EUROPEAN
COMMISSION

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COMMISSION DELEGATED REGULATION (EU) …/...

of XXX

establishing a network code on requirements for grid connection of generators and repealing Regulation (EU) 2016/631

(Text with EEA relevance)

This draft has not been adopted or endorsed by the European Commission. Any views expressed are the preliminary views of the Commission services and may not in any circumstances be regarded as stating an official position of the Commission.

EXPLANATORY MEMORANDUM

1. CONTEXT OF THE DELEGATED ACT

[Briefly]

2. CONSULTATIONS PRIOR TO THE ADOPTION OF THE ACT

[Essential part]

3. LEGAL ELEMENTS OF THE DELEGATED ACT

[Briefly]

COMMISSION DELEGATED REGULATION (EU) …/...

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establishing a network code on requirements for grid connection of generators and repealing Regulation (EU) 2016/631

(Text with EEA relevance)

THE EUROPEAN COMMISSION,

Having regard to the Treaty on the Functioning of the European Union,

Having regard to Regulation (EU) 2019/943 of the European Parliament and of the Council of 5 June 2019 on the internal market for electricity[1], and in particular Article 59(2), point (a), thereof,

Whereas:

(1) The increasing penetration of renewable energy sources, the growing role of electricity storage and electric vehicles, and the rising share of distributed generation in the electricity system necessitate an update to Commission Regulation (EU) 2016/631[2]. To ensure system security, facilitate market integration, and maintain a level playing field for equipment manufacturers, it is essential to extend the scope of the rules set out in that Regulation to include new technologies, harmonise requirements for mass-market products to the extent possible, and future-proof the electricity grid. The lessons learned from recent system disturbances, such as the Iberian blackout of April 2025, further underscore the need for robust and harmonised technical requirements to enhance system resilience.

(2) In accordance with Article 3 of Directive (EU) 2019/944 of the European Parliament and of the Council[3] Member States are to ensure, inter alia, a level playing field where electricity undertakings are subject to transparent, proportionate and non-discriminatory rules, fees and treatment. In order to provide system security within the interconnected transmission system, it is essential to establish common requirements, from the system perspective, applicable to power-generating modules. Those requirements that contribute to maintaining, preserving and restoring system security in order to facilitate proper functioning of the internal electricity market, and to achieve cost efficiencies, should be regarded as cross-border network issues and market integration issues.

(3) Common rules for grid connection for power-generating modules should be set out in order to provide a clear legal framework for grid connections, facilitate Union-wide

[1] OJ L 158, 14.6.2019, p. 54, ELI: http://data.europa.eu/eli/reg/2019/943/oj.

[2] Commission Regulation (EU) 2016/631 of 14 April 2016 establishing a network code on requirements for grid connection of generators (OJ L 112, 27.4.2016, p. 1, ELI: http://data.europa.eu/eli/reg/2016/631/oj).

[3] Directive (EU) 2019/944 of the European Parliament and of the Council of 5 June 2019 on common rules for the internal market for electricity and amending Directive 2012/27/EU (OJ L 158, 14.6.2019, p. 125, ELI: http://data.europa.eu/eli/dir/2019/944/oj).

trade in electricity, ensure system security, facilitate the integration of renewable electricity sources, increase competition and allow more efficient use of the network and resources, for the benefit of consumers.

(4) Energy storage plays a key and expanding role in the system and has a dual quality of being able to consume electricity from or inject electricity into the network. For this reason, and due to the specific characteristics of storage and its impact on the system, it is necessary to introduce requirements for the grid connection of electricity storage modules. When generating power, electricity storage modules have the same impact on the system as power-generating modules. As such, the requirements on electricity storage modules should be the same as those on power-generating modules, unless different rules are needed in order to take account of their specificities. In the case of electrical equipment, such as synchronous compensators, flywheels and regenerative braking systems which do not fall into the definition of a power-generating module or electricity storage module, the relevant system operator in coordination with the transmission system operator (TSO) should be allowed to specify the technical requirements that apply. If such electrical equipment is integrated into a power-generating module and used solely for the purpose of meeting the requirements of this Regulation it should be considered as part of such module while its capacity should not count towards the power-generating module capacity.

(5) Rules for grid connection for V2G electric vehicles and associated electric vehicle supply equipment should be set out to account for the growing penetration of electric vehicles and their impact on the power system to ensure predictable behaviour. Those rules should be harmonised to the extent possible to not impede free movement of electric vehicles across the Union. The requirements of this Regulation should apply only to the combination of new electric vehicles and new associated supply equipment.

(6) System security depends partly on the technical capabilities of power-generating modules. Therefore, regular coordination at the level of the transmission and distribution networks and adequate performance of the equipment connected to the transmission and distribution networks with sufficient robustness to cope with disturbances and to help to prevent any major disruption or to facilitate restoration of the system after a collapse are fundamental prerequisites.

(7) Secure system operation is only possible if there is close cooperation between power-generating facility owners and system operators. In the context of system security, the networks and the power-generating modules should be considered as one entity from a system engineering point of view, given that those parts are interdependent. Therefore, as a prerequisite for grid connection, relevant technical requirements should be set for power-generating modules.

(8) The generating facility owners in close cooperation with system operators should apply the requirements provided in this Regulation in a way to ensure effective operation of the network.

(9) Different synchronous electricity systems in the Union have different characteristics which need to be taken into account when setting the requirements for generators. It is therefore appropriate to consider regional specificities when establishing network connection rules.

(10) The categories of power-generating modules should be based on the underlying technology, on their size and their effect on the overall system. To ensure an

appropriate harmonisation or rules for mass-market products, capacities of units of different underlying technology, for instance, photovoltaic, energy storage, combined heat and power installations, or vehicle-to-grid (V2G) electric vehicles, should not necessarily be aggregated for the purpose of the categorisation of the type of power-generating module.

(11) For the purposes of determining whether a power-generating module is installed to provide back-up power, the back-up power supply system should be assessed on its basic functional installation purpose. Such system can include, in addition to power generation modules, uninterruptible power supply systems (UPS), and other equipment of similar function, installed as an integral part of the back-up power supply system.

(12) The requirements applicable to power-generating modules should be set at the level necessary to ensure the operational security of the power system. Such requirements have been covered by Regulation (EU) 2016/631 but were largely focused on large power-generating modules. To address the growing impact of small-scale, mass-market generation—such as rooftop solar, electric vehicles, and distributed storage—this Regulation should include certain additional requirements for Type A power-generating modules that were previously limited to higher categories, such as Type B or C. This includes critical system support functions like fault-ride-through, high-voltage ride through, voltage control, and frequency response, which are now essential even for lower-capacity units due to their cumulative effect on grid stability. The same approach to ensure the rules are fit for purpose should be applied to some requirements of the higher categories to meet changing system needs. Those adjustments are necessary to maintain the existing thresholds for the categories of power-generating modules while reflecting the evolving role of decentralised resources in system security.

(13) The specific values set out to implement the requirements of this Regulation should be based on the principles of non-discrimination and transparency as well as on the principle of optimisation between the highest overall efficiency and lowest total cost for all involved parties. Therefore, those requirements should reflect the differences in the treatment of generation technologies with different inherent characteristics. Transmission system operators and distribution system operators ('DSOs') including closed distribution system operators ('CDSOs') should take those differences into account when setting out the values for implementing the requirements in accordance with this Regulation.

(14) Due to its cross-border impact, this Regulation should aim at the same frequency-related requirements for all voltage levels, at least within a synchronous area. That is necessary because, within a synchronous area, a change in frequency in one Member State would immediately impact frequency and could damage equipment in other Member States. In addition, due to those physical interdependencies, requirements for the synchronous area Ireland-Northern Ireland should be specified. Given that Ireland and Northern Ireland constitute the synchronous area Ireland-Northern Ireland, the same requirements for generators should apply both in Ireland and Northern Ireland to ensure their cooperation in terms of security of supply of electricity, and the interoperability of the energy infrastructure.

(15) It is necessary to provide for ranges of parameters for national choices for fault-ride-through capability for transmission faults in order to maintain a proportionate approach reflecting varying system needs such as the level of renewable energy

sources and existing network protection schemes, both transmission and distribution. In view of the configuration of some networks, the upper limit for fault-ride-through requirements should be 250 milliseconds. However, given that the most common fault clearing time in Europe is currently 150 milliseconds, it leaves scope for the designated entity to verify that a longer requirement is necessary before approving it.

(16) Ensuring appropriate reconnection after an incidental disconnection due to a network disturbance is important to the functioning of the interconnected system. Proper network protection is essential for maintaining system stability and security, particularly in the case of disturbances to the system.

(17) Adequate information exchange between system operators and power-generating facility owners is a prerequisite for enabling system operators to maintain system stability and security. System operators need to have a continuous overview of the state of the system, which includes information on the operating conditions of power-generating modules, as well as the possibility to communicate with them in order to direct operational instructions.

(18) Voltage ranges should be coordinated between interconnected systems because they are crucial to secure planning and operation of a power system within a synchronous area. Disconnections because of voltage disturbances have an impact on neighbouring systems with direct network connections.

(19) The reactive power capability needs depend on several factors including the degree of network meshing and the ratio of in-feed and consumption, which should be taken into account when establishing reactive power requirements. When regional system characteristics vary within a systems operator’s area of responsibility, more than one profile could be appropriate. Reactive power production, known as lagging, at high voltages and reactive power consumption, known as leading, at low voltages might not be necessary. Reactive power requirements can constrain the design and operation of power-generating facilities. Therefore, it is important that the capabilities actually required for efficient system operation be thoroughly assessed.

(20) Rapidly increasing penetration of dispersed generation and converter-based technologies into European networks has presented new challenges in ensuring overall system security. To the extent that an adequate contribution to the dynamically transforming system depends partly on advanced capabilities, power-generating modules should be able to support the system robustness by fulfilling appropriate grid forming and rate-of-change-of-frequency withstand requirements.

(21) Synchronous power-generating modules have an inherent capability to resist or slow down frequency deviations, a characteristic which many converter-based technologies do not inherently provide. The increasing penetration of converter-based generation (such as wind, solar, and storage) has reduced system inertia, heightening risks to frequency and voltage stability. To address this, requirements for grid forming capabilities should be introduced to enable power park modules to emulate the stabilising properties of synchronous generators, including synthetic inertia and fast fault current. Given the technological and operational challenges, a phased roadmap is necessary for distribution systems. This should allow national regulatory authorities to assess network readiness, mitigate risks (such as, local islanding, protection conflicts), and align deployment with system needs, ensuring a smooth transition without compromising security of supply.

(22) The regulatory authorities and system operators should ensure that, in the process of developing and approving the requirements for network connection, they are harmonised to the extent possible, in order to ensure full market integration. Established technical standards should be taken into particular consideration in the development of connection requirements. Development of non-exhaustive requirements should, to the extent possible, be carried out by involving European standardisation organisations, thus permitting the evolution of product standards and, as a consequence, their adoption by the industry.

(23) In general, Member States should not set more stringent requirements at national level on power-generating modules outside of the values provided for in this Regulation. However, it should be possible for system operators to agree on more stringent parameters with power-generating facility owners such as wider frequency ranges and longer minimum times for operation to ensure the best use of the technical capabilities of a power-generating module, if it is required to preserve or to restore system security.

(24) The European Stakeholder Committee provides meaningful basis for the development of implementation guidelines and technical standards which allow and support efficient and practical implementation, such as the final reports of its expert groups. Although the Stakeholder Committee has no formal role in the European standardisation process it nevertheless provides the platform for discussion with all relevant stakeholders and subject-matter experts for the purpose of implementing this Regulation.

(25) Given the proliferation of mass-market products, particularly Type A power-generating modules (such as rooftop solar, small-scale storage, and electric vehicle supply equipment), a harmonised and centralised approach is necessary to reduce administrative burdens and facilitate cross-border trade while maintaining system security. Standardised equipment certificates and a unified compliance framework at national level is necessary to enhance legal certainty for manufacturers and system operators. To ensure consistent and efficient compliance verification across the Union, mutual recognition of the certificates should be established.

(26) This Regulation considers recommendations from the blackout in the Iberian Peninsula. In particular, it requires over-voltage ride through from type A power-generating modules, country-specific voltage provisions, and strengthens governance for approving grid connection rules.

(27) Given the absence of fully harmonised European standards capable of ensuring compliance with those requirements and to avoid regulatory uncertainty that could hinder market development and cross-border interoperability, it is necessary to establish a temporary technical annex setting out the compliance and certification framework for V2G EV and V2G EVSE. That annex, developed in coordination with industry stakeholders, should provide for interoperability between V2G EV and V2G EVSE, ensure legal certainty and clarity for manufacturers, system operators, and authorised certifiers during the transitional period until such time as harmonised standards, developed in accordance with Regulation (EU) 1025/2012 of the European Parliament and of the Council[4], are adopted. To ensure that the regulatory framework

[4] Regulation (EU) No 1025/2012 of the European Parliament and of the Council of 25 October 2012 on European standardisation, amending Council Directives 89/686/EEC and 93/15/EEC and Directives 94/9/EC, 94/25/EC, 95/16/EC, 97/23/EC, 98/34/EC, 2004/22/EC, 2007/23/EC, 2009/23/EC and 2009/105/EC of the European Parliament and of the Council and repealing Council Decision

remains up to date and aligned with technological and standardisation developments, the validity of that annex should be limited to five years from the date of entry into force of this Regulation. This would allow sufficient time for the European standardisation organisations to finalise and publish the necessary standards while ensuring that market participants can rely on a clear and uniform compliance framework in the interim.

(28) Although the scope of the Annex is limited to the scope of this Regulation, standards and technical specifications related to data sharing, field interoperability and reliable communication between equipment from different manufacturers of V2G EV and V2G EVSE are being established at the Union level. Therefore, communication standards and specifications, including those prescribed under Regulation (EU) 2023/1804 on the deployment of alternative fuels infrastructure (AFIR) and the Regulation (EU) 2025/656 should be followed in order to promote legal certainty, avoid fragmentation and support a harmonised approach to conformity assessment and market deployment.

(29) V2G EV and V2G EVSE should demonstrate compliance with the technical annex. Any non-compliance with that annex should not, in itself, result in the refusal of a type approval in accordance with to this Regulation until the scope of Regulation (EU) 2018/858 of the European Parliament and of the Council[5] is extended to include provisions on bi-directional charging of EVs. Any non-compliance with the technical annex however should not, in itself, result in the refusal of an approval in accordance with Regulation (EU) 2018/858.

(30) Due to the evolution of system requirements, a cost-benefit analysis should be carried out to determine whether to extend the applicability of certain requirements to existing generators. Based on this analysis, the relevant regulatory authority should be authorised to extend the applicability of the requirements of this Regulation to existing power-generating modules.

(31) A process for derogating from the rules should be set out to take into account local circumstances where exceptionally, for example, compliance with those rules is not required for the safe operation of the power system. System operators should be allowed to propose individual derogations for power-generating modules for approval by the relevant regulatory authority.

(32) Due to the extent of the necessary changes to reflect technological advancements, improve regulatory clarity and legal certainty, and strengthen the internal electricity market, Regulation (EU) 2016/631 should be repealed and replaced by this Regulation. However, in order to ensure that power-generating modules which fall within the scope of application of Regulation (EU) 2016/631 continue to support the resilience of electricity system, the technical requirements applicable to them should continue to apply until the end of their lifetime or until they are significantly modernised and hence fall under the scope of this Regulation.

87/95/EEC and Decision No 1673/2006/EC of the European Parliament and of the Council (OJ L 316, 14.11.2012, p. 12, ELI: http://data.europa.eu/eli/reg/2012/1025/oj).

5 Regulation (EU) 2018/858 of the European Parliament and of the Council of 30 May 2018 on the approval and market surveillance of motor vehicles and their trailers, and of systems, components and separate technical units intended for such vehicles, amending Regulations (EC) No 715/2007 and (EC) No 595/2009 and repealing Directive 2007/46/EC (OJ L 151, 14.6.2018, p. 1, ELI: http://data.europa.eu/eli/reg/2018/858/oj).

(33) V2G electric vehicles (V2G EV) and V2G electric vehicle supply equipment (V2G EVSE) should be subject to mandatory technical requirements, because they act in a similar way as battery storage installations connected the electricity grid. The primary focus should be on the functional and dynamic performance requirements of the V2G EV and associated V2G EVSE and the interaction with the grid. In order to give manufacturers sufficient time to account for the new requirements for V2G EV and V2G EVSE, they should apply from three years after the entry into force of this Regulation for new vehicle types and from four years after the entry into force of this Regulation for all new vehicles placed on the market.

(34) In order for power-generating modules manufacturers to have sufficient time to account for the new requirements set out in this Regulation, unless otherwise specified, the requirements should apply from two years after the entry into force for power-generating modules connecting to the network. Until the new requirements apply, the technical requirements under Regulation (EU) 2016/631 should continue to apply,

HAS ADOPTED THIS REGULATION:

TITLE I

GENERAL PROVISIONS

Article 1

Subject matter

This Regulation establishes a network code which lays down the requirements for grid connection of power-generating facilities, namely synchronous power-generating modules, power park modules, electricity storage modules and offshore power park modules, to the interconnected system. It supports fair conditions of competition in the internal electricity market, to ensure system security and the integration of renewable electricity sources, and to facilitate Union-wide trade in electricity.

This Regulation also lays down the obligations for ensuring that system operators make appropriate use of the power-generating facilities' capabilities in a transparent and non-discriminatory manner to provide a level playing field throughout the Union.

Article 2

Definitions

For the purposes of this Regulation, the definitions in Article 2 of Directive (EU) 2023/1791 of the European Parliament and of the Council[6], Article 2 of Regulation (EU) 2019/943, Article 2 of Commission Regulation (EU) 2015/1222[7], Article 2 of Commission Regulation (EU) No 543/2013[8] and Article 2 of Directive (EU) 2019/944 shall apply.

The following definitions shall also apply:

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[6] Directive (EU) 2023/1791 of the European Parliament and of the Council of 13 September 2023 on energy efficiency and amending Regulation (EU) 2023/955 (OJ L 231, 20.9.2023, p. 1, ELI: http://data.europa.eu/eli/dir/2023/1791/oj).

