discharging. — The contract with flexibility operator has not been validated.

7.8.9 Managed bidirectional power transfer into the grid and/or into the home

Table 29 — Managed bidirectional power transfer into the grid and/or into the home

No.	Type	Description
1	Business use case	Managed bidirectional power transfer into the grid and/or into the home
2	Use case ID	E9
3	Objectives	Bidirectional power transfer into the grid and/or into the home based on messages sent by the local EMS and the EV. This use case is an illustration of how negotiation and re-negotiation take place in the context of BPT and what are the requirements attached.
4	Description	A group of EVs (could be one) are plugged-in at a group of EV supply equipment (could be one) and have established a successful HLC. The EV supply equipment are supplied through a grid delivery point and the total energy is managed by an EMS able to receive messages from the DSO or from a flexibility operator (if any) in order to offer ancillary services to the grid. The EMS may also be in charge of optimizing local production. The EMS is continuously optimizing the consumption and production based on constraints and/or incentives received from the DSO, from its flexibility operator or local DER or energy prices. For example, the DSO may regularly send to the EMS a certain bidirectional profile of maximum power during a specific duration, starting at certain time. The EMS may also receive price-related information for consuming from and feeding back energy into the grid. As other local DER may participate in this transfer it is up to the EMS to decide whether to allocate all or only a part of the energy to be exchanged with the grid from or to the EV batteries. Another DER for example may be an EV itself. In this case the EV may send a certain bidirectional profile of maximum power during a specific duration, starting at a certain time to the EMS. If available, also including price-related information for feeding back energy into the infrastructure. The EMS then calculates the aggregated maximum power profile (positive or negative) that all EVs should transfer and informs periodically the SECCs of this demand. If available, the EMS also communicates prices for energy (consuming and feeding back) to the SECCs. NOTE 1 The way and form of messages used by the EMS to inform the SECC is out of scope of the ISO 15118 series. For example, it could be through a communication channel with the CSO. In that case the CSO would distribute the available power among all EVs depending on their e-mobility needs and contracts. NOTE 2 If possible and needed, the EMS, via the CSO, can need to ask an existing e-mobility clearing house if the contracts signed between the users and the flexibility operators can be accepted by the flexibility operator having a contract with the premise energy operator operating the EMS. NOTE 3 The EMS, before sending the information to each SECC, can modify the power, the duration and the starting date originally received in order to adapt them to grid codes, local constraints or market opportunities. The SECCs, notified by the EMS via the CSO, send a renegotiation message to the EVCCs in order to initiate the exchange of information related to mobility needs, new target settings, scheduling and tariffs. Equivalent to the SECC, the EVCC, notified by an EV internal trigger (changed mobility needs, new target settings, etc.), can trigger a renegotiation. After the renegotiation is successfully done, SECCs inform the EMS of the actual scheduling of the bidirectional power transfers. If needed, the EMS may decide to allocate new resources. During and after the bidirectional power transfer sequences, the energy transferred needs to be measured in order to establish the reality of the transfer and ensure traceability of the transactions.

Table 29 *(continued)*

No.	Type	Description
		Measurements can be done in the EV, the EV supply equipment or both. Eventually, an SDR is issued by the EV supply equipment in order to notify the users and other SAs of the energy transferred. The SDR shall reflect the details of energy transfers and may use information from the EV in case the EV supply equipment does not have access to all measurements. Measurement parameters like period and precision depend on local regulations and have been communicated by the appropriate SA to the SECC before the BPT session. The actors involved are:
		— Primary actors: EV, EVCC, EV supply equipment, SECC. — Secondary actors: EMS, DSO, CSO, flexibility operator(s), e-mobility clearing house, EMSP, user.
5	Prerequisites	— The users or the building energy operator or both have valid contracts with one or more flexibility operators for transferring energy in the grid. — The EV supply equipment are certified by the local authority (e.g. DSO) to inject energy into the grid. Certification may depend on the local grid and safety codes. — The EVCCs are engaged in a successful ISO 15118 HLC session with the SECCs with whom they have exchanged information about their EMSP contract. — Consideration of local installation limits shall be available.
6	Requirements	— The users shall input their e-mobility needs. — EVCCs and SECCs shall exchange information about their bidirectional physical limitations. — EVCCs and SECCs shall exchange information about availability of energy (power over time) and prices for consuming energy or feeding back energy (price for power over time). NOTE 4 The prices for feeding energy into the system can be set by the sources of energy themselves. That means, that the prices for consuming energy from the grid can be set and communicated by the energy actors (communication channel and protocols are out of scope of this document). The prices for feeding back energy from an EV into the system can be set (directly or indirectly) and communicated by the EV. In that case the communication channel can be the ISO 15118 HLC between the EV and the EV supply Equipment — 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. — All EV supply equipment shall measure the energy effectively transferred to the grid, taking into account local grid codes and flexibility contract measurement requirements. — EVs may check the energy measured by the EV supply equipment. — If required, the EV supply equipment 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 the EMS. The SDR shall be signed and encrypted by the EV supply equipment. It may be checked by the EV.

Table 29 *(continued)*

No.	Type	Description
		Triggers: — The authorization of discharging has been completed and EVs are ready to transfer energy. — The charging loop is established and one of the interrupts occurs and the SECC or the EVCC has the necessity to renegotiate. If the result of the renegotiation is a bidirectional service then this use case can start.
7	End conditions	Success end conditions: — The EV supply equipment is transferring power within the maximum local limits of installation and according the conditions agreed during the renegotiations. — EVs will be charged according the mobility needs of the users. Failure end conditions: — The EV supply equipment is not able to transfer power due to contactor failure. — Negotiation between the EV and the EV supply equipment failed. — No power transfer between the EV supply equipment and the EV. — Flexibility contracts can't be assessed as valid by the SAs.

7.9 Energy transfer controlling and re-scheduling [F]

7.9.1 Energy transfer loop

Table 30 — Energy transfer loop

No.	Type	Description
1	Use case element name	Energy transfer loop
2	Use case element ID	F0
3	Objectives	Continue energy transfer process until success conditions reached and enable billing of transferred energy.
4	Description	This use case covers the basic energy transfer loop. The following information needs to be exchanged between the actors: The actors involved are: — Primary actors: EV, EVCC, EV supply equipment, SECC. From the EVCC to the SECC: EV status (as stipulated in ISO 15118-2 or ISO 15118-20). From the SECC to the EVCC: EV supply equipment status (e.g. maximum current, as stipulated in ISO 15118-2 or ISO 15118-20).
5	Prerequisites	— E1, E2, E4, E5, E6 or E7 target setting or energy transfer scheduling use cases shall be successfully established. — The energy transfer loop shall be active.
6	Requirements	— The EVCC shall send the SECC the current status in a specified time frame according to ISO 15118-2 or ISO 15118-20. — The SECC shall reply with no interrupt flag. — The EVCC and the SECC shall comply with traceability requirements.
7	End conditions	Success end conditions:

Table 30 *(continued)*

No.	Type	Description
		— The energy transfer loop continues. Failure end conditions: — The energy transfer loop will be stopped. — The energy transfer loop is terminated due to traceability check fails.

7.9.2 Energy transfer loop with metering information exchange

Table 31 — Energy transfer loop with metering information exchange

No.	Type	Description
1	Use case element name	Energy transfer loop with metering information exchange
2	Use case element ID	F1
3	Objectives	Continue the energy transfer process until success conditions are reached and enable billing of transferred energy.
4	Description	This use case covers the basic energy transfer loop with meter reading. For reliable control of the energy transferred, all SAs involved shall be able to prove that energy was transferred to or from a specific EV/customer. It is therefore mandatory for an EV to confirm that energy was transferred at a certain time and from or to a certain EV supply equipment. With respect to the communication between the EVCC and the SECC, one possibility is that the vehicle signs the meter readings from the SECC to confirm the reception of the meter record. The vehicle may perform a plausibility check between the EV supply equipment measured energy amount and the transferred energy amount to validate if there is an unexpected high-energy loss during the energy transfer process. The actors involved are: — Primary actors: EV, EVCC, EV supply equipment, SECC. As stipulated in ISO 15118-2 or ISO 15118-20, the following information shall be exchanged between the actors: From the EVCC to the SECC: EV status, signed meter reading. From the SECC to the EVCC: EV supply equipment status, meter reading.
5	Prerequisites	— Target setting or energy transfer scheduling according to use case elements E1, E2, E6 or E7 shall be established successfully. — The energy transfer loop shall be active.
6	Requirements	— The EVCC shall send the SECC the current status in a specified time frame according to ISO 15118-2 or ISO 15118-20. — The SECC shall reply with no interrupt flag. — The SECC shall send a meter readout to the EVCC for signing. — The SECC shall send the signed meter readout to the EMSP. — The EVCC and the SECC shall comply with traceability requirements. — For AC connections, if no meter reading is provided during the charging loop control then the EV may stop immediately any reverse power flow.
7	End conditions	Success end conditions:

Table 31 *(continued)*

No.	Type	Description
		— The EVCC receives the metering information and creates a signature for it. — The SECC receives the signature of the metering information. — The energy transfer loop continues. Failure end conditions: — The validation of the information fails, e.g. the delivered energy amount is different from the received energy amount. — The SECC has not received the signed meter reading for a certain period or for a pre-specified amount of energy. — The EV supply equipment stops energy transfer as the EVCC validation was not received. — The energy transfer loop is terminated due to traceability check fails. — The energy transfer loop will be stopped.

7.9.3 WF1: WPT charging loop

Table 32 — WPT charging loop

No.	Type	Description
1	Use case element name	WPT charging loop.
2	Use case element ID	WF1
3	Objectives	Continue the charging process until success conditions are reached and enable billing of transferred energy.
4	Description	This use case covers the basic energy transfer loop. The following information shall be exchanged between the actors: The actors involved are: — Primary actors: EV, EVCC, EV supply equipment, SECC. From the EVCC to the SECC: EV status (as stipulated in ISO 15118-20). From the SECC to the EVCC: EV supply equipment status (e.g. maximum wireless power, as stipulated in ISO 15118-20).
5	Prerequisites	— Target setting or charging scheduling according to use case elements WE shall be established successfully. — The energy transfer loop shall be active.
6	Requirements	— The EVCC shall send the SECC the current status in a specified time frame according to ISO 15118-20. — The SECC shall reply with no interrupt flag. — The EVCC and the SECC shall comply with traceability requirements.
7	End conditions	Success end conditions: — The energy transfer loop continues. Failure end conditions: — The energy transfer loop will be stopped. — The energy transfer loop is terminated due to traceability check fails.

