Netherlands Enterprise Agency

ELECTRIC VEHICLE CHARGING

DEFINITIONS AND EXPLANATION

Version: October 2018

CONTENT

1. INTRO

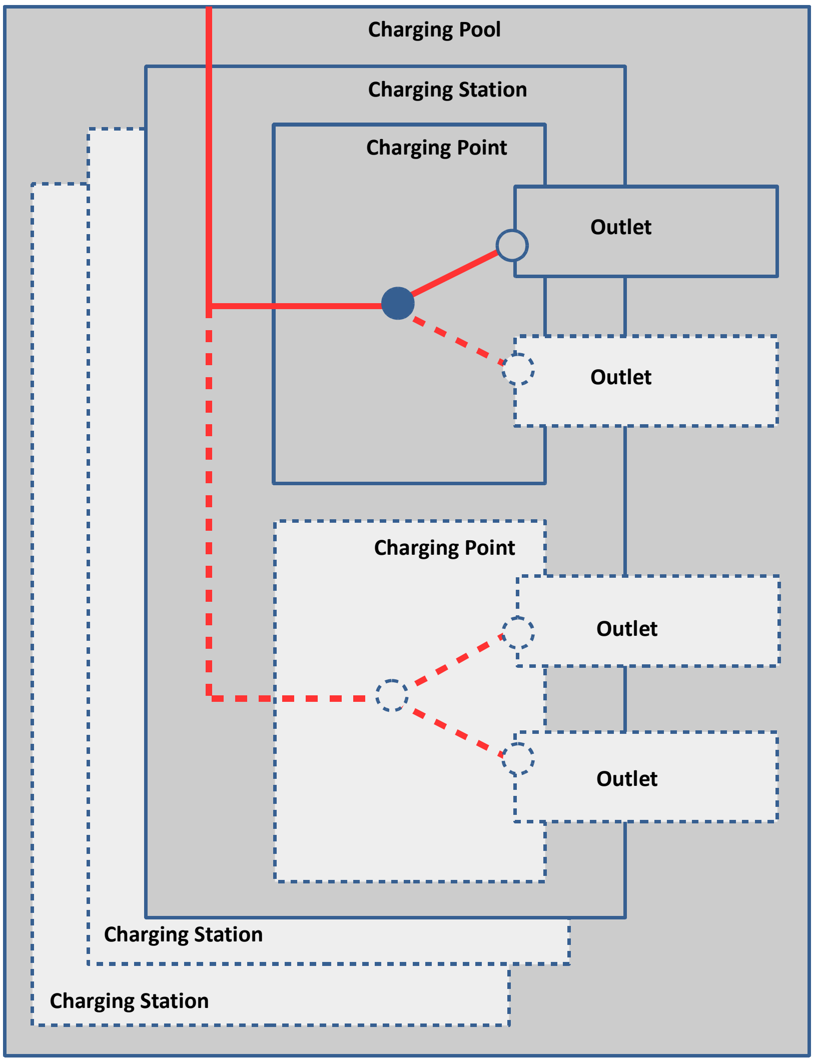
Charging electric vehicles is relatively new and technology develops in a rapid pace. As a result, lots of different terms and definitions are used, often referring to the same phenomenon. This publication enables the reader to familiarize with the relevant terms. These terms are grouped per theme. This publication aims to give clear definitions and explanations on relevant aspects of electric vehicle charging.[i]

This publication has been produced by Netherlands Enterprise Agency (www.rvo.nl) in collaboration with ElaadNL, the knowledge and innovation centre in the field of smart charging infrastructure in the Netherlands (www.elaad.nl) and NKL, the Netherlands Knowledge Platform for Public Charging Infrastructure (www.nklnederland.nl).

This publication will be updated regularly. For the most recent version, go to: https://www.rvo.nl/onderwerpen/duurzaam-ondernemen/energie-en-milieu-innovaties/elektrisch-rijden/publicaties-elektrisch-rijden. There is a version of this publication in Dutch available too. Suggestions for improvements of this publication are welcome. We like to receive your feedback through: elektrischrijden@rvo.nl. Please, mention why in your vision a particular text is incorrect, not clear enough, etc. We appreciate if you supply us with a proposal for a concrete alternative text.

2. CHARGING POOL, -STATION, -POINT, OUTLET…

The EU - Sustainable Transport Forum[ii] gives the following definitions providing us the starting point of this publication.



