Vehicle-one-Grid and Vehicle-to-X Standards

New requirements for smart and bidirectional EV charging

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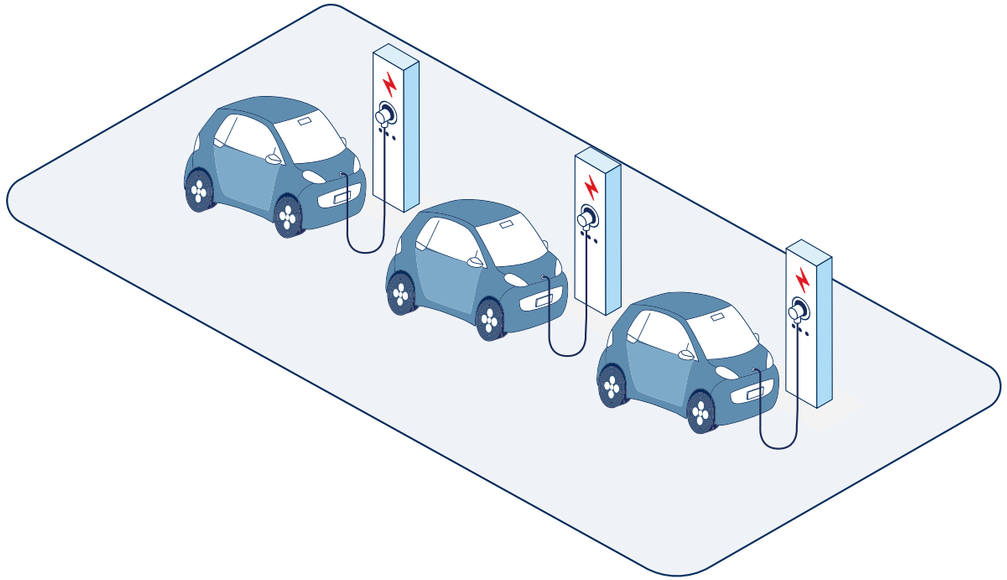
V1G definition

V1G, or unidirectional smart charging, refers to an intelligent electric vehicle (EV) charging system. This system manages and optimizes the charging process - time speed and power flow – based on factors such as grid demand, electricity prices, and the user's needs.

V1G only allows power to flow from the grid to the vehicle.

Key aspects of V1G smart charging:

- **Time-of-use optimization** - V1G systems can schedule charging during off-peak hours when electricity demand and rates are lower. This saves money for the EV owner and helps balance the load on the electrical grid.
- **Demand response** - V1G can respond to signals from the grid operator to temporarily reduce or delay charging during times of high demand on the grid. This helps prevent grid overload and potential blackouts.
- **Renewable energy integration** - Smart charging can be synchronized with periods of high renewable energy generation, such as sunny or windy conditions. This maximizes clean energy use for EV charging.
- **User preferences** - V1G systems can account for the user's schedule and mobility requirements. This helps ensure the vehicle is fully charged and ready to use when needed.
- **Remote control and monitoring** - EV owners can often control and monitor the charging process remotely via smartphone apps, allowing for greater convenience and flexibility.



V2X definitions

V2X (vehicle-to-everything) refers to an interaction model where the EV interacts with any entity that may affect or be affected by the vehicle's charging process.

In the context of EV charging, V2X encompasses several specific interaction scenarios:

- **V2G (vehicle-to-grid) –** EVs interact with the power grid to sell excess energy back to the grid or to manage charging times based on grid load. This can help stabilize the grid, especially during peak demand times.
- **V2H (vehicle-to-home)** or **V2B (vehicle-to-building)** – EVs can supply energy to a home or building. This allows them to act as a backup power source during outages or peak energy periods when electricity from the grid is more expensive (energy arbitrage).
- **V2L (vehicle-to-load)** – EVs provide power to external devices, such as appliances, in case of a power outage or in applications without access to the power grid.
- **V2V (vehicle-to-vehicle)** - In some cases, EVs could share power with each other. V2V is rarely used due to losses during power transfer.

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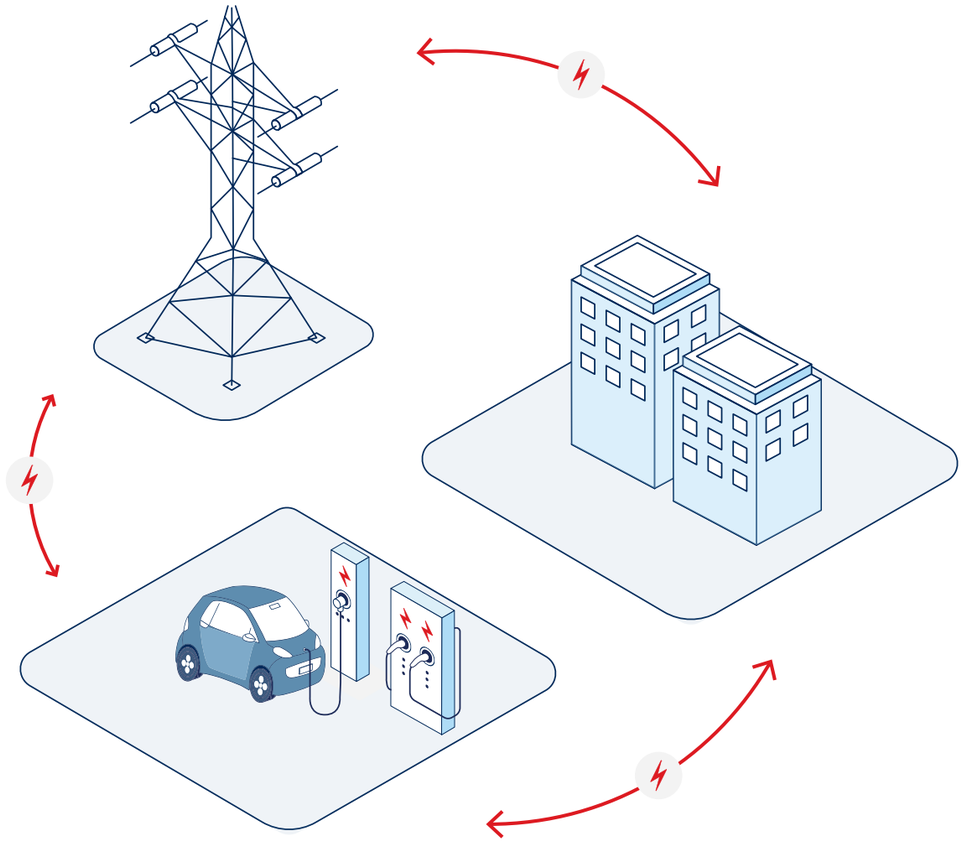
V2X technology for EV charging involves a combination of hardware and software that enables secure and efficient communication between the vehicle and various entities. It is an important part of the smart grid and smart city initiatives, aiming to improve energy efficiency, reduce costs, and enhance the overall sustainability of transportation and energy systems.



Application use cases

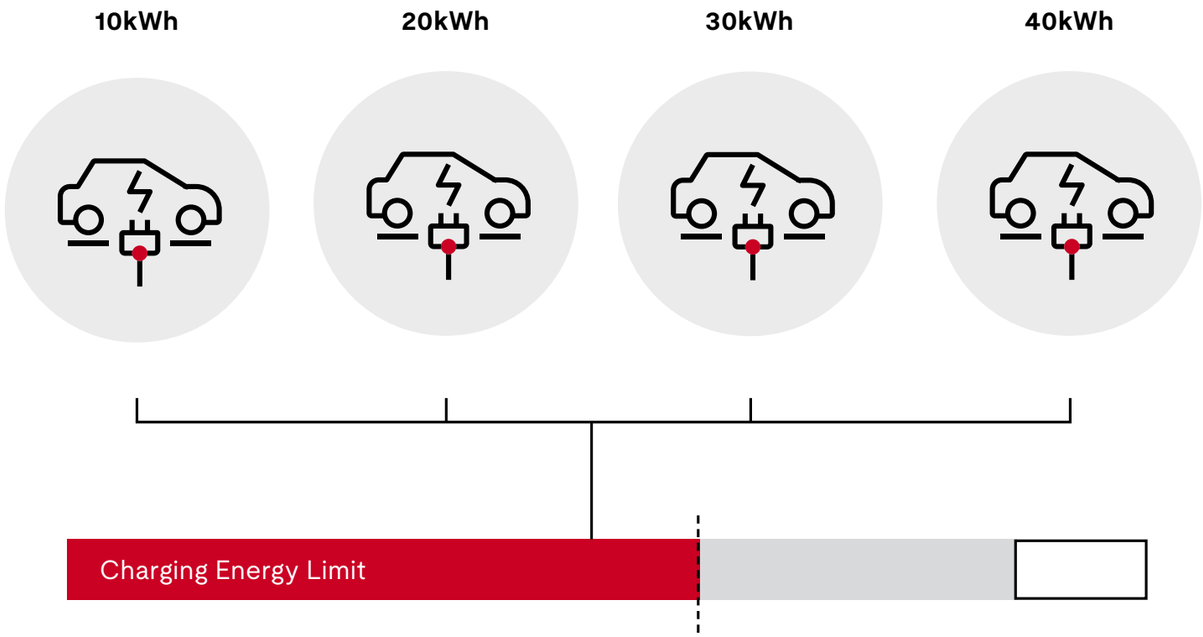
Use case	V1G	V2X
Load management/peak shaving	• Avoid grid overload (peaks) by EV charging load management, which can impact the service continuity	• Use the EV battery to shave power peaks (V2H)
Energy arbitrage/self-consumption	• Try to charge EVs when energy price and carbon footprint are low	• Charge EVs when there is solar power and discharge EVs when there isn't (V2H)
Demand response	• Respond to signal by EV charging load management	• Discharge battery electric vehicles (BEVs) when asked due to grid congestion (V2G)
Frequency fast response		• Quickly discharge BEVs when asked, in a similar way to uninterruptible power supplies (UPS), for EVSE DC high power transfer (V2G)
Off-grid service continuity		• Use the BEV battery as inertia or as UPS (V2L)

New requirements	V1G	V2X
Certification	• Equipment certificate for EVs and EVSEs >0.8 kW based on Agency for the Cooperation of Energy Regulators (ACER) recommendation submitted to EU	• Type test certificates issued according to local grid codes (Regulation EC No 2016/631)

Use case example: load management with V1G

Dynamic load management (DLM) refers to a system or process that actively manages EV charger power consumption. It typically responds to power supply or optimizes for cost, efficiency and electrical grid stability.