7.9.4 Energy transfer loop with interrupt from the SECC

Table 33 — Energy transfer loop with interrupt from the SECC

No.	Type	Description
1	Use case element name	Energy transfer loop with interrupt from the the SECC
2	Use case element ID	F2
3	Objectives	Continue the energy transfer process until the SECC interrupts the energy transfer loop.
4	Description	The EVCC is the “client” and always requests information from the SECC. If an SECC wants to interrupt the energy transfer loop, for example with an updated charging schedule or new set-point for the load levelling, then this use case will describe the process. The actors involved are: — Primary actors: EV, EVCC, EV supply equipment, SECC. The following information shall be exchanged between the actors: From the EVCC to the SECC: EV status (as stipulated in ISO 15118-2 or ISO 15118-20). From the SECC to the EVCC: EV supply equipment status (as stipulated in ISO 15118-2 or ISO 15118-20), SECC interrupt, new departure time provided by the USER. NOTE In case of a new departure time set by the USER and transmitted by the SECC, the corresponding SA takes care of a secured way of transmission.
5	Prerequisites	— Target setting or energy transfer scheduling according to use case elements of E shall be established successfully. — The energy transfer loop shall be active.
6	Requirements	— The SECC shall send the EVCC the current status in a specified time frame according to ISO 15118-2 or ISO 15118-20. — The energy transfer process interrupt flag set by the SECC/secondary actor. — The EVCC shall initialize the energy transfer set-up process again. — The EVCC and the SECC shall comply with traceability requirements.
7	End conditions	<u>Success end conditions:</u> — The energy transfer loop interrupt occurred and either the energy transfer set-up or end of energy transfer process starts. <u>Failure end conditions:</u> — The energy transfer loop does not start again. — The energy transfer loop is terminated due to traceability check fails.

7.9.5 Energy transfer loop with interrupt from the EVCC or USER

Table 34 — Energy transfer loop with interrupt from the EVCC or USER

No.	Type	Description
1	Use case element name	Energy transfer loop with interrupt from the EVCC or USER
2	Use case element ID	F3
3	Objectives	Possibility for the EVCC or USER to interrupt the energy transfer loop.

Table 34 *(continued)*

No.	Type	Description
4	Description	The EVCC or the USER interrupts the energy transfer process when e.g. the energy transfer schedule changes or an unpredictable event in the EV occurs or the USER returns and wants to leave. The actors involved are: — Primary actors: EV, EVCC, EV supply equipment, SECC, USER.
		This use case covers the basic energy transfer loop with interrupt from the EVCC or USER. — The EVCC shall send an EV status in a specified time frame according to ISO 15118-2 or ISO 15118-20. — The SECC shall reply with an EV supply equipment status in a specified time frame according to ISO 15118-2 or ISO 15118-20. — The EV will continue either with the energy transfer set-up process or with the end of the energy transfer process. As stipulated in ISO 15118-2 or ISO 15118-20, the following information shall be exchanged between the actors: From the EVCC to the SECC: EV status, EVCC Interrupt, new departure time. From the SECC to the EVCC: EV supply equipment status.
5	Prerequisites	— Target setting or energy transfer scheduling according to use case elements of E shall be established successfully. — The energy transfer loop shall be active.
6	Requirements	— The EVCC shall send the SECC the current status in a specified time frame according to ISO 15118-2 or ISO 15118-20. — The SECC shall reply in a specified time frame according to ISO 15118-2 or ISO 15118-20. — The EV or the USER shall re-schedule or terminate the energy transfer process. — The EVCC and the SECC shall comply with traceability requirements.
7	End conditions	Success end conditions: — The energy transfer loop interrupt occurred and either the energy transfer set-up or end-of-energy transfer process starts. Failure end conditions: — The energy transfer process does not start again. — The energy transfer loop is terminated due to traceability check fails.

7.9.6 Energy transfer control based on dynamic control mode

Table 35 — Energy transfer control based on dynamic control mode

No.	Type	Description
1	Use case element name	Energy transfer control based on dynamic control mode
2	Use case element ID	F4
3	Objectives	Continue the energy transfer process until success conditions are reached and enable fast responding services to the grid.

Table 35 *(continued)*

No.	Type	Description
4	Description	This use case covers both the AC and DC energy transfer loop. It covers also services related to reactive power compensation. This use case describes the situation where the SECC controls the amount of active and reactive power to be transferred during the energy transfer loop. The power shall be within the boundaries and target defined in E8 use case element. If not, the loop breaks and goes to end conditions. During the loop the SECC may change the power boundaries and the active and/or reactive power targets based on SA requirements and mobility needs. the EVCC will make its best efforts to follow the changes or break the loop if it is not possible to follow the new conditions specially according to mobility needs. During the charging loop, the EV may change the current and power boundaries. The SECC adapts its targets based on the information provided by the EVCC. During the loop, the EVCC updates its energy requests in relation with mobility needs. For example, if the EV is transferring energy to the grid, the total amount of energy needed to comply with mobility needs will increase. The involved actors are: — Primary actors: EV, EVCC, EV supply equipment, SECC. — Secondary actors: user, EMS, energy actors like EMS, DSO or flexibility operator.
5	Prerequisites	— Target setting or bidirectional power transfer based on dynamic control mode according to use case element E6 shall be established successfully. — The bidirectional power transfer loop shall be active.
6	Requirements	— The performance time and timeouts for the bidirectional power transfer loop messages in dynamic control mode shall be parameterized in order to ensure fast responding services. — During the control loop the EV and the EV supply equipment shall take into account all relevant local grid codes and if applicable, shall conform to EN 50549-1. — In case of three-phase energy transfer, the EV shall make its best efforts to balance the power among the three phases. — The EVCC and the SECC shall comply with traceability requirements. — In case of AC and if a dual channel architecture is used, the EVCC shall indicate the power flow direction to the SECC. The SECC is then able to perform the relevant contactor control by HLC. — In case of DC, the SECC should indicate to the EVCC the present current and voltage value. — In case of AC, the SECC should indicate to the EVCC the target set point of active and reactive power. — The SECC shall send an element to inform the EV that channel configuration (dual or single channel) change is ongoing or finished.
7	End conditions	Success end conditions:

Table 35 *(continued)*

No.	Type	Description
		— Bidirectional power transfer is done with appropriate active power and reactive power exchanges. Failure end conditions: — Bidirectional power transfer is done with inappropriate active power and reactive power exchanges. — Bidirectional power transfer loop messages have not been sent within timeouts defined in ISO 15118-20. — The energy transfer loop is terminated due to traceability check fails.

7.10 Value-added services [G]

7.10.1 Value-added services

Table 36 — Value-added services

No.	Type	Description
1	Use case element name	Value-added services
2	Use case element ID	G1
3	Objectives	VAS information exchange between the EVCC and the SECC.
4	Description	Optional services that may connect to the local network domain (EV supply equipment) or the internet using IP protocols. In addition to the function of pure charging of electric vehicles, which are described in the various use case elements, additional value-added services to maximize the customer convenience may arise in future applications and environments. EXAMPLE Reservation of a public charging site, spots availability along the journey, required energy for next usage. Scenario description: — The OEM or user requests VAS. — The SECC requests service from the EVCC. — The SECC routes information.
5	Prerequisites	— If required a suitable authorization method needs to be applied prior to using VAS. — The SECC should be online. — The EV and the EV supply equipment are capable of enabling value-added services in general.
6	Requirements	The EV supply equipment shall offer the value-added service. Trigger: — The USER has to request information.
7	End conditions	Success end conditions: — The USER or the secondary actor receives the requested information. Failure end conditions: — The USER or the secondary actor does not receive the requested information.

7.10.2 WG1: ACD system status check

This use case element is a selectable service where the EV/EV supply equipment can check the system status before, during and after energy transfer in parallel to the energy transfer procedure.

Table 37 — ACD system status check

1	Use case element name	ACD system status check
2	Use case element ID	WG1
3	Objectives	For the EV/EV supply equipment to check the system status at all times after establishment of HLC so that there will be no damage to both the EV and EV supply equipment due to unexpected conditions before/during/after the energy transfer process.
4	Description	This use case is a service which when selected will run in parallel to the energy transfer process. The actors involved are: — Primary actors: EV, EVCC EV supply equipment, SECC. Basic elementary use case description: — After HLC establishment, the EV can select the additional service which performs constant checking on the system status. — If the energy transfer involves ACD, the EV has to select the system status service, and can only charge or discharge at an EV supply equipment which provides this service. — The system status service may be used as soon as it was selected. — If selected, the EVCC shall support the system status service throughout the whole energy transfer process. — Messages are exchanged between the EVCC and the SECC to query and report on its system status. If an error occurs during checking of the system status, the energy transfer process shall be aborted. — In case of safety errors handled by another channel than ISO 15118 (e.g. IEC 61851-1 pilot wire) HLC is used only to inform communication controllers of the new state reached after the error.
5	Prerequisites	— HLC is established. — The system status service is offered by the EV supply equipment and selected by the EV.
6	Requirements	— If selected, the EVCC shall support the system status service throughout the whole energy transfer process. — Messages are exchanged between the EVCC and the SECC to query and report on its system status. If an error occurs during checking of the system status, the energy transfer process shall be aborted. Trigger — The EV initiates the system status service.
7	End conditions	Success end conditions: — The system status is reported whenever a query is made throughout the energy transfer procedure. Failure end conditions: — Either the EV or the EV supply equipment is not able to provide the system status service at any point of time after it is selected before the energy transfer procedure has ended.

7.10.3 Energy transfer details

Table 38 — Energy transfer details

No.	Type	Description
1	Use case element name	Energy transfer details
2	Use case element ID	G2
3	Objectives	Information supply of current energy transfer process to the vehicle user or secondary actor.
4	Description	This use case covers the exchange of information regarding the current energy transfer process to the SECC. Parameters like battery status and state of charge could be provided for the SECC. The SECC or secondary actor, aware of the status of its energy transfer process, delivers information to the vehicle user. The actors involved are: — Primary actors: EV, EVCC, EV supply equipment, SECC, HMI. Scenario Description: — An SDR is requested. — The SECC requests a record from the EVCC. — The EVCC sends the record to the SECC after the request is accepted. — The SECC provides information for the secondary actor or HMI. The following information needs to be exchanged between the actors: From the EVCC to the SECC: EV charging and discharging details according to the requested list. It shall be indicated if the requested information is not available from the EV side. From the SECC to the EVCC: Authorization to request energy transfer details, list of requested energy transfer details.
5	Prerequisites	— Target setting or energy transfer scheduling according to use case elements of E shall be established successfully. — The energy transfer loop shall be active. — The EV is capable of delivering energy transfer details.
6	Requirements	— The USER/HMI or secondary actor has requested information. — The EVCC and the SECC shall comply with traceability requirements.
7	End conditions	Success end conditions: — The USER or secondary actor receives the requested information. Failure end conditions: — The USER or secondary actor does not receive the requested information.

7.11 End of energy transfer process [H]

7.11.1 General

The EVCC should end the energy transfer process by sending a request to the SECC and the SECC should respond by switching off the power in case of charging and releasing the locking feature (if implemented). All or single steps of this shutdown sequence may only be necessary if the energy transfer process is still in progress when the user initiates the end of the process.

If the system is equipped with a locking feature and it has been activated at least once during the current energy transfer session, it shall not be deactivated before the state transition from “C” (or “D”) to “B” according to IEC 61851-1 occurs.

NOTE If the physical connection between the EV and the EV supply equipment is impaired by an unexpected disconnect or other error, impacting the electrical safety of the energy transfer system, the procedures of IEC 61851–1 apply.

