Nationale Agenda Laadinfrastructuur

Smart Charging Requirements (SCR)

NAL Working Group Smart Charging

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This document gives substance to one of the agreements that is being implemented within the NAL Smart Charging working group and concerns the commitment that in the period up to 2030 only charging infrastructure will be rolled out that is Smart Charging Ready (agreement k in chapter 3 of the NAL).

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Introduction

National Agenda Charging Infrastructure (NAL)

The Netherlands has great ambitions in making mobility more sustainable. An important condition is that mobility remains affordable and that the burden of the transition to sustainable mobility is distributed fairly, so that all Dutch people can make the transition to zero-emission vehicles. The focus is currently on electric passenger transport. The preconditions are: charging an electric car must be just as user-friendly and reliable as charging a mobile phone.

An integral part of the Climate Agreement presented in 2019 is the National Agenda for Charging Infrastructure (NAL). The NAL's ambition is to ensure that the charging infrastructure does not form a barrier to the roll-out of electric transport. The use of smart charging must ensure a stable electricity system in which optimal use can be made of renewable energy and its advantages for EV drivers. This will accelerate the roll-out of charging infrastructure in the period up to 2030.

One of the agreements in the NAL is that in the period up to 2030, only 'Smart Charging Ready' charging infrastructure will be rolled out. The Smart Charging Requirements (SCR) aim to provide an unambiguous definition of "smart charging ready". The SCR describe the technical conditions for making smart charging possible. This concerns the vehicle, the charging cable, the charging point and the electricity installation, the metering device and the grid connection.

Establishment

The SCR was established through the active participation of interest groups and stakeholder experts. The starting point of the SCR are the smart charging requirements that have already been requested in recent years in The Netherlands through public tenders. An analysis of the public tenders shows that in the Netherlands, the majority of the rolled out infrastructure is already fit for Smart Charging and that many pilots are already being carried out in which Smart Charging is the starting point. However, there is a need for a uniform market standard for Smart Charging, so that future developments of Smart Charging can be applied as much as possible to the infrastructure yet to be rolled out.

The requirements have been further supplemented by members of the NAL core team Smart Charging. The core team members represent interest groups with a wide range of consumers and organizations among their followers: car manufacturers, (sustainable) energy suppliers, charging station operators, charging station manufacturers, logistics, national and local governments, network operators, (electric) drivers and mobility service providers.

The SCR was subsequently reviewed by a broad group of stakeholder experts. The stakeholder experts were invited on the recommendation of the constituencies of the core team members to participate in so-called expert sessions. During six expert sessions, more than 40 stakeholder experts from more than 25 organizations participated in the review of the SCR. In addition, various organizations have taken advantage of the option to provide written feedback. All feedbacks have been processed in conjunction in the current version of the SCR.

Smart charging

Charging electric vehicles is still relatively new and the technology and organization surrounding electric transport is still in full development. This has resulted in all kinds of new terms. The Netherlands Enterprise Agency (RVO) has compiled a list of definitions which is published in the report "Charging electric vehicles". On the basis of this publication, smart charging is defined as follows:

Smart charging is a term used to indicate that smart techniques can control the charging transaction remotely. This means that electric vehicles are charged at the most optimal time, seen from the perspective of the e-driver, the charging station operator or the grid operator. For example, when one or more of the points below apply:

- High supply of renewable energy.
- Sufficient capacity on the electricity network.
- Low electricity prices.

When one or more of the above mentioned points does not apply, there is a less optimal moment. This means that electric cars do not charge or charge more slowly. The primary purpose of charging infrastructure is taken into account as much as possible: to provide electric vehicles with electricity.

Scope of the Smart Charging Requirements

Over the past ten years, a lot of experience has been gained with smart charging and The Netherlands has acquired a worldwide recognized and leading position in the field of smart charging. This document is the first to bundle all knowledge and experience into an integrated set of requirements and conditions for smart charging: the Smart Charging Requirements.
The Smart Charging Requirements have the following scope:

- **Destination Charging (including charging at work and at home)**[1]
  Applies to charging sessions where the connection time is usually longer than the charging time. The SCR does not distinguish between charging power and charging technology (AC / DC).
- **All charging locations**[2]
  Applicable in public spaces and on private land, including the possible setups such as a charging point, a charging station and a charging plaza (incl. Master-slave setup).
- **All electric passenger vehicles**[3]
  Applicable to all electric passenger vehicles.
- **All types of optimalizations**
  Applicable to all smart charging sessions, regardless of the optimization goal, with associated (information) services.

[1] Fast charging next to highways and opportunity charging of trucks and buses are oute of scope because the connection time there is usually the same as the chjarging time and charging happens at very high powers.
[2] By means of Modules it is pointed out which requirements are applicable for which locations.
[3] Buses, trucks and Light Electric Vehicles are out of scope in the current version

An important aspect of Smart Charging is the communication between different actors in the charging chain. There are different routes that can be used for this, and also different languages with which the actors "talk" to each other. In addition, it is important that this communication is secure. Open standards and protocols play an important role here.
The Smart Charging Requirements describe guidelines that are necessary for the application of smart charging via various routes.

The various routes are shown schematically in the figure below.

- The Control System connected to the electric vehicle can be a back-end of an Automotive or a fleet manager application or a (3rd party) driver application.
- The Control System connected to the charging point can be a back-end of the CPO, or a (local) Energy Management System or a (third party) application.
- Based on the use cases that are agreed between parties and the interaction that takes place between parties, certain protocols may or may not be applied or adjusted.