A charging pool can contain several charging stations

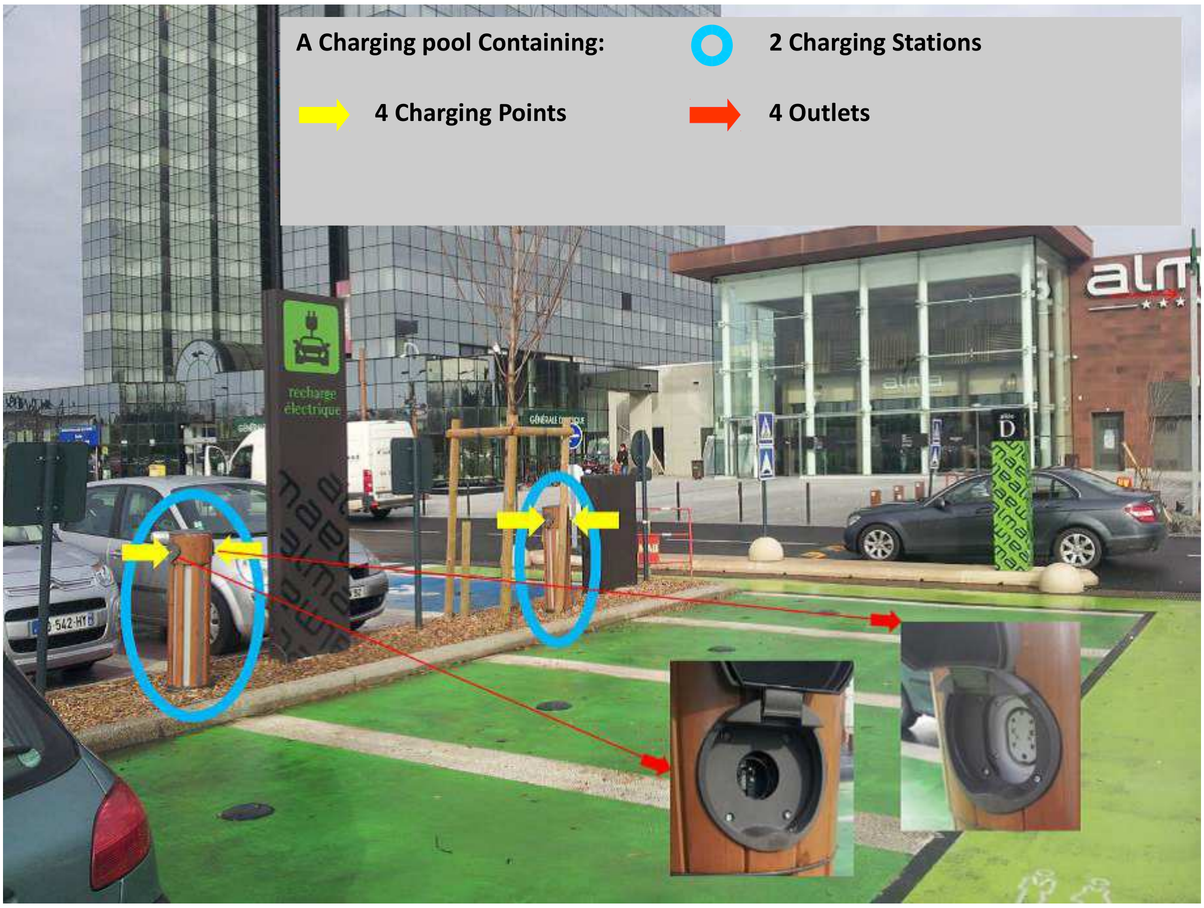
A charging station can contain several charging points

A charging point can contain several outlets

Only one outlet of a charging point can be active (used for EV charging) at a time

A charging pool contains at least:
1 charging station;
1 charging point;
1 outlet.

Here presented in total:
1 charging pool;
3 charging stations;
6 charging points;
12 outlets.



Source: STF, Sustainable Transport Forum; SGEMS, Sub-Group to foster the creation of an Electro-mobility Market of Services

Charging Pool
A charging pool consists of one or multiple charging stations and the accommodating parking lots. The charging pool is operated by one charge point operator (CPO) at one location/address and GPS coordinates[iii]. The charging pool is an object relevant for "cartographic view", guiding tools and all features that represent a charging infrastructure element on a map. A charging pool is defined by: One location/address and GPS coordinates; One charge point operator.

Charging Station / Charging Pole / Charging Dock / Electric Vehicle Charging Station (EVCS)
A Charging Station is a physical object with one or more charging points, sharing a common user identification interface. All the physical "human-machine" interfaces are located at the charging station. Some charging stations have a badge / RFID reader, buttons, displays, LEDs. Other stations are 'Plug & Charge', without buttons, display, etc. A charging station is defined by: One physical object; One user interface.[iv]

Charging Point / Charging Position / Electric Vehicle Supply Equipment (EVSE)
The electric energy is delivered through a charging point. A charging point can handle the charging process of one electric vehicle at a time. A charging point may have one or several outlets (socket) in order to accommodate different connection types (plug, see chapter 3). Only one can be used at the same time. A charging point is defined by: Handling the electric energy delivery; Charging one vehicle at a time.[v]

Charging (station-) Outlet
A charging outlet is a physical interface on the charging station used for the physical connection to the electric vehicle. The outlet can consist of:
(a) a socket on the charging station. The end of the cable that can be connected to the outlet is called a plug;
(b) a connector attached on an inseparable cable to the station (common for fast charging stations).
A charging outlet is defined by: A physical outlet/interface, physical connection.

The physical interface on the vehicle is called an inlet. The end of the cable, that is connected to the inlet on the vehicle, is called a connector[vi].

3. CONNECTION TYPES (OUTLET, PLUG, INLET, CONNECTOR)

The connection types are situated on the vehicle as well as on the charging point. The male and female versions ensure the charging cable can only be connected the correct way.

Type 1 / Yazaki (SAE J1772, IEC 62196-1)
This is the standard Japanese connector for electric vehicle charging in alternating current (also adopted by the north American countries, and accepted by the EU).[vii] It can be used to charge electric vehicle models such as Opel Ampera, Nissan Leaf, Nissan E-NV200, Mitsubishi Outlander, Mitsubishi iMiev, Peugeot iON, Citröen C-Zero, Renault Kangoo ZE (type 1), Ford Focus electric, Toyota Prius Plug in and KIA SOUL.

Type 2 (IEC 62196-2)
This connection type is appointed by the Commission of the European Union as the standard for regular (≤ 22 kW) charging of electric vehicles.[viii] It can be used to charge electric vehicle models such as BMW i3, i8, BYD E6, Renault Zoe, Volvo V60 plug-in hybrid, VW Golf plug-in hybrid, VW E-up, Audi A3 E-tron, Mercedes S500 plug-in, Porsche Panamera and Renault Kangoo ZE.