[7] Commission Regulation (EU) 2015/1222 of 24 July 2015 establishing a guideline on capacity allocation and congestion management (OJ L 197, 25.7.2015, p. 24, ELI: http://data.europa.eu/eli/reg/2015/1222/oj).

[8] Commission Regulation (EU) No 543/2013 of 14 June 2013 on submission and publication of data in electricity markets and amending Annex I to Regulation (EC) No 714/2009 of the European Parliament and of the Council (OJ L 163, 15.6.2013, p. 1, ELI http://data.europa.eu/eli/reg/2013/543/oj).

1. ‘entity’ means a regulatory authority, other national authority, system operator or other public or private body appointed under national law;
2. ‘synchronous area’ means an area covered by synchronously interconnected transmission system operators (TSOs);
3. ‘voltage’ means the difference in electrical potential between two points measured as the root-mean-square value of the positive sequence phase-to-phase voltages at fundamental frequency;
4. ‘apparent power’ means the product of voltage and current at fundamental frequency, and the square root of three in the case of three-phase systems, usually expressed in kilovolt-amperes (‘kVA’) or megavolt-amperes (‘MVA’);
5. ‘power-generating module’ means either a synchronous power-generating module or a power park module;
6. ‘power-generating facility owner’ means a natural or legal entity owning a power-generating facility;
7. ‘synchronous power-generating module’ means a set of machines which cannot be operated independently from each other and can generate electrical energy such that the frequency of the generated voltage, the generator speed and the frequency of network voltage are in a constant ratio and thus in synchronism;
8. ‘power-generating module document’ or ‘PGMD’ means a document provided by the power-generating facility owner to the relevant system operator for a type B or C power-generating module which confirms that the power-generating module’s compliance with the technical criteria set out in this Regulation has been demonstrated and provides the necessary data and statements, including a statement of compliance;
9. ‘supply equipment document’ or ‘SED’ means a document provided by the V2G electrical charging park owner to the relevant system operator for a EV3 V2G electric vehicle supply equipment which confirms that the supply equipment’s compliance with the technical criteria set out in this Regulation has been demonstrated and provides the necessary data and statements, including a statement of compliance;
10. ‘network’ means a plant and apparatus connected together in order to transmit or distribute electricity;
11. ‘relevant system operator’ means the transmission system operator or distribution system operator to whose system a power-generating module, demand facility, distribution system, V2G electric vehicle and associated V2G electric vehicle supply equipment or high-voltage direct current (HVDC) system is or will be connected;
12. ‘connection agreement’ means a contract between the relevant system operator and either the power-generating facility owner, demand facility owner, distribution system operator or HVDC system owner, which includes the relevant site and specific technical requirements for the power-generating facility, demand facility, distribution system, distribution system connection or HVDC system;
13. ‘connection point’ means the alternating current (AC) electrical interface at which the power-generating module, demand facility, distribution system or HVDC system is connected to a transmission system, offshore network, distribution system, including closed distribution systems, or HVDC system, as set out in the connection agreement;
14. ‘maximum capacity’ or ‘Pmax’ means the maximum continuous active power which a power-generating module can produce, less any demand or losses associated solely with

facilitating the operation of that power-generating module as specified in the connection agreement or as provided by the equipment certificate when a connection agreement is not required;

15. ‘power park module’ means a unit or set of units that can generate electricity, which is not a synchronous power-generating module and that also has a single connection point to a transmission system, distribution system including closed distribution system or HVDC system;
16. ‘offshore power park module’ means a power park module located offshore with an offshore connection point;
17. ‘synchronous compensation operation’ means the operation of an alternator without prime mover to regulate voltage dynamically by production or absorption of reactive power;
18. ‘active power’ means the real component of the apparent power at fundamental frequency, expressed in watts or multiples thereof such as kilowatts (‘kW’) or megawatts (‘MW’);
19. ‘pump-storage’ means a hydro unit in which water can be raised by means of pumps and stored to be used for the generation of electrical energy;
20. ‘frequency’ means the electric frequency of the system expressed in hertz that can be measured in all parts of the synchronous area under the assumption of a consistent value for the system in the time frame of seconds, with only minor differences between different measurement locations, and whose nominal value f_n is 50 Hz;
21. ‘droop’ means the ratio of a steady-state change in frequency to the resulting steady-state change in active power output, expressed in percentage terms, where the change in frequency is expressed as a ratio to nominal frequency and the change in active power expressed as a ratio to maximum capacity or actual active power at the moment the relevant threshold is reached;
22. ‘minimum regulating level’ means the minimum active power, as specified in the connection agreement or as agreed between the relevant system operator and the power-generating facility owner, down to which the power-generating module can control active power;
23. ‘setpoint’ means the target value for any parameter typically used in control schemes;
24. ‘instruction’ means any command given by a system operator, within its authority, to a power-generating facility owner, demand facility owner, distribution system operator or HVDC system owner in order to perform an action;
25. ‘secured fault’ means a fault which is successfully cleared in accordance with the system operator’s planning criteria;
26. ‘reactive power’ means the imaginary component of the apparent power at fundamental frequency, usually expressed in kilovar (‘kVAr’) or megavar (‘MVAr’);
27. ‘fault-ride-through’ means the capability of electrical devices to be able to remain connected to the network and operate through periods of low voltage at the connection point caused by secured faults;
28. ‘alternator’ means a device that converts mechanical energy into electrical energy by means of a rotating magnetic field;

29. ‘current’ means the rate at which electric charge flows which is measured by the root-mean-square value of the positive sequence of the phase current at fundamental frequency;

30. ‘stator’ means the portion of a rotating machine which includes the stationary magnetic parts with their associated windings;

31. ‘inertia’ means the property of a rotating rigid body, such as the rotor of an alternator, such that it maintains its state of uniform rotational motion and angular momentum unless an external torque is applied;

32. ‘synthetic inertia’ means a prescribed electrical dynamic performance provided by a power park module or an HVDC system at its connection point with the purpose to emulate the equivalent dynamic effect of the inertia provided by a synchronous power-generating module;

33. ‘frequency control’ means the capability of a power-generating module or HVDC system to adjust its active power output in response to a measured deviation of system frequency from a setpoint, in order to maintain stable system frequency;

34. ‘frequency sensitive mode’ or ‘FSM’ means the operating mode of a power-generating module or HVDC system in which the active power output changes in response to a change in system frequency, in such a way that it assists with the recovery to target frequency;

35. ‘limited frequency sensitive mode - overfrequency’ or ‘LFSM-O’ means a power-generating module or HVDC system operating mode which will result in active power output reduction in response to a change in system frequency above a certain value;

36. ‘limited frequency sensitive mode - underfrequency’ ‘LFSM-U’ means a power-generating module or HVDC system operating mode which will result in active power output increase in response to a change in system frequency below a certain value;

37. ‘frequency response deadband’ means an interval used intentionally to make the frequency control unresponsive;

38. ‘frequency response insensitivity’ means the inherent feature of the control system specified as the minimum magnitude of change in the frequency or input signal that results in a change of output power or output signal;

39. ‘P-Q-capability diagram’ means a diagram describing the reactive power capability of a power-generating module in the context of varying active power at the connection point;

40. ‘steady-state stability’ means the ability of a network or a synchronous power-generating module to revert [to?] and maintain stable operation following a minor disturbance;

41. ‘island operation’ means the independent operation of a whole network or part of a network that is isolated after being disconnected from the interconnected system, having at least one power-generating module or HVDC system supplying power to this network and controlling the frequency and voltage;

42. ‘houseload operation’ means the operation which ensures that power-generating facilities are able to continue to supply their in-house loads in the event of network failures resulting in power-generating modules being disconnected from the network and tripped onto their auxiliary supplies;

43. ‘black start capability’ means the capability of recovery of a power-generating module from a total shutdown through a dedicated auxiliary power source without any electrical energy supply external to the power-generating facility;

44. ‘authorised certifier’ means an entity that issues equipment certificates and power-generating module documents and whose accreditation is given by the national affiliate of the European cooperation for Accreditation (‘EA’), established in accordance with Regulation (EC) No 765/2008 of the European Parliament and of the Council[9];

45. ‘equipment certificate’ means a document issued by an authorised certifier for equipment used by a power-generating module, demand unit, distribution system, demand facility or HVDC system, which sets out its validity and which may, for the purpose of replacing specific parts of the compliance process, include models that have been verified against actual test results;

46. ‘excitation control system’ means a feedback control system that includes the synchronous machine and its excitation system;

47. ‘U-Q/Pmax-profile’ means a profile representing the reactive power capability of a power-generating module or HVDC converter station in the context of varying voltage at the connection point;

48. ‘minimum stable operating level’ means the minimum active power, as specified in the connection agreement or as agreed between the relevant system operator and the power-generating facility owner, at which the power-generating module can be operated stably for an unlimited time;

49. ‘overexcitation limiter’ means a control device within the AVR which prevents the rotor of an alternator from overloading by limiting the excitation current;

50. ‘underexcitation limiter’ means a control ~~device~~ within the AVR, the purpose of which is to prevent the alternator from losing synchronism due to lack of excitation;

51. ‘automatic voltage regulator’ or ‘AVR’ means the continuously acting automatic equipment controlling the terminal voltage of a synchronous power-generating module by comparing the actual terminal voltage with a reference value and controlling the output of an excitation control system;

52. ‘power system stabiliser’ or ‘PSS’ means an additional functionality of the AVR of a synchronous power-generating module whose purpose is to damp power oscillations;

53. ‘fast fault current’ means a current injected by a power park module or HVDC system during and after a voltage deviation caused by an electrical fault with the aim of identifying a fault by network protection systems at the initial stage of the fault, supporting system voltage retention at a later stage of the fault and system voltage restoration after fault clearance;

54. ‘power factor’ means the ratio of the absolute value of active power to apparent power;

55. ‘slope’ means the ratio of the change in voltage, based on reference 1 pu voltage, to a change in reactive power in-feed from zero to maximum reactive power, based on maximum reactive power;

[9] Regulation (EC) No 765/2008 of the European Parliament and of the Council of 9 July 2008 setting out the requirements for accreditation and repealing Regulation (EEC) No 339/93 (OJ L 218, 13.8.2008, p. 30, ELI: http://data.europa.eu/eli/reg/2008/765/oj).

56. ‘installation document’ means a simple structured document containing information about a type A power-generating module or a demand unit, with demand response connected below 1 000 V, and confirming its compliance with the relevant requirements;

57. ‘statement of compliance’ means a document provided by the power-generating facility owner, demand facility owner, distribution system operator or HVDC system owner to the system operator stating the current status of compliance with the relevant specifications and requirements;

58. ‘final operational notification’ or ‘FON’ means a notification issued by the relevant system operator to a power-generating facility owner, demand facility owner, distribution system operator or HVDC system owner who complies with the relevant specifications and requirements, allowing them to operate respectively a power-generating module, demand facility, distribution system or HVDC system by using the grid connection;

59. ‘energisation operational notification’ or ‘EON’ means a notification issued by the relevant system operator to a power-generating facility owner, demand facility owner, distribution system operator or HVDC system owner prior to energisation of its internal network;

60. ‘interim operational notification’ or ‘ION’ means a notification issued by the relevant system operator to a power-generating facility owner, demand facility owner, distribution system operator or HVDC system owner which allows them to operate respectively a power-generating module, demand facility, distribution system or HVDC system by using the grid connection for a limited period of time and to initiate compliance tests to ensure compliance with the relevant specifications and requirements;

61. ‘limited operational notification’ or ‘LON’ means a notification issued by the relevant system operator to a power-generating facility owner, demand facility owner, distribution system operator or HVDC system owner who had previously attained FON status but is temporarily subject to either a significant modernisation or loss of capability resulting in non-compliance with the relevant specifications and requirements;

62. ‘electricity storage module’ or ‘ESM’ means a power-generating module which can inject and consume active power to and from the network for energy storage behind a single connection point, including V2G electric vehicle and associated V2G electric vehicle supply equipment with a bidirectional functionality, but excluding pump-storage power-generating modules;

63. ‘maximum consumption capacity’ means the maximum continuous active power which a demand unit or electricity storage module can consume, as specified in the connection agreement or as agreed between the relevant system operator and the demand facility owner or power-generating facility owner or as provided by the equipment certificate when a connection agreement is not required;

64. ‘V2G electric vehicle’ or ‘V2G EV’ means a vehicle that is powered, fully or in part, with electricity and is equipped with technology enabling the vehicle to inject electricity to the network over vehicle-to-grid (V2G) electric vehicle supply equipment;

65. ‘V2G electric vehicle supply equipment’ or ‘V2G EVSE’ means the infrastructure necessary to conduct electrical energy from the network to the electric vehicle and from the electric vehicle to the network, which does not include electrical wirings, cables, connectors, fixed installation components, or other elements connecting the electric vehicle supply equipment to the grid connection point;

66. ‘V2G electrical charging park’ means an installation that has a single connection point to the network and where one or more V2G electric vehicles can be simultaneously connected;

67. ‘V2G electrical charging park owner’ means a natural or legal entity owning a V2G electrical charging park;

68. ‘power-generating unit’ or ‘PGU’ means an aggregation of components converting a primary source of energy into electricity at the terminals of a unit generating electricity, which is synchronously connected to the network or which is either non-synchronously connected to the network or connected through power electronics;

69. ‘component’ means any active element which is part of a power-generating module whose response may have an impact on the electrical characteristics or compliance with the requirements of this Regulation, or both;

70. ‘PGU family’ means a group of PGUs from the same manufacturer with electrical performance characteristics equivalent to those of a representative PGU which has undergone conformance tests;

71. ‘component family’ means a group of components from the same manufacturer with electrical performance characteristics equivalent to those of a representative component which has undergone conformance tests;

72. ‘certification scheme’ means a conformity assessment in accordance with internationally recognised standards, for the power-generating module, PGU or components included in the compliance scheme;

73. ‘compliance scheme’ means a compliance verification programme specifying assessment measures to demonstrate the compliance of a power-generating module, PGU or components with the relevant technical requirements during the operational notification procedure;

74. ‘placing on the market’ in the context of the V2G EV and V2G EVSE shall have the same meaning as in Article 3(50) of Regulation (EU) 2018/858 of the European Parliament and of the Council;

75. ‘type of vehicle’ means a type of vehicle as defined in Article 3 of Regulation (EU) 2018/858;

76. ‘forced oscillation’ means a sustained oscillatory disturbance caused by an internal driving source such as control systems or the inherent nature of the facility process, electrical, mechanical, or meteorological phenomena which affects electrical quantities in the power generated or consumed;

77. ’power oscillation damping’ means an additional system support functionality in the control system of a power park module whose purpose is, through the control of the active power, reactive power, or both, to damp the power oscillations.

78. ‘power-generating facility’ means power-generating facility as defined in point (28) of Article 2 of Regulation (EU) 2019/943.

Article 3

Scope

1. This Regulation applies to transmission system operators, distribution system operators and power-generating modules including electricity storage modules, as categorised in accordance with Article 5.

2. This Regulation does not apply to:

   (a) power-generating modules connected to the transmission system and distribution systems, or to parts of the transmission system or distribution systems, of islands of Member States whose systems are not operated synchronously with either the Continental Europe, Nordic, Ireland and Northern Ireland synchronous areas;

   (b) power-generating modules installed to provide back-up power and operate in parallel with the system for less than five minutes per calendar month while the power system is in normal system state or to supply an off-grid system. Parallel operation during maintenance or commissioning tests of that power-generating module shall not count towards the five-minute limit;

   (c) power-generating modules without a permanent connection point and used by the system operators to temporarily provide power when normal system capacity is partly or completely unavailable;

   (d) uninterruptible power supply systems or other equipment of similar function installed exclusively as an integral part of a back-up power supply system.

3. Unless otherwise provided for in this Regulation, all requirements laid down therein shall apply at the connection point.

Article 4

Significant modernisation

1. The regulatory authority shall establish the definition of significant modernisation of power-generating modules upon a proposal by the TSO. In developing that proposal, the TSO shall coordinate with distribution system operators (DSOs) and conduct a public consultation in accordance with Article 10.

2. The definition of significant modernisation shall set parameters in accordance with all the following criteria:

   (a) an increase above the existing maximum capacity of the power-generating module. That increase may result from a single modernisation or from the cumulation of the several modernisations, provided that the first modernisation has been implemented after [the date of entry into force of this Regulation]. Transmission system operators shall specify a minimum percentage of the increase in the range of 5 - 20%;

   (b) an increase from the reactive power capability of the power-generating module, whether that deviation results from a single modernisation or from the cumulation of the several modernisations, provided that the first modernisation has been implemented after [the date of entry into force of this Regulation]. Transmission system operators shall specify a minimum percentage of the increase in the range of 10 - 20%;

(c) a change in frequency stability and active power management capabilities of the power-generating module, whether that change results from a single modernisation or from the cumulation of the several modernisations, provided that the first modernisation has been implemented after [the date of entry into force of this Regulation];

(d) for Type C and D, a change of components of a power-generating module except for changes resulting from maintenance.

In the proposal referred to in paragraph 1, the TSO may propose additional criteria for the purpose of defining a significant modernisation with regard to site-specific requirements only.

3. The requirements of this Regulation shall apply to the entire power-generating module and not only to the modernised part of the power-generating module.

Article 5

Determination of categories of power-generating modules

1. Power-generating modules shall comply with the requirements of this Regulation on the basis of their maximum capacity according to the categories set out in paragraph 2.

2. Power-generating modules shall be categorised as follows:

(a) maximum capacity of 0.8 kW or more (type A);

(b) maximum capacity at or above a threshold specified in accordance with paragraph 4 (type B). This threshold shall not be above the limit for type B power-generating modules contained in Table 1;

(c) maximum capacity at or above a threshold specified in accordance with paragraph 4 (type C). This threshold shall not be above the limit for type C power-generating modules contained in Table 1;

(d) maximum capacity at or above a threshold specified in accordance with paragraph 4 (type D). This threshold shall not be above the limit for type D power-generating modules contained in Table 1.