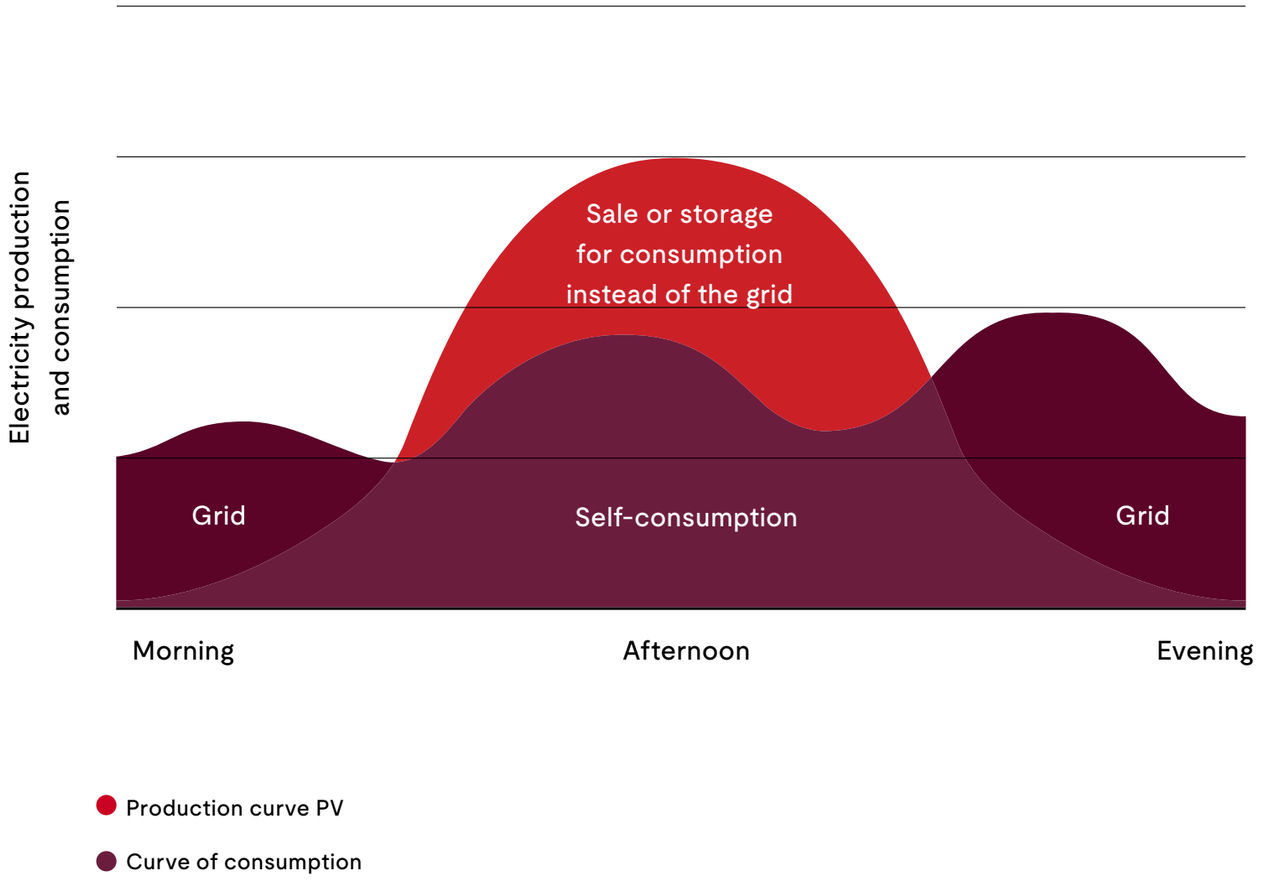
Smart charging systems can adjust the charging rate of each vehicle in real time based on various factors, such as the maximum available power and the charging capacity, to ensure all vehicles are efficiently charged.



Use case example: self-consumption with V2H/V2B

Self-consumption refers to the practice of using energy when it is produced locally and storing it when it is purchased from the grid.

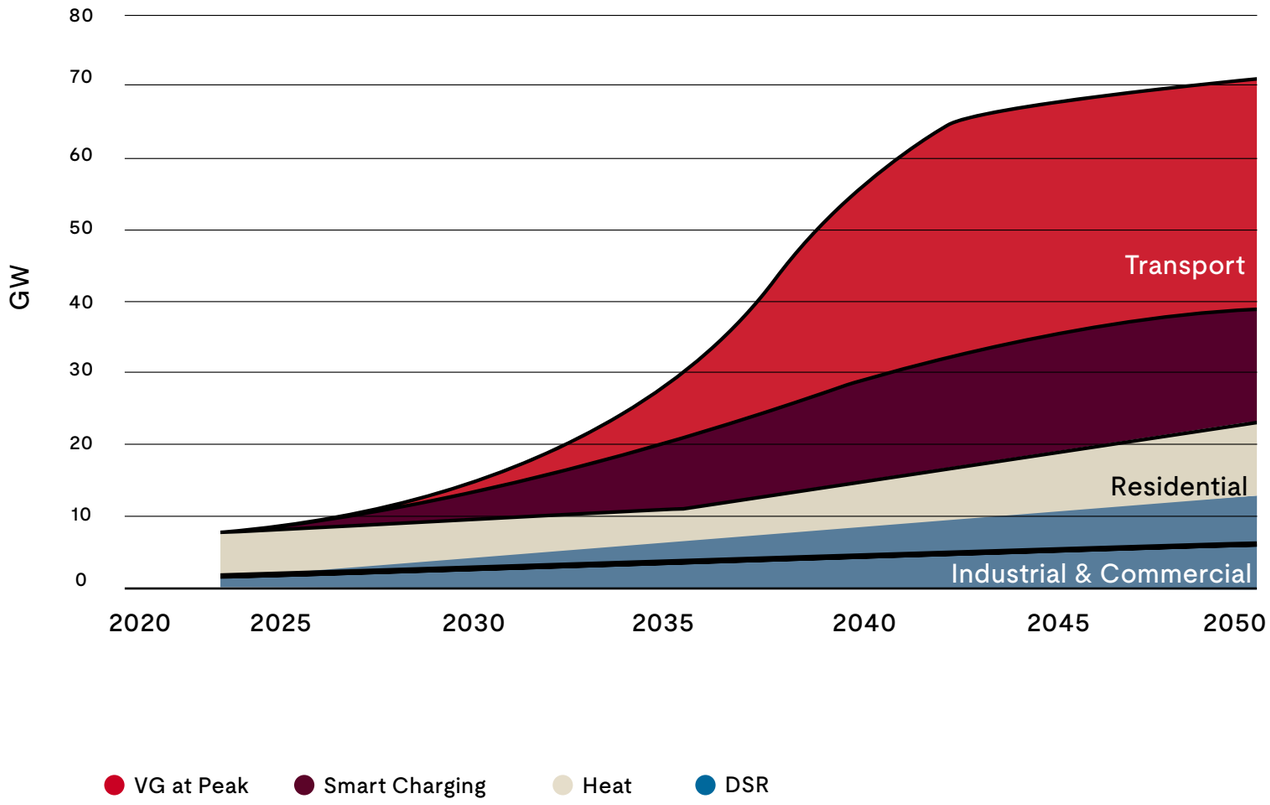
In a home or building with solar installations, consuming the energy produced by the solar installation is typically more convenient than buying it from the grid. An entity with the ability to store energy, such as a bidirectional charging system, could charge EVs during solar hours and then release energy back to the home or building during the rest of the day.



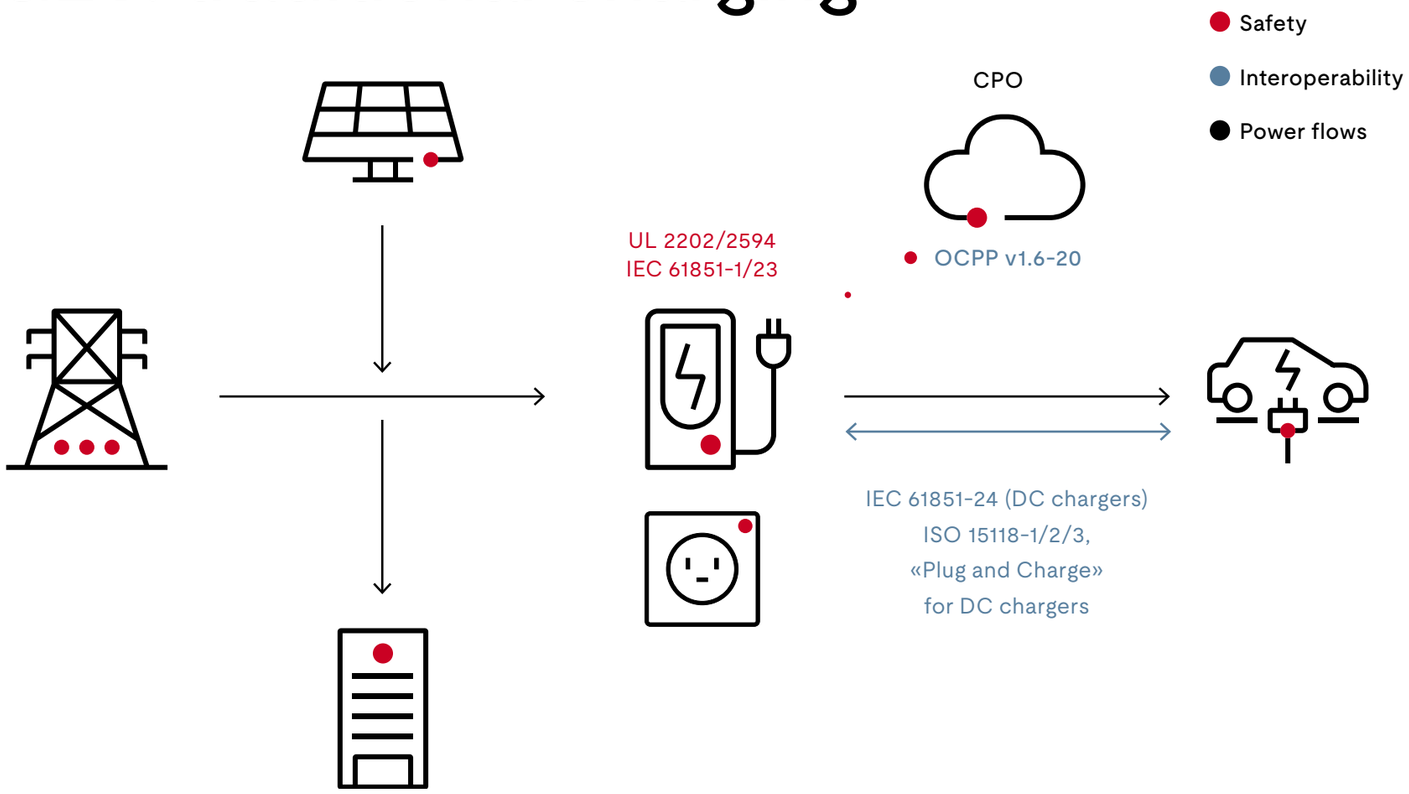
Use case example: flexibility services with V2G

Flexibility services enable the energy transition with higher adoption of renewables.

In the U.K., **demand side response** (DSR) in residential appliances and industrial and commercial processes supports system flexibility. BEVs using vehicle-to-grid (V2G) functionality have the potential to reduce demand by 32 GW by 2050, the largest of any consumer flexibility technology.

