EEBUS | SPEAK ENERGY

E-Mobility Use Cases

Technical White Paper
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DEVICES
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The global language for energy in the Internet of Things.

Contents

Introduction

The increased power demand for charging electric vehicles (EVs) gives rise to challenges, but also opportunities.

As EVs consume significant amounts of power, it is important to integrate them into an energy management system to coordinate the charging process with other consumers, such as heat pump, and producers, such as photovoltaic system (PV). This will help optimize cost and sustainability.

Through energy management, significant cost and CO_2 savings can be implemented. For instance, if the energy generated by a PV system cannot be fed into the grid, the EV can be charged with the costless surplus energy. PV or other types of self-produced energy can be stored in the EVs battery, to improve the overall autarky rate, cover power outage, or compensate for a high energy price through flexible tariffs. As a future scenario, self-produced PV energy could also be made available to other EV owners by granting access to the house owners' charging station.

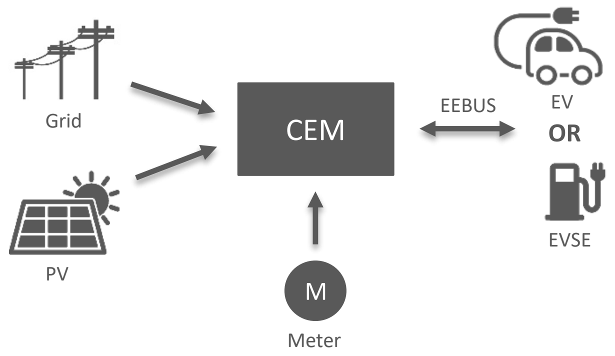
The increased power demand of EVs will be challenging for the grid itself. As EVs become more and more common and will start charging at the same time, it is important to balance consumption and production by energy management systems. This will ensure the EV can be charged by a stable grid condition within the limits set by the owner. Furthermore, the batteries of EVs can, in the future, also be used to stabilize the grid.

To solve these problems, EEBUS members and our specification engineers have defined the appropriate use cases and extended the SPINE toolbox with corresponding data models and functionalities.

This document provides an overview of the e-mobility use cases released by EEBUS. The table below shows the supported use cases and EV communication.

Use Cases	ISO 15118	IEC 61851 PWM
Coordinated EV Charging	x	(x)
Overload Protection by EV Charging Current Curtailment	x	x
Optimization of Self-Consumption during EV Charging	x	x
EV Charging Electricity Measurement	x	x
EV Charging Summary	x	x
EV Commissioning and Configuration	x	(x)
EVSE Commissioning and Configuration	x	x

The following figure shows the system participants where the charging station (EVSE) typically acts as an EEBUS to ISO 15118/IEC 61851 gateway:



Direct or cloud-based communication between EV and CEM can be implemented as well.

Terms

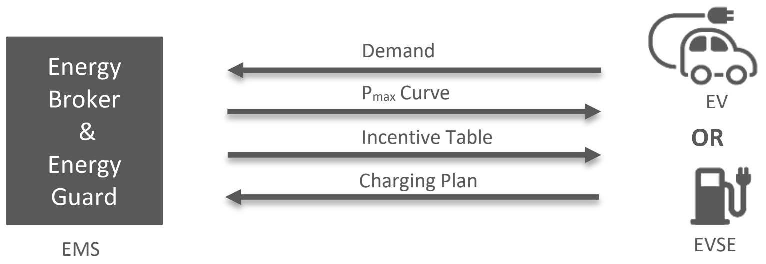
CEM	Abbreviation for customer energy manager. The CEM is an essential actor in many EEBUS use cases. It coordinates energy consumers and producers to reach certain optimization goals. Energy management functions can be implemented both on an energy manager, a control box of a grid provider, or on any device within the EEBUS network.
Energy Broker	Rather than directly controlling the consumption or production of devices, the energy broker provides incentives. If the incentives are attractive, the devices use them to increase their energy flexibility. In many cases, the energy broker will be the CEM.
Energy Guard	The energy guard sets energy consumption or production limits to ensure stability of the local grid (e.g. avoid fuse failures), as well as of the electricity grid (e.g. avoid an overload scenario). In many cases the Energy Guard will be the CEM but it may also be realized on a control box of a grid operator.
EV	Abbreviation for electric vehicle. The EV is an essential actor in most E-Mobility use cases.
EVSE	Abbreviation for electric vehicle supply equipment. Also used to refer to the combination of EV and EVSE during charging.
E-Mobility	Abbreviation for electric mobility
FNN	Abbreviation for “Forum Netztechnik/Netzbetrieb”. VDE/FNN is the technical regulator for power grids in Germany.
PV	Abbreviation for a photovoltaic system. Produces energy that can be fed into the grid or used by devices based on the energy management.