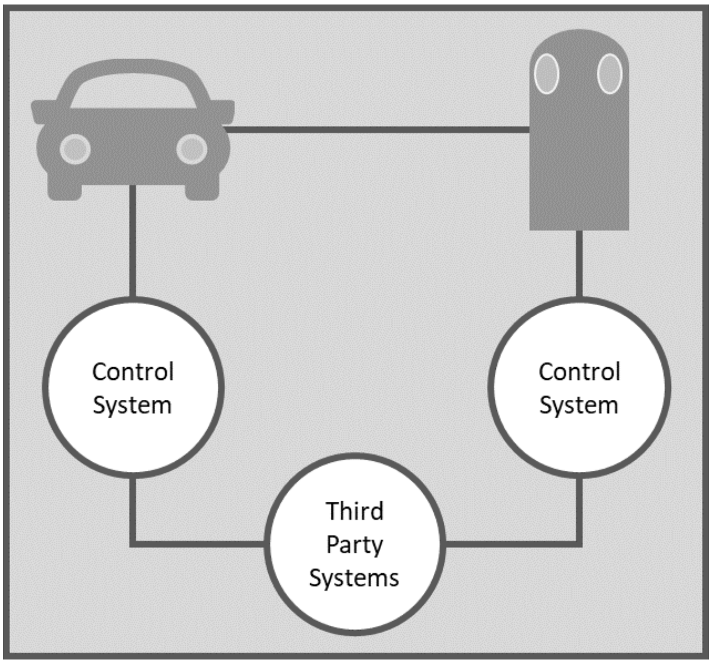

Figure 1.Schematic representation of communication routes

The requirements in the SCR are a bundling and clarification of the general and safety requirements that already apply to the charging of electric vehicles. This concerns communication protocols to allow the vehicle, charging point and underlying systems to communicate with each other as well as technical conditions with regard to the hardware in the vehicle, the charging cable, the charging point and the electricity installation, the metering device and the grid connection.

Application

The use of smart charging in the period up to 2030 is essential. The charging infrastructure that is being rolled out today is expected to still work in 10 to 15 years' time and should not form a barrier to smart charging of electric vehicles. The same goes for electric vehicles that are sold today that should still be able to charge smart in a decade. That is why it is essential that with the Smart Charging Requirements a standard package of conditions for smart charging is established to which the entire market is committed.

This bundling of conditions ensures a minimal and uniform set of technical Smart Charging requirements, which creates clarity for all parties involved. The Smart Charging Requirements can be anchored in and used for:

- Drafting (inter) national legislation and regulations.
- Forming (inter) national and local policy, which is implemented in the purchase of charging infrastructure and / or electric vehicles.
- The development of products and propositions by market parties, as a checklist for manufacturers who develop Smart Charging charging infrastructure and electric passenger cars.

The techniques for charging infrastructure and electric cars are still under development. This means that new requirements are also being developed and existing requirements may be tightened. From an innovation perspective, parties can choose to implement requirements that are still under development and not yet included in the SCR.

The intention is to review the Smart Charging Requirements on a regular basis (eg every 2 years) based on the then applicable standards and norms. The anchoring and updating of the Requirements in a Dutch and European context is part of the tasks of the NAL Smart Charging Working Group and will be issued there.

Reading Guide

The Smart Charging Requirements are divided into five modules that can be applied independently or in addition to each other:

- **Smart Charging Basics (MODULE 1 and 2)**
  The basic conditions for smart charging for every electric vehicle **(MODULE 1)** and for every charging point **(MODULE 2)**

- **Smart Charging – Private and Semi-public (MODULE 3A)**
  Additional requirements for Smart Charging at Private and Semi-Public charging points

- **Smart Charging - Public (MODULE 3B)**
  The additional basic conditions for smart charging for charging points in the public space, with additional protocol support

- **Bidirectional Charging (MODULE 4 and 5)**
  The additional conditions for every electric vehicle and for every charging point, with the option of discharging the vehicle battery (Vehicle-to-Anything)

The illustration below shows how the modules relate to each other. The conditions in MODULES 1 and 2 are the mandatory basic requirements for Smart Charging. The conditions in MODULE 3 are only mandatory in public environment. The conditions in MODULES 4 and 5 are optional and recommended when using bidirectional charging.