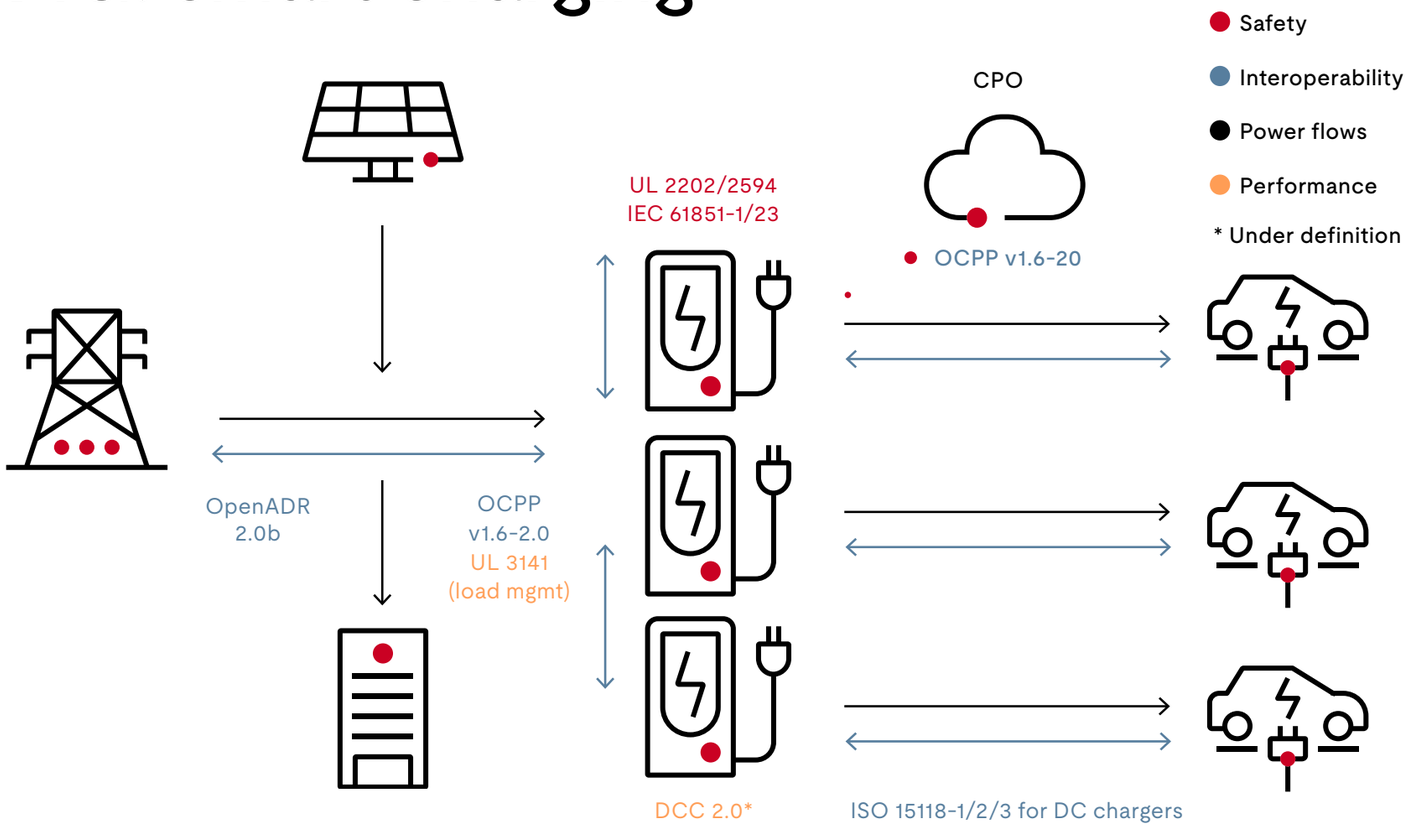


Standard requirements for G2V: traditional charging



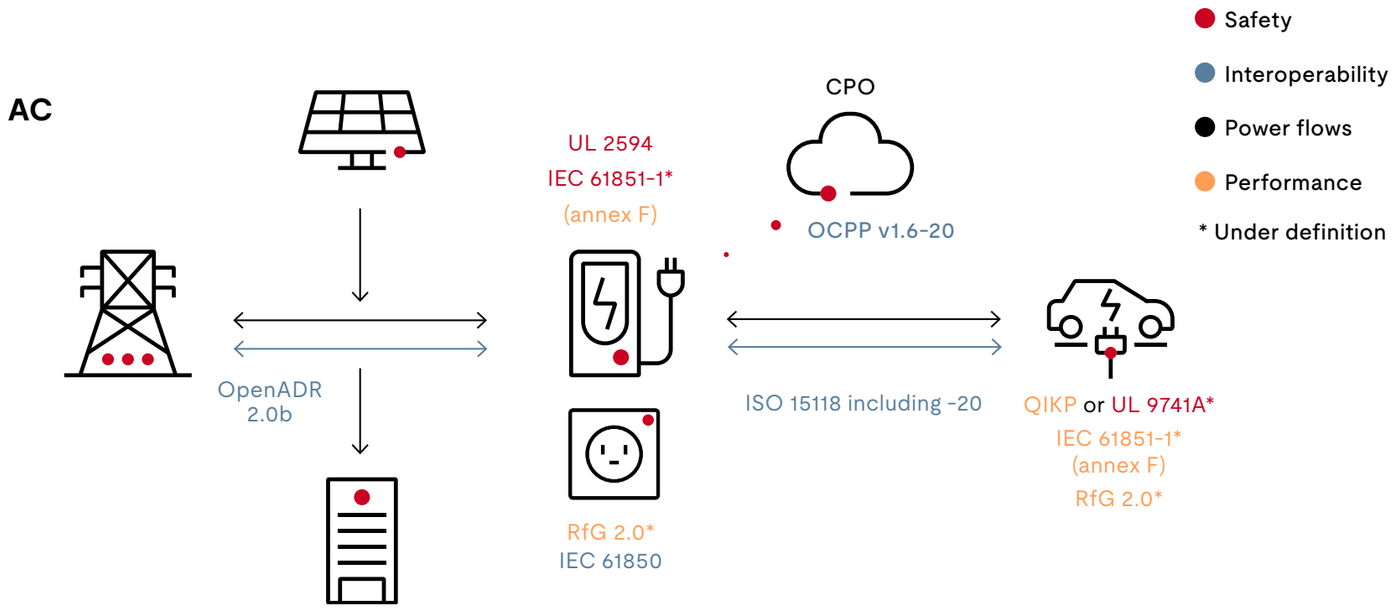
G2V: Grid-to-Vehicle
CPO: Charge Point Operator
OCPP: Open Charge Point Protocol

Standard requirements for V1G: smart charging



The reported standards are updated to May 2025

Standardization future requirements under definition for V2G: bidirectional charging



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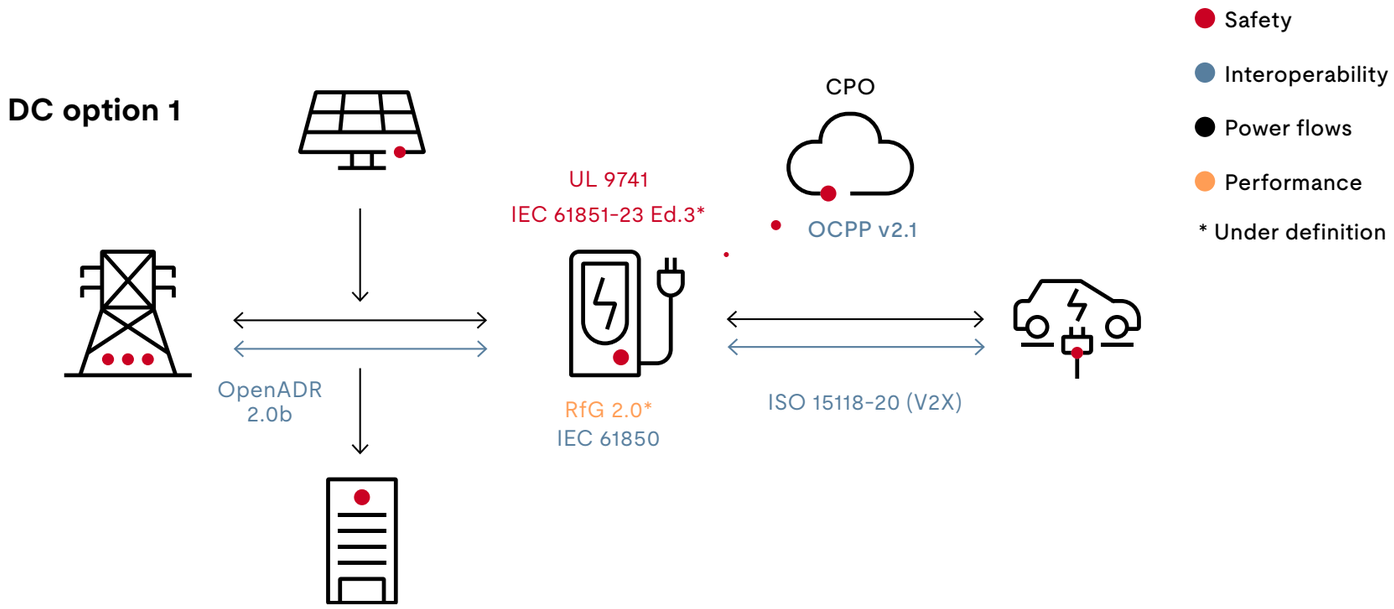
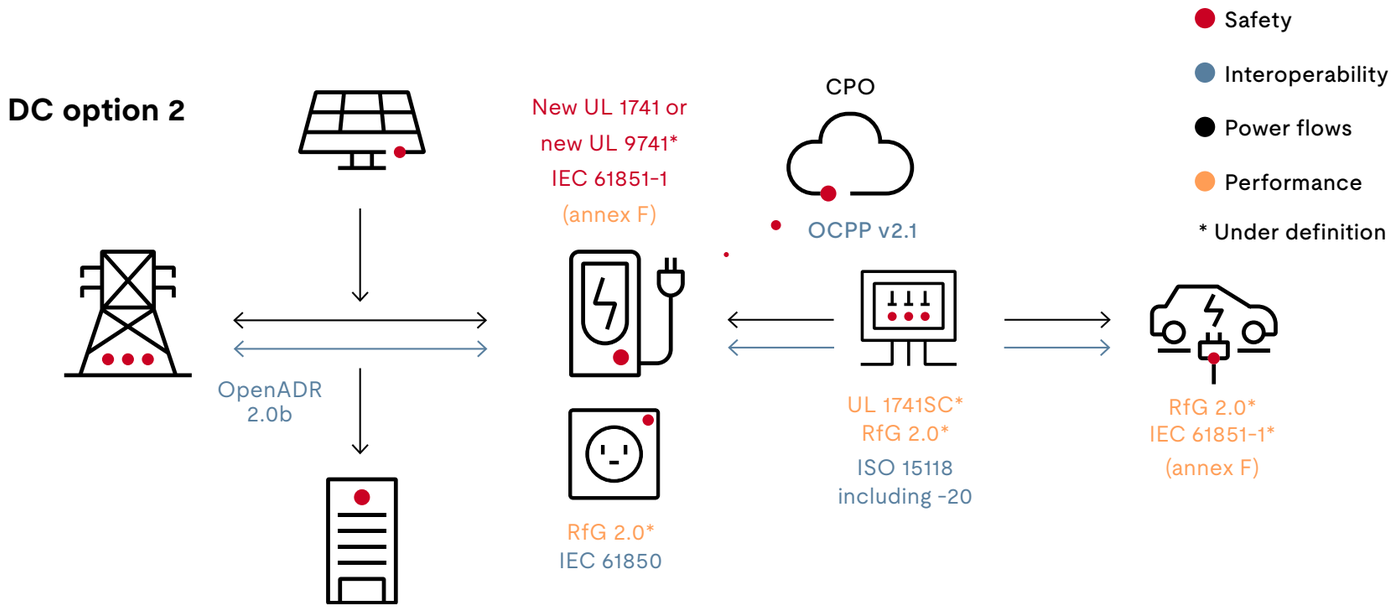
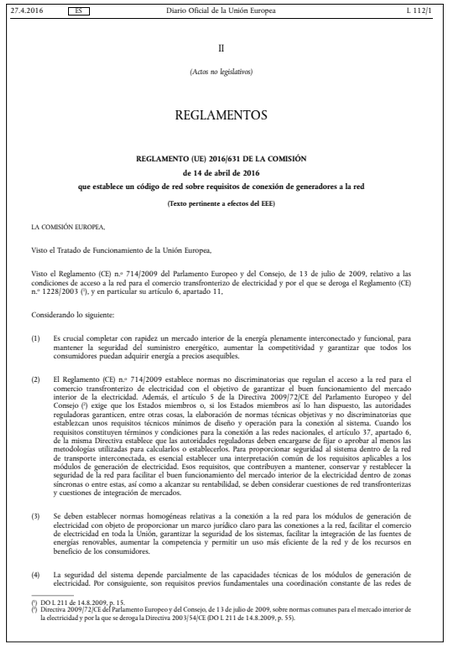