Coordinated EV Charging

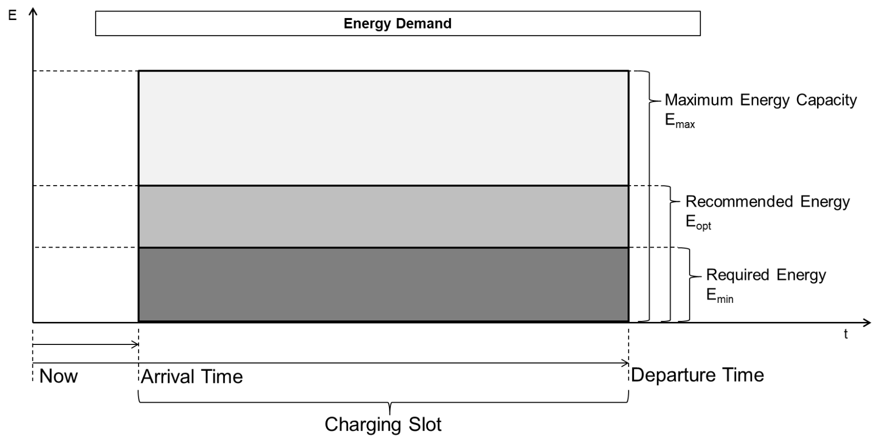
This use case focuses on the coordination of the charging process of an EV to ensure limitations by the grid are considered and optimization goals are met.

Examples for optimization goals associated with a charging process are
- reduction of the electricity costs,
- reduction of the CO_2-footprint,
- grid stabilization (e.g. through demand response setpoints).

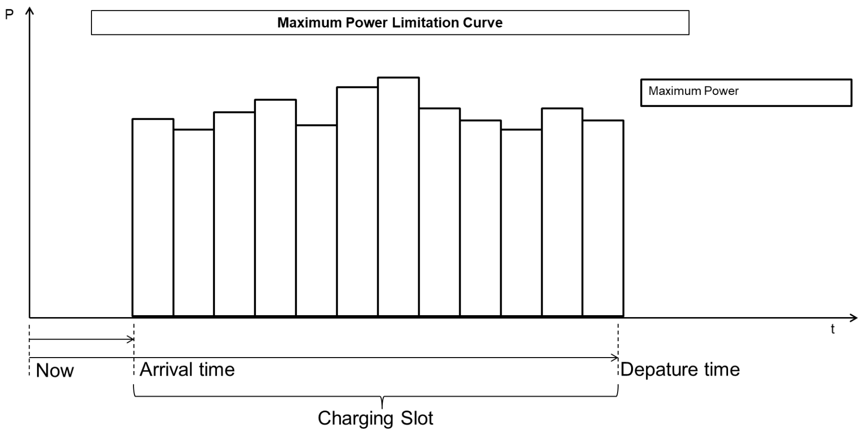
To achieve the goal, an *energy broker* can guide the consumption of an EV through incentives. Additionally, a maximum power limitation (P_{max}) is provided by an *energy guard* to avoid overload situations during EV charging. Both energy broker and guard may be implemented by the CEM.