Combined Charging System (CCS Combo 2)
This connection is the enhanced version of type 2 with additional power contacts for fast charging. CCS is compatible with AC and DC and CCS is the standard for fast charging in Europe since 2017.[ix] Manufacturers such as Audi, BMW, Porsche and Volkswagen incorporate this type of connector.

Type 4 / CHAdeMO
CHAdeMO[x] operates exclusively with DC and can be used for fast charging. It can be used to charge electric vehicle models such as Nissan Leaf, Nissan E-NV200, Mitsubishi Outlander, Mitsubishi iMiev, Peugeot iON, Citröen C-Zero and KIA SOUL.

Tesla Supercharger
Exclusively for Tesla. The Tesla supercharger has the same configuration as the type 2 connection, however slightly modified, so it doesn't fit in the standard type 2 outlet.

4. CHARGING CAPACITY, SPEED AND LOAD BALANCING

Charging time depends on different factors such as the capacity of the vehicle battery and the power and settings of the charging station. Charging time is expected to decrease rapidly in the coming years.

Regular power charging point
A charging point that allows for a transfer of electricity to an electric vehicle with a power less than or equal to 22 kW.

High power charging point
A charging point that allows for a transfer of electricity to an electric vehicle with a power of more than 22 kW.[xi]
A very common fast charger delivers 50 kW. Development of fast charging is ongoing and nowadays there are fast chargers delivering 175 kW and some even 350 kW.

Load balancing / Charging plaza
A charging plaza[xii] consists of several charging points that share a single connection to the electricity network. The charging plaza allocates the available capacity to the charging sockets based on the demand at a given time, allowing electric vehicle drivers to charge their vehicles optimally. This is referred to as "load-balancing". Charging speed is adjusted automatically as soon as maximum capacity is reached.

5. ALTERNATING CURRENT (AC) / DIRECT CURRENT (DC) CHARGING

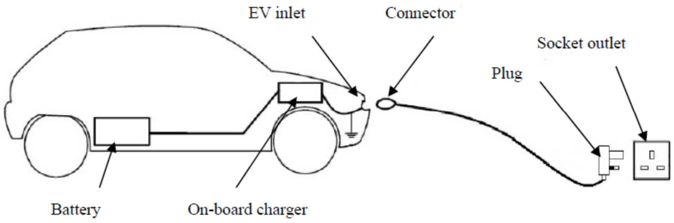
DC charging
Converting AC from the grid into DC, needed for charging the battery, takes place outside the vehicle in the charging point. Direct current (DC) enables the charging point to charge at high power (> 22 kW). The charging point has direct contact with the car battery.

AC charging
Converting AC from the grid into DC, needed for charging the battery takes place in the vehicle. The capacity of the AC-DC converter in the car determines how much of the available charging capacity of the charging station can be utilized. AC-charging usually comes with slower charging speed (however AC fast charging is possible (> 22 kW)).

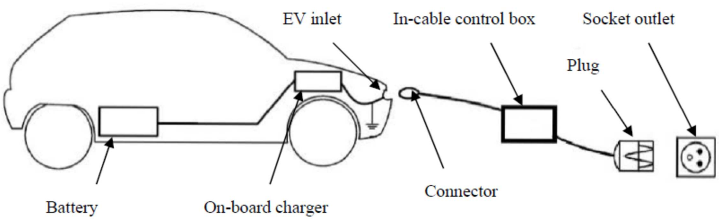
6. CHARGING MODES

The concept of 'mode' refers to charging technique (capacity, communication, safety). Four charging modes are being distinguished[xiii]:

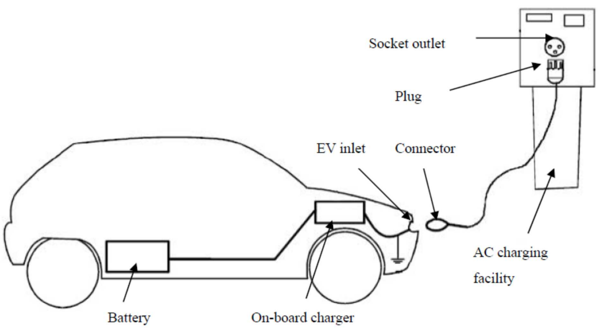
Mode 1 means charging at a regular 230 Volts socket (AC). This charging method lacks communication, hence safety. Therefore (by norm IEC 61851-1) in mode 1 the charging capacity is limited to max. 2.3 kW (1-phase, 10A).



Mode 2 entails charging through a cable with an In-Cable Control Box (ICCB)[xiv]. Mostly at a regular 230 Volts socket or at a home charging station (AC). In practise the maximum charging capacity is 2.3 kW (1-phase, 10A) but in mode 2 a charging capacity of max. 7.4 kW can be (1-phase, 32A) or 22 kW (3-phase, 32A) delivered (the charging capacity is being controlled by the ICCB).

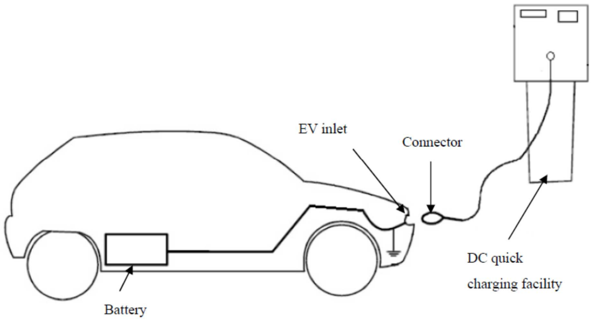


In **Mode 3** the adequate charging capacity (AC) is determined by communication between charging station and vehicle. In most cases the public mode 3 charging stations deliver 11 kW, 22 kW or sometimes 43 kW (>22 kW = fast charging).