Standardization future requirements under definition V2G: bidirectional charging



The reported standards are updated to May 2025

Europe from regulations to grid code standards



27.4.2016 ES Diario Oficial de la Unión Europea L 112/1

II

(Actos no legislativos)

REGLAMENTOS

REGLAMENTO (UE) 2016/631 DE LA COMISIÓN
de 14 de abril de 2016
que establece un código de red sobre requisitos de conexión de generadores a la red
(Texto pertinente a efectos del EEE)

LA COMISIÓN EUROPEA,

Visto el Tratado de Funcionamiento de la Unión Europea,

Visto el Reglamento (CE) n.º 714/2009 del Parlamento Europeo y del Consejo, de 13 de julio de 2009, relativo a las condiciones de acceso a la red para el comercio transfronterizo de electricidad y por el que se deroga el Reglamento (CE) n.º 1228/2003 (1), y en particular su artículo 6, apartado 11,

Considerando lo siguiente:

(1) Es crucial completar con rapidez un mercado interior de la energía plenamente interconectado y funcional, para mantener la seguridad del suministro energético, aumentar la competitividad y garantizar que todos los consumidores puedan adquirir energía a precios asequibles.

(2) El Reglamento (CE) n.º 714/2009 establece normas no discriminatorias que regulan el acceso a la red para el comercio transfronterizo de electricidad con el objetivo de garantizar el buen funcionamiento del mercado interior de la electricidad. Además, el artículo 5 de la Directiva 2009/72/CE del Parlamento Europeo y del Consejo (2) exige que los Estados miembros o, si los Estados miembros así lo han dispuesto, las autoridades reguladoras garanticen, entre otras cosas, la elaboración de normas técnicas objetivas y no discriminatorias que establezcan unos requisitos técnicos mínimos de diseño y operación para la conexión al sistema. Cuando los requisitos constituyen términos y condiciones para la conexión a las redes nacionales, el artículo 37, apartado 6, de la misma Directiva establece que las autoridades reguladoras deben encargarse de fijar o aprobar al menos las metodologías utilizadas para calcularlos o establecerlos. Para proporcionar seguridad al sistema dentro de la red de transporte interconectada, es esencial establecer una interpretación común de los requisitos aplicables a los módulos de generación de electricidad. Esos requisitos, que contribuyen a mantener, conservar y restablecer la seguridad de la red para facilitar el buen funcionamiento del mercado interior de la electricidad dentro de zonas síncronas o entre estas, así como a alcanzar su rentabilidad, se deben considerar cuestiones de red transfronterizas y cuestiones de integración de mercados.

(3) Se deben establecer normas homogéneas relativas a la conexión a la red para los módulos de generación de electricidad con objeto de proporcionar un marco jurídico claro para las conexiones a la red, facilitar el comercio de electricidad en toda la Unión, garantizar la seguridad de los sistemas, facilitar la integración de las fuentes de energías renovables, aumentar la competencia y permitir un uso más eficiente de la red y de los recursos en beneficio de los consumidores.

(4) La seguridad del sistema depende parcialmente de las capacidades técnicas de los módulos de generación de electricidad. Por consiguiente, son requisitos previos fundamentales una coordinación constante de las redes de

(1) DO L 211 de 14.8.2009, p. 15.
(2) Directiva 2009/72/CE del Parlamento Europeo y del Consejo, de 13 de julio de 2009, sobre normas comunes para el mercado interior de la electricidad y por la que se deroga la Directiva 2003/54/CE (DO L 211 de 14.8.2009, p. 55).

RfG 2016/631
Establishing a network code on requirements for grid connection of generators in Europe

SIST EN 50549-1:2019

EUROPEAN STANDARD
NORME EUROPÉENNE
EUROPÄISCHE NORM

EN 50549-1

February 2019

ICS 29.160.20

Supersedes CLC/TS 50549-1:2015, EN 50438:2013, EN 50438:2013/IS1:2015

English Version

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

Exigences relatives aux centrales électriques destinées à être raccordées en parallèle à des réseaux de distribution - Partie 1: Raccordement à un réseau de distribution BT - Centrales électriques jusqu'au Type B inclus

Anforderungen für zum Parallelbetrieb mit einem Verteilnetz vorgesehene Erzeugungsanlagen - Teil 1: Anschluss an das Niederspannungsverteilnetz bis einschließlich Typ B

This European Standard was approved by CENELEC on 2018-08-09. CENELEC members are bound to comply with the CEN-CENELEC Internal Regulations which stipulate the conditions for giving this European Standard the status of a national standard without any alteration.

Up-to-date lists and bibliographical references concerning such national standards may be obtained on application to the CEN-CENELEC Management Centre or to any CENELEC member.

This European Standard exists in three official versions (English, French, German). A version in any other language made by translation under the responsibility of a CENELEC member into its own language and notified to the CEN-CENELEC Management Centre has the same status as the official versions.

CENELEC members are the national electrotechnical committees of Austria, Belgium, Bulgaria, Croatia, Cyprus, the Czech Republic, Denmark, Estonia, Finland, Former Yugoslav Republic of Macedonia, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, the Netherlands, Norway, Poland, Portugal, Romania, Serbia, Slovakia, Slovenia, Spain, Sweden, Switzerland, Turkey and the United Kingdom.

CENELEC

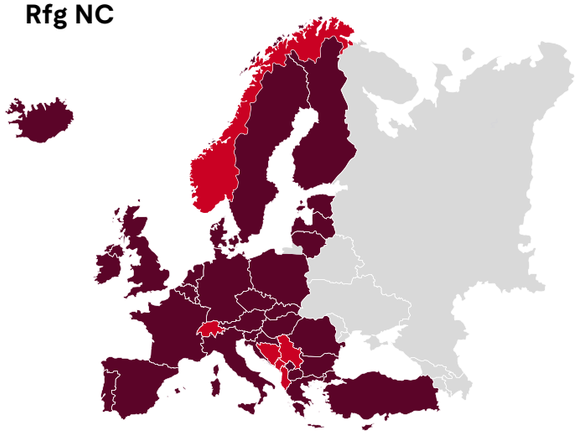
European Committee for Electrotechnical Standardization
Comité Européen de Normalisation Electrotechnique
Europäisches Komitee für Elektrotechnische Normung

CEN-CENELEC Management Centre: Rue de la Science 23, B-1040 Brussels

Ref. No. EN 50549-1:2019 E

EN 50549-1/2
Requirements for generating plants to be connected in parallel with distribution networks

Rfg NC



- Approved/binding
- Non EU MS - Implementation under different framework
- No proposals

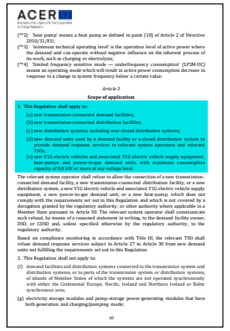
Source: Entso-E

Adoption in main countries:

- Germany VDE-AR-N
- Italy CEI 0-21/0-16
- Poland EqC/RoGA
- Spain NTS
- U.K. G99

Future Requirements for Demand Connection 2.0

ACER recommendation submitted to the EC (European Commission) for Power Generating Units (PGU)



ACER

('**2) 'heat pump' means a heat pump as defined in point (18) of Article 2 of Directive 2010/31/EU;

('**3) 'minimum technical operating level' is the operation level of active power where the power generating module is able to maintain stable operation as the inherent process of its work, such as charging or electrolysing;

('**4) 'limited frequency sensitive mode — underfrequency consumption' (LFSM-UC) means an operating mode which will result in active power consumption decrease in response to a change in system frequency below a certain value.

Article 3

Scope of application

1. This Regulation shall apply to:

(a) new transmission-connected demand facilities;

(b) new transmission-connected distribution facilities;

(c) new distribution systems, including new closed distribution systems;

(d) new demand units used by a demand facility or a closed distribution system to provide demand response services to relevant system operators and relevant TSOs;

(e) new V1G electric vehicles and associated V1G electric vehicle supply equipment, heat-pumps and power-to-gas demand units, with maximum consumption capacity of 0,8 kW or more at any voltage level.

The relevant system operator shall refuse to allow the connection of a new transmission-connected demand facility, a new transmission-connected distribution facility, or a new distribution system, a new V1G electric vehicle and associated V1G electric vehicle supply equipment, a new power-to-gas demand unit, or a new heat-pump, which does not comply with the requirements set out in this Regulation and which is not covered by a derogation granted by the competent authority or by the competent authority of the Member State pursuant to Article 58. The relevant system operator shall communicate such refusal, by means of a reasoned statement in writing, to the demand facility owner, DSO, or CDSO and, unless specified otherwise by the regulatory authority, to the regulatory authority.

Based on compliance monitoring in accordance with Title III, the relevant TSO shall refuse demand response services subject to Article 27 to Article 30 from new demand units not fulfilling the requirements set out in this Regulation.