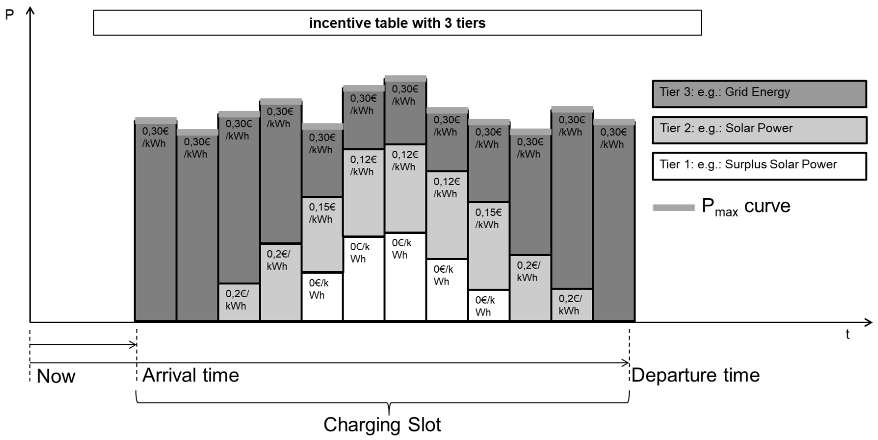
The EV will inform the energy guard and broker about its actual energy demand. This information enables the energy guard and energy broker to provide the maximum power limitation, and to tailor its incentives to the energy demand of the EV.



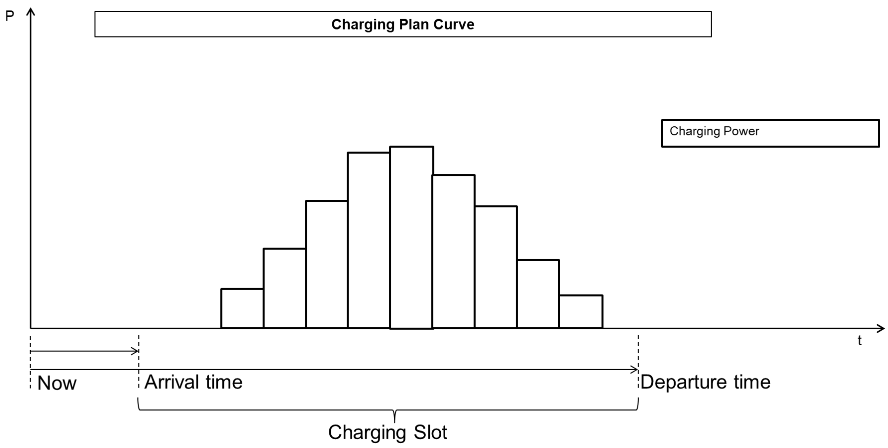
The EV can then request the maximum power limitation (P_{max}) curve. The charging power of the EV needs to stay below the maximum power limitation.



Next, the EV requests incentives from the Energy Broker. These incentives are provided through a table containing time slots with incentivized power contingents. Different kinds of incentives are possible, like price, CO_2 emission, or renewable energy percentage. Generally, there are several types of energy at different costs: costless surplus PV energy (during power curtailment of the PV inverter), PV energy and grid energy.



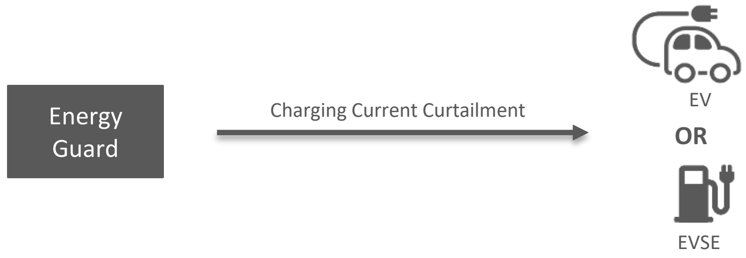
With knowledge of the maximum power limitation and incentives, the EV can generate a cost optimized charging plan. The charging plan is then sent to the energy guard and energy broker. They consider the charging profile in their energy management and adjust other consumers accordingly, if necessary.



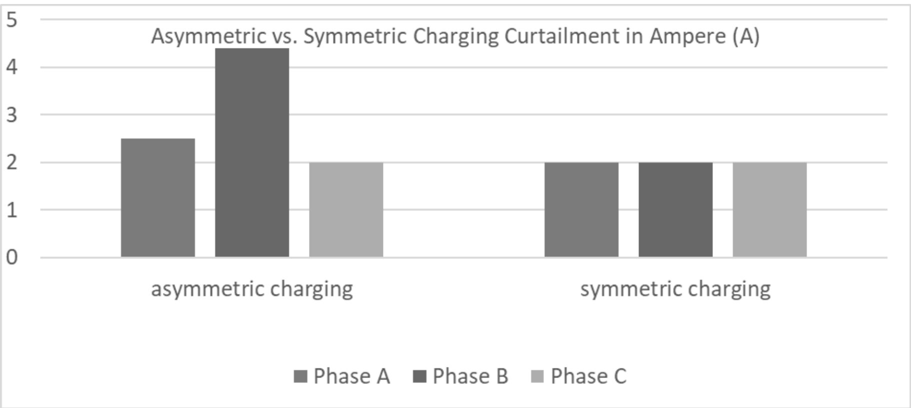
Overload Protection by EV Charging Current Curtailment