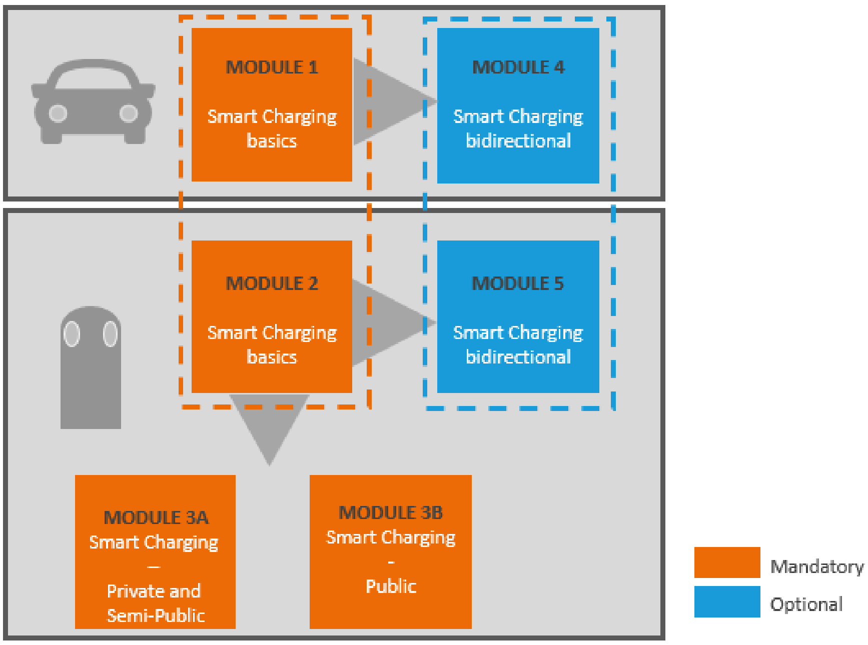

Figure 2. Positioning of the Modules

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MODULE 1: SMART CHARGING BASICS – EV

Applicable for: Electric Vehicles
Module 1 forms the basis for Smart Charging and is mandatory for all charging points and electric vehicles within the scope of the Smart Charging Requirements. The guidelines described relate to the vehicle, the charging cable and the charging point.

Many different standards apply to (electric) vehicles. The part that has to do with charging is relevant for Smart Charging: the On Board Charger and the charging control capabilities of the vehicle. The requirements below relate to properties of this charger, such as the technical specifications, the options for Smart Charging and the Power Quality properties as well as charging control in general where the OBC is not per se used. These requirements apply to manufacturers of vehicles and / or on-board chargers and are outside the sphere of influence of the charging station manufacturer. Note. in case of DC charging, the On Board Charger is not used. The standards also apply to DC charging and charging control is also applicable if the OBC is not used.

1.1. Standards for EV's and Charging Cables

The vehicle and charging cable comply with the applicable standards for electric vehicles and their charging systems below.

ID	Requirement	Explanation
1-1	IEC 61851-1:2017; Electric vehicle conductive charging system - Part 1: General requirements For communication with EVSE: Annex A 'Control pilot function through a control pilot circuit using a PWM signal and a control pilot wire'	This standard describes, among other things, how a current [A] value can be communicated to an electric vehicle from a charging point. This is the basic principle behind Smart Charging. Scope: AC Charging
1-2	IEC 61851-21-1, -23 and -24 DC Charging (Mode 4)	For DC charging, the vehicle complies with the applicable IEC standard
1-3	ISO 17409:2020; Electrically propelled road vehicles — Conductive power transfer — Safety requirements	Contains requirements for, among other things, inrush peaks and Power Factor, essential for the reliability of the electricity grid
1-4	The vehicle is equipped with at least 1 of the following plugs / contact points as described in the IEC 62196 -1,2,3 The vehicle always uses the Type 2 female connector for AC charging.	Standardization of the charging plug is important for uniformity in smart charging.
1-5	UN-ECE R10 – Electromagnetic Compatibility	The vehicle must be immune to EMC and must not cause any disturbances itself

1-6	IEC 62196 series; Plugs, socket-outlets, vehicle connectors and vehicle inlets – Conductive charging of electric vehicles	Contains Requirements for the standard charging plugs
1-7	The supply voltage of the charging point is within the limits of EN 50160; the vehicle must charge stably at least within the limits of this standard	Dealing with full spectrum of supply voltages
1-8	EN 50620:2017; Electric cables - Charging cables for electric vehicles	Contains Requirements for charging cables for electric vehicles

1.2. Charging Power and -control of EV

The vehicle must support charge control, and it is also important to set a framework for the charging currents that must be supported, as this is sometimes insufficient in the standards.

ID	Requirement	Explanation
1-9	The minimum charging speed at which the vehicle must be able to be charged is 1x6A	The minimum charging current as specified in IEC 61851-1, but not yet supported by all electric vehicles. Note that this charging current is rarely used due to the low efficiency of the OBC, but falls within the effective range of the Mode 3 PWM signal NB. During a charging break (PWM 100%) the vehicle "charges" with 0A.
1-10	The vehicle can handle the charging currents that are communicated from the charging station. Specifically, the vehicle must be able to handle the following situations: • Frequent changes of maximum charging current, alternating with charging pauses (PWM 100%); it must be possible to resume charging after an indefinite pause. (This can occur several times within the same charging session) • Dealing with current / power variations between the Pmax and Pmin of the vehicle • Delayed charging: after connecting to the charging station, a delayed start takes place (indefinite time) before charging starts (PWM 100% = 0A).	Although this falls within the Mode 3 spectrum of the IEC 61851-1, not all electric vehicles support it well This also concerns longer waiting times by the vehicle, for example when it is in 'deep sleep' mode.
1-11	The maximum charging current as indicated by the charging point always indicates the maximum permissible charging current, regardless of any other charging speeds programmed in the vehicle or received via Connected Car telematics	Vehicle settings or charge control via, for example, "connected car" may never exceed the current offered by the charging point. This is also secured by the charging point

1.3. Power Quality EV

Charging and discharging an electric vehicle can affect the quality of the electricity in the grid, and at its turn the power grid can also influence the charging behaviour. When charging, a vehicle can affect the voltage of the power grid, while the quality of the voltage has an influence on the quality of the power that the vehicle consumes.