2. This Regulation shall not apply to:

(f) demand facilities and distribution systems connected to the transmission system and distribution systems, or to parts of the transmission system or distribution systems, of islands of Member States of which the systems are not operated synchronously with either the Continental Europe, Nordic, Ireland and Northern Ireland or Baltic synchronous area;

(g) electricity storage modules and pump-storage power generating modules that have both generation and charging/pumping mode.

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V1G (no differentiation either AC or DC)

- V1G (Annex 2 of ACER amendment proposal)

“Source: Scope of application Article 3”

1. This Regulation shall apply to:

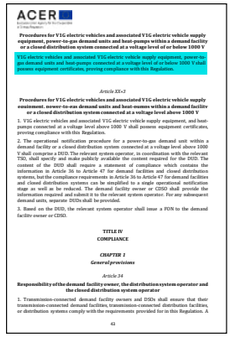
(a) new transmission-connected demand facilities;

(b) new transmission-connected distribution facilities;

(c) new distribution systems, including new closed distribution systems;

(d) new demand units used by a demand facility or a closed distribution system to provide demand response services to relevant system operators and relevant TSOs;

(e) new V1G electric vehicles and associated V1G electric vehicle supply equipment, heat-pumps and power-to-gas demand units, with maximum consumption capacity of 0,8 kW or more at any voltage level.



ACER

Procedures for V1G electric vehicles and associated V1G electric vehicle supply equipment, power-to-gas demand units and heat-pumps within a demand facility or a closed distribution system connected at a voltage level of or below 1000 V

V1G electric vehicles and associated V1G electric vehicle supply equipment, power-to-gas demand units and heat-pumps connected at a voltage level of or below 1000 V shall possess equipment certificates, proving compliance with this Regulation.

Article XX+2

Procedures for V1G electric vehicles and associated V1G electric vehicle supply equipment, power-to-gas demand units and heat-pumps within a demand facility or a closed distribution system connected at a voltage level above 1000 V

1. V1G electric vehicles and associated V1G electric vehicle supply equipment, and heat-pumps connected at a voltage level above 1000 V shall possess equipment certificates, proving compliance with this Regulation.

2. The operational notification procedure for a power-to-gas demand unit within a demand facility or a closed distribution system connected at a voltage level above 1000 V shall comprise a DSO. The relevant system operator, in coordination with the relevant TSO, shall specify and make publicly available the content required for the DSO. The content of the DSO shall require a statement of compliance which contains the information in Article 36 to Article 47 for demand facilities and closed distribution systems, but the compliance requirements in Article 36 to Article 47 for demand facilities and closed distribution systems can be simplified to a single operational notification stage as well as be reduced. The demand facility owner or CDSO shall provide the information required and referred to the relevant system operator. For any subsequent demand units, separate DSOs shall be provided.

3. Based on the DSO, the relevant system operator shall issue a PON to the demand facility owner or CDSO.

TITLE IV
COMPLIANCE

CHAPTER 1
General provisions

Article 24

Responsibility of the demand facility owner, the distribution system operator and the closed distribution system operator

1. Transmission-connected demand facility owners and DSOs shall ensure that their transmission-connected demand facilities, transmission-connected distribution facilities, or distribution systems comply with the requirements provided for in this Regulation. A

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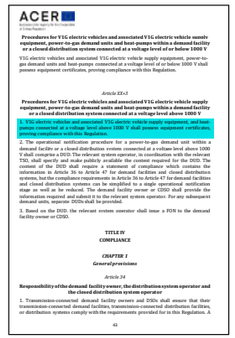
“Source: Article XX+2”

V1G electric vehicles and associated V1G electric vehicle supply equipment, power-to-gas demand units and heat-pumps connected at a voltage level of or below 1000 V shall possess equipment certificates, proving compliance with this Regulation.



ACER

Procedures for V1G electric vehicles and associated V1G electric vehicle supply equipment, power-to-gas demand units and heat-pumps within a demand facility or a closed distribution system connected at a voltage level of or below 1000 V

V1G electric vehicles and associated V1G electric vehicle supply equipment, power-to-gas demand units and heat-pumps connected at a voltage level above 1000 V shall possess equipment certificates, proving compliance with this Regulation.

Article XX+3

Procedures for V1G electric vehicles and associated V1G electric vehicle supply equipment, power-to-gas demand units and heat-pumps within a demand facility or a closed distribution system connected at a voltage level above 1000 V

1. V1G electric vehicles and associated V1G electric vehicle supply equipment, and heat-pumps connected at a voltage level above 1000 V shall possess equipment certificates, proving compliance with this Regulation.

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TITLE IV
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1. Transmission-connected demand facility owners and DSOs shall ensure that their transmission-connected demand facilities, transmission-connected distribution facilities, or distribution systems comply with the requirements provided for in this Regulation. A

41

“Source: Article XX+3”

1. V1G electric vehicles and associated V1G electric vehicle supply equipment, and heat-pumps connected at a voltage level above 1000 V shall possess equipment certificates, proving compliance with this Regulation.

- Laboratories may support manufacturers by informative test reports.

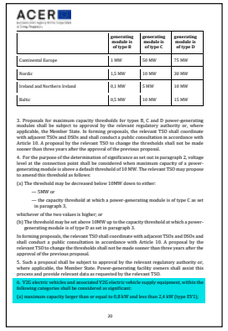
Future Requirements for Generators 2.0

ACER recommendation submitted to the EC (European Commission) for PGUs

V2G (no differentiation either AC or DC)

- V2G (Annex 1 of the ACER amendment proposal)

“Source: Article 5 Determination of significance”



	generating module is of type B	generating module is of type C	generating module is of type D
Continental Europe	1 MW	50 MW	75 MW
Nordic	1,5 MW	10 MW	30 MW
Ireland and Northern Ireland	0,1 MW	1 MW	10 MW
Baltic	0,5 MW	10 MW	15 MW

3. Proposals for maximum capacity thresholds for types B, C and D power-generating modules shall be subject to approval by the relevant regulatory authority or, where applicable, the Member State. Power-generating facility owners shall assist this process and provide relevant data as requested by the relevant TSO.

4. V2G electric vehicles and associated V2G electric vehicle supply equipment, within the following categories shall be considered as significant:

(a) maximum capacity larger than or equal to 0,8 kW and less than 2,4 kW (type EV1);

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(b) maximum capacity larger than or equal to 2,4 kW and less than or equal to 50 kW (type EV2);

(c) maximum capacity larger than 50 kW and less than 1 MW (type EV3).

Requirements applicable to type EV1 and EV2 electric vehicles and associated V2G electric vehicle supply equipment are set out exhaustively in Article 13a. Type EV2 V2G electric vehicles and type EV1 V2G electric vehicles and associated V2G electric vehicle supply equipment shall possess equipment certificates, proving compliance with this Regulation. Type EV2 associated V2G electric vehicle supply equipment follow compliance provisions of Article 38a only, whereas requirements applicable to type EV2 electric vehicles and type EV1 electric vehicles are set out exhaustively in Article 14a and follow compliance provisions of Article 38b only.

7. If, as a result of modification of the thresholds, a power-generating module qualifies under a different type, the procedure laid down in Article 4(2) concerning existing power-generating modules shall apply before compliance with the requirements for the new type is required.

8. Requirements applicable to type A power-generating modules are set out in Article 13, Article X and Article Y, requirements for type B power-generating modules are set out in Article 14, Article 17 and Article 20, whereas requirements applicable to type C are set out in Article 15, Article 18 and Article 21. Requirements applicable to type D are set out in Article 16, Article 19 and Article 22.

Article 6

Application to offshore power-generating modules, pump-storage power-generating modules, power-generating modules embedded in the networks of industrial sites, electricity storage modules, V2G electric vehicles and associated V2G electric vehicle supply equipment, and combined heat and power facilities

1. Offshore power-generating modules connected to the interconnected system shall meet the requirements for onshore power-generating modules, unless the requirements are modified for this purpose by the relevant system operator or unless the connection of power park modules is via a high voltage direct current connection or via a network whose frequency is not synchronously coupled to that of the main interconnected system (such as via a back-to-back converter scheme).

2. Pump-storage power-generating modules in generating operation, pumping operation and synchronous compensation mode shall fulfil the following requirements:

(a) the technical design of power-generating modules shall not limit in time the capability to provide synchronous compensation operation of the power-generating module. Synchronous compensation operation of full-converter variable-speed machines is performed by the converters;

(b) pump-storage power-generating modules with fixed-speed machines and single-shaft tertiary machines shall be considered as synchronous power-generating modules;

(c) pump-storage power-generating modules with variable-speed machines shall be considered as power park modules. For double-fed induction machines, the parameters in Table 1[Q3.1.1 and Table 1[Q3.1.2, or Table 1[T7.1.1, Table 1[H]-7.1.2,

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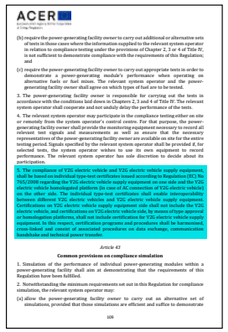
6. V2G electric vehicles and associated V2G electric vehicle supply equipment, within the following catégories shall be considered as significant:

a. maximum capacity larger than or equal to 0.8 kW and less than 2.4 kW (type EV1):

b. maximum capacity larger than or equal to 2,4 kW and less than or equal to 50 kW (type EV2);

c. maximum capacity larger than 50 kW and less than 1 MW (type EV3).



(b) require the power-generating facility owner to carry out additional or alternative sets of tests in those cases where the information supplied to the relevant system operator or relevant to compliance testing under the provisions of Chapter 2, 3 or 4 of Title IV, is not sufficient to demonstrate compliance with the requirements of this Regulation; and

(c) require the power-generating facility owner to carry out appropriate tests in order to demonstrate a power-generating module's performance when operating on alternative fuels or fuel mixes. The relevant system operator and the power-generating facility owner shall agree on which types of fuel are to be tested.

3. The power-generating facility owner is responsible for carrying out the tests in accordance with the conditions laid down in Chapters 2, 3 and 4 of Title IV. The relevant system operator shall cooperate and not unduly delay the performance of the tests.

4. The relevant system operator may participate in the compliance testing either on site or remotely from the system operator's control centre. For that purpose, the power-generating facility owner shall provide the relevant system operator with access to the relevant test signals and measurements as well as ensure that the necessary representatives of the power-generating facility owner are available on site for the entire testing period. Signals specified by the relevant system operator shall be provided if, for selected tests, the system operator wishes to use its own equipment to record performance. The relevant system operator has sole discretion to decide about its participation.

5. The compliance of V2G electric vehicle and V2G electric vehicle supply equipment, shall be based on individual type-test certificates issued according to Regulation (EC) No 765/2008 regarding the V2G electric vehicle supply equipment on one side and the V2G electric vehicle homologated platform (in case of AC connection of V2G electric vehicle on the other side. The individual type-test certificates shall enable interoperability between different V2G electric vehicle and V2G electric vehicle supply equipment. Certifications on V2G electric vehicle supply equipment side shall not include the V2G electric vehicle, and certifications on V2G electric vehicle side, by means of type approval or homologation platforms, shall not include certification for V2G electric vehicle supply equipment. In this respect, certification programs and procedures shall be harmonised, cross-linked and consist of associated procedures on data exchange, communication handshake and technical power transfer.