7.11.2 End of energy transfer process

Table 39 — End of energy transfer process

No.	Type	Description
1	Use case element name	Ending energy transfer process
2	Use case element ID	H1
3	Objectives	Closing down the energy transfer process in a safe and secure way whilst exchanging all relevant information required for subsequent procedures.
4	Description	This use case covers the basic ending energy transfer process. The actors involved are: — Primary actors: EV, EVCC, EV supply equipment, SECC, USER Basic elementary use case description: — The USER returns to the EV or EV supply equipment and initiates the end of energy transfer process. — Usually the USER requests the end of the energy transfer process on the EV side and the EVCC will tell the SECC that the energy transfer process will end. — For specific scenarios where the USER is indicating this on the EV supply equipment side, e.g. using authentication by alternative means, the SECC will request the EVCC to end the energy transfer process. NOTE 1 The SECC Indicates the end of the charging session by setting the notification parameter according to ISO 15118-2 or ISO 15118-20. — The EV switches to state B according to IEC 61851-1. — The EV supply equipment opens main switches according to IEC 61851-1. — If an SDR is generated on the EV supply equipment side, it will be transferred to authorized secondary actors. — If applicable, the EV supply equipment releases the connector on the EV supply equipment as soon as it detects state A according to IEC 61851-1. Between the EVCC and the SECC the information end energy transfer process is exchanged. NOTE 2 The exact sequence and nature of each step depends on the preceding use cases.
5	Prerequisites	Charge controlling and re-scheduling according to use case elements F2 or F3 or F4 shall be established successfully; or End of energy transfer according to conditions defined in ISO 15118-2 or ISO 15118-20.
6	Requirements	The SDR may be generated according to traceability requirements and sent to authorized secondary actors. Trigger: The energy transfer loop shall be completed. The USER, the EV supply equipment or the EV initiates the end of energy transfer process.

Table 39 *(continued)*

No.	Type	Description
7	End conditions	Success end conditions:
		— The process is terminated and the billing procedure is terminated normally. — The SDR is sent to the authorized SA. Failure end conditions: — The procedure is not terminated normally and information is lost. — The EV does not respect the indication of the EV supply equipment and the sequence as for IEC 61851-1:2017, Annex A.

7.12 WPT end of charge WH1

7.12.1 General

The EVCC should end the charging process by sending a request to the SECC and the SECC should respond by switching off the power and releasing the locking feature (if implemented). All or single steps of this shutdown sequence may only be necessary if the charge process is still in progress when the user initiates the end of the process.

If the system is equipped with a (wheel) locking feature and it has been activated at least once during the current charging session, it shall not be deactivated before the state transition from “WPT_S_STO” to “WPT_S_SB” according to IEC 61980-2.

NOTE If the physical connection between the EV and the EV supply equipment is impaired by an unexpected unlock or other error, impacting the electrical safety of the charging system, the procedures of IEC 61980-2 apply.

7.12.2 WPT end of charge WH1

Table 40 — WPT end of charge

1	Use case element name	WPT end of charge
2	Use case element ID	WH1
3	Objectives	Closing down the charging process in a safe and secure way whilst exchanging all relevant information required for subsequent procedures.
4	Description	This use case covers the basic ending charging process. The actors involved are: — Primary actors: EV, EVCC, EV supply equipment, SECC, USER Basic elementary use case description:

Table 40 *(continued)*

1	Use case element name	WPT end of charge
		— The user returns to the EV or the EV supply equipment and initiate ending the charge process. — Usually the user requests the end of the charging process on the EV side and the EVCC will tell the SECC that the charging process will end. — For specific scenarios where the user is indicating this on the EV supply equipment side, e.g. using authentication by alternative means the SECC will request the EVCC to end the charging process. — For indicating the end of a charging session the SECC would use the value StopCharging in the EVSENotificationType according to ISO 15118-20. — The EV sends the power delivery request with termination parameter according to ISO 15118-20. — The EV supply equipment switches off wireless power transfer according to IEC 61980-2. — The SDR is generated on the EV supply equipment side. This may be transferred to authorize secondary actors. — If applicable, the EV supply equipment releases the EV (wheel) lock. The EVCC and the SECC exchange the information of end of charge. NOTE The exact sequence and nature of each step depends on the preceding use cases.
5	Prerequisites	Charge controlling and re-scheduling according to use case elements WF shall be established successfully; or End of charging according conditions defined in ISO 15118-20.
6	Requirements	The SDR shall be generated according to traceability requirements and sent to authorized secondary actors. Trigger: — The charging loop shall be completed. — The user, the EV supply equipment or the EV initiates the end of charge process.
7	End conditions	Success end conditions: — The billing procedure is terminated normally. — The SDR is sent to authorized SAs. Failure end conditions: — The procedure is not terminated normally and information is lost. — The EV supply equipment will not deliver power, due to WPT failure.

7.13 ACD connect/disconnect WI

7.13.1 ACD connect/disconnect WI

Table 41 — ACD connect/disconnect WI

No.	Type	Description
1	Use case element name	ACD connect/disconnect
2	Use case element ID	WI
3	Objectives	To use HLC over wireless communication for connecting and disconnecting charging devices between the EV and the EV supply equipment.
4	Description	This use case covers the procedure of connecting and disconnecting charging devices after the establishment of HLC without USER intervention. The actors involved are: — Primary actors: EV, EVCC EV supply equipment, SECC. Basic elementary use case description: — The EVCC and the SECC exchange parameters for charging devices to ensure interoperability. — When the charging device/methods parameter matches, the EV requests the EV supply equipment through the EVCC and the SECC to start an ACD connection process. — The EVCC and the SECC exchange messages during the connecting procedure until the charge device is successfully connected so that the energy transfer procedure can proceed. — At the end of power transfer, the EV requests the EV supply equipment through the EVCC and the SECC to start the ACD disconnection process. — The EVCC and the SECC exchange messages during the disconnection procedure till the charging device is successfully disconnected and the EV can leave the charging site.
5	Prerequisites	— HLC is established. — The EVCC initiates the service to check the system status.
6	Requirements	Trigger: — The charging device type fits between the EV and the EV supply equipment. — The EVCC initiates connect/disconnect requests by sending the corresponding message to the SECC.
7	End conditions	<u>Success end conditions:</u> — The charge device is connected/disconnected successfully. <u>Failure end conditions:</u> — The charge device is not connected. — Loss of HLC terminates the connecting/disconnecting procedure. — The ACD doesn’t reach within appropriate time its home position.

Annex A
(informative)

Conductive charging infrastructure architecture

A.1 Overview

A.1.1 General information

For setting up an intelligent charging infrastructure, the topology of power distribution, control pilot handling, distribution of control logic, contactors and PLC modems can be divided into three major subgroups.

As a basis for further discussions and documents, this annex summarizes these topologies and discusses their typical application, requirements, advantages and challenges.

A.1.2 Assumptions

This annex assumes that all the topologies described use an individual control pilot wire between the EV supply equipment and the EV, according to SAE J1772 and IEC 61851-1:2017, Annex A.

This annex assumes that PLC according to ISO 15118-3 is used. A corresponding annex with wireless communication may be added later on during the draft edition process.

The PLC connection will not focus on a specific technology. However, for each topology attention needs to be given to the signal travel paths and the dimensions of the commonly used physical media.

Any individual network node, within a common physical medium, is part of the same collision domain, which means sharing the whole bandwidth with all other network nodes in the same collision domain.

Whenever the term “electric vehicle” is used, an electric vehicle with integrated PLC communication is assumed, e.g. EVCC and PLC.

The systems will be compatible with existing and future HANs and LANs.

A.1.3 Applicable symbols

The table below specifies symbols with its associated description.

Table A.1 — Applicable symbols

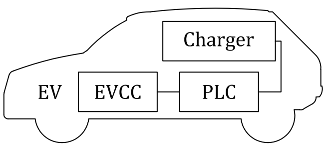
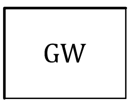
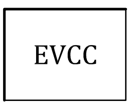
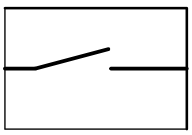
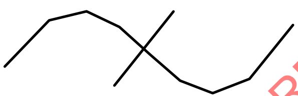
Symbol	Description
	EV with integrated application layer implementation, PLC interface and AC charger.
	Application layer gateway, which terminates an application layer protocol and interfaces to another application layer protocol.
	Electric vehicle communication controller, e.g. instance which is implementing the application layer according to ISO 15118-2 or ISO 15118-20.

Table A.1 *(continued)*

Symbol	Description
SECC	Supply equipment communication controller, e.g. instance which is implementing the application layer according to ISO 15118-2 or ISO 15118-20.
Secondary actor	Application layer implementation on the secondary actor side, to interface with the application layer implementation of the gateway.
SECC / Intelligent control unit	Supply equipment communication controller integrated in a detached intelligent control unit, which provides secondary actor data.
Router	Router that separates IP subnets. If dashed lines are used it is optional.
PLC / Bridge	PLC to HAN, LAN or other physical layer converter. Bridge performs MAC addressing.
Filter	Optional filter device to eliminate/reduce electromagnetic emissions, see ISO 15118-3 for details. This may break the PLC communication.
Pilot control	Entity performing the control pilot handling according to IEC 61851-1.
	Contactor to switch charging power to the charging coupler.
	PLC bypass and PWM filter device.
	Control pilot and PLC communication line if PLC is used “in line”.
	Optional control flow between the EV supply equipment controller and entities related to the ISO 15118 series.
	Power distribution and PLC communication line if PLC is used via mains.
	Local transmission media between the PLC bridge and the SECC, or the GW, which may be inside a circuit board if the PLC chip and the SECC or the GW are on the same circuit board; it may be a HAN if the PLC bridge is connected to the SECC using a HAN installation.
	Line identifying the communication counterparts on the same application layer, e.g. an application layer session is established between the two entities. An application layer gateway divides such a communication path into two sides, one using an application layer 1 and another using an application layer 2.

A.1.4 Network characteristics

There are two communication paths:

— EVCC ↔ SECC

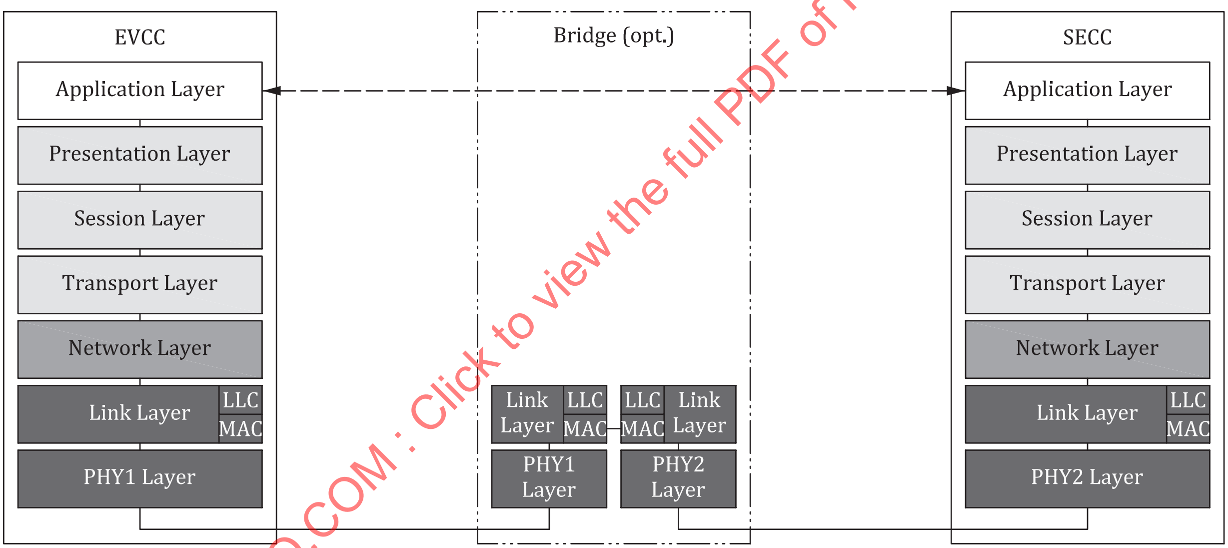
— SECC ↔ Secondary actor

NOTE Communication between the EVCC and the SA is out of the scope of this document.