ID	Requirement	Explanation
1-12	With regard to EMC, the vehicle must also be tested for non-rated (lower) charging currents (<16A).	Lower charging currents (<16A) are used regularly. EMC is important in these bandwidths as well.
1-13	To avoid supra-harmonic disturbances, the switching behaviour of the inverter must be adjusted to the highest possible frequency. No disturbances may be injected into the charging point from the vehicle.	A high frequency produces less disturbance
1-14	No disturbances, such as Supra-Harmonic Currents (between 2 kHz and 150 kHz) may be injected into the charging point from the vehicle. Supra-Harmonic emissions, usually caused by the switching frequency of the AC / DC converter in the On Board Charger, must be prevented, for example by using a filter, using other power electronics or changes in the switching behavior.	Supra-harmonic disturbances are not yet sufficiently included in standards

MODULE 2: SMART CHARGING BASICS – CHARGE POINT

Applicable for: all charge points (private, semi-public and public)
This Module describes the standards for charging points and the aspects where further clarification or addition on standards is necessary. The additions are subdivided by theme. The scope is Smart Charging; only those requirements that are relevant within the theme of Smart Charging are included.

2.1. Standards for Charge Points

Standards that a charging point must meet to make Smart Charging possible.

ID	Requirement	Explanation
2-1	IEC 61851-1:2017; Electric vehicle conductive charging system	Basic standard for EVs and Charging points
2-2	EN 50160 - Voltage characteristics of electricity supplied by public distribution systems	The charging point must be able to handle the voltage spectrum described in this standard.
2-3	NEN 1010 - Safety provisions for low voltage installations	For a safe installation
2-4	Power electronic converters with a nominal power greater than 5 kW (> 1-phase 22A, (…) are generally connected to three phases.* *Subject to selectivity limits	In accordance with the Electricity Network Code (October 2020) article 2.33 paragraph 5 Note: In Germany the following requirement is applied: The asymmetrical load on the grid connection point is limited to 4.6kVA (between the phases)
2-5	In the case of a DC charger where vehicles with Chademo connectors are also expected, the charging station supports Chademo v2.0	So that EVs with a Chademo connector can also be charged (smart)
2-6	The protection of electrical installations and parts thereof is selective with the protection that the network operator applies in the connection of the electrical installation or in the supply network.	In accordance with the prevailing Grid Code Electricity (October 2020). See Appendix 2.

2.2. Communication Protocols Charge Point

The foundation needed for smart charging protocols to work.

ID	Requirement	Explanation
2-7	New official published versions of all mentioned protocols will be implemented within the following period: • Larger structural changes (normally indicated by a shift in the first number of a version, for example from v1.0 to v2.0) will be implemented within 2 years after publication • Smaller incremental changes (normally indicated by a shift in the second number of a version, for example from v1.0 to v1.1) will be implemented within one year from the date of publication.	So that the charging points are up to date asap, within the capabilities of the manufacturer
2-8	All charging points have a telecommunication module	European regulations in the field of the European internal energy market state that an end customer must be enabled to become "active" in the energy market. There is an essential role for the end customer in realizing more flexibility in the electricity system, for example through its EV.
2-9	Telecommunications connections are online and connected at least 98% of the time	This is important to send and receive Smart Charging signals
2-10	The charging point and the communication connections used comply with the most recent Cyber Security Requirements for EV Charging Stations Current version: EV-301-2016	Secure communication is essential for smart charging
2-11	The communication between charge point and backend is in conformity of the Open Charge Point Protocol. The goal for Open Charge Point Protocol (OCPP) is to offer a uniform solution for the method of communication between charge point and central system. Prevailing version: 2.01	Charge Point - Control System communication *With OCPP it is possible to connect any central system with any charge point, regardless of the vendor. A uniform standard prevents all kinds of coordination problems and is therefore an advantage for the whole electric vehicle market.*

MODULE 3A: SMART CHARGING – PRIVATE AND SEMI PUBLIC

Applicable for: private and semi-public charge points, in addition to Module 2: Smart Charging Basics – Charge Point.
This Module contains additional requirements for Smart Charging that are only applicable for Private and Semi-Public Charge Points. Note: the requirements in Module 2 are thus **also** applicable for Private and Semi-Public Charge Points.

3A.1. Communication protocols Private and Semi-Public Charge Point

3A-1	The charge point can communicate with an Energy Management System (EMS) via an open protocol	Charge Point - Control System communication For communication between EVSE and Energy Management System
3A-2	The charge point can communicate with the meter in the Grid Connection if this meter supports local connection possibilities.	Charge Point - Control System communication For communication between EVSE and Energy Management System and/or Power Grid Management System

MODULE 3B: SMART CHARGING - PUBLIC

Applicable for: Public Charge Points.
This module is mandatory for public charging points and is an addition to Module 2: Smart Charging Basics – Charge Point. This module focuses on communication from the CPO with Third Parties and thus external options for charge control. Additional guidelines with regard to metering equipment apply to public charging points.

3B.1. Standards Public Charge Point

Standards that a public charging point must meet for Smart Charging (in addition to the basic standards from Module 2: Smart Charging Basics - Charging point).