Table 1

Limits for thresholds for type B, C and D power-generating modules

Synchronous areas	**Threshold of maximum capacity from which a power-generating module is of type B**	**Threshold of maximum capacity from which a power-generating module is of type C**	**Threshold of maximum capacity from which a power-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	5 MW	10 MW

3. The category of power-generating modules shall be determined based on their maximum capacity, their effect on the overall system and the following requirements:

   (a) synchronous machines shall be classed on the machine size and include all the components of a generating facility that normally run indivisibly. An installation containing a set of synchronous machines that cannot be operated independently from each other shall be assessed on their aggregated capacity;

   (b) power-generating units of the same underlying technology, where they form an economic unit and where they have a single connection point shall be assessed on their aggregated capacity;

   (c) the capacity of power-generating units of different underlying technology connected at a single connection point shall be determined in the agreement between the relevant system operator and power-generating facility owner, or in accordance with a different method in a decision by the regulatory authority;

   (d) V2G EV and associated V2G EVSE connected to a V2G electrical charging park shall not be assessed on their aggregated capacity;

   (e) energy storage integrated to a power-generating module used solely for the purpose of meeting the grid forming requirements of this Regulation shall be considered as part of such module and its capacity shall not count towards the power-generating module categorisation.

4. The designated entity shall establish the maximum capacity thresholds for types B, C and D power-generating modules upon a proposal by the TSO. In forming proposals, the TSO shall coordinate with DSOs and TSOs with a direct network connection and shall conduct a public consultation in accordance with Article 10.

5. A proposal to change the thresholds shall not be made sooner than three years after the approval of the previous proposal.

6. Power-generating facility owners shall assist the process set out in paragraphs 4 and 5 and provide relevant data as requested by the TSO.

7. In case of a change to the thresholds, the power-generating module shall comply with the requirements of the category applicable at the moment of its connection to the network, until the end of its lifetime or until it is significantly modernised pursuant to Article 4 of this Regulation.

8. V2G electric vehicles and associated V2G electric vehicle supply equipment shall be categorised as follows:

   (a) maximum capacity at or above 0.8 kW and below 2.4 kW (type EV1);

   (b) maximum capacity at or above 2.4 kW and at or below 50 kW (type EV2);

   (c) maximum capacity above 50 kW and below 1 MW (type EV3).

Article 6

Application to pump-storage power-generating modules, power-generating modules embedded in the networks of industrial sites, combined heat and power facilities, electricity storage modules, V2G EV and associated V2G EVSE

1. Pump-storage power-generating modules:

   (a) with fixed speed machines and single shaft ternary machines shall meet the requirements of synchronous power-generating modules;

   (b) with variable speed machines shall meet the requirements of power park modules.

   With regard to pump-storage power-generating modules with variable speed machines, if the maximum response time T_{resp}, set out in Figure 4 is greater than the value set out in Article 15(6), point (b), the power-generating facility owner and the relevant system operator shall agree on the acceptable response time, as a site-specific requirement.

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

   (a) the technical design of power-generating modules shall not limit in time operation in the synchronous compensation operation mode;

   (b) synchronous compensation operation mode of full-converter variable speed machines shall be performed by converters.

3. Pump-storage power-generating modules in pumping operation mode shall fulfil the following requirements:

   (a) the active power response shall be the same as in the generation operation mode;

   (b) for single shaft ternary pump-storage generating modules, where Article 15 or Article 22(2) apply, the reference active power for LFSM-O or LFSM-U respectively shall be the maximum capacity of the turbine.

4. Pump-storage power-generating modules in pumping operation mode shall not be required to remain connected and continue operation if the frequency is below 49 Hz, unless otherwise agreed pursuant to Article 14(1), point (a)(ii).

5. Pump-storage power-generating modules in pumping operation mode shall be capable of disconnection from the network at the frequency thresholds defined by the TSO; this disconnection shall not extend to the auxiliary supply of the power-generating module.

6. For pump-storage generating modules which are doubly-fed induction machines and full-converter variable speed machines, the parameters in Table 7.1 and 7.2, or Table 8.1 and 8.2 shall apply to Figure 10 when defining the voltage-against-time profile with regard to fault-ride-through capability.

7. For pump-storage generating modules, the following provisions shall not apply:

   (a) with regard to pump-storage power-generating modules with fixed speed machines:

   (i) in pumping operation mode and synchronous compensation operation mode: Article 15, Article 16 and Article 22(2), (4) and (5);

   (ii) in pumping operation mode: Article 25(3), second sentence;

   (iii) in synchronous compensation operation mode: Article 25(3);

   (b) with regard to pump-storage power-generating modules with single shaft ternary machines in pumping operation mode: Article 15(10) and Article 22(4);

   (c) with regard to pump-storage power-generating modules with single shaft ternary machines in pumping operation mode if only pumps are operated: Article 15(1) to (11), Article 16, Article 22(2) and (4), Article 22(5), point (d), and Article 25(3), second sentence;

   (d) with regard to pump-storage power-generating modules with single shaft ternary machines in synchronous compensation operation mode: Article 15 and 16, Article 22(2) and (4), Article 22(5), point (d), and Article 25(3);

   (e) with regard to pump-storage power-generating modules with variable speed machines in pumping operation mode: Article 15(10) and Article 22(4);

   (f) with regard to pump-storage power-generating modules with variable speed machines in synchronous compensation operation mode: Article 15 and 16, Article 22(2) and (4) and Article 22(5), point (d).

8. With regard to power-generating modules embedded in the networks of industrial sites, power-generating facility owners, system operators of industrial sites and relevant system operators whose network is connected to the network of an industrial site may agree, in coordination with the TSO, on conditions for disconnection of such power-generating modules together with critical loads, which secure production processes, from the relevant system operator's network.

9. With regard to combined heat and power production embedded in the networks of industrial sites, the requirements to maintain constant active power output or to modulate active power output shall not apply, where all of the following criteria are met:

   (a) the primary purpose of those facilities is to produce heat for production processes of the industrial site concerned;

   (b) heat and power-generating is inextricably interlinked, namely any change of heat generation results inadvertently in a change of active power-generating and vice versa;

(c) the power-generating modules are of type A, B, C, and in the case of the Nordic synchronous area also type D as categorised in accordance with Article 5.

The derogation laid down in the first subparagraph of this paragraph shall not apply to the requirements under Article 14 and Article 15(1) or where the national legislation provides otherwise.

10. Combined heat and power-generating facilities shall comply with the requirements of this Regulation on the basis of their electrical maximum capacity.

11. Electricity storage modules shall comply with the requirements of this Regulation when injecting and consuming active power to and from the network.

12. V2G EV and associated V2G EVSE shall comply with the requirements of this Regulation when injecting and consuming active power to and from the network.

Article 7

Regulatory aspects

1. The designated entity shall be the regulatory authority unless otherwise provided by the Member State. The designated entity shall act independently from any political or market interest and not seek or take direct instructions from any government or other public or private entity when carrying out its tasks.

2. Where a data exchange interface is referred to in this Regulation, system operators shall require that such an interface complies with cyber-security requirements pursuant to the Regulation (EU) 2024/284 of the European Parliament and of the Council[10].

3. When applying this Regulation, designated entities and system operators shall:

(a) apply the principles of proportionality and non-discrimination;

(b) ensure transparency;

(c) apply the principle of optimisation between the highest overall efficiency and lowest total costs for all parties involved;

(d) respect the responsibility assigned to the relevant system operator in order to ensure system security, including as required by national legislation;

(e) consult with DSOs, where relevant, and take account of potential impacts on their system;

(f) take into consideration agreed European standards, technical specifications, implementation guidance documents developed by European Network of Transmission System Operators for Electricity (ENTSO for Electricity) in accordance with Article 59(15) of Regulation (EU) 2019/943, and relevant nuclear safety rules;

(g) where necessary, take into consideration local system needs in specifying site-specific requirements for power-generating modules' capabilities.

[10] Regulation (EU) 2024/284 of the European Parliament and of the Council of 23 October 2024 on horizontal cybersecurity requirements for products with digital elements and amending Regulations (EU) No 168/2013 and (EU) 2019/1020 and Directive (EU) 2020/1828 (Cyber Resilience Act) (OJ L 2847, 20.11.2024, ELI: http://data.europa.eu/eli/reg/2024/2847/oj).

4. Requirements established by the designated entity pursuant to this Regulation or changes of those requirements shall be based on proposals by the relevant system operators and be publicly available free of charge. This applies to all instances where system operators specify values to implement requirements.

5. Site-specific requirements to be established by relevant system operators shall be subject to approval by the designated entity.

6. Where the relevant system operator needs to submit a new proposal or to update an existing proposal for setting out values to implement requirements of this Regulation, or the methodology to calculate or establish them, as appropriate, the relevant system operator shall submit that proposal, update or methodology for approval to the designated entity by [date of entry into force of this Regulation plus 9 months]. The designated entity may provide for a shorter time period for all or parts of the requirements or the methodologies.

   System operators may propose updates to values to implement requirements, as needed.

7. Where this Regulation requires the relevant system operators and power-generating facility owners to seek agreement, they shall endeavour to do so within six months after a first proposal has been submitted by one party to the other. If no agreement has been found within that timeframe, each party may request the designated entity to issue a decision on the subject in question within six months.

8. The designated entity shall take decisions on proposals for requirements or methodologies within six months following the receipt of such proposals.

9. Any party having a complaint against a system operator in relation to that system operator's obligations under this Regulation may refer the complaint to the regulatory authority which, acting as dispute settlement authority, shall issue a decision within two months after receipt of the complaint. That period may be extended by two months where additional information is sought by the regulatory authority. That extended period may be further extended with the agreement of the complainant. The regulatory authority's decision shall have binding effect unless and until overruled on appeal.

10. If a system operator, regulatory authority or designated entity deems an amendment to requirements or methodologies approved under paragraphs 4 and 5 to be necessary, the principles and procedures provided for in this Article shall apply to the proposed amendment. Any amendment shall take into account the legitimate expectations, if any, of power-generating facility owners, equipment manufacturers and other stakeholders based on the initially specified or agreed requirements or methodologies.

11. Where the requirements under this Regulation are to be established by a relevant system operator that is not a TSO, the regulatory authority may provide that the TSO is responsible for establishing the relevant requirements.

12. The relevant system operator shall refuse the connection of a power-generating module which does not comply with the requirements set out in this Regulation and which is not covered by a derogation granted by the regulatory authority pursuant to Article 57. The relevant system operator shall communicate such refusal, by means of a reasoned statement in writing, to the power-generating facility owner and, unless specified otherwise by the regulatory authority, to the regulatory authority.

Article 8

Multiple TSOs

1. Where more than one TSO exists in a Member State, the rights and obligations of TSOs under this Regulation shall be exercised and discharged by the TSO in whose control area a power-generating module or a distribution system or a HVDC system is or will be connected.
2. Where more than one TSO exists in a Member State, those TSOs shall coordinate their proposals before sending them for approval to the regulatory authority or the designated entity.

Article 9

Recovery of costs

1. The costs stemming from the obligations laid down in this Regulation borne by system operators subject to network tariff regulation shall be assessed by the relevant regulatory authorities. Costs that are assessed as reasonable, efficient and proportionate shall be recovered through network tariffs or other appropriate mechanisms.
2. If requested by the relevant regulatory authorities, system operators shall, within three months of the request, provide the information necessary to facilitate assessment of the costs incurred.

Article 10

Public consultation

1. System operators shall carry out a public consultation with stakeholders when required under this Regulation. The consultation shall last at least for one month.
2. The system operators shall duly take into account the views of stakeholders resulting from the consultations prior to the submission of the proposal for approval by the designated entity. In all cases, a sound justification for including or not the views of the stakeholders shall be provided and published in a timely manner before, or simultaneously with, the publication of the proposal.

Article 11

Stakeholder involvement

The European Union Agency for the Cooperation of Energy Regulators ('the Agency'), involving the ENTSO for Electricity and the entity of distribution system operators in the Union (the EU DSO Entity), shall establish a European Stakeholder Committee to organise stakeholder involvement regarding the requirements for grid connection of power-generating facilities and other aspects of the implementation of this Regulation. This shall include regular meetings with stakeholders to identify problems and propose improvements.

Article 12

Confidentiality obligations

1. Any confidential information received, exchanged or transmitted pursuant to this Regulation shall be subject to the conditions of professional secrecy laid down in paragraphs 2, 3 and 4.
2. The obligation of professional secrecy shall apply to any persons and entities subject to the provisions of this Regulation.
3. Unless otherwise provided by national law, [the other provisions of] this Regulation or other relevant Union law, confidential information received by the persons and entities in the course of their duties shall not be divulged to any other person or authority.
4. Unless otherwise provided by national or Union law, entities or persons who receive confidential information pursuant to this Regulation shall use it only for the purpose of carrying out their duties under this Regulation.

TITLE II
REQUIREMENTS

CHAPTER 1

General requirements

Article 13

General requirements for type A power-generating modules

Type A power-generating modules shall fulfil the requirements set out in Articles 14 to 18.

Article 14

Frequency stability requirements

1. The following requirements related to frequency stability shall apply:
   (a) with regard to frequency ranges:
      i. the power-generating module shall be capable of remaining connected to the network and operating stably within the frequency ranges and time periods specified in Table 2;
      ii. the relevant system operator, in coordination with the TSO and the power-generating facility owner may agree on wider frequency ranges, longer minimum times for operation or specific requirements for combined frequency and voltage deviations to ensure the best use of the technical capabilities of the power-generating module, if it is required to preserve or to restore system security;

Table 2

Minimum time periods for which a power-generating module shall be capable of operating at different frequencies without disconnecting from the network

Synchronous area	Frequency range	Time period for operation
Continental Europe	47.5 Hz ≤ f < 48.5 Hz	30 minutes
	48.5 Hz ≤ f < 49.0 Hz	90 minutes
	49.0 Hz ≤ f < 51.0 Hz	Unlimited
	51.0 Hz ≤ f < 51.5 Hz	30 minutes
	51.5 Hz ≤ f < 52.5 Hz	10 seconds
Nordic	47.5 Hz ≤ f < 48.5 Hz	30 minutes
	48.5 Hz ≤ f < 49.0 Hz	30 minutes
	49.0 Hz ≤ f < 51.0 Hz	Unlimited
	51.0 Hz ≤ f < 51.5 Hz	30 minutes
	51.5 Hz ≤ f < 52.5 Hz	10 seconds
Ireland and Northern Ireland	47.5 Hz ≤ f < 48.5 Hz	90 minutes
	48.5 Hz ≤ f < 49.0 Hz	90 minutes
	49.0 Hz ≤ f < 51.0 Hz	Unlimited
	51.0 Hz ≤ f < 51.5 Hz	90 minutes
	51.5 Hz ≤ f < 52.5 Hz	10 seconds

(b) with regard to the capability to withstand the rate-of-change-of-frequency:

(i) a synchronous power-generating module shall be capable of remaining connected to the network and operating at rates-of-change-of-frequency up to the following values:

(1) ±2.0 Hz/s over a period of 0.5 seconds;

(2) ±1.5 Hz/s over a period of 1 second;

(3) ±1.25 Hz/s over a period of 2 seconds;

(ii) a power park module shall be capable of remaining connected to the network and operating at rates-of-change-of-frequency up to the following values:

(4) ±4.0 Hz/s over a period of 0.25 seconds;

(5) ±2.0 Hz/s over a period of 0.5 seconds;

(6) ±1.5 Hz/s over a period of 1 second;

(7) ±1.25 Hz/s over a period of 2 seconds;

(iii) without prejudice to point (ii), a power park module shall be capable of remaining connected to the network and operating through the sequence of rates-of-change-of-frequencies, as specified by the overfrequency against time profiles in Figure 1 and the underfrequency against time profiles in Figure 2;

(iv) protection schemes shall not jeopardise rate-of-change-of-frequency withstand capability;

(v) without prejudice to point (iv), if rate-of-change-of-frequency is used for loss of mains protection, the relevant system operator, in coordination with the TSO, shall specify the threshold of this rate-of-change-of-frequency for loss of mains protection.