In mode 1, 2 and 3 the charging takes place through the converter in the vehicle (AC from the charging station to DC in the vehicle battery) and the charging process is being controlled by the vehicle. The capacity of the converter determines how much of the available charging capacity of the charging station can be utilized.

Mode 4 is DC-charging and is mainly being applied for fast charging[xv]. The conversion from AC to DC takes place in the charging station. Hence, no use is being made of the converter in the vehicle. The cable is inseparable linked to / integral part of the charging point. The charging capacity delivered varies mostly from 50 kW to 120 kW (higher capacities are being developed).[xvi]

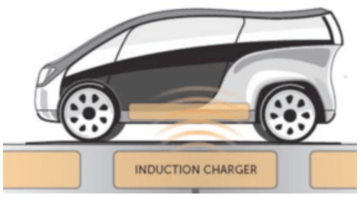


7. OTHER FORMS OF ELECTRIC VEHICLE CHARGING

Besides the already described charging with the use of cables, there are other forms of electric vehicle charging available: Induction charging and charging through a pantograph.

Induction charging / Wireless charging / Plug less charging

Through electromagnetic fields, the current is transferred to the car.[xvii] The field starts charging when the electric car is parked at the charging point. The car drives over an induction plate located in the road surface of a parking space. Charging can be started with the aid of an app. This technology is still in development and it is not clear when the consumer market will be able to use this technology.[xviii] In addition to wireless charging in parking spaces, work is also being carried out on technologies which will enable electric cars to be charged whilst being driven.



Pantograph

A Pantograph can either be on the vehicle or on the charging point.
Pantograph up (pantograph on vehicle) is comparable to the systems used on trains and trams. Power line communication is possible and doesn't entail cyber security risks. The pantograph could also be used for depot charging. Relatively cheap and light hoods are needed on the ceiling of the depot.
Pantograph down (pantograph on charging point): The vehicle has a contact point only. The Pantograph is located on the charging point. This means that the vehicle has less weight and a favourable centre of gravity. Wifi ensures communication between vehicle and charging infrastructure, this signal needs to be well-secured.[xix]

Opportunity charging

'Opportunity charging' refers to charging a vehicle at its stop- and end location. It is mainly used for charging electric buses, but could be interesting for other electric vehicles as well. Charging occurs by means of an induction system or pantograph.

8. ACCESSIBILITY

Charging point accessible to the public

A charging point which provides 24/7, non-discriminatory access to users. Non-discriminatory access may include different terms of authentication, use and payment (Directive 2014/94/EU, art. 2.7).[xx]

A charging-parking spot is the space that is intended as a parking spot for your car while it is being charged. Cars other than electric vehicles or electric vehicles that are not being charged are not allowed to use this parking spot. There's not always a dedicated parking spot per charging point available. This depends on the local policy.

Semi-public charging points
Semi-public charging points are accessible to all, but there may be restricted public access to them because of parking or opening times. Examples include charging points in underground car parks, at hotel and catering establishments or service stations. There may be restrictions on use, such as the requirement to make use of the associated facilities.

Private charging points / Home charger
Private charging points are installed on a private site and connected to a private electricity supply.[xxi] These charging points are often not accessible to electric cars other than those belonging to the owner of the charging point.

Charging at workplaces
This is considered as private charging and occurs when companies install charging points for use by employees (and clients) on business premises.

9. SMART CHARGING

Smart charging[xxii] is charging an electric vehicle that can be externally controlled (i.e. “altered by external events”), allowing for adaptive charging habits, providing the electric vehicle with the ability to integrate into the whole power system in a grid- and user-friendly way. Smart charging must facilitate the security (reliability) of supply while meeting the mobility constraints and requirements of the user.

Grid-to-vehicle (G2V)
Grid-to-vehicle-technology enables vehicles to charge at varying capacities, depending on energy availability. Electric vehicle batteries can be charged in a smart way to prevent peak loads on the grid. This can be based on energy demand and available capacity on a local level. The vehicle to grid technology determines when, and at which capacity, the vehicle will be charged.[xxiii]

Vehicle-to-grid (V2G)
Vehicle-to-grid-technology enables vehicles to feed electricity back into the grid.[xxiv] The battery in the vehicle can be used as a buffer to store energy in times of high (sustainable) energy production, but also to act as an energy supplier in times of low (sustainable) energy production. Vehicle-to-grid technology contributes to optimizing sustainable energy usage.

10. PARTIES / INSTITUTIONS / ACTORS

EV driver
The EV driver is the electric vehicle driver. The consumer who currently is driving the car and needs to charge it to be able to drive it.

Charge Point Operator (CPO)
The CPO is responsible for the management, maintenance and operation of the charging stations (both technical and administrative). The role of CPO can be segmented into 1. CPO responsible for the administrative operation (e.g. access, roaming, billing to MSP etc.) and 2. CPO responsible for the technical maintenance, which is often done by the manufacturer. Sometimes the CPO is also called a Spot Operator.

Charge location owner
This is the owner of the charge location and often the owner of the charge point. Depending on the location (public, private) the energy is purchased by the charge location owner or by the charge point operator.