ID	Requirement	Explanation
3B-1	The charging point complies with the Connection Requirements for charging objects with an integrated grid connection.	Contains requirements from Dutch network operators on how a connection to the electricity network must be realized in a charging station. See Appendix 2: Related Documentation
3B-2	The connection is used in accordance with the Grid Code Electricity.	Decision of the Netherlands Authority for Consumers and Markets of April 21, 2016, reference ACM / DE / 2016/202151, establishing the conditions as referred to in Article 31 of the Electricity Act 1998 (Grid Code Electricity). See Appendix 1 and 2.

3B.2. Smart Charging Public Charge Point

ID	Requirement	Explanation
3B-3	When Smart Charging is active, regardless of the Smart Charging profile, charging is always started for a short period (for example, 30 seconds). Then any charging profile is executed.	So that the user knows that his vehicle is properly connected.
3B-4	All charging points, regardless of power, must be remotely controlled, whereby the power can be adjusted in time (read charging speed) “near real-time” (NRT; within 1 minute), within the capabilities of the communication link.	To enable Smart Charging.
3B-5	With single phase charging, the power is limited to 3.7 kW (16A).	Necessary to avoid phase imbalance.

3B.3. Communication Protocols Public Charge Point

These are communication protocols that a CPO uses to approach Third Parties. These protocols apply to the backend in which (groups of) charge points are managed.

ID	Richtlijn	Toelichting
3B-6	To enable data sharing with other market parties and -roles, the Open Charge Point Interface (OCPI) is used. Prevailing version: v2.2 (September 2019)	Control System – Third Party System communicatie *Open Charge Point Interface (OCPI) - Supports connections between Mobility Service Providers who have EV drivers as customers, and Charge Point Operators who manage charge stations.* See Appendix 2.
3B-7	To enable Smart Charging based on actual grid load, IEC 62746-10:2018 (OpenADR) OR the Open Smart Charging Protocol (OSCP) is used.	No choice has yet been made regarding the protocol standard for this purpose. Support of one of these protocols is done in consultation with the client and is only applicable when Smart Charging use cases in which charge control takes place on the basis of DSO signals are used.

3B.4. Measuring Device Public Charge Point

Requirements for the metering device of the charge point. Note: This concerns the meters on the sockets. Guideline 3B-1 describes the requirements for connection to the electricity grid, where another dedicated meter is used. The meter from the Connection Specifications prescribed in Guideline 3B-1 is always a Smart (DSMR) Meter, owned by the grid operator.

ID	Requirement	Explanation
3B-8	Any charging point that is measured uses an accountable MID meter.	Measuring instrument directive; this meter may then be used for billing.
3B-9	The technology and protocols implemented in the charge point and backend are suitable to provide the driver with insight into the charged kWh and the price for it at any time.	Technology should not be an obstacle to this. Specific details of how the user gains this insight is up to the CPO and eMSP.

MODULE 4: BIDIRECTIONAL CHARGING - EV

Applicable for: electric vehicles supporting Bidirectional Charging/V2X
This module is mandatory for vehicles that support bidirectional charging / V2X. To make V2X possible, both the vehicle and the charging station must support this technology. This Module concerns the requirements for the EV. Since the technology (AC or DC) is not determined, some requirements also apply to the charging point. These are therefore included in Module 5.

4.1. Standards and Protocols V2X

Standards and Protocols that an EV must meet when bidirectional charging is supported.

ID	Requirement	Explanation
4-1	NEN-EN 50549-1:2019 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	Standard for distribution units
4-2	VDE-AR-N 4105 Power Generating Plants in the Low Voltage Grid	Standard for distribution units
4-3	The Grid Code Electricity (October 2020) and the Requirements for Generators (RfG) incorporated therein	Particularly Chapter 3 applies to distribution units. The specific articles are included in Appendix 1.
4-4	The protocols used for V2X are: • CHAdeMO • ISO 15118-20 (draft, expected in 2021) In case of DC V2G, the vehicle supports at least one of these protocols. In case of AC V2G, the vehicle supports at least ISO 15118-20.	Depending on the choice of AC or DC V2G; CHAdeMO can only be used for DC V2G. Support of CHAdeMO depends on the expected types / brands of vehicles at the bidirectional charge point.

4.2. Functional Requirements V2X Vehicle

ID	Requirements	Explanation
4-5	The vehicle must be capable of bidirectional charging using AC and / or DC technology; In the case of AC: • Minimum with 1.4 kW (AC 1x6A) • Maximum 22 kW (AC 3x32A). • With single phase feed-in, the power is limited to 3.7 kW (16A). In the case of DC: • At least 5kW; maximum 20kW	As whether or not the vehicle supports V2X is beyond the control of the charging station manufacturer, this is an optional module. Even if it is decided to prepare the infrastructure for V2X, non-bidirectional vehicles must be able to use the infrastructure.
4-6	It must be possible to start bidirectional charging from 100% SOC, even if this 100% SOC has been applicable for a longer period of time.	So that V2X is possible if the battery has been fully charged for a longer period of time. See also ID 1-10.

MODULE 5: BIDIRECTIONAL CHARGING – CHARGE POINT

Applicable for: private, semi-public and public charge points that support V2X/Bidirectional Charging.
This module is mandatory for charging points that support bidirectional charging / V2X. To make V2X possible, both the vehicle and the charging station must support this technology. This Module concerns the requirements for the charge point. Since the technology (AC or DC) is not determined, some requirements also apply to the EV. These are therefore included in Module 4.

5.1. Standards and Protocols V2X

Standards that a charging point must meet when bidirectional charging is supported.