Figure 1

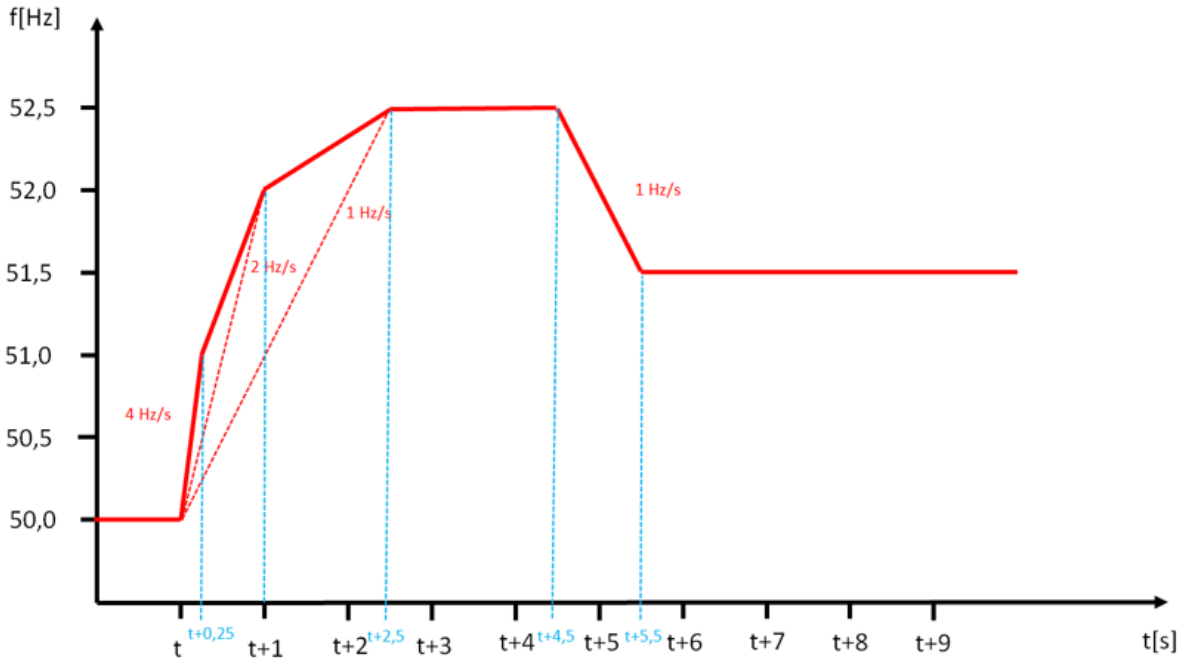
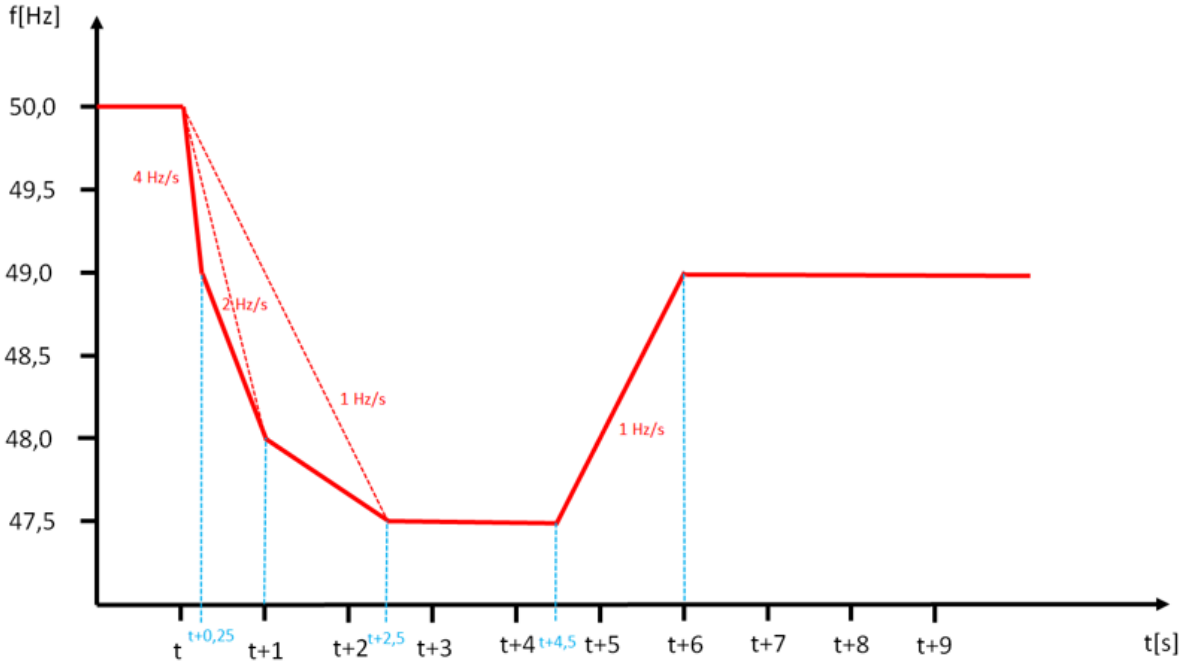


Figure 2



Article 15

Active power regulation and LFSM-O

1. The power-generating module shall be capable of maintaining constant output, and in the case of electricity storage modules, output or input, at its target active power value, regardless of changes in frequency, except where output or input follows the changes specified in accordance with this Article or Article 22(2), points (b) and (c), if applicable.

2. The power-generating module shall be capable of activating the provision of active power frequency response in limited frequency sensitive mode - overfrequency automatically, in accordance with Figure 3 at a frequency threshold specified in point (a) and droop specified by the TSO within the range set out in point (b):

   (a) the frequency threshold shall be 50Hz+Δf_1, where Δf_1 is set out in Table 3;

   (b) the droop shall be between 2% and 12%;

Table 3

Δf_1 used for FSM, LFSM-O and LFSM-U

Synchronous area	Δf_1 thresholds
Continental Europe	0.2 Hz
Nordic	0.5 Hz
Ireland and Northern Ireland	0.2 Hz (LFSM-O and FSM), 0.5 Hz (LFSM-U)

3. The power-generating module shall be capable of operating stably during LFSM-O operation.

4. When LFSM-O is active, the LFSM-O setpoint shall prevail over any other active power setpoints which would result in an increase of active power above the LFSM-O setpoint.

5. When activating LFSM-O, the following response parameters shall apply:

   (a) the start of active power decrease (initial delay time T_{id} in Figure 4) by the power-generating module shall not be intentionally delayed;

   (b) the response time for active power decrease (T_{resp} in Figure 4) in the case of increasing frequency shall be as fast as technically feasible and shall not exceed:

      (i) for a synchronous power-generating module: 8 seconds for an active power setpoint change of 45% of maximum power;

      (ii) for a power park module: 2 seconds for an active power setpoint change of 50% of maximum power.

6. The TSO shall specify the capability of the power-generating module upon reaching minimum regulating level as either of the following:

   (a) continuing operation at this level;

   (b) further decreasing active power output to the minimum stable operating level.

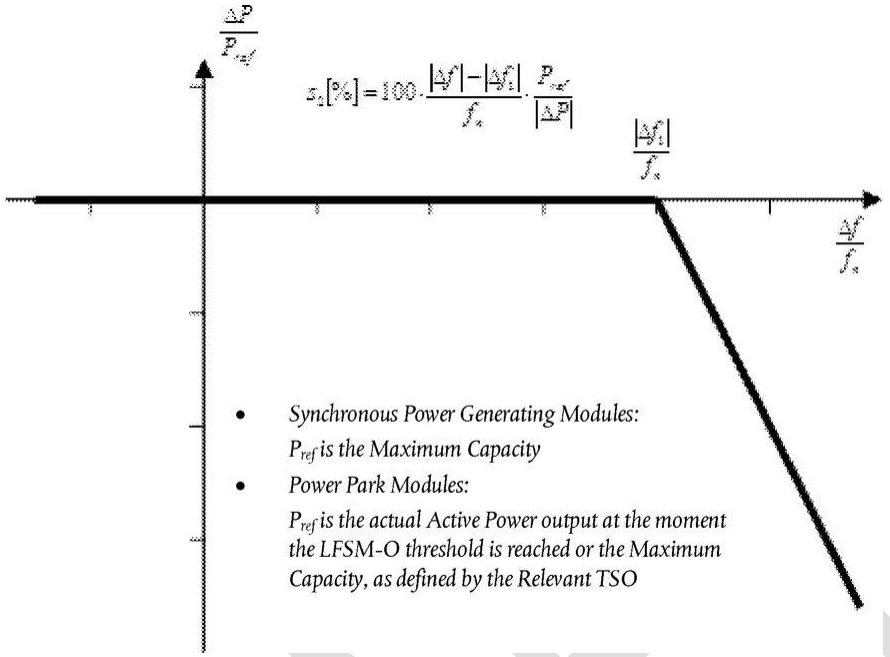
7. The power-generating module shall be capable of receiving and reacting to an external signal to enable the relevant system operator to freeze or block active power LFSM-O mode in real-time. The TSO in coordination with the relevant system operator shall specify the framework conditions for the use of this function.

8. The electricity storage module shall be capable of activating the provision of active power frequency response in LFSM-O from the current active power input or output automatically, up to the maximum consumption capacity, in accordance with Figure 3. The electricity storage module shall consume power up to the maximum energy content that it is able to store.

9. The electricity storage module shall be capable of switching from consumption to generation and vice versa as fast as technically feasible. The relevant system operator may request the demonstration of technical evidence of the declared switching time.

Figure 3

Active power frequency response capability of a power-generating module in LFSM-O



In the context of synchronous power-generating modules, P_{ref} is the maximum capacity.

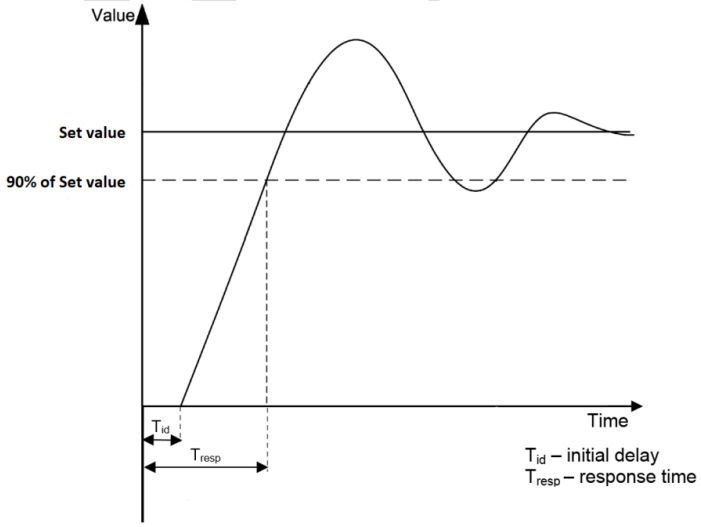
In the context of power park modules, P_{ref} is the actual active power output at the moment the LFSM-O threshold is reached or the maximum capacity, as specified by the TSO.

ΔP is the change in active power output from the power-generating module.

f_n is the nominal frequency (50 Hz) in the network and Δf_1 is the frequency deviation in the network as specified in Table 3.

Figure 4

Response parameters



10. The TSO shall specify the admissible active power reduction from maximum output with falling frequency expressed as a rate of reduction within the boundaries illustrated by the solid lines in Figure 5:

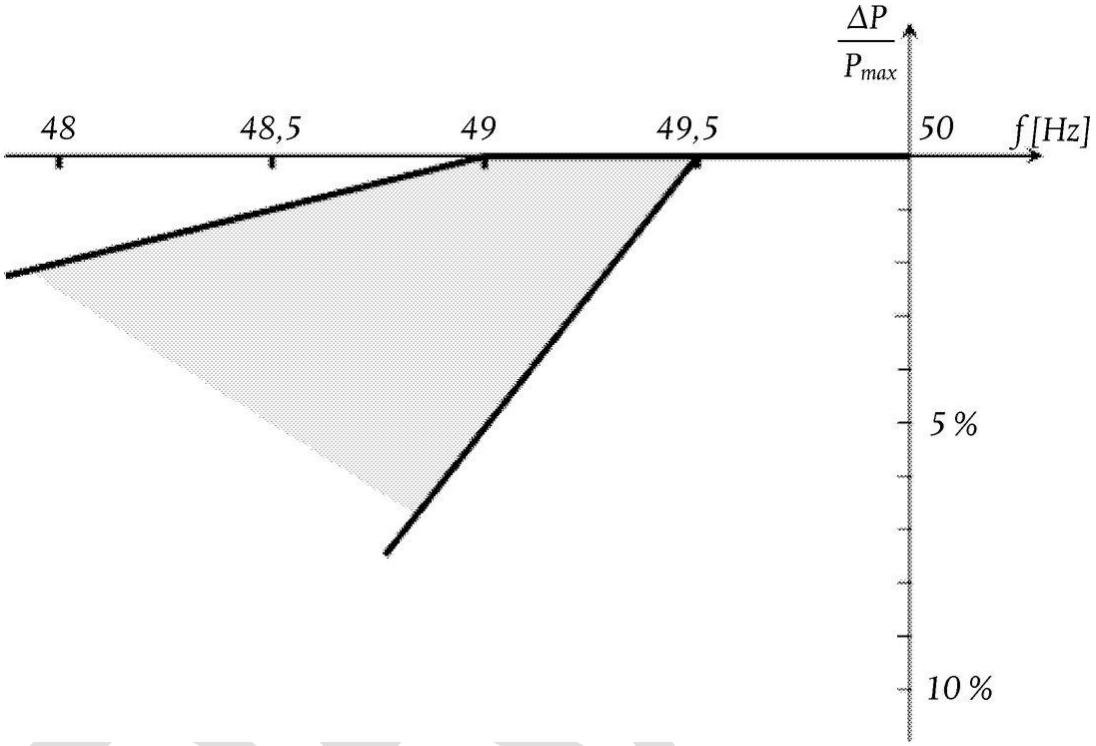
(a) below 49 Hz at a rate of 2% of the maximum capacity at 50 Hz per 1 Hz frequency drop;

(b) below 49.5 Hz at a rate of 10% of the maximum capacity at 50 Hz per 1 Hz frequency drop.

The admissible active power reduction from maximum output shall account for the different ambient conditions and the technical capabilities of power-generating modules.

Figure 5

Maximum power capability reduction with falling frequency



11. The power-generating module shall be equipped with a data exchange interface (input port) in order to reduce, without undue delay, active power output following an instruction received at the input port.

12. The electricity storage module shall be equipped with a data exchange interface (input port) in order to modulate, without undue delay, active power output and input following an instruction received at the input port.

13. The relevant system operator may require the power-generating module to enable remote reduction or, for electricity storage modules, the modulation of active power output or input.

Article 16

Autonomous connection to the network

1. Unless specified otherwise by the relevant system operator in coordination with the TSO, autonomous connection shall be allowed.
2. The power-generating module shall be capable of autonomously connecting to the network within the following ranges:
   (a) adjustable observation time from 0 to 300 seconds for parameters set out in points (b), (c) and (d);
   (b) voltage within the range defined for unlimited time operation pursuant to Article 17(4) or in Table 6;
   (c) frequency range: 47.5 Hz ≤ f ≤ 51 Hz;
   (d) adjustable limitation of the maximum gradient of active power increase within the range from 0% to 20% of P_{max}/P_{min}.
3. Unless specified otherwise by the relevant system operator in coordination with the TSO, the default settings for an autonomous connection shall be as follows:
   (a) minimum observation time: 60 seconds;
   (b) voltage range: 0.9 pu ≤ U ≤ 1.1 pu;
   (c) frequency range:
      (i) Continental Europe: 47.5 Hz ≤ f ≤ 50.1 Hz;
      (ii) other synchronous areas: 49.0 Hz ≤ f ≤ 50.5 Hz;
   (d) maximum gradient of active power increase up to 20 % of P_{max}/P_{min};
   (e) voltage phase angle difference measured on each side of the switchgear: $\Delta\theta <$ 10;
   (f) voltage magnitude difference measured on each side of the switchgear: $\Delta U <$ 0.04 pu;
   (g) frequency difference measured on each side of the switchgear: $\Delta f <$ 0.2 Hz.

Article 17

Reactive power and voltage stability

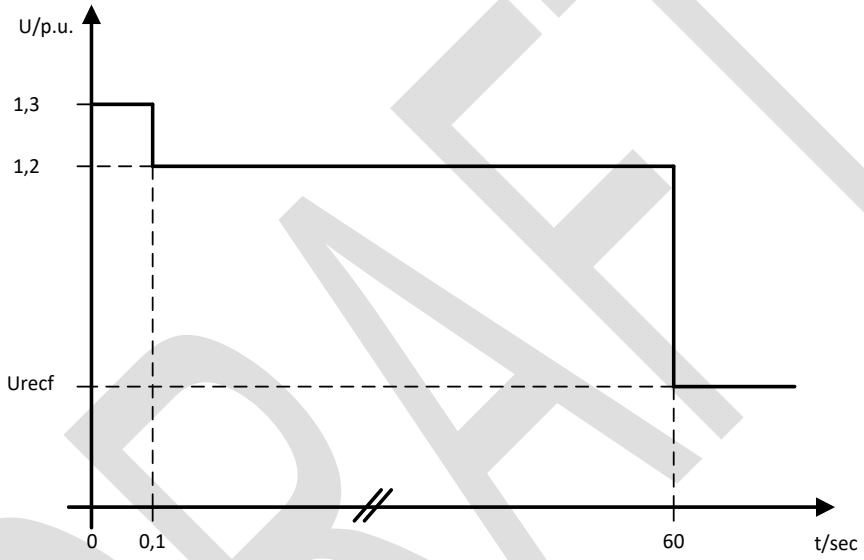
1. The power-generating module shall be capable of absorbing or supplying reactive power, when importing or exporting active power, over its entire operating range, automatically, by voltage control mode, reactive power control mode, power factor control mode or active power-related power factor control mode.
2. The default mode shall be voltage control mode. The relevant system operator may request the activation of another mode.
3. The power-generating module shall be capable of receiving and reacting to an external signal enabling the relevant system operator to transmit reactive power or voltage control mode setpoints. The power-generating module controls shall apply any revised setpoints without undue delay.
4. The power-generating module connected at or below 1000 V shall be capable of remaining connected to the network and operating stably within the voltage range of

0.85 pu – 1.1 pu. The power-generating module connected above 1000 V and below 110 kV shall be capable of remaining connected to the network and operating continuously within the voltage range of 0.9 pu – 1.1 pu.

5. The power-generating module shall be capable of operating stably without disconnecting from the network, if none of the phase-to-phase voltages exceeds the voltage-against-time-profile set out in Figure 6. The relevant system operator, in coordination with the TSO, and the power-generating facility owner may agree to apply longer times for operation.

Figure 6

High voltage-ride-through profile of a power-generating module



The diagram represents the higher limit of a voltage-against-time profile of the voltage, expressed as the ratio of its actual value and its reference 1 pu value, before, during and after a fault.

U_{recf} is the maximum voltage referred to in Article 17(5) and 19(11).