Although the SECC to secondary actor communication is outside the scope of the ISO 15118 series, some ISO 15118 messages require this communication, and thus the ISO 15118 series will specify some requirements to ensure the interoperability between the EVCC and the secondary actor.

Depending on the system architecture, these communication paths involve different components for establishing and maintaining communication. The drawings are intended for outlining the most general cases. If all of the components shown are separately present in a specific implementation, it is up to the OEM and the EV supply equipment supplier.

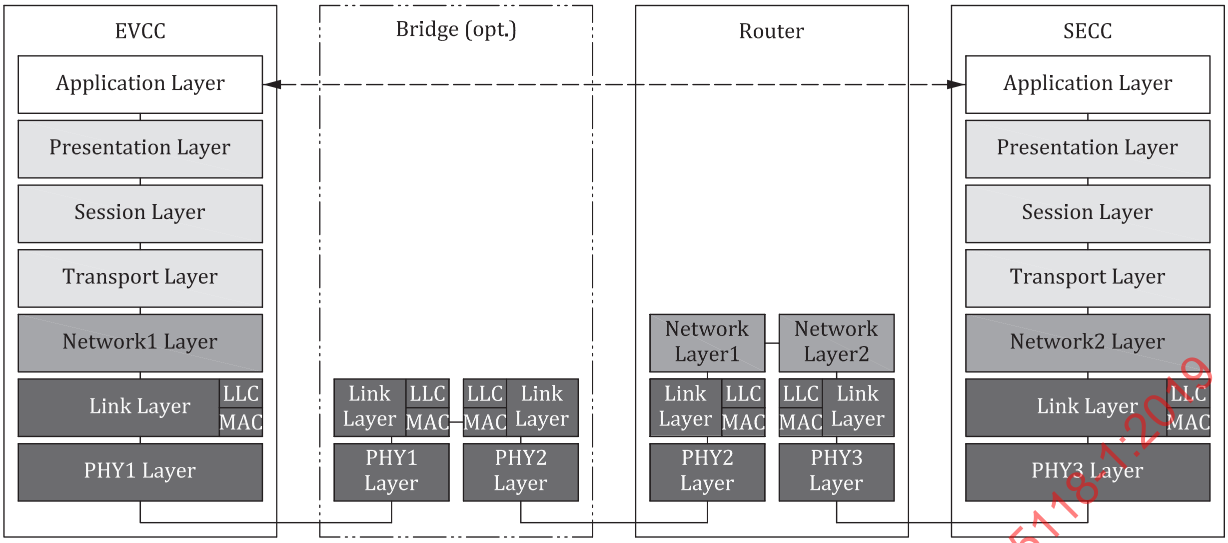
Communication between the EVCC and the SECC can be divided into two set-ups, depending on whether the SECC is "local" (Figure A.1) to the EVCC or "remote" (Figure A.2).



Key

◄- - - - -► end-to-end communication of application
MAC media access control
LLC logical link connection

Figure A.1 — EVCC to SECC communication in a "local" set-up



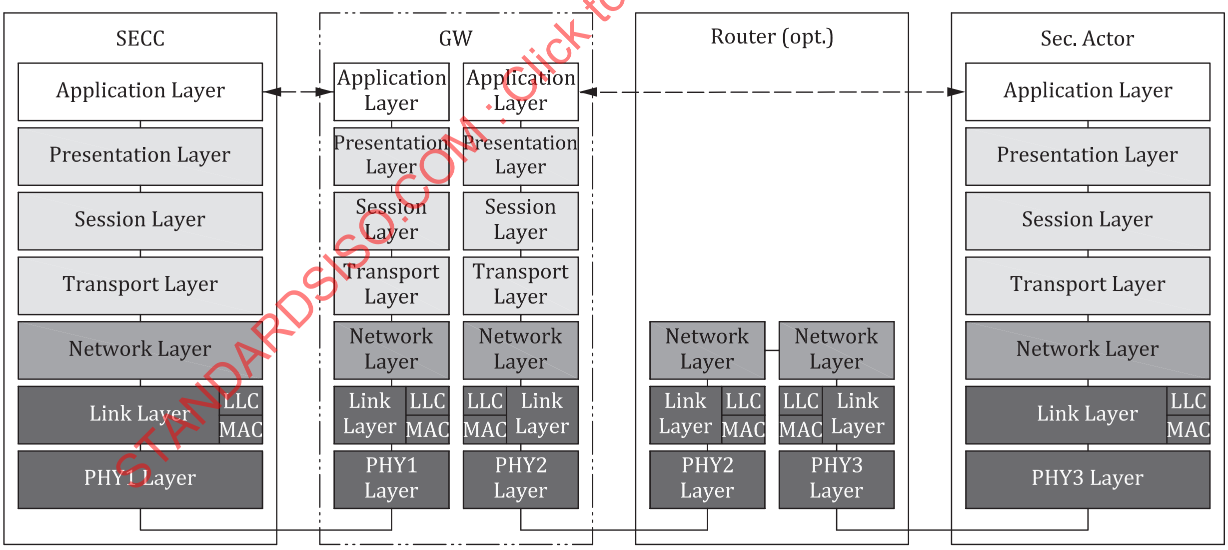
Key

◄– – – – ►	end-to-end communication of application
MAC	media access control
LLC	logical link connection

Figure A.2 — EVCC to SECC communication in a "remote" set-up

Depending on the installation architecture, multiple "bridges", routers might be necessary.

Figure A.3 shows the general case, requiring an application gateway for communication to the network/ application layer.



Key

◄– – – – ►	end-to-end communication of application
MAC	media access control
LLC	logical link connection

Figure A.3 — SECC communicates with the secondary actor using an application gateway

A.2 Variations of the SECC and EVCC set-ups

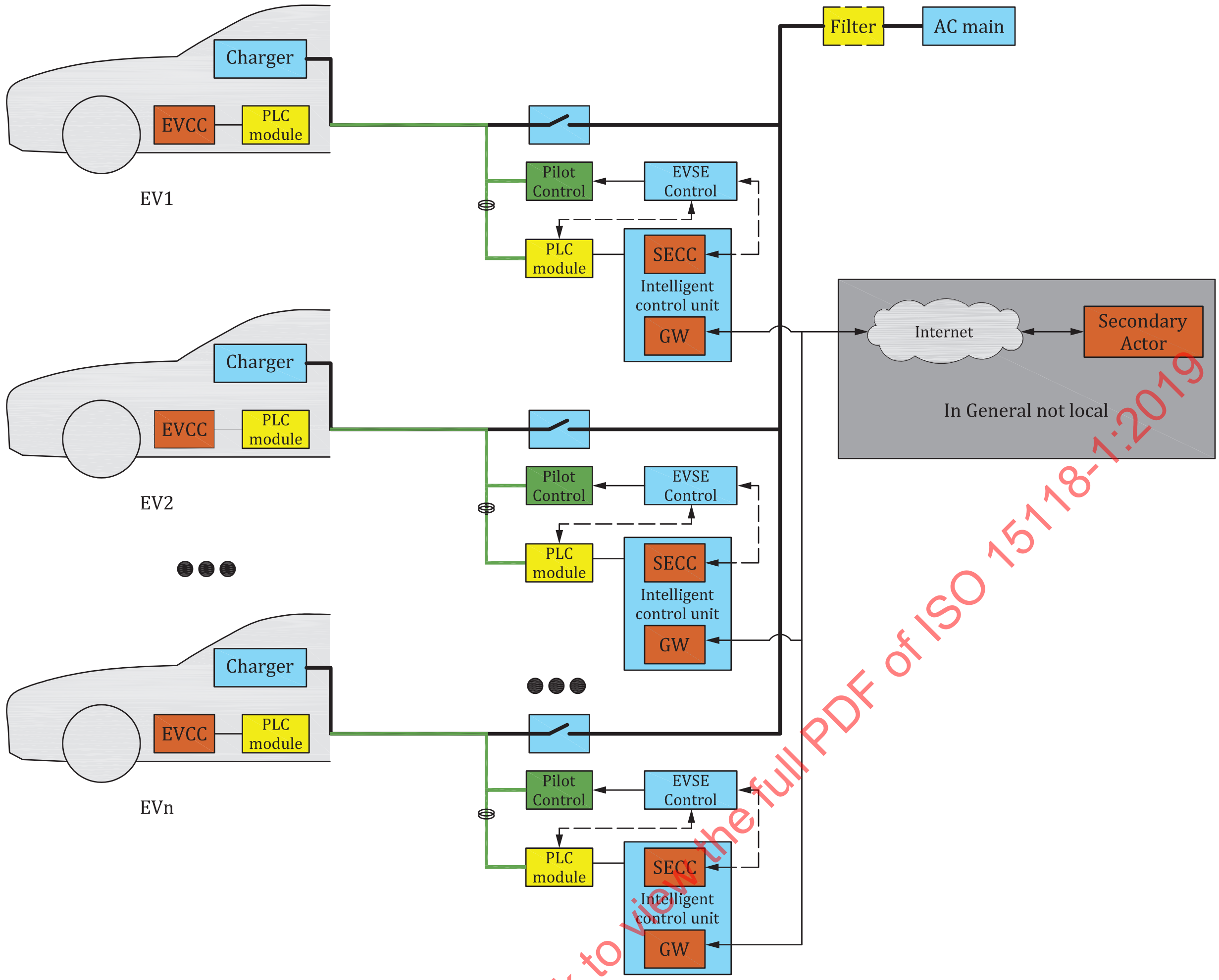
Typical SECC and EVCC set-ups for PLC use cases can be divided into:

— 1:1 communication relationship between an SECC and an EVCC over all OSI layers. The SECC manages one EVCC, knowing to which outlet it is connected. See Figure A.4 a).