This use case aims to prevent an ongoing EV charging process from tripping the fuse of the supply side infrastructure (e.g. mains fuse) by power curtailing the ongoing charging process of an EV by the energy guard. The energy guard may be implemented in the CEM or any kind of control box e.g. FNN.

To avoid an overload situation, the energy guard continuously monitors the power consumption through the according measurement points. It will immediately initiate curtailing of the charging power of the EV if a potential overload at the corresponding circuit breaker is detected. According to technical connection rules, the EVSE must implement the set point within 4s.

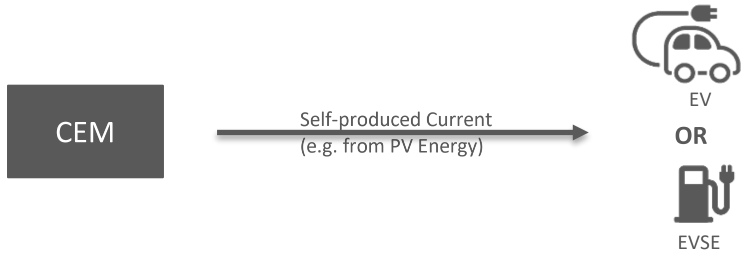


It is recommended to support asymmetric charging to make use of the maximum available power of each phase. If asymmetric charging is not supported, the electric current of all phases needs to be adjusted to the lowest phase. This may lead to a significantly lower charging power, as shown in the figure below.



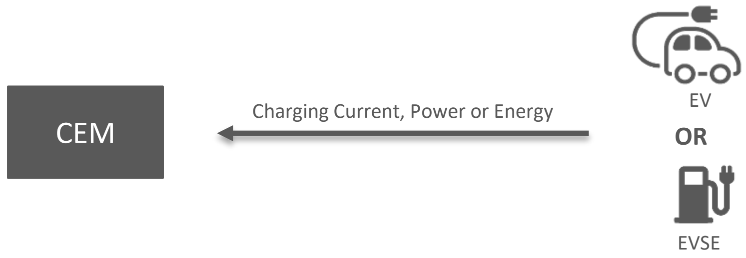
Optimization of Self-Consumption during EV Charging

This use case aims to optimize consumption of self-produced energy (e.g. PV energy) during the EV charging process. In order to operate the EV at low costs, home owners with PV systems should maximize the use of PV energy in EV recharging.
To ensure this, the CEM continuously monitors the self-produced absolute current at according measurement points and immediately provides the available self-produced absolute current to the EV.



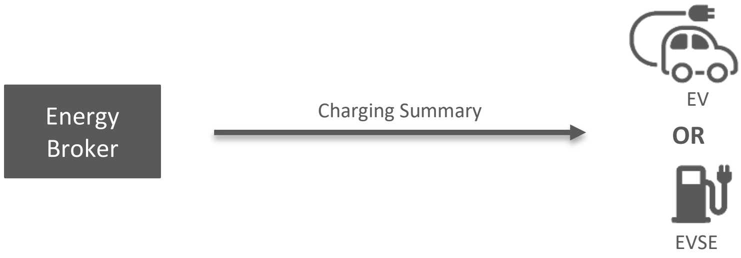
EV Charging Electricity Measurement

This use case aims to continuously monitor the power consumed by the EV charging process to enable the CEM to evaluate the charging power and react accordingly. In order to enable the CEM to calculate power consumption during charging, the EV needs to deliver the measured value of the charging power (symmetric/asymmetric), current (asymmetric) or energy (symmetric). The CEM shall be able to use all 3 values for its calculation. It can, for instance, calculate a new charging current value for overload protection. However, if asymmetric charging is supported, power or current measurements are required on each of the phases.