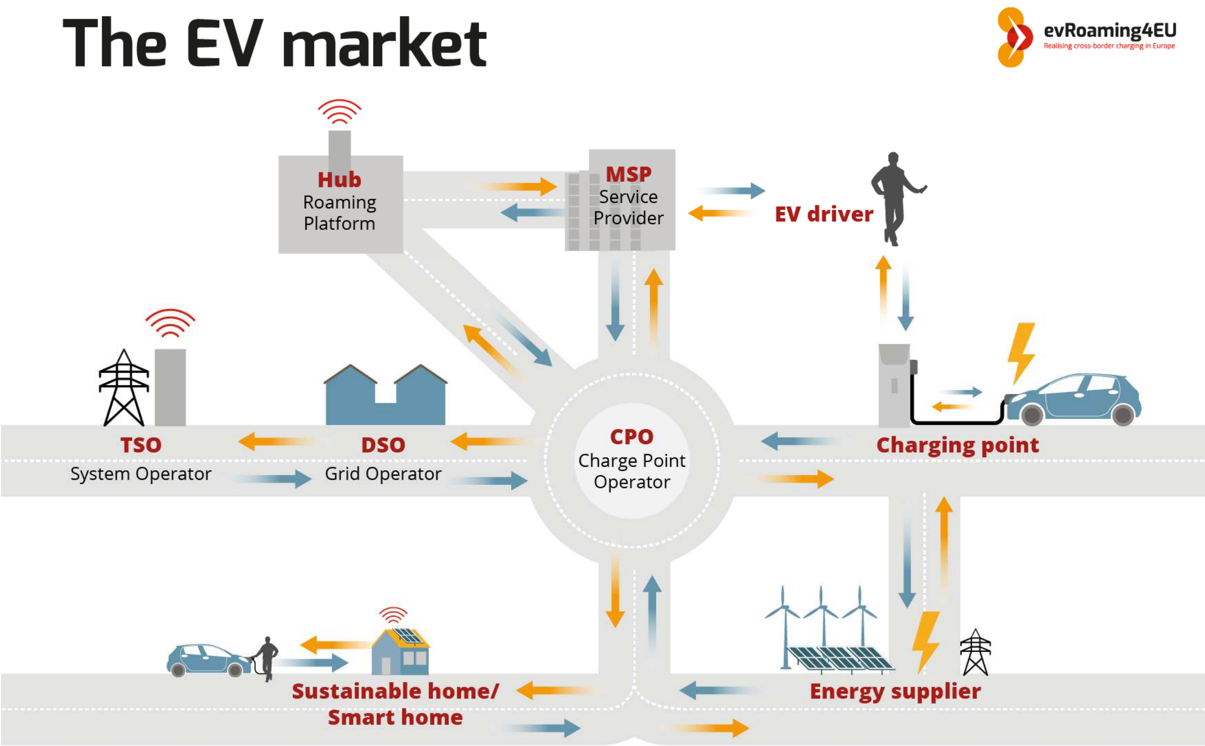
Energy supplier
The energy supplier offers the energy for the electric car via (public) charging points. There are various suppliers who produce energy or buy energy themselves.

Regional Grid Operator - Distribution System Operator (DSO)
The organization that designs, operates and maintains the public distribution medium and low voltage grid through which charging spots are supplied. The charging spots are connected to a private grid (home, building, installation site…) connected to DSO grid.[xxv]

eMobility Operator – Mobility Service Provider (MSP or EMP)
The entity with which the EV driver has a contract for all services related to the EV operation. Typically the eMobility operator will include some of the other actors, like an energy provider or a CPO, and has a close relationship with the distribution system operator and meter operator. A car manufacturer or utility could also fulfil such a role. The eMobility operator authenticates contract IDs from its customers received either from the eMobility operator clearing house, CPO or other eMobility operators it is in relation with.[xxvi]

Roaming Platform
A central organization that facilitates information exchange between multiple market players. Roaming platforms connect different market players to create a digital and cross-border charging network for electric vehicles.

Transport System Operator (TSO)
A party that is responsible for a stable power system (high voltage) operation (including the organization of physical balance) through a transmission grid in a geographical area. The System Operator will also determine and be responsible for cross border capacity and exchanges. If necessary he may reduce allocated capacity to ensure operational stability.[xxvii]



11. CHARGING PROTOCOL / CHARGING DATA

11.1 Charging protocol general

OCPP - Open Charge Point Protocol/ Open Charge Alliance
The Open Charge Point Protocol (OCPP) has been designed and developed to standardize the communications between an EV charge point and a central system, which is used for operating and managing charge points. The communication protocol is open and freely available to ensure the possibility of switching from charging network

without necessarily replacing all the charging stations or significant programming, including their interoperability and access for electric grid services. The protocol is intended to exchange information related to transactions and for operating a charge point including maintenance. It can also be used for schedule-based EV charging. For Roaming OCPP provides technical access to the charge point and facilitates forwarding of transactions to the E-mobility Operator/ Mobility Service Provider. More information: www.openchargealliance.org/protocols/ocpp/ocpp-20.

Open ADR – Open Automated Demand Response Standard / OpenADR Alliance
The protocol is aimed at automating demand response communication, it supports a system and/or device to change power consumption or production of demand-side resources. This can, for example, be done based on grid needs, either by means of tariff and/ or incentives or emergency signals that are intended to balance demand to sustainable supply. The OpenADR protocol specification profiles A and B are publicly available at no cost from: www.openadr.org.