Article 18

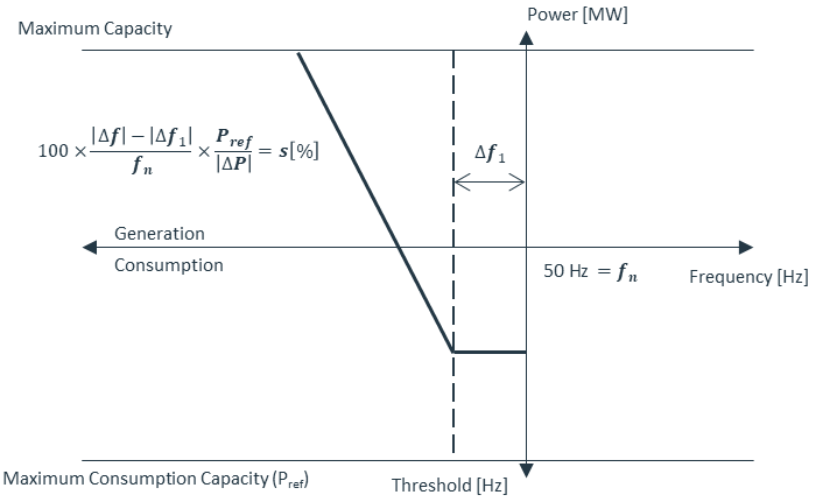
Load frequency sensitive mode - underfrequency for electricity storage modules

1. The electricity storage module shall be capable of activating the provision of active power frequency response in LFSM-U from the current active power input or output automatically, up to the maximum capacity, in accordance with Figure 7, at a frequency threshold specified in point (a) and droop specified by the TSO in accordance with point (b):

   (a) the frequency threshold shall be 50Hz-Δf_1, where Δf_1 is set out in Table 3;

   (b) the droop shall be between 0.2% and 5%, and the default droop ‘s’ shall be 1%.

Figure 7



2. The electricity storage module shall be capable of remaining connected to the network and operating stably in LFSM-U mode as long as the frequency is below the frequency threshold and up to its content of energy.

3. When LFSM-U is active, the LFSM-U setpoint shall prevail over any other active power setpoints which would result in a decrease of active power below the LFSM-U setpoint.

4. While the frequency is recovering, the electricity storage module shall follow the power-frequency characteristic in Figure 7 until the frequency threshold is met and the electricity storage module is back to its prior state of active power input or output.

5. The electricity storage module shall be capable of receiving and reacting to an external signal enabling the relevant system operator to freeze or block active power LFSM-U mode in real-time. The TSO, in coordination with the relevant system operator, shall specify the framework conditions for the use of this function.

6. Electricity storage modules shall fulfil the following requirements related to LFSM-U:

   (a) the start of generation increase or consumption decrease (initial delay time T_{id} in Figure 4) by the electricity storage module shall not be intentionally delayed;

   (b) the response time for LFSM-U (T_{resp} in Figure 4) shall be as fast as technically feasible and shall not exceed:

      (i) for a synchronous power-generating module: 8 seconds for any active power setpoint change excluding the time for switching from consumption to generation or vice versa;

      (ii) for a power park module: 0.5 seconds for any active power setpoint change, excluding the time for switching from consumption to generation or vice versa;

   (c) the resolution of the frequency measurement shall be 10 mHz or better;

   (d) the accuracy of the active power response shall be ±5% of P_{max} or better.

7. The electricity storage module shall be capable of switching from consumption to generation and vice versa as fast as technically feasible. The relevant system operator may request the demonstration of technical evidence of the declared switching time.

Article 19

General requirements for type EV1 and EV2 V2G electric vehicles and associated V2G electric vehicle supply equipment

1. The type EV1 and EV2 V2G EV and associated V2G EVSE shall fulfil the following requirements related to frequency stability:

   (a) be capable of remaining connected to the network and operating within the frequency ranges and time periods specified in Table 4;

   (b) with regard to the rate-of-change-of-frequency withstand capability:

      (i) be capable of remaining connected to the network and operating at rates-of-change-of-frequency up to the following values:

         (1) ±4.0 Hz/s over a period of 0.25 seconds;

         (2) ±2.0 Hz/s over a period of 0.5 seconds;

         (3) ±1.5 Hz/s over a period of 1 second;

         (4) ±1.25 Hz/s over a period of 2 seconds;

      (ii) without prejudice to point (i), the type EV1 and EV2 V2G EV and associated V2G EVSE shall be capable of remaining connected to the network and operating through the sequence of rates-of-change-of-frequencies as specified by the overfrequency against time profiles in Figure 1 and the underfrequency against time profiles in Figure 2;

      (iii) if the rate-of-change-of-frequency is used for loss of mains protection, the rate-of-change-of-frequency threshold shall be set at wider values than the ones set out in point (i);

   (c) the protection schemes shall not jeopardise the performance of frequency withstand capability specified in point (b).

Table 4

Minimum time periods for which a type EV1 and EV2 V2G EV and associated V2G EVSE shall be capable of operating at different frequencies without disconnecting from the network

Frequency range	**Time period for operation**
47.5 Hz ≤ f < 49.0 Hz	30 minutes
49.0 Hz ≤ f < 51.0 Hz	Unlimited
51.0 Hz ≤ f < 51.5 Hz	30 minutes
51.5 Hz ≤ f < 52.5 Hz	10 seconds

2. The type EV1 and EV2 V2G EV and associated V2G EVSE, as relevant, shall be equipped with a data exchange interface in order to modulate, without undue delay, active power output and input following an instruction received at the input port.

3. The type EV1 and EV2 V2G EV and associated V2G EVSE shall be capable of maintaining constant output at its target active power value regardless of changes in frequency, except where limited frequency sensitive mode – overfrequency and limited frequency sensitive mode – underfrequency mode is active.

4. The type EV1 and EV2 V2G EV and associated V2G EVSE shall fulfil the following requirements related to LFSM-O or LFSM-U:

   (a) the droop setting 's' shall be 5%;

   (b) the start of generation increase or decrease or consumption increase or decrease (initial delay time T_{id} in Figure 4) shall not be intentionally delayed;

   (c) switching from generation to consumption and vice versa shall be as fast as technically feasible;

   (d) the resolution of the frequency measurement shall be 10 mHz or better;

   (e) the accuracy of the active power response shall be ±5% of P_{max} or better;

   (f) the response time (T_{resp} in Figure 4), shall be as fast as technically feasible and shall not exceed 0.5 seconds for an active power setpoint change of 30% of P_{ref} and 1.2 seconds for an active power setpoint change of 90% of P_{ref}.

5. The type EV1 and EV2 V2G EV and associated V2G EVSE shall fulfil the following requirements related to LFSM-O:

   (a) where they consume active power during an overfrequency event, they shall be capable of activating the provision of active power frequency response in LFSM-O from the current active power input (P_{ref}) automatically, up to the maximum consumption capacity (maximum consumption active power negotiated between V2G EV and V2G EVSE), in accordance with Figure 8a, at the frequency threshold equal to 50.2 Hz, except for the synchronous area Nordic, where the frequency threshold shall be 50.5 Hz;

   (b) where they generate active power during an overfrequency event, they shall be capable of activating the provision of active power frequency response from the current active power output (P_{ref}) automatically, down to the minimum technical operational level, in accordance with Figure 8b at the frequency threshold equal to 50.2 Hz, except for the synchronous area Nordic, where the frequency threshold shall be 50.5 Hz;

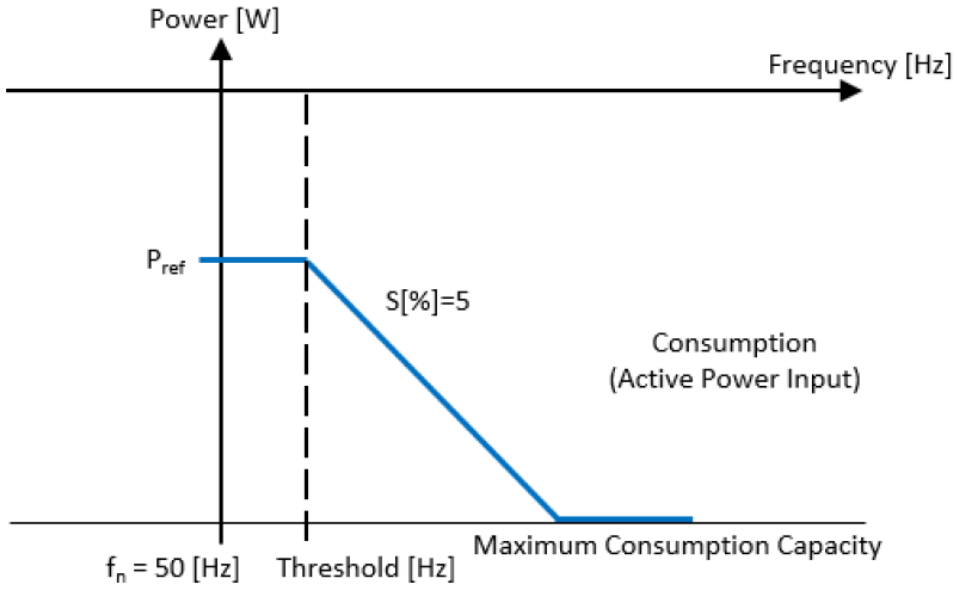
   (c) be capable of remaining connected and operating stably in this mode as long as the frequency is above the frequency threshold and in accordance with the content of energy and the minimum technical operational level, or maximum consumption capacity of the traction battery;

   (d) when LFSM-O is active and while the frequency is recovering, the V2G EV and associated V2G EVSE shall follow the power-frequency characteristic in Figure 8a or 8b until the frequency threshold is met and is back to its prior state of active power input or output;

   (e) when LFSM-O is active, the LFSM-O setpoint shall prevail over any other active power setpoints which would result in either an increase of generation or decrease of consumption away from the LFSM-O setpoint.

Figure 8a

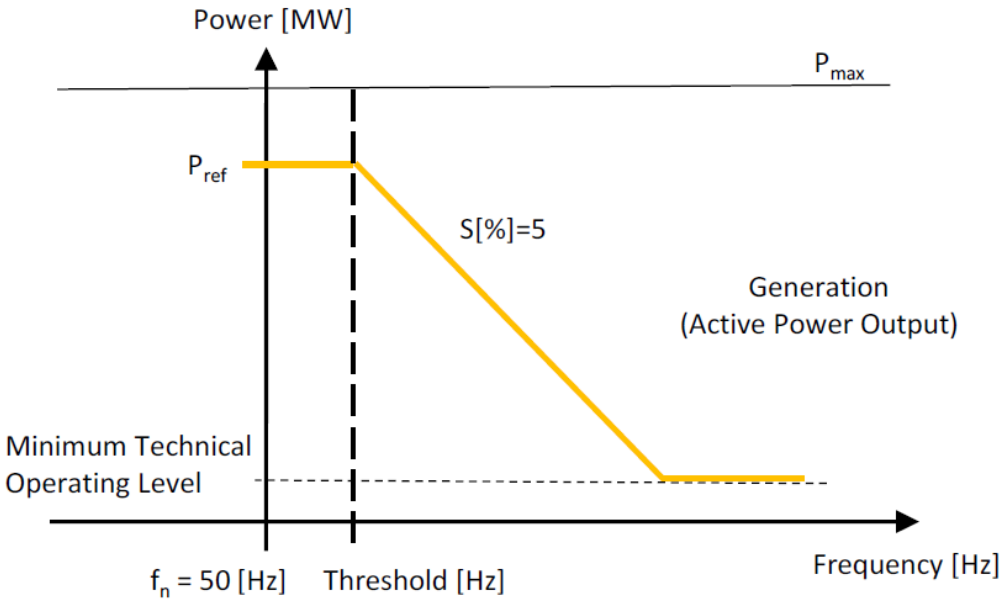
Active power input frequency response capability of type EV1 and EV2 V2G EV and associated V2G EVSE in LFSM-O



P_{ref} is the actual active power input at the moment the LFSM-O threshold is reached

Figure 8b

Active power output frequency response capability of type EV1 and EV2 V2G EV and associated V2G EVSE in LFSM-O



P_{ref} is the actual active power output at the moment the LFSM-O threshold is reached

6. The type EV1 and EV2 V2G EV and associated V2G EVSE shall fulfil the following requirements related to the LFSM-U:

   (a) where they generate active power during an underfrequency event, they shall be capable of activating the provision of active power frequency response from the current active power output (P_{ref}) automatically, up to the maximum capacity (maximum generation active power negotiated between EV and EVSE), in accordance with Figure 9a, at the frequency threshold equal to 49.8 Hz, except for the synchronous areas Ireland and Northern Ireland and Nordic, where the frequency threshold shall be 49.5 Hz;

   (b) where they consume active power during an underfrequency event, they shall be capable of activating the provision of active power frequency response from the current active power output (P_{ref}) automatically, down to the minimum technical operational level in accordance with Figure 9b;

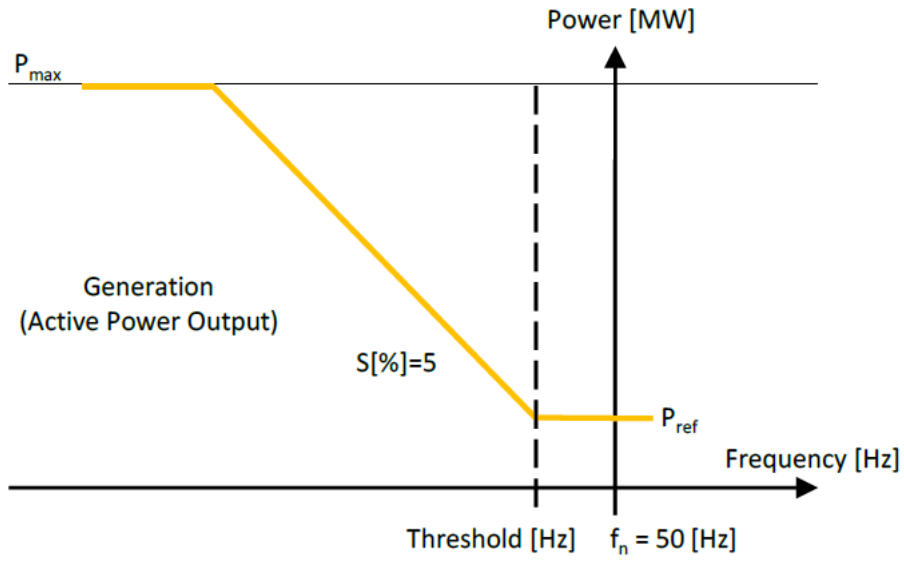
   (c) be capable of remaining connected and operating stably in this mode as long as the frequency is below the frequency threshold and in accordance with the content of energy and the minimum technical operational level, or maximum capacity of the traction battery;

   (d) when the LFSM-U is active and while the frequency is recovering, the V2G EV and associated V2G EVSE shall follow the power-frequency characteristic in Figure 9a or 9b until the frequency threshold is met and is back to its prior state of active power input or output;

   (e) when the LFSM-U is active, the LFSM-U setpoint shall prevail over any other active power setpoints which would result in either an increase of consumption or a decrease in generation away from the LFSM-U setpoint.

Figure 9a

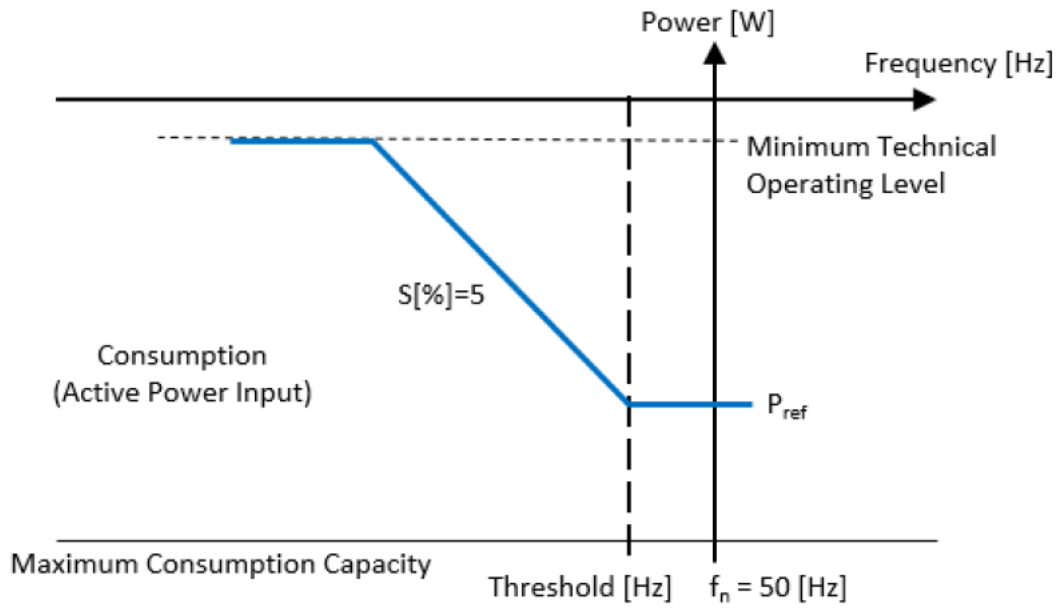
Active power output frequency response capability of type EV1 and EV2 V2G EV and associated V2G EVSE in LFSM-U



P_{ref} is the actual active power output at the moment the LFSM-U threshold is reached.

Figure 9b

Active power input frequency response capability of type EV1 and EV2 V2G EV and associated V2G EVSE in LFSM-U



P_{ref} is the actual active power input at the moment the LFSM-U threshold is reached.

7. The type EV1 and EV2 V2G EV and associated V2G EVSE may autonomously connect to the network under the following conditions:
   (a) voltage range: 0.9 pu ≤ U ≤ 1.1 pu;
   (b) frequency range: 49.8 Hz ≤ f ≤ 50.1 Hz;
   (c) minimum observation time: 5 seconds.
8. The type EV1 and EV2 V2G EV and associated V2G EVSE may autonomously reconnect to the network after tripping due to a system disturbance under the following conditions:
   (a) voltage range: 0.9 pu ≤ U ≤ 1.1 pu;
   (b) frequency range: 49.8 Hz ≤ f ≤ 50.1 Hz;
   (c) minimum observation time: 60 seconds.
9. With regard to voltage stability, a type EV1 and EV2 V2G EV and associated V2G EVSE shall:
   (a) be capable of absorbing or supplying reactive power, when importing or exporting active power over its entire operating range, automatically, by voltage control mode;
   (b) be capable of remaining connected to the network and operating stably within the range of 0.85 pu – 1.1 pu. In the case of voltages below 1 pu, the V2G EV and associated V2G V2G EVSE may reduce the apparent power to within the current limits. This reduction shall be as small as technically feasible;

(c) when operating above the minimum stable operating level, be capable of remaining connected to the network and operating stably after the power system has been disturbed by symmetrical faults on the transmission network when the voltage is above the voltage-against-time-profile in accordance with Figure 10 and with the parameters set out in Table 5.1 and Table 5.2.