Article 42

Common provisions on compliance simulation

1. Simulation of the performance of individual power-generating modules within a power-generating facility shall aim at demonstrating that the requirements of this Regulation have been fulfilled.

2. Notwithstanding the minimum requirements set out in this Regulation for compliance simulation, the relevant system operator may:

(a) allow the power-generating facility owner to carry out an alternative set of simulations, provided that those simulations are efficient and suffice to demonstrate

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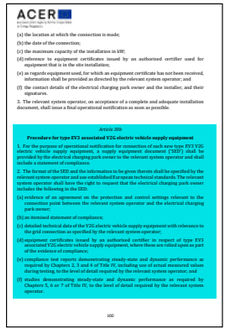
“Article 42 Common provisions for compliance testing”

5. The compliance of V2G electric vehicle and V2G electric vehicle supply equipment, shall be based on individual type-test certificates issued according to Regulation (EC) No 765/2008 regarding the V2G electric vehicle supply equipment on one side and the V2G electric vehicle homologated platform (in case of AC connection of V2G electric vehicle on the other side. The individual type-test certificates shall enable interoperability between different V2G electric vehicle and V2G electric vehicle supply equipment. Certifications on V2G electric vehicle supply equipment side shall not include the V2G electric vehicle, and certifications on V2G electric vehicle side, by means of type approval or homologation platforms, shall not include certification for V2G electric vehicle supply equipment. In this respect, certification programs and procedures shall be harmonised, cross-linked and consist of associated procedures on data exchange, communication handshake and technical power transfer.

- The V2G type-test certificates will be issued by EU-based certification bodies which are accredited to ISO 17065 for the local grid codes.

Future Requirements for Generators 2.0

ACER recommendation submitted to the EC (European Commission) for PGSs

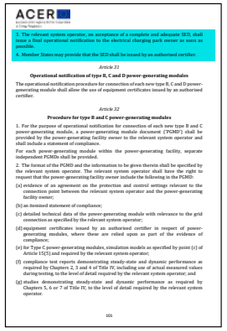


V2G

- V2G (Annex 1 of the ACER amendment proposal)

“Article 30b Procedure for type EV3 associated V2G electric vehicle supply equipment”

1. *For the purpose of operational notification for connection of each new type EV3 V2G electric vehicle supply equipment, a supply ‘equipment document (SED’) (shall be provided by the electrical charging park owner to the relevant system operator and shall include a statement of compliance.*
2. *The format of the SED and the information to be given therein shall be specified by the relevant system operator and use established European technical standards. The relevant system operator shall have the right to request that the electrical charging park owner includes the following in the SED:*
   a. *evidence of an agreement on the protection and control settings relevant to the connection point between the relevant systern operator and the electrical charging park owner;*
   b. *an itemised statement of compliance;*
   c. *detailed technical data of the V2G electric vehicle supply equipment with relevance to the grid connection as specified by the relevan’t system operator;*
   d. *equipment certificates issued by an authorised certifier in respect of type EV3 associated V2G electric vehicle supply equipment, where these are relied upon as part of the evidence of compliance;*
   e. *compliance|test reports demonstrating steady-state and dynamic performance as required by Chapters 2, 3 and 4 of Title IV, including use of actual measured values during testing, to the level of detail required by the relevant system operator; and*
   f. *studies demonstrating steady-state and dynamic performance as required by Chapters 5, 6 or 7 of Title; IV, to the level of detail required by the relevant system operator.*
3. *The relevant system operator, on acceptance of a complete and adequate SED, shall issue a final operational notification to the electrical charging park owner as soon as possible.*
4. *Member States may provide that the SED shall be issued by an authorised certifier.*



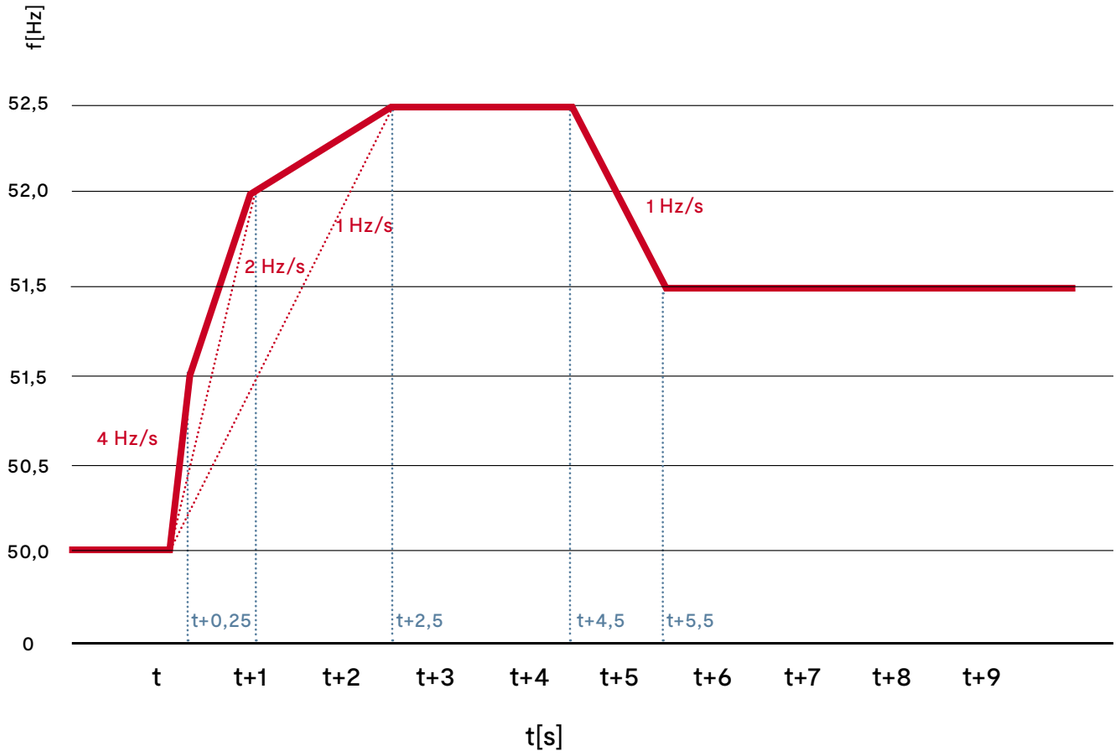
- Depending on the European Union member Country, the supply equipment document (SED) will be issued by EU-based certification bodies that are accredited to ISO 17065 for the local grid codes.
- Laboratories may support charging park owners by informative test reports and grid studies.

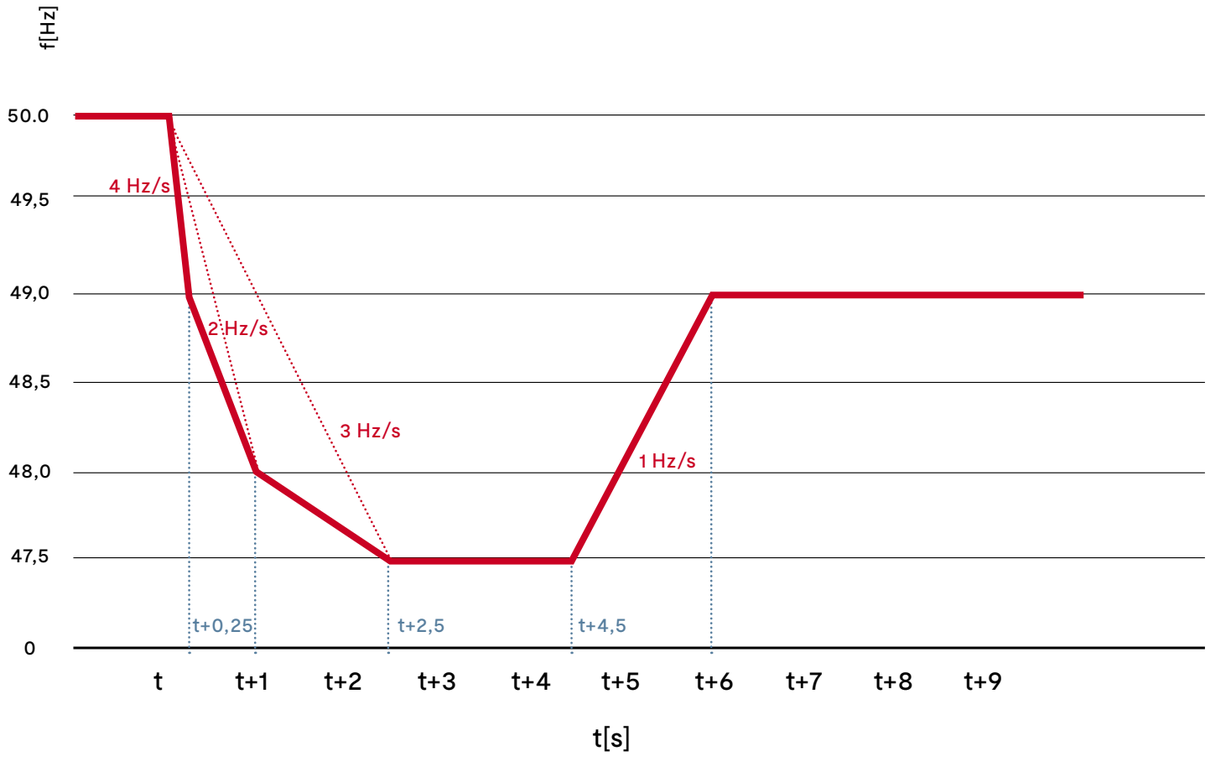
V1G requirements

Frequency range	Time period for operation
47,5 Hz-48,5 Hz	30 minutes
48,5 Hz-49,0 Hz	30 minutes
49,0 Hz-51,0 Hz	Unlimited

Frequency range	Time period for operation
51,0 Hz-51,5 Hz	30 minutes
51,5 Hz-52,5 Hz	10 seconds