OSCP - Open Smart Charging Protocol/ Open Charge Alliance
The Open Smart Charging Protocol communicates forecasts of the available capacity of the electricity grid to other systems. The protocol is based on a budgetary system where client systems can indicate their needs to a central system, which guards against overuse of the grid by handing out budgets per cable. If a system requires more it can request more, if it requires less it can hand back part of its budget, to be available for other systems. The OSCP protocol is publicly available at no cost from: www.openchargealliance.org/protocols/oscp/oscp-10.

IEC 61850/ IEC
The IEC 61850-90-8 document is not a protocol in itself. It is a technical report which describes an object model for electric mobility. It models Electric Vehicles as a specific form of Distributed Energy Resource according to the paradigms defined in IEC 61850. The IEC 61850 specification is publicly available at limited cost from the website of IEC: www.iec.ch/dyn/www/f?p=103:23:0::::FSP_ORG_ID:1255.

11.2 Charging protocol roaming

EV ROAMING
EV Roaming enables EV drivers to charge at each charging station and manages the billing of the charge action towards the driver. Condition is an open charging infrastructure for electric drivers. It means a shared use of charging infrastructure, independent of technology, without fiscal and legal obstacles.[xxviii]

OCPI - Open Charge Point Interface protocol/ NKL Nederland
OCPI is an independent roaming protocol that makes it easy to exchange data. It can be used both by companies (peer-to-peer) and via a roaming hub or platform.
The protocol is supported internationally. With OCPI EV drivers get an insight into the availability and costs of charging points. OCPI protocol is publicly available at no cost via NKL Nederland. OCPI development is co-funded by the projects evRoaming4EU and ECISS, which receive EU and NL subsidies. More information: www.nklnederland.nl and www.evroaming4.eu.

OCHP - Open Clearing House Protocol/ e-clearing.net
The Open Clearing House Protocol (OCHP) is a protocol which is meant for exchanging authorization data, charging transaction and charge point information data for roaming via the e-clearing.net platform. The protocol consists of 2 parts:

1. A part that is specifically for communication between market parties and an EV clearing house;
2. A part that is for peer to peer communication between market parties, this is called OCHPdirect. The OCHP is publicly available at no cost. More information on: https://e-clearing.net.

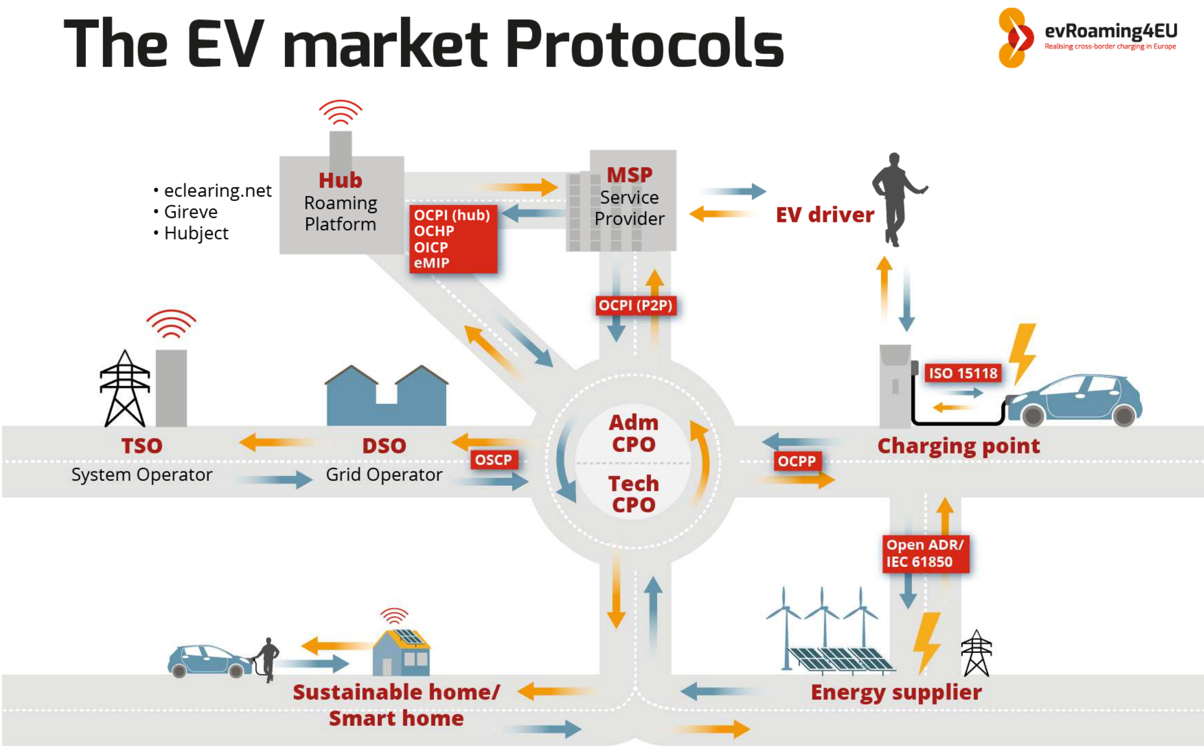
eMIP – eMobility Intoperation Protocol / GIREVE
The eMobility Interoperation Protocol, called eMIP, is provided by GIREVE as part of his main business objective: “open access to vehicle charging stations”. eMIP targets two goals:

1. enabling roaming of charging services by providing a charge authorisation;
2. a data clearing house API and providing access to a comprehensive charging point database.

The eMIP protocol is publicly available at no cost. More information: www.gireve.com/wp-content/uploads/2017/02/Gireve_Tech_eMIP-V0.7.4_ProtocolDescription_1.0.2_en.pdf.