Table 5.1

Voltage parameters for Figure 10 for fault-ride-through capability of type EV1 and EV2 V2G EV and associated V2G EVSE

Voltage parameters (pu)	
U_{ret}:	0.05
U_{clear}:	0.15
U_{rec1}:	0.15
U_{rec2}:	0.85

Table 5.2

Time parameters for Figure 10 for fault-ride-through capability of type EV1 and EV2 V2G EV and associated V2G EVSE

Time parameters (seconds)	
t_{clear}:	0.15
t_{rec1}:	0.15
t_{rec2}:	0.15
t_{rec3}	3.0

10. Where, following the fault clearance, the network voltage resumes to a value within the range of 0.85 pu – 1.1 pu, a type EV1 and EV2 V2G EV and associated V2G EVSE shall recover to an active power production or consumption level of the pre-fault value in accordance with the following:

    (a) if the post-fault network voltage resumes to or above 1 pu, the recovery level shall be 100% of the pre-fault level;

    (b) if the post-fault network voltage resumes to below 1 pu and active power consumption is constrained by the maximum current rating of the EV1 or EV2 V2G EV and associated V2G EVSE, the active power operation point shall be reduced below its pre-fault value in proportion to the post-fault to pre-fault network voltage of its pre-fault value;

    (c) the recovery time shall not exceed 1 second.

11. Type EV1 and EV2 V2G EV and associated V2G EVSE shall be capable of operating stably without disconnecting from the network, if none of the phase-to-phase voltages exceeds the voltage-against-time-profile set out in Figure 6. The relevant system operator,

in coordination with the TSO, and the V2G electrical charging park owner may agree to apply longer times for operation.

Article 20

General requirements for type B power-generating modules

1. Type B power-generating modules shall fulfil the general requirements for Type A power-generating modules set out in Article 14 to 18 and the additional requirements set out in this Article .
2. The following requirements related to voltage stability with regard to connection points at 110 kV and above shall apply:
   (a) the power-generating module shall be capable of remaining connected to the network and operating within the ranges and for the time periods specified in Table 6. For voltages not included in Table 6 the value of the nearest voltage level shall apply;
   (b) the TSO may specify shorter time periods during which the power-generating module shall be capable of remaining connected to the network in the event of simultaneous overvoltage and underfrequency or simultaneous undervoltage and overfrequency;
   (c) for the 380 kV and 400 kV grid voltage levels, the reference 1 pu value is 400 kV; for other grid voltage levels, the reference 1 pu voltage may differ for each system operator in the same synchronous area;
   (d) the relevant system operator, in coordination with the TSO, and the power-generating facility owner may agree on wider voltage ranges or longer minimum time periods for operation to ensure the best use of the technical capabilities of the power-generating module, if it is required to preserve or to restore system security.

Table 6

Voltage ranges and minimum time periods during which a power-generating module shall be capable of operating without disconnecting from the network

Synchronous area	Rated Voltage	Voltage range (per unit, pu)	Time period for operation
Continental Europe	110 kV	0.85 pu-0.90 pu	60 minutes
		0.90 pu-1.118 pu	Unlimited
		1.118 pu-1.15 pu	To be specified by each TSO, but not less than 20 minutes and not more than 60 minutes
	220 kV	0.85 pu-0.90 pu	60 minutes
		0.90 pu-1.113 pu	Unlimited
		1.113 pu-1.15 pu	To be specified by each TSO, but not

			less than 20 minutes and not more than 60 minutes
	330 kV	0.88 pu-0.90 pu	60 minutes
		0.90 pu-1.097 pu	Unlimited
		1.097 pu-1.15 pu	To be specified by each TSO, but not less than 20 minutes and not more than 60 minutes
	400 kV	0.85 pu-0.90 pu	60 minutes
		0.90 pu-1.05 pu	Unlimited
		1.05 pu-1.10 pu	To be specified by each TSO, but not less than 20 minutes and not more than 60 minutes
Nordic	110 kV	0.85 pu-0.90 pu	To be specified by each TSO, but not more than 60 minutes
		0.90 pu-1.05 pu	Unlimited
		1.05 pu-1.10 pu	60 minutes
	220 kV	0.85 pu-0.90 pu	To be specified by each TSO, but not more than 60 minutes
		0.90 pu-1.05 pu	Unlimited
		1.05 pu-1.10 pu	60 minutes
	400 kV	0.85 pu-0.90 pu	To be specified by each TSO, but not more than 60 minutes
		0.90 pu-1.05 pu	Unlimited
		1.05 pu-1.10 pu	To be specified by each TSO, but not more than 60 minutes
Ireland and Northern Ireland	110 kV	0.85 pu-0.90 pu	To be specified by each TSO, but not more than 60 minutes
		0.90 pu-1.118 pu	Unlimited
	220 kV	0.85 pu-0.90 pu	To be specified by each TSO, but not more than 60 minutes
		0.90 pu-1.113 pu	Unlimited
	275 kV	0.85 pu-0.90 pu	To be specified by each TSO, but not

			more than 60 minutes
		0.90 pu-1.09 pu	Unlimited
	400 kV	0.85 pu-0.90 pu	To be specified by each TSO, but not more than 60 minutes
		0.90 pu-1.05 pu	Unlimited

3. With regard to fault-ride-through capability:

(a) each TSO shall specify a voltage-against-time profile for fault conditions in accordance with Figure 10 and within the ranges set out in Table 7.1, Table 7.2, Table 8.1 and Table 8.2;

(b) the power-generating module, when operating above the minimum stable operating level, shall be capable of remaining connected to the network and operating stably after the power system has been disturbed by secured faults on the transmission system when the voltage is above the voltage-against-time-profile referred to in point (a);

(c) each TSO, in co-ordination with the relevant system operator, shall specify the pre-fault and post-fault conditions for the fault-ride-through capability in terms of the following:

(i) the calculation of the pre-fault minimum short circuit capacity at the connection point;

(ii) pre-fault active and reactive power operating point of the power-generating module at the connection point and voltage at the connection point;

(iii) calculation of the post-fault minimum short circuit capacity at the connection point;

(d) at the request of a power-generating facility owner, the relevant system operator shall provide the pre-fault and post-fault conditions to be considered for fault-ride-through capability, as an outcome of the calculations as specified in point (c) or as generic values derived from typical cases, regarding the following:

(i) pre-fault minimum short circuit capacity at each connection point expressed in MVA;

(ii) pre-fault operating point of the power-generating module expressed in active power output and reactive power output and voltage;

(iii) post-fault minimum short circuit capacity at each connection point expressed in MVA;

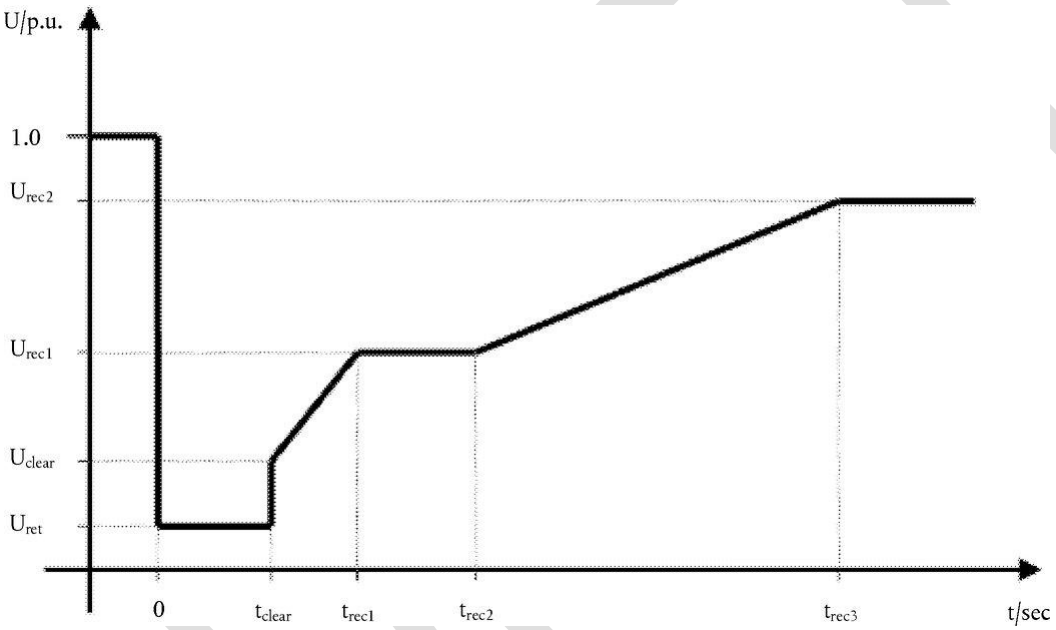
(e) the power-generating module shall be capable of remaining connected to the network and operating stably in the actual course of the phase-to-phase voltages on the network voltage level during a symmetrical fault, provided that the pre-fault and post-fault conditions referred to in points (c) and (d) remain above the lower limit specified in paragraph (a), and unless the protection scheme for internal electrical faults requires the disconnection of the power-generating module from the network;

(f) the protection schemes and settings for internal electrical faults shall not jeopardise fault-ride-through capabilities of the power-generating module;

(g) without prejudice to point (e) of this paragraph, undervoltage protection (either fault-ride-through capability or minimum voltage specified) shall be set by the power-generating facility owner in accordance with the widest possible technical capability of the power-generating module, unless the relevant system operator requires narrower settings in accordance with paragraph 7, point (b). The relevant settings shall be justified by technical evidence by the power-generating facility owner.

Figure 10

Fault-ride-through profile of a power-generating module



The voltage-against-time-profile expresses a lower limit of the actual profile of the phase-to-phase voltages on the network voltage level during a symmetrical fault, as a function of time before, during and after the fault.

In the diagram the lower limit of a voltage-against-time profile of the voltage is expressed as the ratio of its actual value and its reference 1 pu value before, during and after a fault. U_{ret} *is the retained voltage during a fault,* t_{clear} *is the instant when the fault has been cleared.* U_{rec1}, U_{rec2}, t_{rec1}, t_{rec2} *and* t_{rec3} *specify certain points of lower limits of voltage recovery after fault clearance.*

Table 7.1

Voltage parameters for Figure 10 for fault-ride-through capability of a synchronous power-generating module

Voltage parameters (pu)	
U_{ret}:	0.05-0.3
U_{clear}:	0.7-0.9 and $\leq U_{rec2}$
U_{rec1}:	U_{clear}
U_{rec2}:	Minimum voltage specified in Article 20(2) and Article 17(4)

Table 7.2

Time parameters for Figure 10 for fault-ride-through capability of a synchronous power-generating module

Time parameters (seconds)	
t_{clear}:	0.14-0.15 or 0.14-0.25 if required by the TSO
$t_{r\ ec1}$:	t_{clear}
$t_{r\ ec2}$:	t_{rec1}-0.7
$t_{r\ ec3}$:	t_{rec2}-1.5

Table 8.1

Voltage parameters for Figure 10 for fault-ride-through capability of a power park module

Voltage parameters (pu)	
U_{ret}:	0.05-0.15
U_{clear}:	U_{ret}-0.15
U_{rec1}:	U_{clear}
U_{rec2}:	Minimum voltage specified in Article 20(2) and Article 17(4)

Table 8.2

Time parameters for Figure 10 for fault-ride-through capability of a power park module

Time parameters (seconds)	
t_{clear}:	0.14-0.15 or 0.14-0.25 if required by the TSO
t_{rec1}:	t_{clear}
t_{rec2}:	t_{rec1}
t_{rec3}:	1.5-3.0

4. Each TSO shall specify a voltage-against-time profile for fault-ride-through capabilities for asymmetrical faults.

5. The power-generating module shall be capable of ensuring robustness to its control system where a change in the network leads to the minimum short-circuit level defined in the connection agreement.

6. The following requirements related to general system management requirements shall apply:

   (a) with regard to system restoration, the use of autonomous connection as set out in Article 16 shall be subject to prior authorisation by the relevant system operator and to the reconnection conditions specified by the TSO, in coordination with the relevant system operator:

      (i) within the capability provided for in Article 16(2), the TSO, in coordination with the relevant system operator, may specify the settings for an autonomous connection;

      (ii) if no settings are specified, the default settings for an autonomous connection set out in Article 16(3) shall apply;

   (b) with regard to control schemes and settings, the schemes and settings of the different control devices of the power-generating module that are necessary for transmission system stability and for taking emergency action, and any changes thereof, shall be coordinated and agreed between the TSO, the relevant system operator and the power-generating facility owner;

   (c) with regard to electrical protection schemes and settings:

      (i) the relevant system operator shall specify the schemes and settings necessary to protect the network, taking into account the characteristics of the power-generating module;

      (ii) the protection schemes needed for the power-generating module and the network as well as the settings relevant to the power-generating module and any changes thereof shall be coordinated and agreed between the relevant system operator and the power-generating facility owner;

      (iii) the protection schemes and settings for internal electrical faults shall not jeopardise the technical capabilities of the power-generating module;

(iv) electrical protection to mitigate any damage to the power-generating module shall prevail over requirements of this Regulation;

(v) protection schemes may cover the following aspects:

(1) external and internal short circuit;

(2) asymmetric load (negative phase sequence);

(3) stator and rotor overload;

(4) over-/underexcitation;

(5) over-/undervoltage at the connection point;

(6) over-/undervoltage at the alternator terminals;

(7) inter-area oscillations;

(8) inrush current;

(9) asynchronous operation (pole slip);

(10) protection against inadmissible shaft torsions such as subsynchronous resonance;

(11) power-generating module line protection;

(12) transformer protection;

(13) backup against protection and switchgear malfunction;

(14) overfluxing (U/f);

(15) reverse power;

(16) rate of change of frequency;

(17) neutral voltage displacement;

(d) with regard to information exchange:

(i) power-generating facilities shall be capable of exchanging information with the relevant system operator or the TSO in real time. The content of real-time data shall be consistent with the data exchange requirements set out in Title 2 of Regulation (EU) 2017/1485;

(ii) the relevant system operator may specify that power-generating facilities be capable of providing fault recording for the following parameters:

(1) voltage;

(2) active power;

(3) reactive power;

(4) frequency;

(iii) the settings of the fault recording equipment, including triggering criteria and the sampling rates shall be agreed between the power-generating facility owner and the relevant system operator in coordination with the TSO;

(iv) the power-generating facility owner shall enable access to information regarding quality of supply and dynamic system behaviour for the relevant system operator and TSO. The communications protocols for recorded data shall be agreed between the power-generating facility owner, the relevant system operator and the TSO.

7. The power-generating facility owner shall organise its protection and control devices in accordance with the following priority ranking (from highest to lowest):

(a) network and power-generating module protection;

(b) synthetic inertia, if applicable;

(c) frequency control (active power adjustment);

(d) power restriction;

(e) power gradient constraint.

Article 21

Requirements for type EV3 V2G electric vehicle supply equipment and type EV3 associated V2G electrical charging parks

1. The type EV3 V2G electric vehicle supply equipment (EVSE) shall fulfil the requirements set out in Article 19 and in this Article, except for Article 19(8), point (b), and Article 19(9).

2. The type EV3 V2G EVSE shall fulfil the following requirements related to voltage stability:

(a) with regard to voltage below 110 kV, a type EV3 V2G EVSE shall be capable of remaining connected to the network and operating stably within the range of 0.9 pu – 1.1 pu. Outside that voltage range, the under and over voltage ride-through immunity limits, as specified in paragraph 3 of this Article and Article 17(5) apply;

(b) with regard to voltage of 110 kV and above:

(i) the type EV3 V2G EVSE shall be capable of remaining connected to the network and operating within the ranges and for the time periods specified in Table 6. For voltages not included in Table 6, the value of the nearest voltage level shall apply;

(ii) the relevant system operator, in coordination with the TSO, and the type EV3 V2G electrical charging park owner may agree on wider voltage ranges or longer minimum time periods for operation to ensure the best use of the technical capabilities of type EV3 V2G EVSE, if it is required to preserve or to restore system security.

3. Type EV3 V2G EVSE shall fulfil the following requirements with regard to fault-ride-through capability:

(a) each TSO shall specify a voltage-against-time-profile for fault conditions in accordance with Figure 10, and within the ranges set out in Table 9.1 and Table 9.2;

(b) type EV3 V2G EVSE, when operating above the minimum stable operating level, shall be capable of remaining connected to the network and operating

stably after the power system has been disturbed by secured faults on the transmission system when the voltage is above the voltage-against-time-profile referred to in point (a);

(c) each TSO, in co-ordination with the relevant system operator, shall specify the pre-fault and post-fault conditions for the fault-ride-through capability in terms of the following:

(i) the calculation of the pre-fault minimum short circuit capacity at the connection point;

(ii) pre-fault active and reactive power operating point of the type EV3 V2G EVSE at the connection point and voltage at the connection point;

(iii) calculation of the post-fault minimum short circuit capacity at the connection point;

(d) at the request of a type EV3 V2G electrical charging park owner, the relevant system operator shall provide the pre-fault and post-fault conditions to be considered for fault-ride-through capability, as an outcome of the calculations as specified in point (c) or as generic values derived from typical cases, regarding the following:

(i) pre-fault minimum short circuit capacity at each connection point expressed in MVA,

(ii) pre-fault operating point of the type EV3 V2G EVSE expressed as active power output and reactive power output and voltage,

(iii) post-fault minimum short circuit capacity at each connection point expressed in MVA;

(e) the type EV3 V2G EVSE shall be capable of remaining connected to the network and operating stably in the actual course of the phase-to-phase voltages on the network voltage level during a symmetrical fault, provided that the pre-fault and post-fault conditions in referred to in points (c) and (d) remain above the lower limit specified in point (a), and unless the protection scheme for internal electrical faults requires the disconnection of the type EV3 V2G EVSE from the network;

(f) the protection schemes and settings for internal electrical faults shall not jeopardise fault-ride-through capabilities of a type EV3 V2G EVSE;

(g) without prejudice to point (e) of this paragraph, undervoltage protection (either fault-ride-through capability or minimum voltage specified) shall be set by the type EV3 V2G electrical charging park owner in accordance with the widest possible technical capability of the type EV3 V2G EVSE, unless the relevant system operator requires narrower settings in accordance with paragraph 7, point (b).