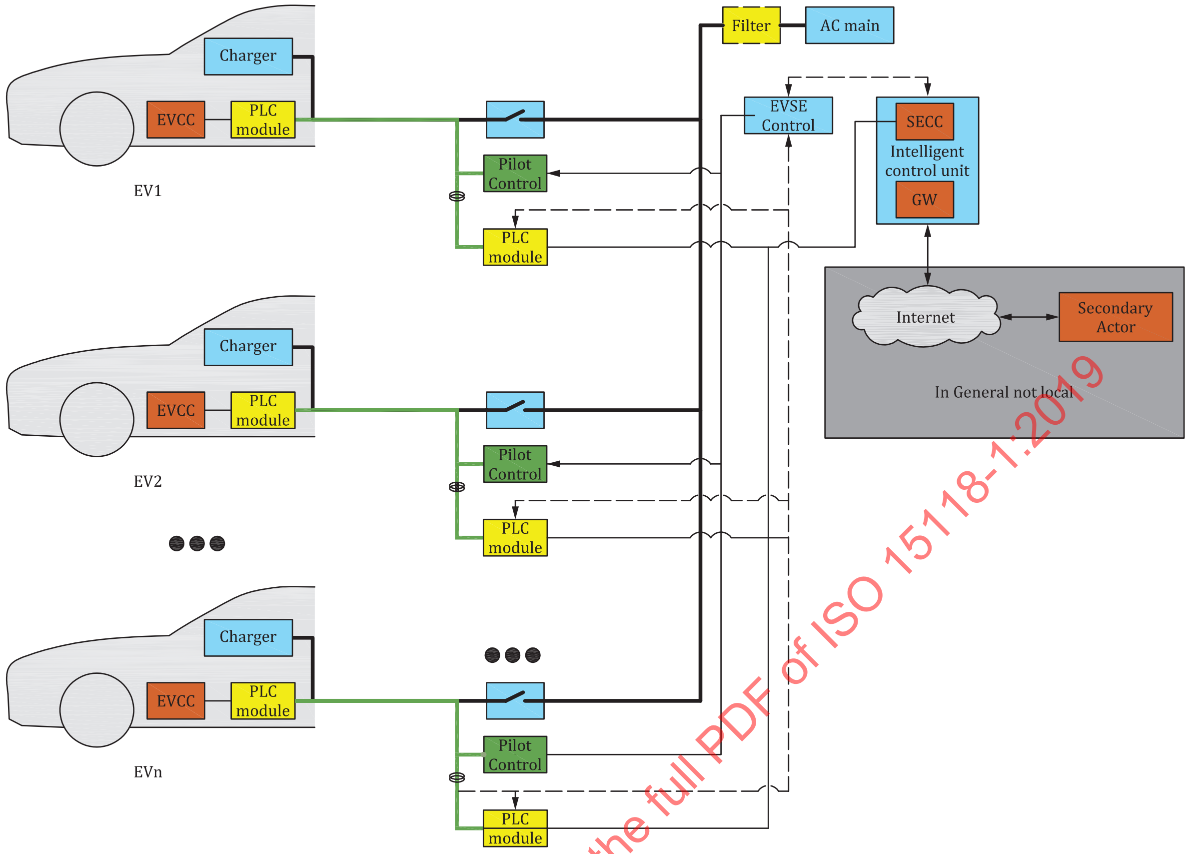
— 1:n communication relationship between one SECC and multiple EVCCs. The SECC manages multiple EVCCs, knowing which EVCC is connected to which outlet. The SECC may be local or remote (communication done on an IP address basis). See Figure A.4 b).

Figures A.4 a) and A.4 b) are illustrating system architectures that are supported by ISO 15118-2 or ISO 15118-20[10)] and ISO 15118-3. In any case, each power outlet has its own PWM controller, for monitoring earth continuity (see IEC 61851-1).

10) Under preparation. Stage at the time of publication: ISO/DIS 15118-20:2019.



a) Communication architecture set-up PLC 1



b) General communication architecture set-up PLC 2

Figure A.4 — System architectures

The characteristics and possibilities of these communication set-ups are defined below:

— The control pilot handling is described in IEC 61851-1. Depending on the infrastructure set-up, each duty cycle may either indicate HLC required or indicate the actual maximum power rating of the outlet.

— The PLC devices should be sufficiently close to each other, see ISO 15118-3 for detailed requirements. Depending on the PLC technology, additional elements may be necessary (not shown here), see ISO 15118-3.

— The association on physical and data link layer is always done based on the MAC addresses of the connected devices, with local bridge(s)/device(s), see ISO 15118-3 for details and limitations:

  — One PLC bridge/device per power outlet.

— Alternatives regarding the number of SECCs per physical outlet.

  — One SECC per physical power outlet, see Figure A.4 a).

  — One SECC for multiple physical power outlets that is handling the communication to all EVCCs connected to these power outlets, see Figure A.4 b).

— Alternatives regarding the interaction of the EV supply equipment controller, PLC module and SECC.

  — If the EV supply equipment controller has the possibility to interact with the PLC module, it is possible to ensure that the PLC module on the infrastructure side is associated with the correct PLC module on the EV side, with implemented control flow between the EV supply equipment controller and the PLC module. Details are specified in ISO 15118-3.

- If the SECC needs to know which EVCC is connected to which physical outlet, the SECC might need the possibility to interact with the EV supply equipment controller to get additional information from the specific EV supply equipment with implemented control flow between the EV supply equipment controller and the SECC.
- If it is not necessary to identify exactly to which outlet the EV is connected, the PLC module might not need to interact with the EV supply equipment controller.
- End-to-end communication on the application layer between the SECC and each connected EVCC is possible in all cases.

- The SECC may require an application gateway to exchange information with a secondary actor. The entity implementing this secondary actor is generally located elsewhere compared to the SECC entity, see grey highlighted boxes in Figures A.4 a) and A.4 b). The definition of this application gateway is within the scope of the ISO 15118 series.
- Optional EVCC IP communication to HAN through PLC module and router or SECC.

A.3 Location of charging process related elements

The energy transfer process can be split into different elements, in general. These are:

- Target Setting;
- Demand and Prognosis;
- Scheduling; and
- Charging Control.

“Target Setting” covers all kinds of user demand-related information such as:

- What type of service will be selected, FPT, RPT or BPT.
- What type of control mode will be selected, scheduled or dynamic.
- What are the e-mobility needs.
- When the charging process is finished.
- How much energy is needed.
- Charging preferences like fast charging, cheapest charging, least CO_2 charging, etc.
- EP.

“Demand and Prognosis” covers the collection of grid and local installation limits which apply to the actual energy transfer process, e.g.

- sales tariff table containing a price, efficiency or CO_2 content information vs. time based on grid, energy production, energy demand and customer contract information, along with an optional contract-based current limitation;
- grid schedule containing a current vs. time limitation at the specific EV supply equipment due to local installation and local electricity demand situation.

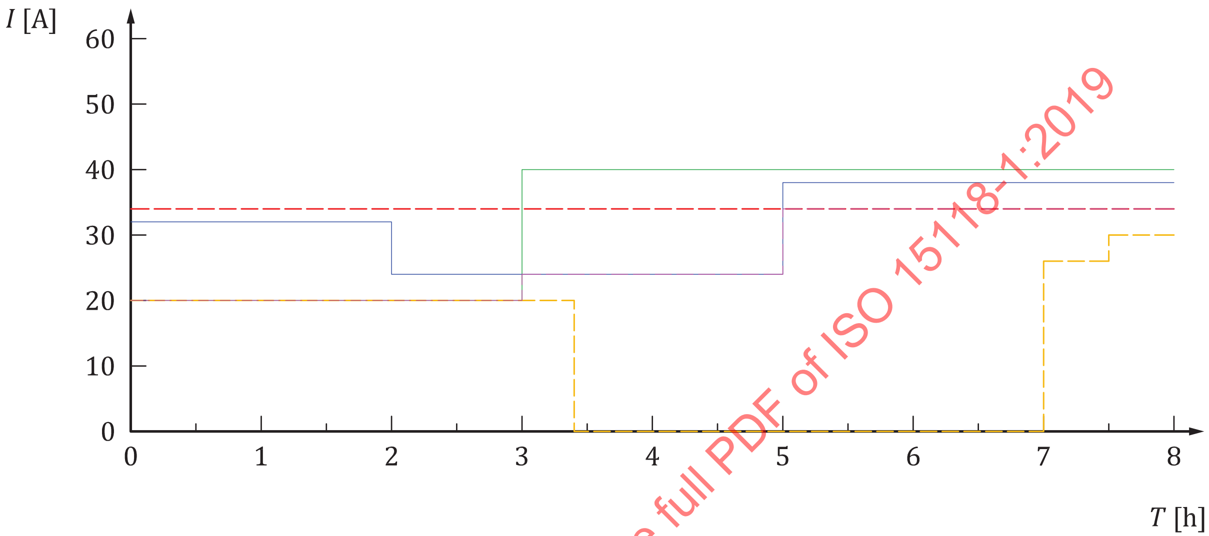
“Scheduling” covers the compilation of “target setting” and “demand and prognosis” information when necessary to create an energy transfer schedule, i.e. charging/discharging current vs. time prognosis, for the current energy transfer process. See Figure A.5.

- Calculate an energy transfer plan to meet customer requirements, which respects e-mobility needs, current limitations from the sales tariff table, grid schedule and local installation.

— The result of the calculation is a timetable of maximum power allowed to be transferred from or to the EV supply equipment.

— The schedule may be changed according to the real time situation, the control mode selected and secondary actor's constraints.

— The schedule respects tariff limitations, grid limitations, local infrastructure limitations and EV limitations. The level selector does the combination of tariff limitations, grid limitations and local infrastructure limitations.



Key

T	time
I	current
(green solid line)	contract-based current limitation provided by the secondary actor to the SECC/EVCC, contained in the sales tariff table from the SECC to the EVCC
(blue solid line)	grid-based current limitation available at the SECC provided by the secondary actor, contained in the grid schedule from the SECC to the EVCC
(red dashed line)	logical physical limit, minimum of rating of the outlet and cable
(pink dashed line)	level selection minimum of sales tariff and grid current limitations done at the EV or the EV supply equipment
(yellow dash-dot line)	scheduled current limitation the EV follows while charging, contained in the charge schedule from the EVCC or the SECC

Figure A.5 — Effects of scheduling on communicated current

"Charging Control" covers the control of the charging process according to "Scheduling" results.

NOTE Actual charging current to the battery is controlled by the BMS. It is outside the scope of this document.

The BMS charges the battery under the current limitations provided by "Charging Control".

The cooperation between these elements is shown in Figure A.6 in the context of charging only.