Withstand rate of change of frequency (ROCOF) – up to 4 Hz/s for 0.25 s

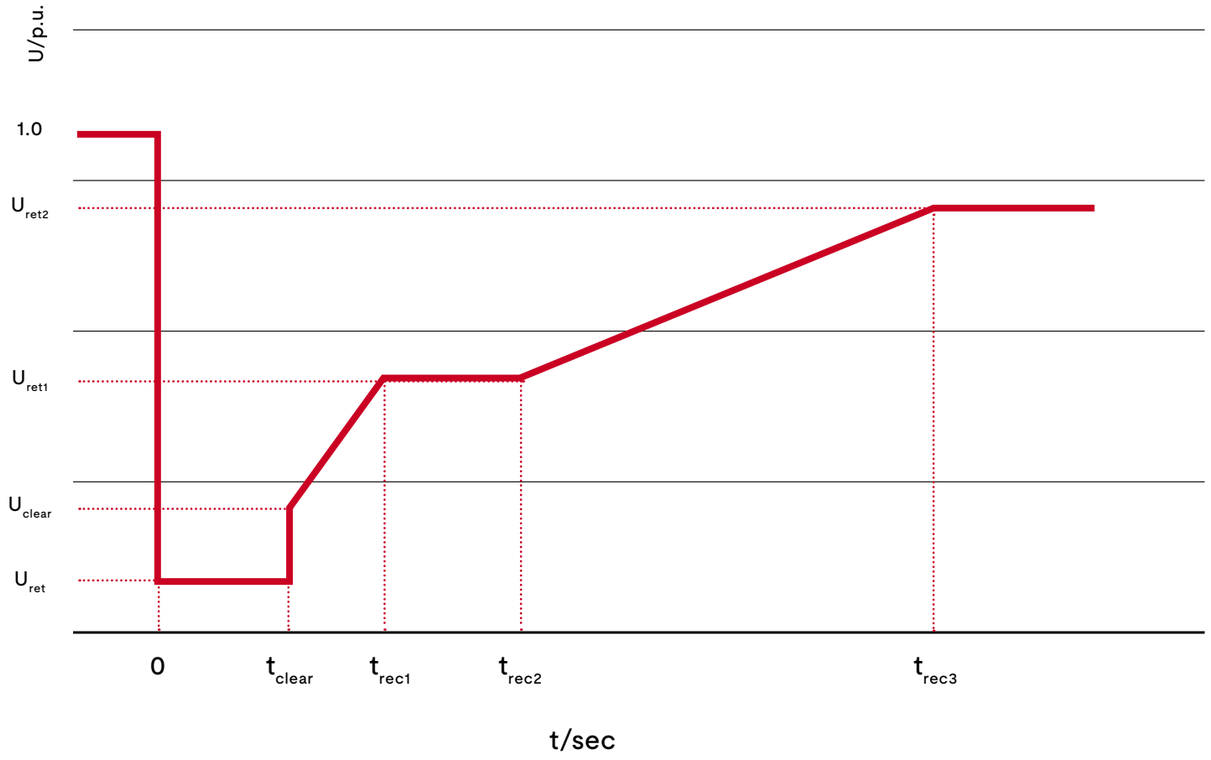




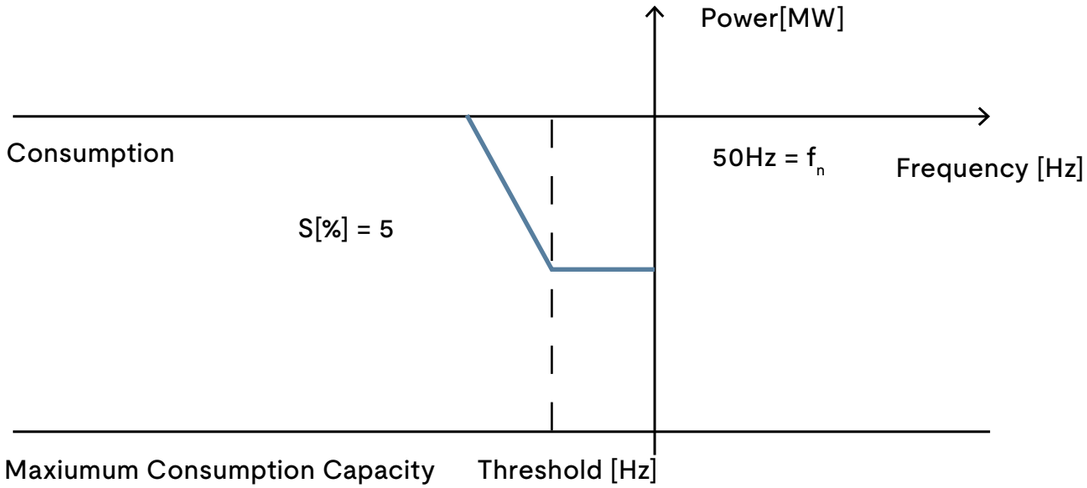
The contents are extracted from the ACER amendment and used for example only

V1G requirements

Voltage ride-through with capability to recharge by 60 s if voltage restores in the range of 85%-110%



Active power frequency response in under-frequency with 5% drop



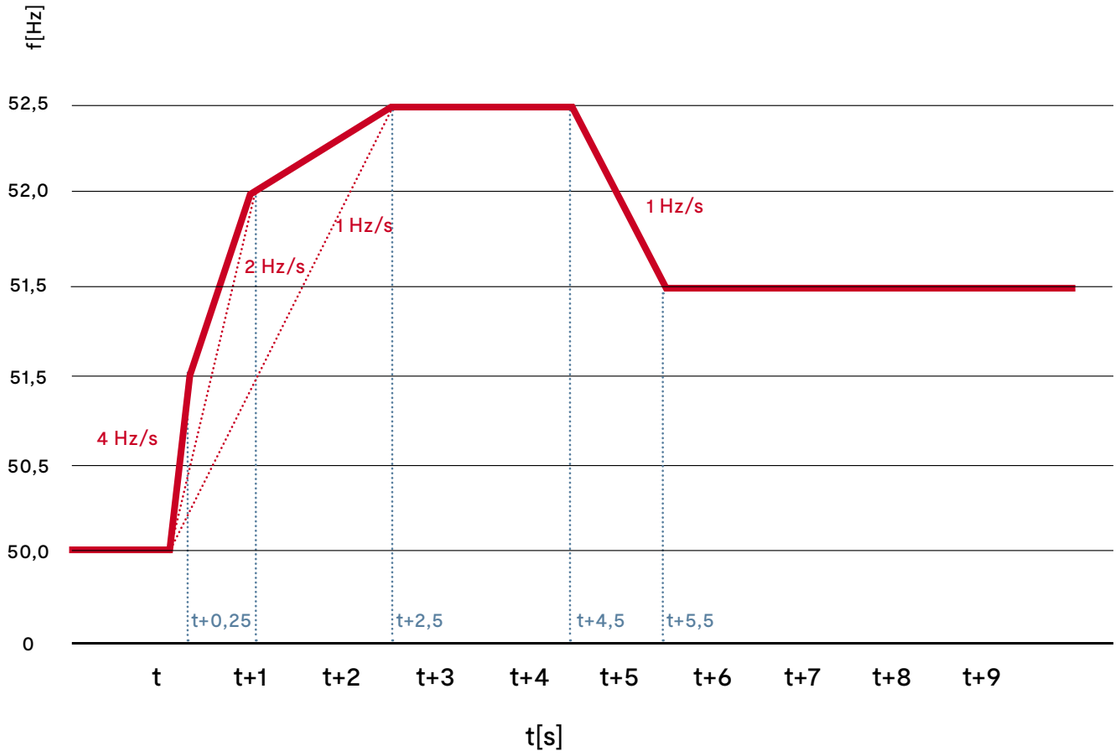
The contents are extracted from the ACER amendment and used for example only

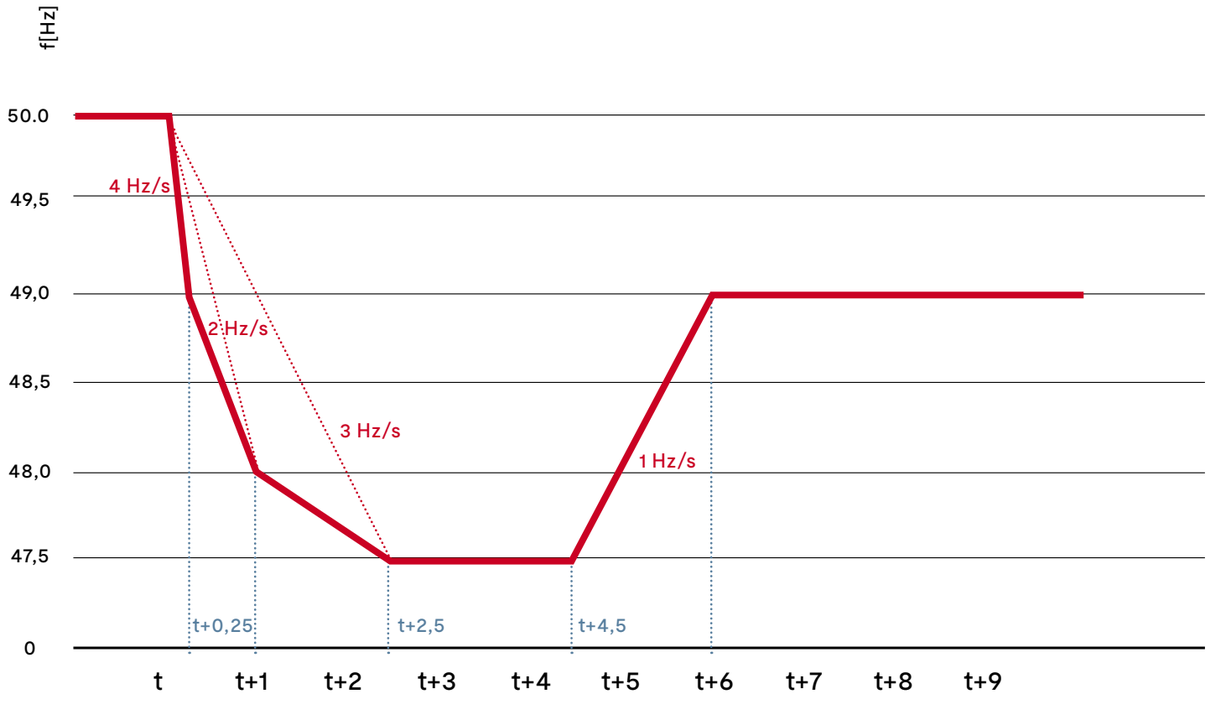
V2G requirements (focus on EV1 and EV2)

Frequency range	Time period for operation
47,5 Hz-48,5 Hz	30 minutes
48,5 Hz-49,0 Hz	30 minutes
49,0 Hz-51,0 Hz	Unlimited

Frequency range	Time period for operation
51,0 Hz-51,5 Hz	30 minutes
51,5 Hz-52,5 Hz	10 seconds