IEC 63119/ IEC
IEC 63119 is a standard that is currently being developed : Information exchange for Electric Vehicle charging roaming service. It contains of four parts: Part 1: General – aimed publication date August 2019, Part 2: Use Cases, Part 3: Message structure, Part 4: Cybersecurity and information privacy. All last three parts have aimed publication date March 2022. More information: www.iec.ch/dyn/www/f?p=103:23:0::::FSP_ORG_ID:1255.

OICP - Open InterCharge Protocol/ Hubject
The Open InterCharge Protocol (OICP) is a roaming protocol which can be used to communicate with the Hubject B2B Service Platform.This platform enables exchanging roaming messages between an EMSP and a CPO. The protocol consists of two parts that together create the protocol: a separate part for the EMSP and a separate part for the CPO. The OICP protocol is publicly available at no cost. More information on: www.hubject.com/en/downloads/oicp (Roaming Hub).



12. PLATFORMS AND PROJECTS

The knowledge and innovation centre in the field of smart charging infrastructure in the Netherlands: ElaadNL
Through their mutual involvement via ElaadNL, the grid operators prepare for a future with electric mobility and sustainable charging. It is the mission of ElaadNL to make sure that everyone can charge smart. ElaadNL monitors the EV-charging infrastructure and coordinates the connections between public charging stations and the electricity grid.[xxix]

The Netherlands Knowledge Platform for Public Charging Infrastructure EV: NKL
NKL is the platform where government, knowledge institutions and companies come together to achieve affordable public charging of electric vehicles. NKL stimulates development in the public charging sector, facilitate innovative projects, support various initiatives and ensure the exchange of knowledge. In the process, NKL strengthens the position of the Netherlands in the public charging sector. NKL's current programs: 1. Sector Optimization, 2. Protocols and Standards and 3. Smart Charging.[xxx]

eViolin
eViolin is the branch organisation for EV charging infrastructure organisations in the Netherlands. eViolin manages and promotes the interoperability and usability of EV charging stations from different operators and service providers.[xxxi]

Living Lab Smart Charging
The Living Lab Smart Charging is an open platform which facilitates the development of Smart Charging and related concepts. In the Living Lab Smart Charging, partners work under equivalent conditions on researching and testing Smart Charging. The platform encourages collaborations and tries to connect parties given their common aim to develop Smart Charging and to make charging infrastructure actually smart. The ultimate goal of the Living Lab Smart Charging is: Driving on solar and wind energy in the Netherlands.[xxxii]

evRoaming4EU
This NKL project is a collaborative partnership between four countries (Denmark, Germany, Austria and the Netherlands) to facilitate roaming services and provide transparent information about charging in Europe through the use of the open independent OCPI protocol. Local and international partners, suppliers and electric vehicle drivers are welcome to contribute to the project and share knowledge and experiences. The project's ultimate goal is to enable all electric vehicle drivers to charge hassle-free anywhere in the EU. The Dutch partners of evRoaming4EU are NKL – Netherlands knowledge platform for charging infrastructure, Eindhoven University of Technology and MRA-Electric.[xxxiii]

Word of thanks

We are very thankful to the people who gave input and feedback on previous versions of this document:
- ElaadNL: Nazir Refa, Martijn Ockers, Bram van Eijsden, Klaas van Zuuren, Rutger de Croon, Lonneke Driessen, Arjan Wargers, Baerte de Brey, Eric van Kaathoven;
- NKL: Roland Ferwerda, Nicole van der Schraaf;
- Allego: Koen Schröder, Jan Wieling;
- Fastned: Pepijn Vloemans;
- Ministerie Economische Zaken en Klimaat: Bastijn Ravenshorst, Marten Hamelink;
- Hogeschool van Amsterdam: Robert van den Hoed, Simone Maase, Rick Wolbertus;
- Eco-Movement: Roderick van den Berg;
- Rijkswaterstaat: Simon Lubach, Gerben Passier;
- Rijksdienst voor Ondernemend Nederland: Suzan Reitsma, Sonja Munnix, Thijs Duurkoop.

Bibliography and remarks

[i] Focus Group on European Electro-Mobility Standardization for road vehicles and associated infrastructure Report in response to Commission Mandate M/468 concerning the charging of electric vehicles Version 2 – October 2011: "Although standards and other documents drafted by different bodies - be they in ISO, IEC, UNECE or other bodies - do use the same or similar terms, the related definitions are sometimes different or even conflicting, which may lead to misunderstanding. While deciding on exact terms and definitions is beyond the scope of the Focus Group, it strongly recommends that terms and definitions be harmonized urgently." https://www.cencenelec.eu/standards/Sectors/Transport/ElectricVehicles/Pages/default.aspx (CEN and CENELEC = European Standardization Organizations www.cencenelec.eu)…"For charging infrastructure, many different definitions are used in different countries to describe the power level and the physical situation: rapid chargers, slow chargers, fast chargers to name a few terms for power levels (which are interpreted in different ways as well); station, plug, position, points, locations to name a few descriptions." http://www.eafo.eu/content/faq-0

[ii] STF: Sustainable Transport Forum, SGEMS: Sub-Group to foster the creation of an Electro-mobility Market of Services, Deliverable 1.2, Version V022, SGEMS D1.2 Team, 31/10/2016

[iii] http://nklnederland.nl/uploads/files/OCPI_2.0.pdf: A Location is typically the exact location of one or more EVSEs, but it can also be the entrance of a parking garage or a gated community. It is up to the CPO to use whatever makes the most sense in a specific situation. Once arrived at the location, any further instructions to reach the EVSE from the Location are stored in the EVSE object itself (such as the floor number, visual identification or manual instructions).