ID	Richtlijn	Toelichting
5-1	NEN-EN 50549-1:2019 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	Standard for distribution units
5-2	VDE-AR-N 4105 Power Generating Plants in the Low Voltage Grid	Standard for distribution units
5-3	The Grid Code Electricity (October 2020) and the Requirements for Generators (RfG) incorporated therein	Particularly Chapter 3 applies to distribution units. The specific articles are included in Appendix 1.
5-4	The protocols used for V2X are: • CHAdeMO • ISO 15118-20 (draft, expected in 2021) In case of DC V2G, the charge point supports at least one of these protocols. In case of AC V2G, the charge point supports at least ISO 15118-20.	Depending on the choice of AC or DC V2G; CHAdeMO can only be used for DC V2G. Support of CHAdeMO depends on the expected types / brands of vehicles at the bidirectional charge point.
5-5	OCPP v2.0 + support for bidirectional charging.	Since OCPP 2.0 is the basis for backend communication, but does not yet offer support for bi-directional charging, a separate interim solution must be developed for this.

5.2. Physical requirements V2X charge point

Requirements for the appearance of bidirectional charge points.

ID	Requirement	Explanation
5-6	At/on charge point it is clearly visible that the charge point is suitable for bidirectional charging	So that the e-driver knows whether bidirectional is possible at the charge point.
5-7	The status indicator of the charge point provides an indication when the vehicle (via the charge point) supplies energy to the grid. This indication can be clearly distinguished from the regular indicators	So that the chare points' status is visible

5.3. Functional requirements V2X Charge Point

Requirements for the operation of bidirectional charge points.

ID	Requirement	Explanation
5-8	The system is suitable for both loading and return delivery. The current status must be visible in the backend.	Both charging and discharging should be possible
5-9	It must be possible to both charge and supply within the same transaction	So that the transaction remains active when charging is complete and the user can get the supplied energy billed/rewarded
5-10	The supplied and returned energy is registered on separate counters/registers of the MID meter. Both registered must be readable in the backend.	The charged energy may have a different rate/price than the energy supplied from the vehicle.
5-11	The system is equipped with a mechanism that automatically disconnects the charge point from the grid in case of power failure (anti-islanding). It is allowed to use the relay for this disconnection.	For safety during work during a power failure.

Appendix 1: Used Articles from the Grid Code Electricity

The Grid Code Electricty (October 2020) is a frequently used source for the Smart Charging Requirements. The articles that are specifically mentioned in the Smart Charging Requirements are listed below.
To remain unambiguous, the articles are cited in the language of its origin (Dutch).

Specific articles from the Grid Code mentioned in Modules 1, 2 and 3

Article	Description	Reference ID
2.13 lid 1	De beveiliging van elektrische installaties (en onderdelen daarvan) is selectief ten opzichte van de beveiliging die de netbeheerder in de aansluiting van de elektrische installatie of in het voedende net toepast.	2-6
2.33 lid 5	Vermogenselektronische omzetters met een nominaal vermogen groter dan 5 kW, dan wel een met de netbeheerder in individuele gevallen overeengekomen hogere waarde, zijn in de regel op drie fasen aangesloten.	2-4

Specific articles from the Electricity Grid Code (October 2020) mentioned in Modules 4 and 5 are applicable to Electricity production units. In the SCR this concerns bidirectional charging systems and EVs. The guidelines from the Electricity Grid Code for Type A (800W - 1MW) power-generating units are included below (including the guidelines for installations smaller than 800W; these also apply to Type A).

Article	Description	Reference ID
3.6	In afwijking van het bepaalde in artikel 2.27 mag de arbeidsfactor in het overdrachtspunt van een aansluiting waarachter zich een elektriciteitsproductie-eenheid bevindt, liggen tussen 0,9 capacitief en 0,9 inductief.	4-3, 5-3
3.8	1) De beveiligingen van de elektriciteitsproductie-eenheid zijn selectief ten opzichte van de beveiligingen in het net van de netbeheerder. De netbeheerder kan verlangen dat hiervan een berekening wordt gemaakt. 2) De beveiliging van de elektriciteitsproductie-eenheid is in ieder geval voorzien van: a) een onderspanningsbeveiliging met een aanspreeksnelheid van 2 seconden bij 80% van de nominale spanning; b) een overspanningsbeveiliging met een aanspreeksnelheid van 2 seconden bij 110% van de nominale spanning; c) een frequentiebeveiliging met een aanspreeksnelheid van 2 seconden bij 48 en 51 Hz.	4-3, 5-3