Withstand rate of change of frequency (RoCoF) – up to 4 Hz/s for 0.25 s

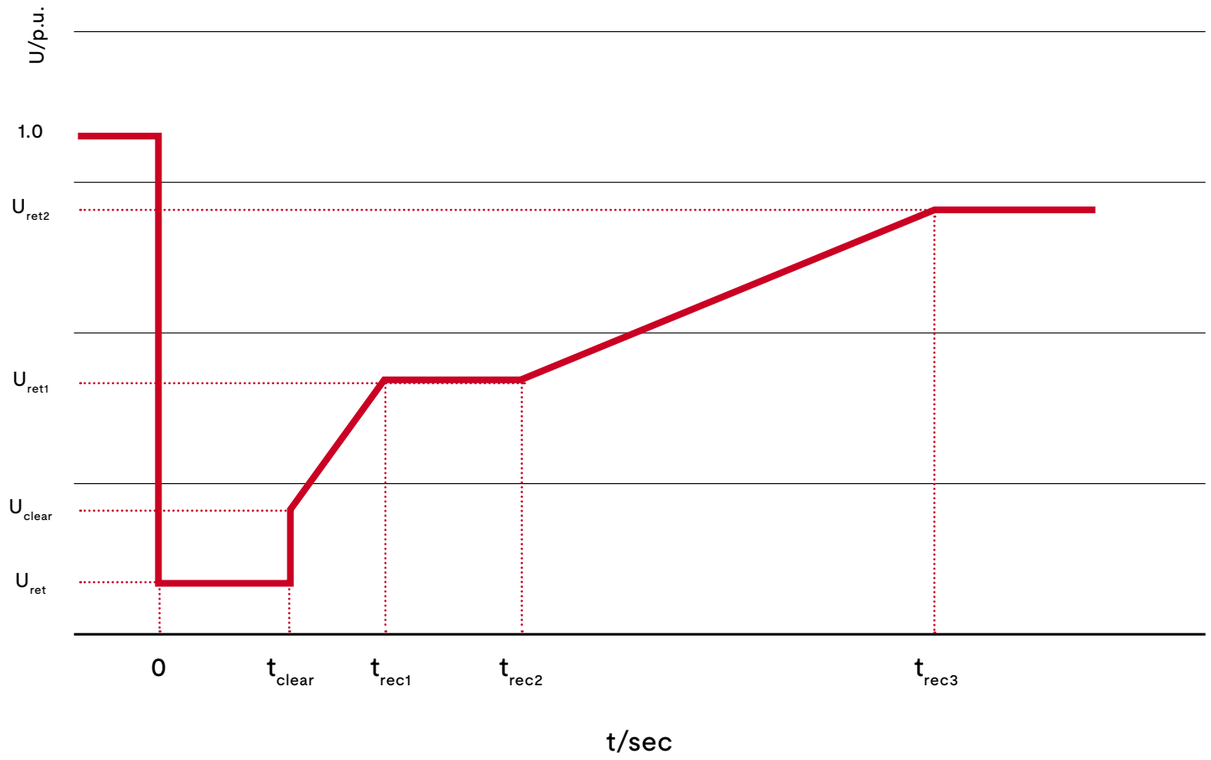




The contents are extracted from the ACER amendment and used for example only

V2G requirements (focus on EV1 and EV2)

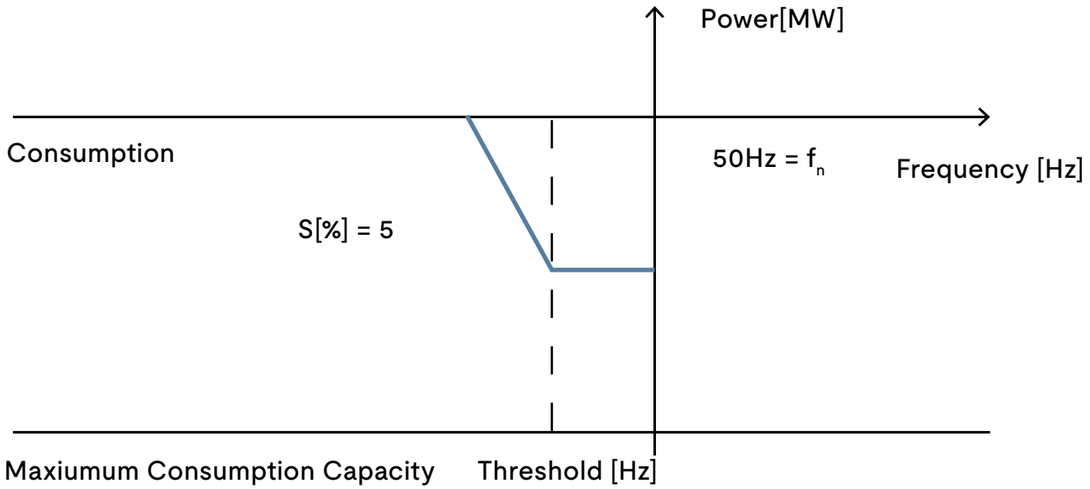
Voltage ride-through with capabiity to recharge by 1 s if voltage comes back in the range of 85%-110%



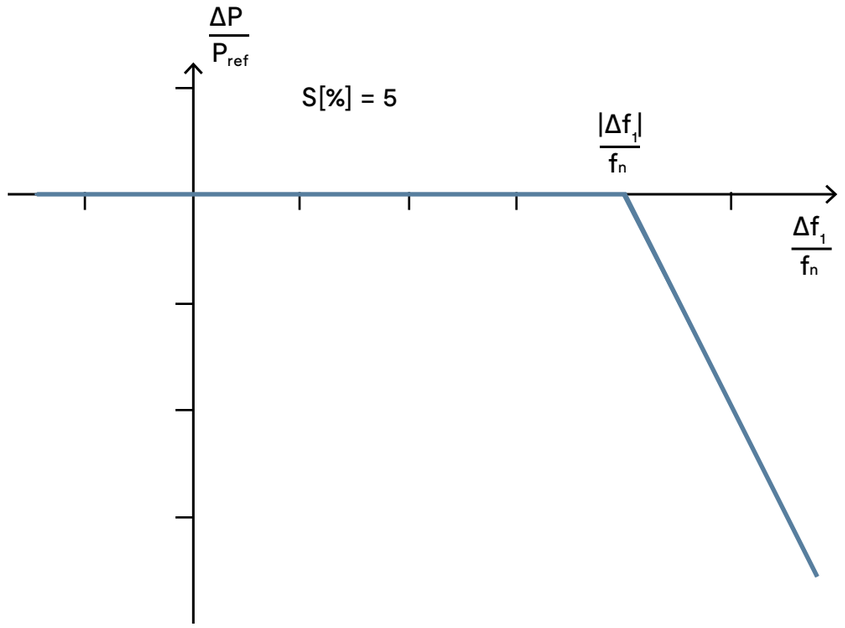
The contents are extracted from the ACER amendment and used for example only

V2G requirements (focus on EV1 and EV2)

Active power frequency response in under-frequency with 5% drop



Data exchange with system operator for remote control of power setpoint



Autonomous reconnection requirements

- Voltage range: 0.9 pu ≤ U ≤ 1.1 pu;
- Frequency range 49.8 Hz ≤ f ≤ 50.1 Hz
- Minimum observation time: 60 s.

The contents are extracted from the ACER amendment and used for example only

Estimated timeline for the new European grid code requirements

*Measures include the adaptation of local grid connection conditions, the upgrading of EVs, EVSEs, IT infrastructure and communication protocols as well as a coordinated approach across all relevant stakeholders to provide conformity procedures.

2023

Amendment proposal by ACER

2025-2026

The European Commission's proposal comes into force

Grid code requirements issued in some countries like Germany (VDE 4105), UK (G99) and Belgium (C 10/11).

3 years

Implementation of measures* to ensure grid code conformity by local committee and stakeholders

2028-2029

Application of grid codes by EV and EVSE

North America

Standards options for bidirectional charging applications

Option 1 for DC EV power export

- **UL 9741 – The Standard for Bidirectional Electric Vehicle (EV) Charging System Equipment**
- **One piece of equipment that performs both functions of a UL 1741 Grid Support Inverter and an EV charger.**
  - Includes a Listed UL 1741 SA/SB inverter/converter that addresses specific local grid codes, so the EV's compliance with current local grid codes is not important.
  - UL 9741 bidirectional charger products can provide a compliance "gatekeeper" for EVs that have not been evaluated by a NRTL for current local grid codes.

Note: UL 9741 also covers all other EVPE products V2X, V2H, V2L, V2V, V2etc. (excluding UL 1741 SC)

Option 2 for AC EV power export

- **UL 1741 Supplement SC – Interconnection Systems Equipment (ISE) –** *under definition*
- **Monitors and oversees EVs with onboard AC inverter/converter that can export to the EPS via a bidirectional electric vehicle supply equipment (BEVSE)/ interconnection systems equipment (ISE)**
- **Very specific to Listed BEVSE/ISE connect to specific EVs that utilize SAE J3072 communications found to comply with:**
  - IEEE 1547-2018 requirements.
  - Testing per IEEE 1547.1-2020
  - UL 1741 SB.

UL 1741 SC BEVSE/ISE will not allow EV export from noncompliant EVs.

UL 1741 Supplement SCEVSE/ISE for EV AC V2G applications

The new UL 1741 SC for BEVSE/ISE is in development to:

- Clearly define the requirements and compliance criteria for non-NRTL-certified EVs capable of **V2G AC electric vehicle power export equipment (EVPE).**
- Interact/communicate with EVs via SAE J3072.
- Monitor EV V2G grid interactions in accordance with local interconnection requirements via the presence of a UL 1741 SC-certified ISE (Interconnection systems equipment) device.

  Cease EV grid export via ISE intervention if the EV:
  - Creates a hazardous overvoltage condition.
  - Does not comply with electric utility requirements.

UL 14741 SC bidirectional EVSE/ISE

- Utility controls
- Permission to export
- Reduce power

- EVSE electrical limits
- Local grid codes (requirements and limits)
- Keep a live signal for export power

Note: EV charging protective functions are required to be provided within the system

New services for the global market access

UL Solutions applies decades of experience to offer comprehensive testing and certification services for EV on-board chargers (OBCs), EVSEs, and EV charging parking facilities to support global V1G and V2X compliance and adoption. We offer:

- Unit safety testing and certification based on UL and IEC standards.
- Unit performance testing and certification in compliance with local grid code standards.
- Unit interoperability evaluation aligned with ISO and property standards.
- System modeling, simulation and grid studies for compliance with local grid code standards.

Partnering with UL Solutions as their sole testing, inspection and certification provider helps EV and EVSE OEMs reduce time and effort needed for their local grid code compliance activities.

UL Solutions also supports EV charging facilities owners navigate local compliance requirements for EVSE installation.

UL.com/Solutions

UL Solutions grid code compliance services for bidirectional chargers

With decades of experience in testing, inspection and certification (TIC) services for EVSE and accreditations as a testing and certification body for more than 60 grid codes around the world, **UL Solutions is well-equipped to support customers. We provide informative test reports and certification services for bidirectional charging systems** up to 500 kW at the Madrid (Spain) facility or at the customer's site.

Grid code accreditations are given by:

- DAkkS
- ENAC No. 1 No. 2
- A2LA
- OSHA

UL.com/Solutions

UL Solutions provides comprehensive services to support compliance with grid code standards worldwide.

Key takeaways

- V1G and V2G are new trends in EV charging systems that have several additional use cases, enabling charging sessions to become profitable.
- In Europe, new regulations and standards apply for V1G and V2G related to new grid codes.
- In North America, UL Standards are in place and are evolving for bidirectional charging systems.
- UL Solutions supports smart and bidirectional charging with testing and certification services, thanks to our extensive expertise, accreditations and facilities.

Find out more:
ul.com/services/electric-vehicle-ev-charging-infrastructure-services

UL.com/Solutions