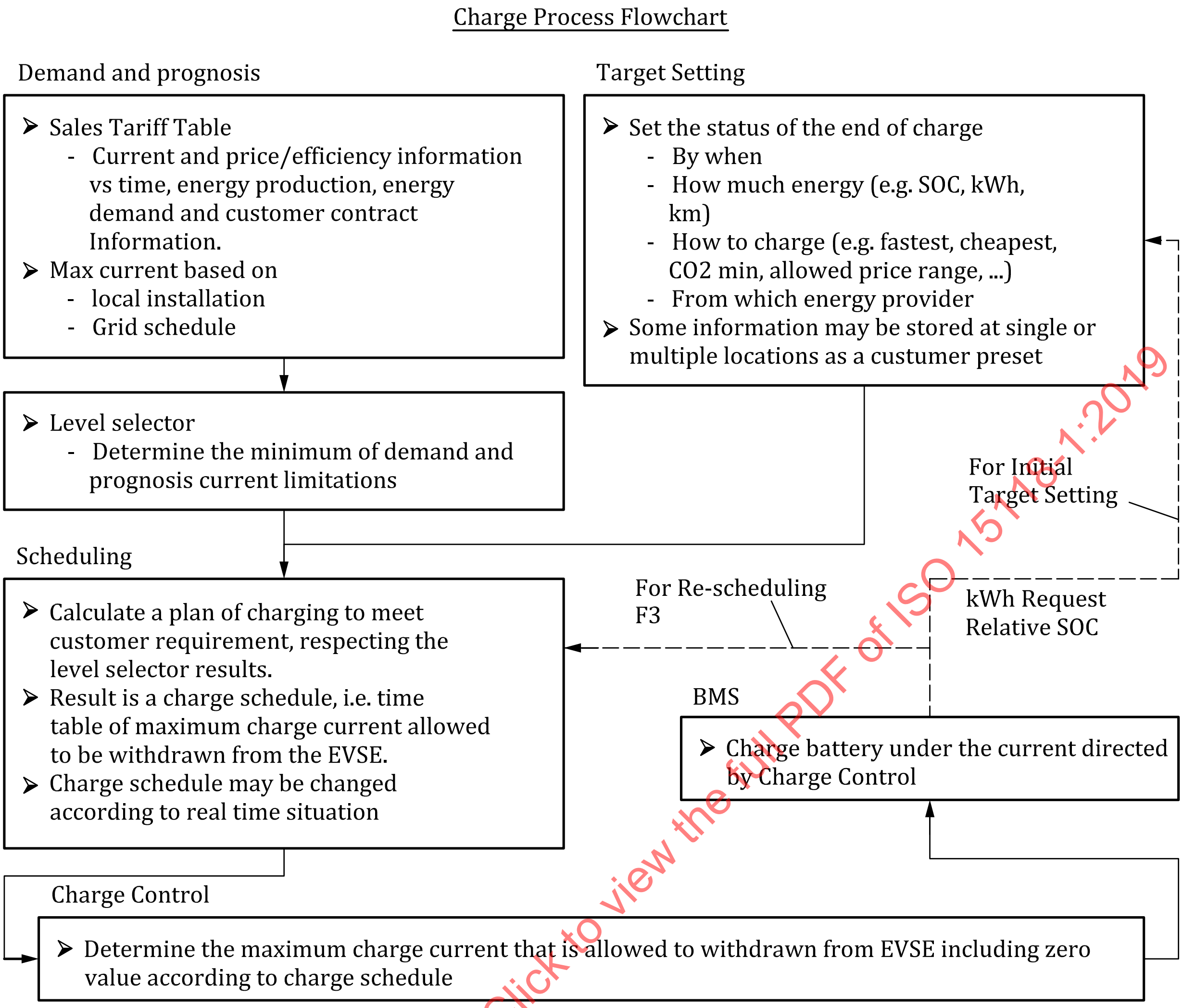


Figure A.6 — Example of charging only process flow chart

In the case of AC and DC, "Demand and Prognosis" is a task of a secondary actor. The remaining elements in the charging process flow chart can either be located in the EV, the EV supply equipment or at a secondary actor. Depending on the decision for a specific system, additional equipment for user interaction, data transfer, availability of a communication link to a secondary actor, etc. arise. See Tables A.2 and A.3 for details.

Table A.2 — Additional equipment required if scheduling and energy transfer control is mainly located on the infrastructure side

Stage	Function	Location and example of equipment			
		EV	**EV supply equipment**	**Secondary actor 1**	**Secondary actor 2**
Target Setting	Setting of the status of the end of energy transfer	Switch/button etc.			
	Setting of the required amount of energy needed for the charging and charging capability of the EV	Calculated by the BMS (Wh calculator)	The SECC may forward the information, depending on the set-up of the SECC/ EV supply equipment	Database to store the target setting data for further processing	
Demand and Prognosis	Development of the sales tariff table			Database to store the sales tariff table for scheduling	Energy provider or EMSP
	Determination of the grid schedule			Database at the DCH or CSO	
	Determination of local limitation		Controller providing the outlet rating and the cable rating		
	Level selector			Controller using the database and charging site information	
Scheduling	Schedule calculation according to “Target Setting” and “Demand and Prognosis” information		Database to store the charging schedule	Schedule calculator result sent to charging site	
	The EV or user confirms the charging schedule (Optional)	Charging schedule confirmation			
Charging Control	Inform the maximum charging current at that time. Pick up from the charging schedule	Controller to follow the current limitation	Controller to follow the charging schedule and inform the EV about the current limitation		
	Renegotiation due to environmental condition changes (t°, ..) (optional)	The EVCC returns to “Target Setting”			
	Renegotiation due to changed environmental condition on the EV supply equipment or the secondary actor side		Return to “Target Setting” or “Demand and Prognosis”	Return to “Target Setting” or “Demand and Prognosis”	

Table A.3 — Additional equipment required if scheduling and charging control is mainly located on the EV side

Stage	Function	Location and example of equipment			
		EV	EV supply equipment	Secondary actor 1	Secondary actor 2
Target Setting	Setting of the status of the end of charging	Switch/button etc.			
	Setting the required amount of charging and charging capability of the EV	Calculated by the BMS (kWh calculator)	The SECC may forward the information, depending on the set-up of the SECC/EV supply equipment		
Demand and Prognosis	Development of the sales tariff table		The SECC forwards the sales tariff table to the EVCC		Energy Provider or EMSP
	Determination of the grid schedule		The SECC forwards the grid schedule to the EVCC	Database at the DCH or CSO	
	Determination of local limitation	Controller providing the cable rating	Controller providing the outlet rating; the SECC forwards this information to the EVCC		
	Level selector	Controller determines the minimum of all current limitation information provided by the SECC			
Scheduling	Schedule calculation according to “Target Setting” and “Demand and Prognosis” information	Controller to calculate a charging schedule			
	The EV or user provides the charging schedule to the SECC	The EVCC provides the charging schedule to the SECC	Charging schedule confirmation		

Table A.3 *(continued)*

Stage	Function	Location and example of equipment			
		EV	EV supply equipment	Secondary actor 1	Secondary actor 2
Charging Control	Inform the maximum charging current at that time. Pick up from the charging schedule	Controller to follow the current limitation			
	Renegotiation due to environmental condition changes (t°, ..) (optional)	The EVCC returns to “Target Setting”			
	Renegotiation due to changed environmental condition on the EV supply equipment or the secondary actor side (optional)		Return to “Target Setting” or “Demand and Prognosis”	Return to “Rarget Setting” or “Demand and Prognosis”	

Annex B
(informative)

Security

B.1 Analysis of target use cases

B.1.1 General

The following scenarios are described as part of the use case matrix in 7.1. These use cases serve as a starting point for the derivation of security requirements later on. The focus for the analysis of the use cases is placed on the communication relations, as well as the data exchanged between the communicating parties.

Use cases in scope of the security concept mapped to the security requirements are described in Table B.1.

The following goals of applying cryptography to communication are an extract from the Handbook of Applied Cryptography[24] and are repeated here for easier understanding of the cryptographic measures.

1) **Confidentiality** is a service used to keep the content of information from all but those authorized to have it. There are numerous approaches to providing confidentiality, ranging from physical protection to mathematical algorithms, which render data unintelligible.

2) **Data integrity** is a service that addresses the unauthorized alteration of data. To assure data integrity, one must have the ability to detect data manipulation by unauthorized parties. Data manipulation includes such things as insertion, deletion, and substitution.

3) **Authentication** is a service related to identification. This function applies to both entities and information itself. Two parties entering into a communication should identify each other. Information delivered over a channel should be authenticated as to origin, date of origin, data content, time sent, etc. For these reasons, this aspect of cryptography is usually subdivided into two major classes: entity authentication and data origin authentication. Data origin authentication implicitly provides data integrity (for if a message is modified, the source has changed).

4) **Non-repudiation** is a service that prevents an entity from denying previous commitments or actions. When disputes arise due to an entity denying that certain actions were taken, a means to resolve the situation is required. For example, one entity may authorize the purchase of property by another entity and later deny such authorization was granted. A procedure involving a trusted third party is needed to resolve the dispute. “Accountability” is equivalent to the term “non-repudiation”.

5) **Privacy** is related to personal data protection. Personal data means any information relating to an identified or identifiable natural person; an identifiable person is one who can be identified, directly or indirectly, in particular by reference to an identification number or to one or more factors specific to his physical, physiological, mental, economic, cultural or social identity.

An additional goal regarding the data communication is defined below.

6) **Reliability/Availability** is the property of a service of being available and working reliably. Degradation of availability and/or communication reliability potentially compromises an offered service.

Table B.1 — Use case elements and their security requirements

No.	Use case element name/grouping	Non repudiation	Authenticity	Confidentiality	Privacy	Integrity	Reliability and availability
A							
A1	Plug-in and forced high-level communication						
WA1	Automatic discovery with reservation		X	X	X	X	X
A2	Plug-in with concurrent IEC 61851-1 and high-level communication						
WA2	Manual or automatic discovery without reservation						
B							
B1	EVCC/SECC communication set-up						
WB1	EVCC/SECC wireless communication set-up		X	X	X	X	X
C							
C1	Certificate update		X	X	X	X	X
C2	Certificate installation		X	X	X	X	X
D							
D1	Authorization using contract certificates performed at the EV supply equipment		X	X	X	X	X
WD1	Authorization with prior reservation		X	X	X	X	X
D2	Authorization using contract certificates performed with SA help		X	X	X	X	X
D3	Authorization at EV supply equipment using external credentials performed at the EV supply equipment		X			X	X
D4	Authorization at EV supply equipment using external credentials performed with SA help		X			X	X
P							
WP1	WPT fine positioning		X			X	X
WP2	WPT fine positioning without communication support						
WP3	Conductive power tranfer pairing		X			X	X
WP4	WPT pairing		X			X	X
E							
E1	AC energy transfer with load levelling based on high-level communication		X			X	X

Table B.1 *(continued)*

No.	Use case element name/grouping	Non repudiation	Authenticity	Confidentielity	Privacy	Integrity	Reliability and availability
WE1	WPT target setting and energy transfer scheduling		X			X	X
E2	Optimized energy transfer with scheduling the secondary actor		X	X	X	X	X
E4	DC energy transfer with load levelling based on high-level communication		X			X	X
E5	Resume to authorized charge schedule		X			X	X
E6	Reverse power transfer with load levelling based on HLC		x				
E7	Reverse power transfer on stand-alone operation		X			X	X
E8	Fast responding energy transfer services based on dynamic control mode		X			X	X
E9	Managed bidirectional power transfer into the grid		X			X	X
F							
F0	Energy transfer loop		X			X	X
F1	Energy transfer loop with metering information exchange	X	X	X	X	X	X
WF1	WPT charging loop		X	X	X	X	X
F2	Energy transfer loop with interrupt from the SECC		X	X	X	X	X
F3	Energy transfer loop with interrupt from the EVCC or user		X	X	X	X	X
F4	Energy transfer control based on dynamic control mode		X	X	X	X	X
G							
G1	Value-added services						
WG1	ACD system status check		X	X	X	X	X
G2	Charging details						
H							
H1	End of charging process					X	X
WH1	WPT end of energy transfer					X	X
WI	ACD connect/disconnect					X	X

NOTE Use case **C1** only has confidentiality requirements if the exchange of new private keys is included. Use case **G1** has security requirements in general, but outside the scope of the V2G CI specification.

These use cases are analysed below to determine the communication peers, as well as the communicated data. Moreover, this communication should be investigated to determine its criticality to the service provided. This information is one basis for the derivation of security requirements.

B.1.2 Entities

B.1.2.1 General

The use cases described above involve the entities described in the following two subclauses.

B.1.2.2 Customer-related

Table B.2 — Description of entities

Entity	Description
Contract	An agreement between the customer and a mobility operator for providing charging services. The contract is identified by an EMAID.

B.1.2.3 EMSPs

Table B.3 — Description of organisational parties

Organization	Description
	Reference to Clause 6
Mobility operator	The organisation to which a customer has a contract for providing EV charging services. The mobility operator might be the CSO, an EP or a third party.

B.1.3 Trust relationships

The following table breaks down the information flow EV, EV supply equipment and SA.