	3) De installatie met een synchrone elektriciteitsproductie-eenheid is voorzien van een inrichting die binnen 0,2 seconden een scheiding met het net bewerkstelligt in geval de netspanning in één of meer fasen daalt tot 70% van de nominale waarde, tenzij uit een berekening blijkt dat een snellere uitschakeling noodzakelijk is.	
3.9	1) Het sterpunt van een elektriciteitsproductie-eenheid die zowel in eilandbedrijf als in parallelbedrijf kan functioneren, is deugdelijk geaard. 2) Maatregelen bij een elektriciteitsproductie-eenheid worden in ieder geval genomen in geval door harmonischen in de installatie de grootte van de nulleiderstroom in dezelfde orde van grootte als die van de fasestroom zal komen.	4-3, 5-3
3.12	1) Elektriciteitsproductie-eenheden van het type A voldoen aan de in deze paragraaf gestelde voorwaarden. 2) Elektriciteitsproductie-eenheden van het type A, kleiner dan 11 kW, aangesloten op een laagspanningsnet, voldoen tevens aan de in paragraaf 3.3 gestelde voorwaarden, met uitzondering van artikel 3.5. 3) Elektriciteitsproductie-eenheden van het type A groter dan of gelijk aan 11 kW, aangesloten op een laagspanningsnet, voldoen tevens aan de in paragraaf 3.3 gestelde voorwaarden, met uitzondering van de artikelen 3.5, 3.7 en 3.11, tweede lid.	4-3, 5-3
3.13	1) De elektriciteitsproductie-eenheid is in staat om op het net aangesloten en in bedrijf te blijven binnen de volgende frequentiebanden en tijdsperiodes, als bedoeld in artikel 13, eerste lid, onderdeel a, subonderdeel i, van de Verordening (EU) 2016/631 (NC RfG): a) in de frequentieband van 47,5 Hz tot 48,5 Hz gedurende 30 minuten; b) in de frequentieband van 48,5 Hz tot 49,0 Hz gedurende 30 minuten; c) in de frequentieband van 49,0 Hz tot 51,0 Hz gedurende onbeperkte tijd; d) in de frequentieband van 51,0 Hz tot 51,5 Hz gedurende 30 minuten. 2) [gereserveerd] 3) Indien een elektriciteitsproductie-eenheid geïntegreerd is in een industrieel productieproces, met dien verstande dat het afgegeven vermogen niet kan worden gewijzigd zonder verstoring van het	4-3, 5-3

productieproces, is het toegestaan om de activering van de FSM te relateren aan het in het (de) overdrachtspunt(en) van de aansluiting resulterende vermogen.

4) De elektriciteitsproductie-eenheid is voor de gelimiteerde frequentiegevoelige modus – overfrequentie (LFSM-O) in staat om de levering van de frequentierespons te activeren, als bedoeld in artikel 13, tweede lid, van de Verordening (EU) 2016/631 (NC RfG), waarbij:

    a) de frequentiedrempelwaarde instelbaar is tussen 50,2 Hz en 50,5 Hz (inclusief);
    b) de instelling van de frequentiedrempelwaarde 50,2 Hz is;
    c) de statiek instelbaar is tussen 4% en 12%;
    d) de default instelling van de statiek 5% is;
    e) de elektriciteitsproductie-eenheid bij het bereiken van het minimumregelniveau op dit niveau in bedrijf blijft;
    f) in geval van een power park module is Pref, als bedoeld in figuur 1 van de Verordening (EU) 2016/631 (NC RfG), gelijk aan het feitelijk gegenereerde werkzame vermogen op het moment dat de drempelwaarde van de LFSM-O is bereikt.

5) De elektriciteitsproductie-eenheid mag beneden een frequentie van 49,5 Hz het werkzaam vermogen reduceren met een gradiënt van 10% van de maximale capaciteit bij 50 Hz, per frequentiedaling met 1 Hz, als bedoeld in artikel 13, vierde lid, van de Verordening (EU) 2016/631 (NC RfG).

6) Indien de netbeheerder eisen stelt aan de apparatuur waarmee het werkzaam uitgangsvermogen van een elektriciteitsproductie-eenheid op afstand binnen vijf seconden naar nul kan worden gereduceerd, als bedoeld in artikel 13, zesde lid, van de Verordening (EU) 2016/631 (NC RfG), maakt hij deze eisen openbaar door publicatie op zijn website.

7) De elektriciteitsproductie-eenheid is in staat om automatisch aan het net te koppelen, als bedoeld in artikel 13, zevende lid, van de Verordening (EU) 2016/631 (NC RfG), indien:

    a) de spanning groter is dan of gelijk aan 0,90 pu en kleiner dan of gelijk aan 1,10 pu;
    b) de frequentie groter is dan of gelijk aan 49,9 Hz en kleiner dan of gelijk aan 50,1 Hz;

	c) de minimum tijd dat de spanning en de frequentie zich binnen de in de onderdelen a en b genoemde bereiken bevinden 60 seconden is; d) de maximum gradiënt van het werkzaam vermogen 20% is van de maximumcapaciteit per minuut.	
3.14	1) Een elektriciteitsproductie-eenheid met een maximumcapaciteit groter dan 11 kW, aangesloten op een laagspanningsnet, is in ieder geval voorzien van: a) een meetinrichting voor de afgegeven stroom; b) een signalering of de elektriciteitsproductie-eenheid al dan niet parallel is geschakeld met het net. 2) De beveiliging van de elektriciteitsproductie-eenheid met een maximumcapaciteit groter dan 11 kW, aangesloten op een laagspanningsnet, is in ieder geval op drie fasen voorzien van: a) een onderspanningsbeveiliging met een aanspreeksnelheid van 2 seconden bij 80% van de nominale spanning én van 0,2 seconden bij 70% van de nominale spanning; b) een overspanningsbeveiliging met een aanspreeksnelheid van 2 seconden bij 110% van de nominale spanning; c) een maximum-stroomtijdbeveiliging; bij een vermogenselektronische omzetter een overbelastingsbeveiliging; d) een frequentiebeveiliging met een aanspreeksnelheid van 2 seconden bij 47,5 en 51,5 Hz; deze beveiliging mag éénfasig zijn. 3) Bij een door middel van vermogenselektronica gekoppelde elektriciteitsproductie-eenheid met een maximumcapaciteit groter dan 11 kW, aangesloten op een laagspanningsnet, mag parallelschakeling eerst enkele minuten nadat de netspanning weer aanwezig is, plaatsvinden.	4-3, 5-3

Nationale
Agenda
Laadinfrastructuur

Appendix 2: Related Documentation

In addition to the standards used in the Smart Charging Requirements, other documentation is relevant and can be related to the SCR.