[iv] It becomes confusing when people use the term 'charging station' as an equivalent of a petrol station: a location with several petrol pumps. Unlike that interpretation we consider 'charging station' equivalent to a single petrol pump (with several charge points, equivalent to several refuelling hoses).

[v] Conform http://nklnederland.nl/uploads/files/OCPI_2.0.pdf we reckon the term 'Electric Vehicle Supply Equipment' (EVSE) as synonym of 'Charging Point'. The terms 'charging point' and 'charge point' are both being used in many sources. In this document we use the term 'charging point'.

[vi] In several publications the term 'connector' is being used as the connection to the charging station outlet as well as the connection to the vehicle inlet. But those 'connectors' are not the same and a 'connector' that fits in an outlet does not fit in an inlet end vice versa.

[vii] https://en.wikipedia.org/wiki/SAE_J1772

[viii] https://en.wikipedia.org/wiki/Mennekes, https://en.wikipedia.org/wiki/Type_2_connector

[ix] https://en.wikipedia.org/wiki/Combined_Charging_System In The Netherlands the maximum charging capacity of this connection type is 50 kW (DC). New fast charging stations are being developed and deployed with charging capacities up to 350 kW.

[x] https://en.wikipedia.org/wiki/CHAdeMO

[xi] http://eur-lex.europa.eu/legal-content/EN/ALL/?uri=celex%3A32014L0094 https://eur-lex.europa.eu/legal-content/NL/TXT/PDF/?uri=CELEX:32014L0094&from=EN

[xii] https://www.arnhemaan.nl/mijn-buurt/arnhem-centrum/eerste-openbare-laadplein-nederland, https://www.allego.eu/companies/smart-charging/?sl=eu

[xiii] See: https://en.wikipedia.org/wiki/IEC_62196; Source of the illustrations: https://www.emsd.gov.hk/filemanager/en/content_444/Charging_Facilities_Electric_Vehicles.pdf

[xiv] Sometimes the term 'IC-CPD: In-Cable Control- and Protecting Device' is being used.

[xv] Not exclusively. There also exist mode 4 DC stations that deliver 10 kW.

[xvi] Mode 4 with much lower charging capacity (i.e. 22 kW) do exist but are rare.

[xvii] Gemeente Rotterdam: Pilot Wireless Charging elektrische auto's, november 2016, http://www.elaad.nl/uploads/downloads/downloads_download/Final_report_Pilot_Wireless_Charging_Rotterdam.pdf

[xviii] The Ministry of Economic Affairs, April 2017, p.14: Vision on the charging infrastructure for electric transport looking ahead to 2035; https://www.rvo.nl/sites/default/files/2015/06/Rapport%20Inductieladen%20(ENG)%2015-05-12%20.pdf

[xix] https://www.elaad.nl/uploads/downloads/downloads_download/ElaadNL_Marktverkenning_Elektrische_Bussen_november_2017.pdf

[xx] http://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:32014L0094

[xxi] The electric current is taken from the group box and the maximum power is therefore dependent on the fuse used therein. The capacities range from 3.7 to 22kW.

[xxii] https://s3.eu-central-1.amazonaws.com/z3r2zxopa4uuqpw5a4ju/livinglab/files/Smart%20Charging%20boek/170701_Book%20Smart%20Charging%20UK-WEB.pdf, https://www.livinglabsmartcharging.nl/nl/slim-laden, https://www.livinglabsmartcharging.nl/en/Smart-Charging

[xxiii] https://nederlandelektrisch.nl/technologie/opladen/g2v-grid-to-vehicle

[xxiv] See for example: https://newmotion.com/en/drive-electric/v2g-charging-next-generation-technology, http://www.amsterdamvehicle2grid.nl/
[xxv] Source: eMI3 Standard V1 Terms and Definitions (http://emi3group.com/documents-links/)
[xxvi] Source: eMI3 Standard V1 Terms and Definitions (http://emi3group.com/documents-links/)
[xxvii] Source: eMI3 Standard V1 Terms and Definitions (http://emi3group.com/documents-links/)
[xxviii] Source: eMI3 Standard V1 Terms and Definitions (http://emi3group.com/documents-links/)
[xxix] https://www.elaad.nl/about-us
[xxx] https://www.nklnederland.com
[xxxi] http://www.eviolin.nl, https://www.rvo.nl/sites/default/files/2016/05/Brochure_E-mobility_in_The_Netherlands_WT_accessible_web.pdf
[xxxii] https://www.livinglabsmartcharging.nl/en/About-us/FAQ
[xxxiii] https://www.nklnederland.com/news/evroaming4eu-selected-for-funding-eme-call/

This is a publication of:
Netherlands Enterprise Agency
Croeselaan 15 | 3521 BJ Utrecht
PO Box 8242 | 3503 RE Utrecht
T +31 (0) 88 042 42 42
E: klantcontact@rvo.nl
www.rvo.nl

Publication number: RVO-169-1801/RP-DUZA

Editor: William Visser

NL Enterprise Agency is a department of the Dutch ministry of Economic Affairs and Climate Policy that implements government policy for agricultural, sustainability, innovation, and international business and cooperation. NL Enterprise Agency is the contact point for businesses, educational institutions and government bodies for information and advice, financing, networking and regulatory matters.

Netherlands Enterprise Agency is part of the ministry of Economic Affairs and Climate Policy.