Table B.4 — Communication relations and exchanged data between involved peers

No.	Peer 1	Peer 2	Communication type, exchange data
1	EV	EV supply equipment/ EV supply equipment operator	Charging control data, contract, EV supply equipment-ID, physical limits (safety monitoring), meter information, charge plan, safety monitoring data
2	EV	Clearing house	Charging information, billing information (indirect), tariff information
3	EV	VAS	Value added service related communication
4	EV supply equipment	EV supply equipment operator	Contracts, limits, meter information, charge plan
			SW-Updates
5	EV supply equipment	Clearing house	Contracts, limits, meter information, charge plan, billing record
6	EV supply equipment	EMSP	Contract, charge control
7	EV supply equipment	Energy provider	

To realize the use cases stated in the introduction of this security annex, assumptions regarding the trust relations should be investigated to ensure trust cryptographic credentials are typically used and thus influence the security requirements, security architecture and the selection of security measures (algorithms, mechanisms, etc.).

The trust relations depend considerably on service relations between the different peers and therefore on the data exchanged between the involved parties as presented in Table B.4.

In addition, Table B.5 provides information about certain assumptions regarding the different peers in relation with their security relevant interactions and/or functions.

Table B.5 — Trust and architecture assumptions

No	Peer	Assumptions
1	Vehicle	— Has means to identify and authenticate itself towards other peers, e.g. by using an EMAID and cryptographic key material.
2	EV supply equipment/ CSO	— The EV supply equipment delivers correct meter information during the energy transfer cycle. — The EV supply equipment may control the energy transfer process. — The vehicle, clearing house and mobility operator may need to transfer information such as tariff information through the EV supply equipment without the EV supply equipment having access to the information. — The EV supply equipment has means to authenticate towards other peers. — The EV supply equipment will not be provided with billing information from the clearing house or the vehicle (billing in this context is related to personal customer data). — Crosstalk between PLC connections is not addressed (rather an issue for physical measures).
3	SA (clearing house)	— The clearing house processes the billing correctly. — The clearing house has means to authenticate towards other peers.
4	SA (VAS provid-er)	— VAS provisioning is orthogonal to the electricity energy transfer and the associated billing.
5	All	— All parties have means to communicate with each other.

B.1.4 Threats for transmission information

The analysis of exchanged data targets the determination of criticality of the data and thus their influence on the service provisioning. It also addresses potential data protection required for the different data types. For general background information about security techniques refer to ISO/IEC 15408-1.

Table B.6 — Communication relations and exchanged data between peers

No	Data/Service	Priority Class	Threatened security goal			
			Integrity	Confident-iality	Non-Repudiation	Availability
1	Charging control data, physical limits charging plan, safety monitoring data		X			X
2	Billing information		X	(X) (if personalised)	X	
3	Tariff information		X	X	(X) (if personalised)	X
4	SW updates		(X) (OEM specific)	(X) (OEM specific)		
5	VAS communication		X (depending on VAS, outside the scope of vehicle to EV supply equipment communication)			
6	Identity information related to physical components (e.g. EV supply equipment ID)		X			X
7	Identity information related to persons (e.g. EMAID)		X	X		
8	Charging Service					X

Annex C
(informative)

Examples of charging scenarios derived from the use case elements

C.1 General

This annex is intended to show the way in which the use case elements defined in Clause 7 can be used to construct specific scenarios. Each of these scenarios offers several ways and each of these is a use case derived from the elements described in Clause 7. The aim is not to include all possible communication use cases in this document. However, this annex presents some typical scenarios that show the use of the different use case elements. The scenarios are used as tests to verify the completeness of the elementary use cases.

The following scenarios present situation for charging only.

C.2 Fleet operation/car park charging

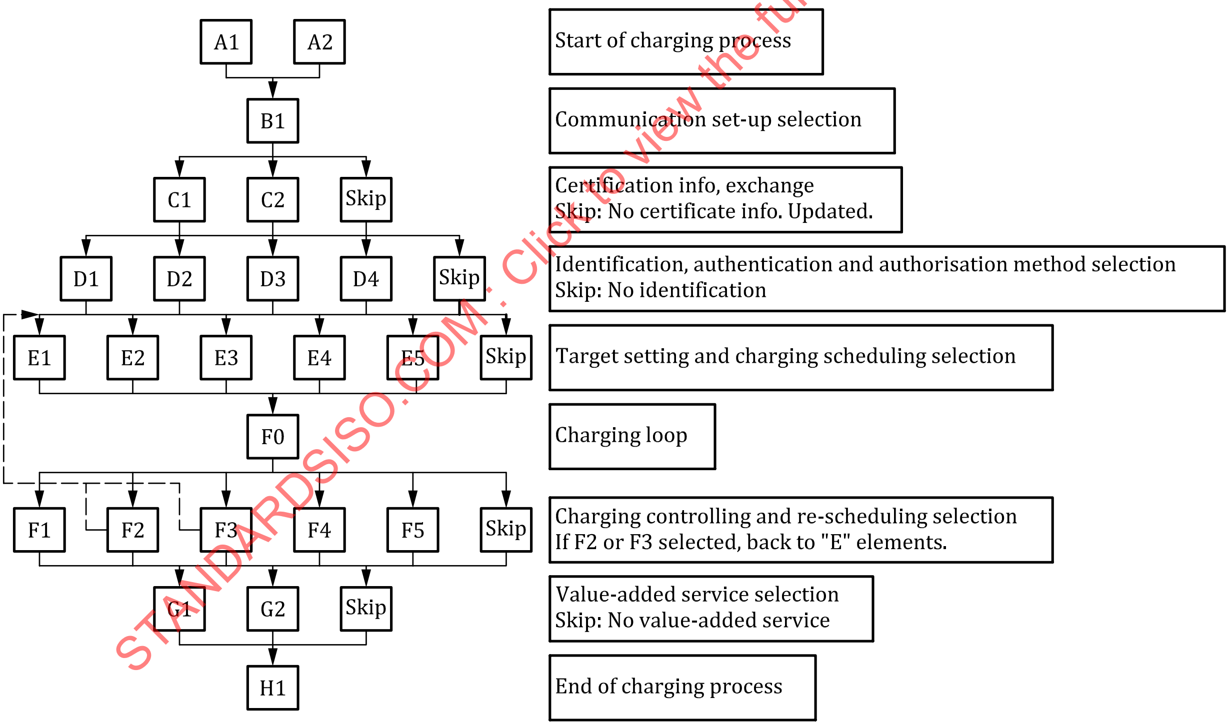


Figure C.1 — Graphical overview of fleet operation/car park charging

The use case of fleet operation might be one of the first use cases in the initial phase of electrical mobility. Knowing that there might be highly varied realizations of such, this use case describes several possibilities to supply a fleet operation sufficiently.

Generally speaking, fleet operation will involve a number of vehicles with limits known by the fleet manager.

NOTE 1 For car park situations, a very similar scenario applies. Therefore, the following sequence is written for a fleet operator but could easily be exchanged to a car park operator.

The succession of use case elements is as follows (see Figure C.1):

— Start of the charging process with optional either required ISO 15118 (A1) or concurrent IEC 61851-1 and ISO 15118 (A2).

— (B1) association and binding is required.

— If certificates are used for the authentication process (D1, D2) the certificate elements (C1, C2) should be supported as well for smooth operation.

— One of the identification, authentication and authorization use case elements (D1-D4) might be chosen. If no identification is necessary, this sequence will be skipped. If the customer is billed for the usage of the energy, the according element (F1) should be supported in addition to the basic charging loop element (F0).

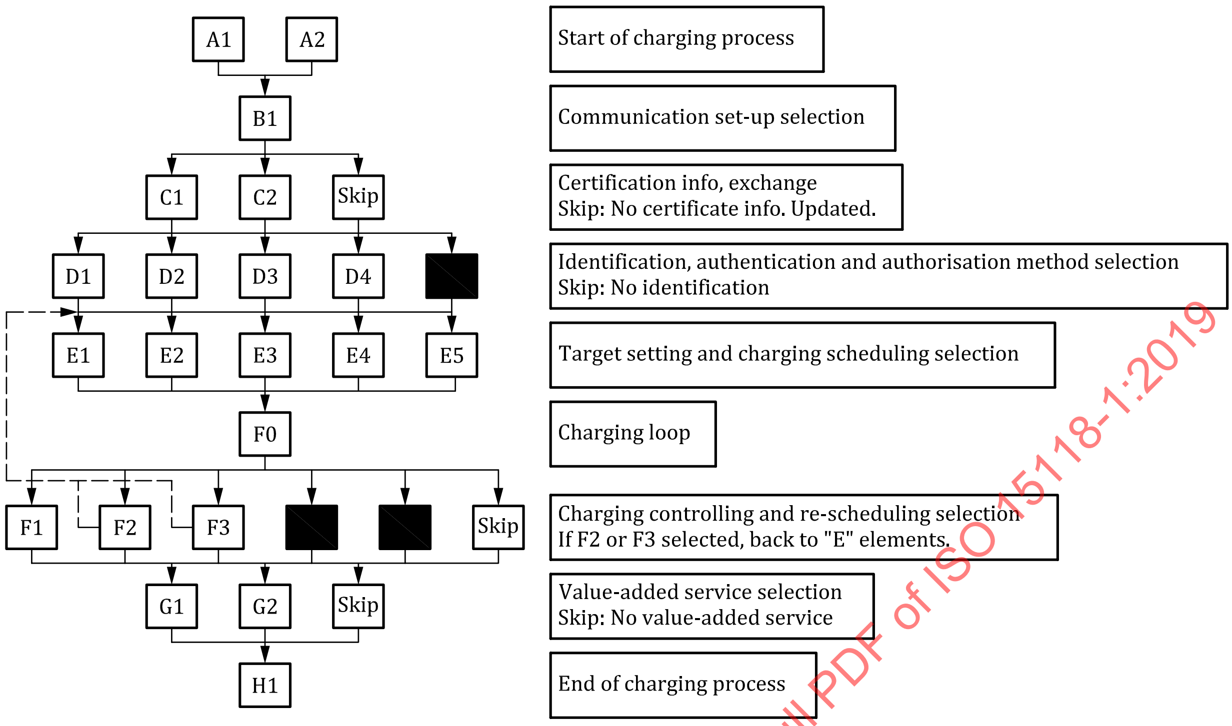
— Depending on the chosen way of load levelling (local installation/respecting grid conditions) use case elements (E1; local) or (E2; grid conditions) apply. Derived from this decision the interrupt conditions (F2) and (F3) should be integrated.

— If the fleet operator wants to meter the energy consumption of each car and get some additional information about the charging, they should include (F1)+(G2).

NOTE 2 In case of fleet operation, the value-added service element (G1) could be used to download actual car routes directly into the vehicle from the management system of the fleet operator.

— Finally, the ending of the charging process should be done by using (H1).

C.3 Public charging at kerb side



NOTE All blacked out items do not seem to be applicable within this scenario.

Figure C.2 — Graphical overview of public charging at kerb side

The scenario description is as follows (see Figure C.2):

— Start of the charging process with optional either required ISO 15118 (A1) or concurrent IEC 61851-1 and ISO 15118 (A2).

— (B1) association and binding is required.

— If certificates are used for the authentication process (D1, D2) the certificate elements (C1, C2) should be supported as well for smooth operation.