Table 9.1

Voltage parameters for Figure 10 for fault-ride-through capability of type EV3 V2G EVSE

Voltage parameters (pu)	
U_{ret}:	0.05-0.15
U_{clear}:	U_{ret}-0.15
U_{rec1}:	U_{clear}
U_{rec2}:	Minimum voltage specified in Article 21(2)

Table 9.2

Time parameters for Figure 10 for fault-ride-through capability of type EV3 V2G EVSE

Time parameters (seconds)	
t_{clear}:	0.14-0.25
t_{rec1}:	t_{clear}
t_{rec2}:	t_{rec1}
t_{rec3}:	1.5-3.0

4. Each TSO shall specify a voltage-against-time profile for fault-ride-through capabilities for asymmetrical faults.

5. The type EV3 V2G EVSE shall be capable of operating stably without disconnecting from the network, if none of the phase-to-phase voltages exceeds the voltage-against-time-profile set out in Figure 10. The relevant system operator, in coordination with the TSO, may specify longer times for operation, if it is required to preserve or to restore system security.

6. With regard to system restoration provided by type EV3 V2G EVSE:

   (a) the use of autonomous connection as set out in Article 16 shall be subject to prior authorisation by the relevant system operator and to the reconnection conditions specified by the TSO, in coordination with the relevant system operator;

   (b) within the capability provided for in Article 16(2), the TSO, in coordination with the relevant system operator, may specify the settings for an autonomous connection;

   (c) if no settings are specified, the default settings for an autonomous connection set out in Article 16(3) shall apply.

7. The following requirements with respect to general system management requirements shall apply:

   (a) with regard to control schemes and settings, the schemes and settings of the different control devices of the type EV3 V2G EVSE that are necessary for transmission system stability and for taking emergency action, and any changes thereof, shall be coordinated and agreed between the TSO, the relevant system operator and the type EV3 V2G electrical charging park owner;

   (b) with regard to electrical protection schemes and settings:

      (i) the relevant system operator shall specify the schemes and settings necessary to protect the network, taking into account the characteristics of the type EV3 V2G EVSE;

      (ii) the protection schemes, and any changes thereof, needed for the type EV3 V2G EVSE and the network as well as the settings relevant to the type EV3 V2G EVSE shall be coordinated and agreed between the relevant system operator and the type EV3 V2G electrical charging park owner;

      (iii) the protection schemes and settings for internal electrical faults shall not jeopardise the technical capabilities of a type EV3 V2G EVSE;

      (iv) electrical protection to mitigate any damage to the EV3 V2G EVSE shall prevail over requirements of this Regulation;

      (v) the protection schemes may cover the following aspects:

         (1) external and internal short circuit;

         (2) asymmetric load (negative phase sequence);

         (3) over-/undervoltage at the connection point;

         (4) inter-area oscillations;

         (5) line protection;

         (6) vector shift;

         (7) transformer protection;

         (8) back-up against protection and switchgear malfunction;

         (9) rate of change of frequency;

         (10) neutral voltage displacement;

   (c) with regard to information exchange:

      (i) type EV3 associated V2G electrical charging parks shall be capable of exchanging information with the relevant system operator or the TSO in real time, as specified by the relevant system operator or the TSO. The content of real-time data shall be consistent with the data exchange requirements set out in Title 2 of Regulation (EU) 2017/1485;

      (ii) the relevant system operator may specify that the type EV3 associated V2G electrical charging park be capable of providing fault recording for the following parameters:

         (1) voltage;

         (2) active power;

(3) reactive power;

(4) frequency;

(iii) the settings of the fault recording equipment, including triggering criteria and the sampling rates shall be agreed between the type EV3 V2G electrical charging park owner and the relevant system operator in coordination with the TSO;

(iv) the relevant system operator or the TSO may require availability of data recordings for quality of supply and dynamic system behaviour. The communication protocols and format of the recorded data shall be agreed between the type EV3 V2G electrical charging park owner, the relevant system operator and the TSO.

8. With respect to voltage stability provided by EV3 V2G EVSE, the relevant system operator may require and specify the capability to supply and absorb reactive power.

9. The TSO may request grid forming capability at its connection point from type EV3 V2G EVSE if required in accordance with Article 29(2).

10. Where grid forming capability is not required in accordance with paragraph 9, the relevant system operator in coordination with the TSO may require capability of providing fast fault current in the case of symmetrical (3-phase) faults. If required, the relevant system operator in coordination with the TSO shall specify:

(a) how and when a voltage deviation is to be determined, including the end of the voltage deviation;

(b) the characteristics of the fast fault current, including the time domain for measuring the voltage deviation and fast fault current and the method for measuring current and voltage, if different from the method specified in Article 2;

(c) the timing and accuracy of the fast fault current, which may include several stages during a fault and after its clearance;

(d) the method of activating the supply of fast fault current, which shall be either ensuring the supply of the fast fault current at the connection point, or measuring voltage deviations at the terminals of the equipment and providing a fast fault current at their terminals.

11. Where grid forming capability is not required in accordance with paragraph 9, with regard to the supply of fast fault current in the case of asymmetrical (1-phase or 2-phase) faults, the relevant system operator in coordination with the TSO may require asymmetrical current injection.

12. The following requirements with regard to robustness shall apply:

(a) the TSO shall specify the capability of equipment for the post-fault active power recovery, in particular the following:

(i) when the post-fault active power recovery begins, based on a voltage criterion;

(ii) a maximum allowed time for active power recovery;

(iii) a magnitude and accuracy for active power recovery;

(b) the specifications under point (a) shall take into account the following:

(i) interdependency between fast fault current requirements and active power recovery;

(ii) dependence between active power recovery times and duration of voltage deviations;

(iii) a specified limit of the maximum allowed time for active power recovery;

(iv) adequacy between the level of voltage recovery and the minimum magnitude for active power recovery;

(v) adequate active power oscillations damping.

13. The type EV3 V2G electrical charging park owner shall organise its protection and control devices in accordance with the following priority ranking (from highest to lowest):

(a) network and EV3 V2G EVSE protection;

(b) synthetic inertia, if applicable;

(c) frequency control (active power adjustment);

(d) power restriction;

(e) power gradient constraint.

Article 22

General requirements for type C power-generating modules

1. Type C power-generating modules shall fulfil the general requirements for Type A power-generating modules set out in Articles 14 to 18, for Type B power-generating modules set out in Article 20, and the additional requirements set out in this Article.

2. The following requirements shall apply:

(a) with regard to active power controllability and control range:

(i) the power-generating module control system shall be capable of adjusting an active power setpoint following an instruction given to the power-generating facility owner by the relevant system operator or the TSO;

(ii) the TSO shall specify the period within which the adjusted active power setpoint needs to be reached. The TSO shall also specify a tolerance (subject to the availability of the prime mover resource) applicable to the new setpoint and the time within which it needs to be reached;

(iii) manual local measures shall be allowed where the automatic remote control devices are out of service;

(b) with regard to limited frequency sensitive mode - underfrequency (LFSM-U):

(i) the power-generating module shall be capable of activating the provision of active power frequency response automatically in accordance with Figure 11 at a frequency threshold and droop specified by the TSO in coordination with the TSOs of the same synchronous area as follows:

(1) the frequency threshold shall be 50Hz-Δf_1, where Δf_1 is set out in Table 3;

(2) the droop ‘s’ shall be between 2 and 12%;

(ii) the power-generating module shall be capable of adjusting the active power frequency response in LFSM-U mode to take account of the following:

(3) the operating conditions of the power-generating module, in particular limitations on operation near maximum capacity at low frequencies and the respective impact of different ambient conditions;

(4) the availability of the primary energy sources;

(5) an external signal allowing the relevant system operator to freeze or block the active power LFSM-U mode in real-time, if required. The TSO, in coordination with the relevant system operator, shall specify the framework conditions for the use of this function;

(iii) the start of active power increase (initial delay time T_{id} in Figure 4) by the power-generating module shall be as short as possible and not intentionally delayed;

(iv) the power-generating module shall be capable of providing a power increase up to its maximum capacity;

(v) the power-generating module shall be capable of operating stably during LFSM-U operation as long as the frequency is below the frequency threshold;

(vi) the LFSM-U setpoint shall prevail over any other active power setpoints which would result in a decrease of active power below the LFSM-U setpoint;

(vii) the response time for LFSM-U (T_{resp} in Figure 4) shall be as fast as technically feasible and shall not exceed:

(6) for synchronous power-generating modules: 5 minutes for an active power setpoint change of 20% of maximum power;

(7) for power park modules: 10 seconds for an active power setpoint change of 50% of maximum power;

(viii) where the response time specified in point (vii) is not technically feasible, the relevant system operator and power generation facility owner shall agree on a longer response time. The relevant system operator may request the demonstration of technical evidence of the declared response time;

(c) notwithstanding point (b), the following shall also apply in frequency sensitive mode:

(i) the power-generating module shall be capable of providing active power frequency response in accordance with the parameters specified in point (ii);

(ii) each TSO shall specify the parameters of providing active power frequency response in accordance with the ranges listed in Table 10, applicable within the range between $50Hz+\Delta f_1$ and $50Hz-\Delta f_1$, where Δf_1 is set out in Table 3. In specifying those parameters, the TSO shall take into account the following:

(1) in the case of overfrequency, the active power frequency response is limited by the minimum regulating level. In the case of

electricity storage modules, the active power frequency response is limited by the minimum regulating level or maximum consumption capacity, or the maximum energy content that the electricity storage module can store or as agreed between the power-generating facility owner and the TSO;

(2) in the case of underfrequency, the active power frequency response is limited by maximum capacity, and, in the case of electricity storage modules, also by the maximum energy content of the electricity storage module or as agreed between the power-generating facility owner and the TSO;

(3) the actual delivery of active power frequency response depends on the operating and ambient conditions as well as on the underlying energy storage technology of the electricity storage module when this response is triggered. In particular, limitations on operation near maximum capacity at low frequencies and availability of primary energy sources shall be considered;

(4) the time needed for some technologies of electricity storage modules to switch from consumption mode to generating mode or vice versa and that the droop of the active power frequency response characteristic in consumption and generating mode may be different;

(iii) the frequency response deadband of frequency deviation and droop shall be reselectable repeatedly;

(iv) in the event of a frequency step change, the power-generating module shall be capable of activating full active power frequency response at or above the solid line shown in Figure 13, in accordance with the parameters specified by each TSO within the ranges set out in Table 11. When specifying the combination of the parameters, the TSO shall take technology-dependent limitations into account and shall aim at avoiding active power oscillations for the power-generating module;

(v) the initial activation of active power frequency response shall be as fast as possible and shall not exceed the maximum admissible initial delay t_1 set out in Table 11. The relevant system operator may request the demonstration of technical evidence of the active power frequency response time;

(vi) the power-generating module shall be capable of providing full active power frequency response as long as the frequency deviation persists, limited by the maximum energy content of the electricity storage module or primary energy source of the power-generating module;

(vii) active power control shall be designed to not adversely impact the active power frequency response of the power-generating module;

(viii) the power-generating module shall be capable of operating stably during FSM operation;

(d) with regard to real-time monitoring of FSM:

(i) the data exchange interface shall be equipped to transfer in real time and in a secured manner from the power-generating facility to the control centre of the relevant system operator or the TSO at least the following signals:

(1) status signal of FSM (on/off);

(2) scheduled active power output;

(3) actual value of the active power output;

(4) actual parameter settings for active power frequency response;

(5) droop and frequency response deadband;

(ii) the relevant system operator and the TSO may specify additional signals to be provided by the power-generating facility by monitoring and recording devices in order to verify the performance of the active power frequency response provision.

3. Type C power-generating modules shall fulfil the following requirements related to robustness:

(a) in the event of power oscillations, the power-generating module shall retain steady-state stability when operating at any operating point of its P-Q-capability diagram;

(b) without prejudice to Article 15(1), the power-generating module shall be capable of remaining connected to the network and operating without power reduction when system conditions are within the frequency ranges specified in Table 2 and voltage ranges specified in Table 6;

(c) the power-generating module shall be capable of remaining connected to the network during single-phase or three-phase auto-reclosures on meshed network lines, if applicable to the network to which they are connected. The details of that capability shall be subject to coordination and agreements on protection schemes and settings as referred to in Article 20(6), point (c).

4. The following requirements related to system restoration shall apply:

(a) with regard to black start capability, if provided:

(i) the TSO may request an offer for providing black start capability from the power-generating facility owner if it considers system security to be at risk due to a lack of black start capability in its control area;

(ii) the power-generating module with black start capability shall be capable of starting from shutdown without any external electrical energy supply within a timeframe specified by the relevant system operator in coordination with the TSO;

(iii) the power-generating module with black start capability shall be capable of automatically regulating the voltage to limit the magnitude of voltage changes caused by connection of demand;

(iv) the power-generating module with black start capability shall at least:

(1) be capable of regulating load connections in block load;

(2) be capable of operating in LFSM-O and LFSM-U during the system restoration phase, as specified in paragraph 2, point (b), of this Article and Article 15(2);

(3) control frequency in case of overfrequency and underfrequency within the whole active power output range between minimum regulating level and maximum capacity as well as at houseload [operation?] level;

(4) be capable of parallel operation of a few power-generating modules in island operation;

(b) with regard to the capability to take part in island operation:

(i) the power-generating module shall be capable of participating in island operation if required by the relevant system operator in coordination with the TSO and:

(1) regulate the frequency within the limits established in accordance with Article 14(1);

(2) regulate the voltage within the limits established in accordance with Article 20(2);

(ii) the power-generating module shall be capable of operating stably during the transition from interconnected system operation to island operation without relying on information provided by the relevant system operator, as specified in paragraph 2, points (b) and (c), of this Article and Article 15;

(iii) the relevant system operator and the power-generating facility owner shall agree on how island operation is detected;

(iv) power-generation modules shall be capable of regulating active power between houseload operation level and minimum stable operating level for a minimum operation time, as specified by the relevant system operator, in coordination with the TSO, taking into consideration the specific characteristics of prime mover technology;

(v) the power-generating module shall be capable to synchronise within the frequency limits set out in Article 14(1) and within the voltage limits set out in Article 17(4) and Article 20(2);

(c) with regard to quick re-synchronisation capability:

(i) in the case of disconnection of the power-generating module from the network, the power-generating module shall be capable of quick re-synchronisation in accordance with the protection strategy agreed between the relevant system operator, in coordination with the TSO, and the power-generating facility owner;

(ii) the power-generating module with a minimum re-synchronisation time greater than 15 minutes after its disconnection from any external power supply shall be capable to trip to houseload from any operating point in its P-Q-capability diagram. In this case, the identification of houseload operation must not be based solely on the position signals of the system operator's switchgear;

(iii) the power-generating module shall be capable of continuing operation following tripping to houseload, for a minimum operation time, irrespective of any auxiliary connection to the external network. The minimum operation time shall be specified by the relevant system operator in coordination with the TSO, taking into consideration the specific characteristics of prime mover technology;

(iv) the power-generating facility owner may agree with the relevant system operator, in coordination with the TSO, to be capable of houseload operation for longer than the minimum operation time.

5. The following general system management requirements shall apply:

(a) with regard to loss of angular stability or loss of control:

(i) the power-generating module shall be capable of disconnecting automatically from the network in order to preserve system security;

(ii) the power-generating facility owner and the relevant system operator, in coordination with the TSO, shall agree on the criteria for detecting loss of angular stability or loss of control;

(b) with regard to instrumentation:

(i) power-generating facilities shall be equipped to provide fault recording and monitoring of dynamic system behaviour for the following parameters:

(1) voltage;

(2) active power;

(3) reactive power;

(4) frequency;

(ii) the device to record dynamic system behaviour shall be capable to start recording based on an oscillation trigger, as specified by the relevant system operator in coordination with the TSO, with the purpose of detecting poorly damped power oscillations;

(c) with regard to the simulation models:

(i) at the request of the relevant system operator or the TSO, the power-generating facility owner shall provide simulation models which accurately reflect the behaviour of the power-generating module for the relevant study purpose in both steady-state and dynamic simulations (root mean square) or in electromagnetic transient simulations. The simulation model requirements and data provided shall not violate the manufacturers' intellectual property.

The power-generating facility owner shall ensure that the models provided have been verified against the results of compliance tests referred to in Title IV, Chapters 2, 3 and 4, and shall notify the results of the verification to the relevant system operator or the TSO. The designated entity may require that such verification be carried out by an authorised certifier;

(ii) the synchronous power-generating module simulation models provided by the power-generating facility owner shall contain the following sub-models, depending on the existence of the individual components:

(1) alternator and prime mover;

(2) speed and power control;

(3) voltage control, including, if applicable, power system stabiliser function and excitation control system;

(4) power-generating module protection models, as agreed between the relevant system operator and the power-generating facility owner;

(iii) for the purposes of electromechanical dynamic simulations (RMS simulation studies), the relevant system operator or the TSO may specify the power park modules simulation model requirements which shall, at least:

(5) be valid for the specified operating range and all control modes of the power-generating facility;

(6) include an accurate representation of the converter modules and its control systems (including the synchronisation module) that influence the dynamic behaviour of the power-generating module in the specified time frame;

(7) be an open-source generic model for cross-border network stability studies;

(8) include the relevant protection function models;

Where encrypted detailed RMS models are accepted by the TSO, it shall specify the requirements of the model encryption according to national regulations (such as use of source code, the model structure and the signal interfaces to be observable in the network studies);

(iv) for the purposes of time domain electromagnetic transient (EMT) simulations, the relevant system operator or the TSO may specify the model requirements of the power park modules which shall, at least:

(9) be valid in the frequency range from 0.2 Hz to 2500 Hz for relevant interaction studies;

(10) be valid for the specified operating range and control modes of the power park module in the positive, negative and in the zero phase sequence;

(11) reproduce the detailed response of the power park module and its control blocks during network faults in the valid frequency range;

(12) include the power plant level control and the power plant relevant functionalities, if applicable;

(13) include the frequency dependence of the lines and/or cables in the power-generating facility;

(14) represent the power park module transformers' model including saturation, resistors, filter, breaker and AC arrester;

(15) include all the relevant protection function models for the relevant interaction studies;

(16) be usable for the numerical calculation of the frequency dependent impedance of power park module (impedance amplitude and impedance phase angle).