Basic Charge Point Requirements

Strongly related to the Smart Charging Requirements is the 'Basisset Afspraken Laadpaal', which contains general requirements for charging infrastructure and is managed by the National Charging Infrastructure Knowledge Platform (NKL). The Smart Charging Requirements are an addition to these basic requirements.

Charge Point Connection Requirements

The Document 'Aansluitspecificaties laadobjecten 3x25A - 3x80A' forms the basis with which the network operator inspection service of ElaadNL inspects the DSO-part of new models of charging objects for admission to the electricity grid. The inspection service is coordinated from ElaadNL and the inspection is carried out by experts from the cooperating network operators. The requirements have been drawn up in such a way that a safe and reliable connection to the public electricity grid is guaranteed.

Grid Code Electricity

Appendix 1 contains the requirements from the Grid Code Electricity relevant to the SCR. Where reference is made to the Grid Code, the current grid code for electricity is always referred to. At the time of v1.0 of the SCR, this concerns the October 2020 edition, Decision of the Authority for Consumers and Markets of 21 April 2016, reference ACM / DE / 2016/202151, establishing the conditions as referred to in Article 31 of the Electricity Act 1998 (Network Code Electricity) (https://wetten.overheid.nl/BWBR0037940/2020-10-20).

Norms, Protocols and Standards

Where reference is made to standards, these are available through NEN, CEN-CENELEC, IEC or ISO. The (Open) Protocols referred to are available from the following sources:

- OCPP and OSCP: https://www.openchargealliance.org/protocols/
- OCPI: https://evroaming.org/downloads/
- Cyber Security: https://encs.eu/encs-document/ev-charging-systems-security-requirements/

Schedules of Requirements

Because smart and innovative charging infrastructure is already being rolled out in the Netherlands, the specifications of the commissioning authorities (municipalities and provinces) have been an important source for drawing up the SCR. The SoRs used are:

Recent Tenders	Year of Publication
Province North-Brabant/Limburg	2020
MRA-e (Amsterdam)	2019
City of Utrecht	2019
Province Groningen/Drenthe	2018
Provincee Gelderland/Overijssel	2018
City of The Hague	2015

International

Work is also being done internationally on standardization around Smart Charging. Examples of this are:

- **United Kingdom**: Automated and Electric Vehicles Act 2018, An Act to make provision about automated vehicles and electric vehicles.
- **Germany**: Informations- und Kommunikationstechnologien (IKT) für Elektromobilität.

Appendix 3: List with involved experts

The following experts have contributed to the realization of the Smart Charging Requirements.

Organization	Name
Alfen	Dhr. M. Sieben
Alliander	Dhr. E. Schepens
ANWB	Dhr. M. van Eenennaam
BMW	Dhr. D. van der Heijden
Daimler	Dhr. M. Corluy
Daimler	Dhr. W. Ingelbrecht
ElaadNL	Dhr. B. van Eijsden
ElaadNL	Dhr. F. Geerts
ElaadNL	Dhr. J. Deckers
Eneco	Dhr. B. Fick
Enexis	Dhr. A. Wargers
Enovates	Dhr. H. de Almeida Cocharro
EVConsult	Dhr. B. Merkx
Everon	Dhr. A. Mordashov
eViolin	Dhr. M. Bayings
Gemeente Den Haag	Dhr. F. van Elzakker
Gemeente Den Haag	Mevr. L. van Kalleveen
GreenFlux	Dhr. L. Verheijen
Jedlix	Dhr. J. van Heesbeen
KIA (NL)	Dhr. R. Dobber
Ministerie van Infrastructuur & Waterstaat	Dhr. R. Monteban
NAL-regio G4	Dhr. J. Burger
Nissan (NL)	Mevr. M. Moerland
NKL	Dhr. R. Blok
NKL	Dhr. R. Ferwerda
NVDE	Dhr. W. Langendoen
Pitpoint	Dhr. J. van Leeuwen
RAI vereniging	Dhr. W. Benning
Renault	Dhr. T. Dreumont
Renault	Dhr. J. van Tiggelen
Stedin	Dhr. H. Fidder
TLN	Dhr. R. Aarse
Total	Dhr. N. Nobel
Toyota	Dhr. D. Tsutsumi

Toyota	Dhr. E. Jongh
Toyota	Dhr. H. Jukurogi
Toyota	Dhr. H. Takamatsu
Toyota	Dhr. I. Teerlinck
Toyota	Dhr. L. Hensley
Toyota	Dhr. R. Braat
Toyota	Dhr. R. Docter
Toyota	Dhr. T. Misawa
Vattenfall	Dhr. T. Hoogvliet
VER	Dhr. R. van Gent
Vereniging DOET	Dhr. E. van Voorden
Volvo Trucks	Dhr. H. Engdahl
Volvo Cars	Dhr. B. van den Bouwhuijsen
Volvo Cars	Dhr. B. Peltenburg
Volvo Cars	Dhr. M. Pesselse