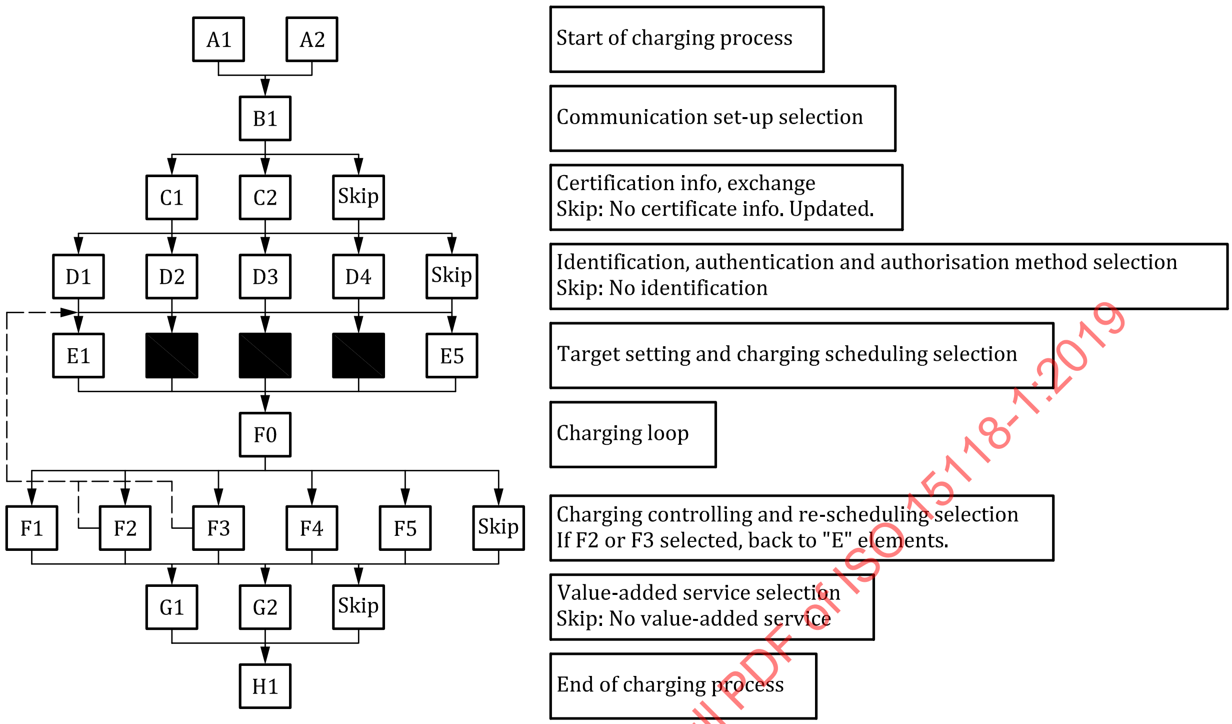
— One of the identification, authentication and authorization use case elements (D1-D4) should be chosen. If the customer is billed for the usage of the energy the according element (F1) should be supported in addition to the basic charging loop element (F0).

— Depending on the chosen way of load levelling (local installation/respecting grid conditions) use case elements (E1; local) or (E2; grid conditions) apply. Derived from this decision the interrupt conditions (F2) and (F3) should be integrated.

— If enabled, broadband services (G1) might be integrated.

— Finally, the ending of the charging process should be done by using (H1).

C.4 Private charging



NOTE All blacked out items do not seem to be applicable within this scenario.

Figure C.3 — Graphical overview of private charging

The scenario description is as follows(see Figure C.3):

— Start of the charging process with optional either required ISO 15118 (A1) or concurrent IEC 61851-1 and ISO 15118 (A2).

— (B1) association and binding is required.

— If certificates are used for the authentication process (D1, D2) the certificate elements (C1, C2) should be supported as well for smooth operation.

— One of the identification, authentication and authorization use case elements (D1-D4) might be chosen, in case the charging station is shared with others. If no identification is necessary, this sequence should be skipped. If the customer is billed for the usage of the energy, the according element (F1) should be supported in addition to the basic charging loop element (F0).

— (E1) charging with simple load levelling at the EV supply equipment side may be chosen to limit connectivity costs or such function is enhanced to the user's smart grid controller. Derived from this decision the interrupt conditions (F2) and (F3) should be integrated.

NOTE The use case elements E2-E4 are not needed to fulfil the objective of this scenario, however there might be some cases in which they could apply (e.g. in regulatory framework).

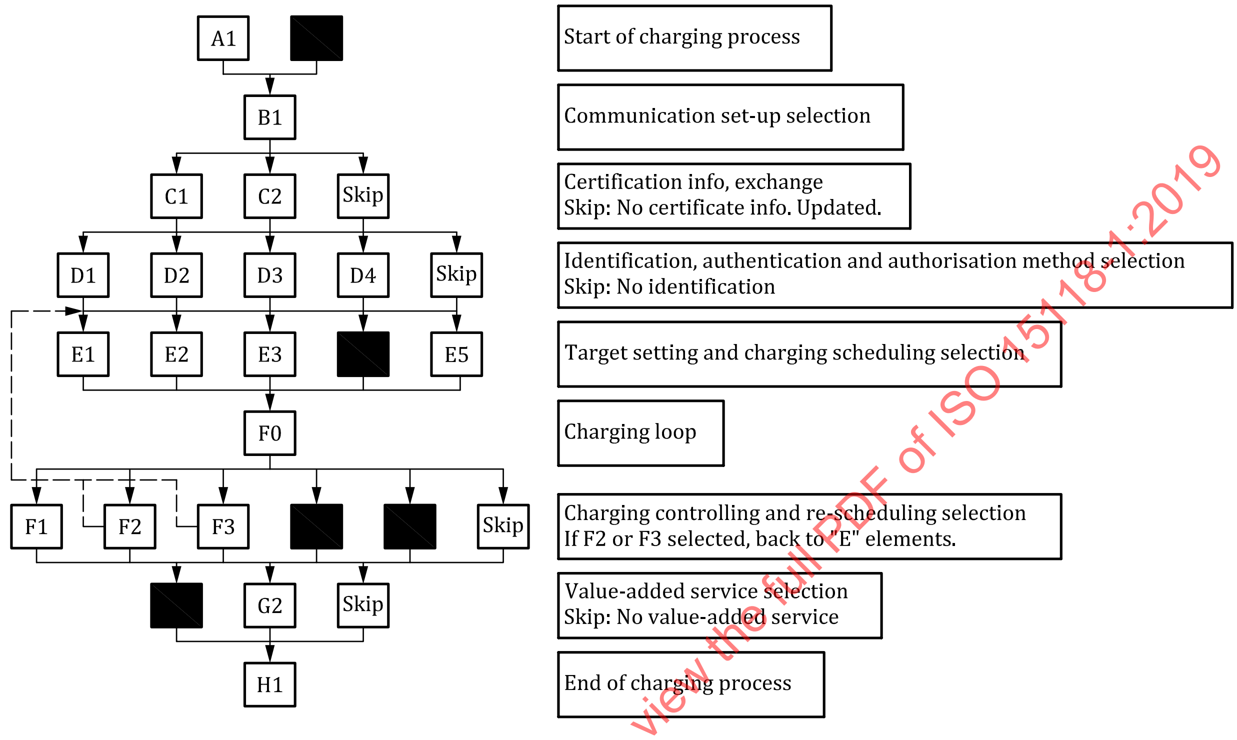
— If a separate meter for the station is installed, the functions (F1)+(G2) are required to perform a valid billing. In the case of an "external" meter in the installation (G2) could be introduced to increase the convenience level of the customer.

— The elements for dynamic control mode (F4) may apply in the private charging scenario, depending on the capabilities of the installation (and each V2G entity).

— If enabled, broadband services (G1) might be integrated.

— Finally, the ending of the charging process should be done by using (H1) that does not need data termination.

C.5 Mobility application using a specific fleet and information transmitted between the EV and the EV supply equipment (charging only)



NOTE All blacked out items do not seem to be applicable within this scenario.

Figure C.4 — Graphical overview of mobility application using a specific fleet and information transmitted between the EV and the EV supply equipment

Mobility applications may generally be composed of a relatively homogeneous fleet of vehicles. This example is constructed for a fleet of identical vehicles with payment of the complete service. Fleets probably have independent GPRS/GPS data transfer to communicate with a central management. The client identifies himself by any contract relevant information, e.g. EMAID, EIM or similar. The logic of mobility applications is the inverse of charging by a vehicle owner. In a case where the identification is done by external means (e.g. EIM) the EV user will identify himself when he takes the vehicle and so stops the charging. He will end his rental when he returns the vehicle. If the customer needs to pay for km or for energy, or both, it is up to the operator.

When the vehicle is returned (see Figure C.4):

— Start of the charging process with required ISO 15118 (A1).

— (B1) association and binding is required.

— If certificates are used for the authentication process (D1, D2) the certificate elements (C1, C2) should be supported as well for smooth operation.

— One of the identification, authentication and authorization use case elements (D1-D4) might be chosen. If there is no identification necessary, this sequence should be skipped. If the customer is billed for the usage of the energy the according element (F1) should be supported in addition to the basic charging loop element (F0).

— Depending on the chosen way of load levelling (local installation/respecting grid conditions) use case elements (E1; local) or (E2; grid conditions) apply. Derived from this decision the interrupt conditions (F2) and (F3) should be integrated.

— To meter the energy consumption of each car and get some additional information about the charging the use case elements (F1) and (G2) are required.

— The elements for dynamic control mode (F4) might apply.

— If enabled, VAS (G1) might be integrated.

— (G2) is required to do a mapping between the used identification method and the consumption if an energy-based billing is chosen. If not, (G2) should be skipped.

When the vehicle is taken out for hire (see Figure C.4):

— Client identification at the payment post, or by EIM key opening beside the "normal" possibility of accessing the car with the ignition key (which then might cause an end of charging process).

— Data transfer between the vehicle and the charge post. If the G1 use case element is used for this communication it might be necessary to re-establish the communication according to the B1 element.

— Ending of the charging process should be done by using (H1) that does not need data termination.

— Unplugging releases the vehicle for driving.

C.6 Wireless communication sequence examples

C.6.1 General

Wireless communication described in ISO 15118-8 is an alternative solution to the existing PLC communication described in ISO 15118-3. This means that wireless communication should support HLC messages described in ISO 15118-20 as if they were transported with PLC means.

As wireless communication may be used for conductive energy transfer as well as for wireless power transfer (WPT), the major difference with conductive communication is that communication may start before the plug-in event of conductive energy transfer.

The action of plugging is meaningless for WPT, therefore the action of physically connecting cables for communication between the EV and the EV supply equipment is replaced by the association of the wireless interfaces of the EV and the SECC. Prior to the association, a discovery process of the EV identifies the right SECC for communication.

Since one SECC may be used for several EV supply equipment to communicate with the EV, a pairing process is used to determine the correct EV supply equipment which will transfer power to the EV.

By arranging these processes differently in time, the following non-exhaustive list of situations may come up:

— driver may decide to park first and then start HLC and optional value-added services;

— driver may decide to wait for HLC and VAS before parking;

— driver may have reserved a parking place in a charging site or not;

— in the case of conductive power transfer, the driver may request VAS before plug-in;

— use case for re-activating the wireless interface of an EV that is in sleep mode,

— in case of ACD, the "plug-in" (establish physical link) and "plug-out" (disconnect physical link) action is controlled through HLC