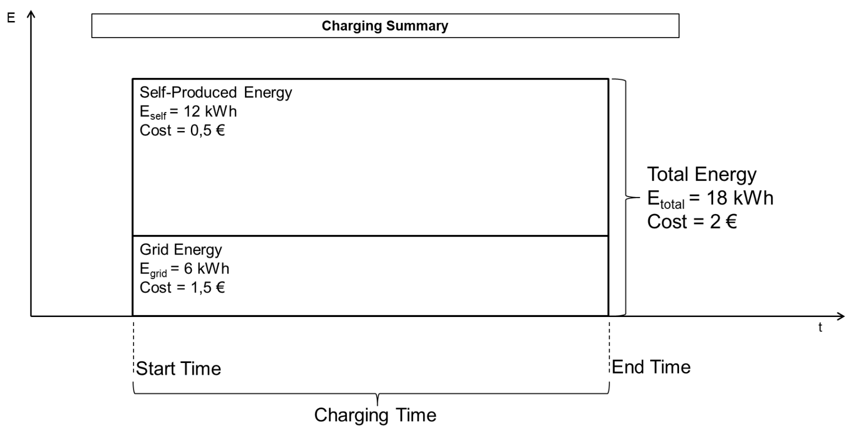
EV Charging Summary

This use case aims to summarize energy consumption and cost of an EV charging process. The charging summary allows the customer to evaluate if cost and energy optimization goals are met. It may also be used for other purposes, such as creating a charging history. However, since it may contain estimated values, it cannot be used for billing purposes.



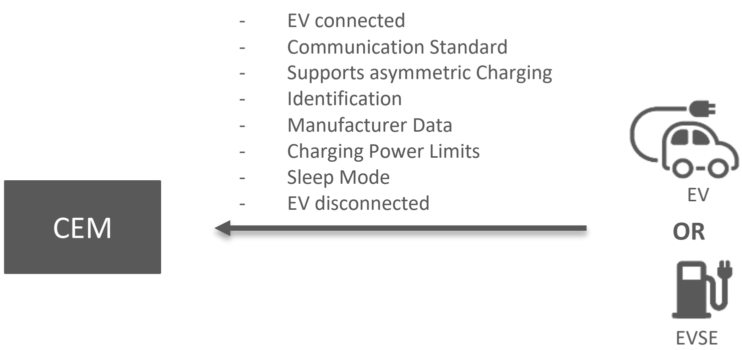
The energy broker continuously monitors the percentage value of the used energy source, as well as the energy costs of the current charging session. During, or at the end of the charging process, the EVSE can request a charging summary.

The charging summary contains the total costs and amount of the charged energy since the EV was connected to the EVSE. It also contains the cost and amount of the self-produced PV energy and the energy that was consumed from the grid.



EV Commissioning and Configuration

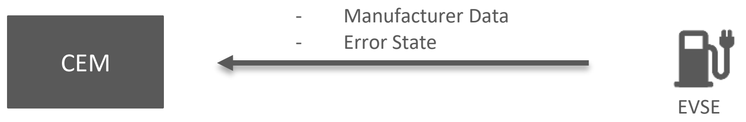
This use case specifies commissioning and configuration processes between the CEM and the EV as the basis for other use cases related to the support of the EV charging process.



The figure above shows a simplified view of data exchange between the EV and the CEM. Typically, the CEM will not communicate with the EV directly, but communicates with the EVSE that the EV is connected to.

EVSE Commissioning and Configuration

This use case specifies the initial setup process between the CEM and the EVSE as basis for other use cases related to the support of EV charging process. For most related use cases, the EVSE typically serves as gateway that transmits the necessary information between the CEM and the EV.



The main part of the commissioning and configuration process is to transmit information from the EVSE to the CEM.

Outlook

The following use cases are in development

- EV State of Charge: enables the CEM to visualize the EV battery's charging status
- Bi-directional EV charging: enables vehicle to home (V2H) and vehicle to grid (V2G) applications
- Fleet EV Charging: allows fleet management in commercial applications
- EV Charging Fallback: allows to configure safety values for the charging process in case the communication to the EV is lost
- RFID/Smart Phone EV User Identification: enables the user identification at the EVSE through RFID or smart phone

Please check www.eebus.org or contact us on info@eebus.org for more information.

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EEBus Initiative e.V.
Butzweilerhof-Allee 4
50829 Cologne | GERMANY
T +49 221 474412 - 28
F +49 221 474412 - 1822

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WWW.EEBUS.ORG