Where encrypted detailed EMT models are accepted by the relevant system operator or the TSO, the relevant system operator or the TSO may specify the model encryption based on national regulations, such as the model structure and the signal interfaces to be observable in the network studies;

(v) for the purposes of frequency domain simulations for the risk assessment of the resonance stability of the power park module, the relevant system operator or the TSO may specify the frequency dependent impedance model requirements which shall, at least:

(17) be valid in the range 5.0 Hz to 2500 Hz. The relevant system operator or the TSO may extend the required applicability of the model to up to 9000 Hz;

(18) be calculated either numerically (using the EMT model) or analytically (using transfer function);

(19) reflect the impedance profile through the whole operating range and control modes of operation;

(20) be valid for the positive, negative and for the zero phase sequence;

(21) consider the influence of the power-generating module control and measurement system and other parts of the power-generating module which influence the output impedance in the specified frequency range.

The power-generating facility owner shall specify and justify simplifications made in the calculation of the impedance model;

(vi) the request by the relevant system operator referred to in points (i), (ii), (iii), (iv) and (v) shall be coordinated with the TSO and shall include:

(22) the format in which models are to be provided;

(23) the documentation on a model's structure and block diagrams;

(24) an estimate of the minimum and maximum short circuit capacity, expressed in MVA, as an equivalent of the network;

(vii) the power-generating facility owner shall provide recordings of the power-generating module's performance to the relevant system operator or the TSO, if requested. The relevant system operator or the TSO may make such a request, in order to compare the response of the models with those recordings;

(d) the power-generating module shall be capable of limiting the rates of change of active power output within minimum and maximum limits (ramping limits), as specified by the relevant system operator in coordination with the TSO, in both an up and down direction, taking into consideration the specific characteristics of prime mover technology.

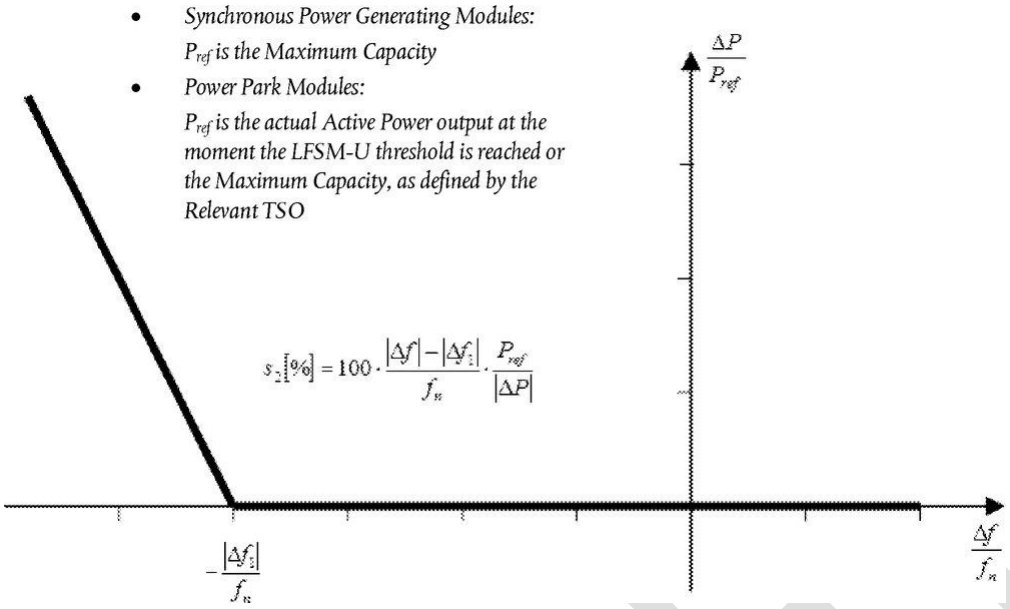
Table 10

Parameters for active power frequency response in FSM (explanation for Figure 12)

Parameters	Ranges
Active power range related to maximum capacity $\frac{\lvert\Delta P_1\rvert}{P_{max}}$	1.5-10%, except for electricity storage module. 1.5-100% for electricity storage module.
Maximum combined effect of inherent frequency response insensitivity $\lvert\Delta f_i\rvert$	10-15 mHz
Possible intentional frequency response dead band for power-generating modules providing FSM $\frac{\lvert\Delta f_i\rvert}{f_n}$	0.02-0.03%
Frequency response deadband	0-500 mHz
Droop s_1	2-27 %

Figure 11

Active power frequency response capability of a power-generating module in LFSM-U



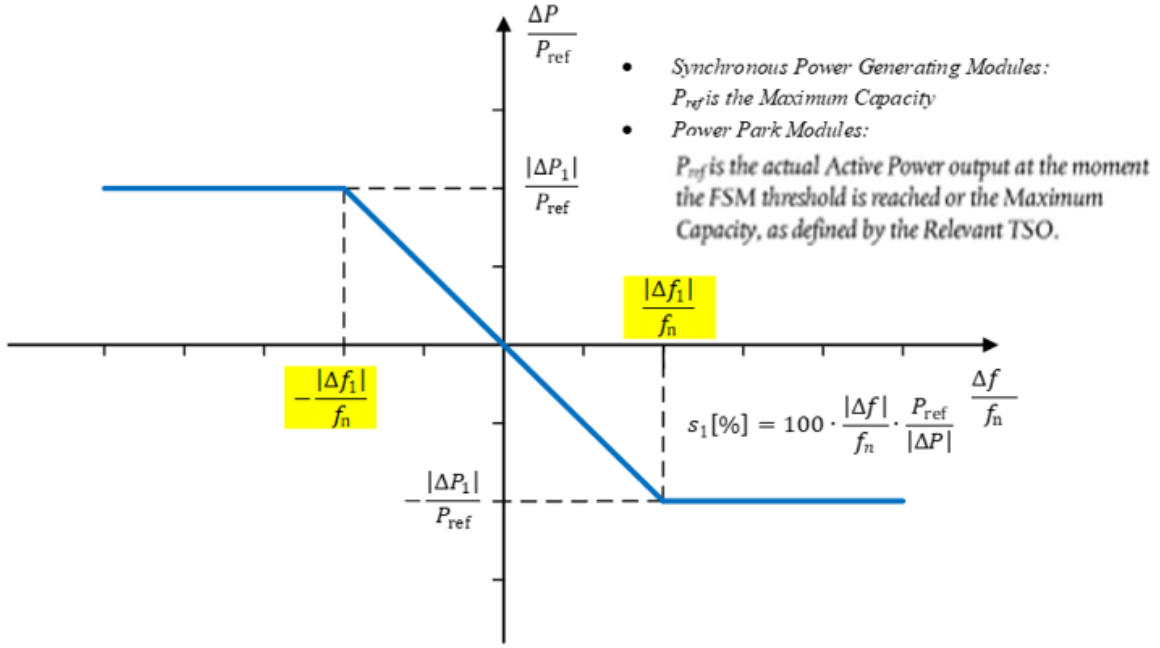
P_{ref} is the reference active power to which ΔP is related and may be specified differently for synchronous power-generating modules and power park modules. ΔP is the change in active power output from the power-generating module.

f_n is the nominal frequency (50 Hz) in the network and Δf_1 is the frequency deviation in the network as specified in Table 3.

At underfrequencies where Δf is below Δf_1 the power-generating module has to provide a positive active power output change in accordance with the droop S_2. In the case of electricity storage modules, P_{ref} is the actual active power at the moment the LFSM-U threshold is reached or the maximum capacity or maximum consumption capacity as agreed with the relevant system operator.

Figure 12

Active power frequency response capability of a power-generating module in FSM illustrating the case of zero frequency response deadband and insensitivity



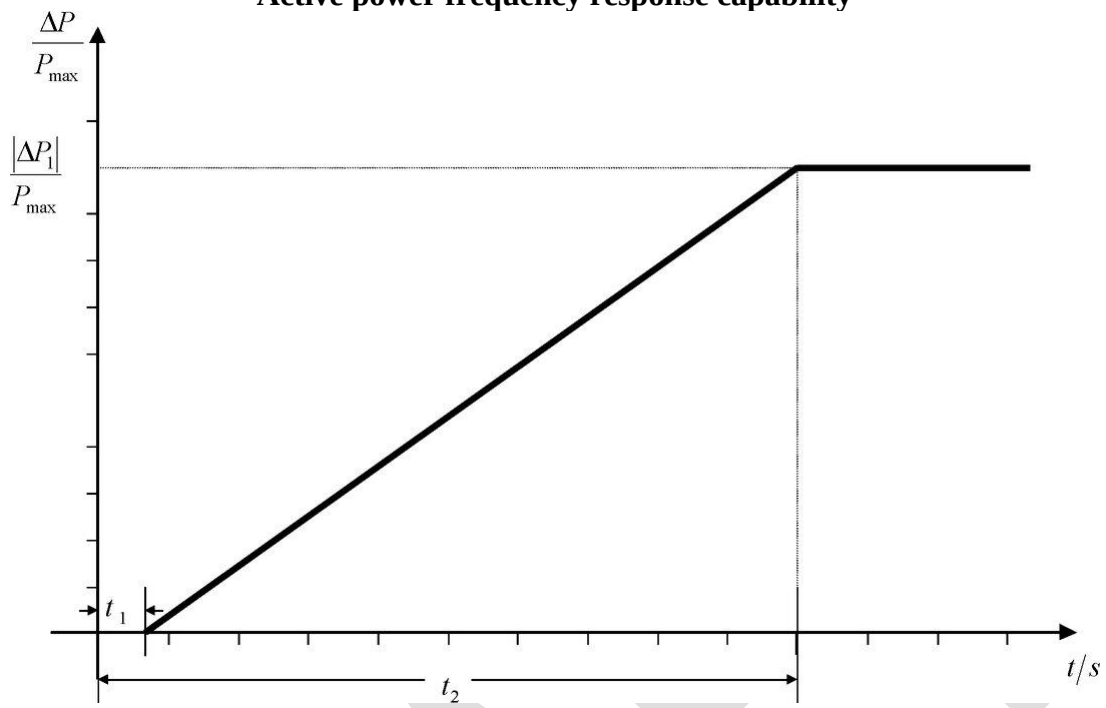
P_{ref} is the reference active power to which ΔP is related. ΔP is the change in active power output from the power-generating module.

f_n is the nominal frequency (50 Hz) in the network and Δf is the frequency deviation in the network as specified in Table 3.

In the case of electricity storage module, P_{ref} is the actual active power generated or the actual active power consumed at the moment the FSM threshold is reached or the maximum capacity or maximum consumption capacity as agreed with the relevant system operator.

Figure 13

Active power frequency response capability



P_{max} is the maximum capacity to which ΔP relates. ΔP is the change in active power output from the power-generating module. The power-generating module shall provide active power output ΔP up to the point $ΔP_1$ in accordance with the times t_1 and t_2 with the values of $ΔP_1$, $t_1$and t_2 being specified by the TSO according to Table 11. t_1 is the initial delay. t_2 is the time for full activation.

Table 11

Parameters for full activation of active power frequency response resulting from frequency step change (explanation for Figure 13)

Parameters	Ranges or values
Active power range related to maximum capacity (frequency response range) $\frlap{\dfrac{\lvert\Delta P_1\rvert}{P_{max}}}$	1.5-10%
For power-generating modules with inertia, the maximum admissible initial delay t_1 unless justified otherwise in accordance with Article 22(2), point (c)(v)	2 seconds
For power-generating modules without inertia, the maximum admissible initial delay t_1 unless justified otherwise in accordance with Article 22(2), point (c)(v)	0.5 seconds
Maximum admissible full activation time t_2,	30 seconds for the synchronous areas Continental Europe and Nordic. 5 seconds for the synchronous area Ireland and Northern Ireland

Article 23

General requirements for type D power-generating modules

1. Type D power-generating modules shall fulfil the general requirements for Type A power-generating modules set out in Articles 14 to 18, for Type B power-generating modules set out in Article 20, for Type C power-generating modules set out in Article 22, and the additional requirements set out in this Article.
2. With regard to voltage stability and without prejudice to Article 20(2), the relevant system operator in coordination with the TSO may specify voltages at which type D power-generating modules shall be capable of automatic disconnection. The terms and settings for automatic disconnection shall be agreed between the relevant system operator and the power-generating facility owner.
3. The following requirements in relation to robustness shall apply:
    (a) each TSO shall specify, for type D power-generating modules connected at or above the 110 kV, a voltage-against-time-profile for fault conditions in

accordance with Figure 10 and within the ranges set out in Table 12.1, Table 12.2, Table 13.1 and Table 13.2;

(b) each TSO shall specify, for type D power-generating modules connected below the 110 kV, a voltage-against-time-profile for fault conditions in accordance with Figure 10 and within the ranges set out in Table 7.1, Table 7.2, Table 8.1 and Table 8.2;

(c) the power-generating module, when operating above their minimum stable operating level, shall be capable of remaining connected to the network and operating stably after the power system has been disturbed by secured symmetrical faults on the transmission system when the voltage is above the voltage-against-time-profile referred to in point (a) or (b);

(d) each TSO shall specify a voltage-against-time profile for fault-ride-through capabilities in the case of asymmetrical faults.

4. With regards to synchronisation, type D power-generating modules shall:

(a) be capable of receiving a signal authorising the synchronisation;

(b) be equipped with the necessary synchronisation facilities;

(c) be capable of synchronising at frequencies within the ranges set out in Table 2.

5. The relevant system operator, in coordination with the TSO, and the power-generating facility owner shall agree on the synchronisation procedure and settings of synchronisation devices prior to operation of the power-generating module. This agreement shall cover:

(a) voltage;

(b) frequency;

(c) phase angle range;

(d) phase sequence;

(e) deviation of voltage and frequency;

(f) procedure for authorisation of synchronisation.

Table 12.1

Voltage parameters for Figure 10 for fault-ride-through capability of a synchronous power-generating module

Voltage parameters (pu)	
U_{ret}:	0
U_{clear}:	0.25
U_{rec1}:	0.5-0.7
U_{rec2}:	Minimum voltage specified in Article 20(2)

Table 12.2

Time parameters for Figure 10 for fault-ride-through capability of a synchronous power-generating module

Time parameters (seconds)	
t_{clear}:	0.14-0.15 or 0.14-0.25 if required by the relevant system operator
$t_{r\ ec1}$:	t_{clear}-0.45
$t_{r\ ec2}$:	t_{rec1}-0.7
$t_{r\ ec3}$:	t_{rec2}-1.5

Table 13.1

Voltage parameters for Figure 10 for fault-ride-through capability of a power park module

Voltage parameters (pu)	
U_{ret}:	0
U_{clear}:	U_{ret}
U_{rec1}:	U_{clear}
U_{rec2}:	Minimum voltage specified in Article 20(2)

Table 13.2

Time parameters for Figure 10 for fault-ride-through capability of a power park module

Time parameters (seconds)	
t_{clear}:	0.14-0.15 or 0.14-0.25 if required by the relevant system operator
t_{rec1}:	t_{clear}
t_{rec2}:	t_{rec1}
t_{rec3}:	1.5-3.0

CHAPTER 2

Requirements for synchronous power-generating modules

Article 24

Requirements for type A synchronous power-generating modules

1. Type A synchronous power-generating modules shall fulfil the general requirements set out for Type A power-generating modules set out in Articles 14 to 18 and the additional requirements set out in this Article.
2. The TSO shall specify if fault-ride-through capabilities are required for Type A synchronous power-generating modules. Where required:
   (a) the synchronous power-generating module shall be capable of remaining connected to the network and operating stably after the power system has been disturbed by faults on the transmission system when the voltage is above the voltage-against-time-profile in accordance with Figure 10 and with the parameters set out in Table 14.1 and Table 14.2;
   (b) each TSO in coordination with the relevant system operator shall specify the pre-fault and post-fault conditions for the fault-ride-through capability in terms of the following:
      (i) the calculation of the pre-fault minimum short circuit capacity at the connection point;
      (ii) pre-fault active and reactive power operating point of the power-generating module at the connection point and voltage at the connection point;
      (iii) calculation of the post-fault minimum short circuit capacity at the connection point.
3. The synchronous power-generating module shall be capable of remaining connected to the network and operating stably in the actual profile of the phase-to-phase voltages (or single phase to neutral voltages for single phase type A synchronous power-generating modules) on the network voltage level during a symmetrical fault, provided that the pre-

fault and post-fault conditions referred to in paragraph 2, point (b), remain above the lower limit specified paragraph 2, point (a), and unless the protection scheme for internal electrical faults requires the disconnection of the power-generating module from the network. The protection schemes and settings for internal electrical faults shall not jeopardise fault-ride-through performance.

Table 14.1

Voltage parameters for Figure 10 for fault-ride-through capability for Type A synchronous power-generating modules

Voltage parameters (pu)	
U_{ret}:	0.3
U_{clear}:	0.7
U_{rec1}:	U_{clear}
U_{rec2}:	0.85

Table 14.2

Time parameters for Figure 10 for fault-ride-through capability for Type A synchronous power-generating modules

Time parameters (seconds)	
t_{clear}:	0.15
t_{rec1}:	T_{clear}
t_{rec2}	0.7
t_{rec3}	1.5

Article 25

Requirements for type B synchronous power-generating modules

1. Type B synchronous power-generating modules shall fulfil the general requirements set out for Type A power-generating modules in Articles 14 to 18 and Article 24, for Type B power-generating modules set out in Article 20, and the additional requirements set out in this Article .

2. Type B synchronous power-generating modules shall fulfil the following additional requirements related to voltage stability:

   (a) with regard to reactive power capability, they shall be capable of supplying and absorbing reactive power, if required. The relevant system operator in coordination with the TSO may specify the capability of supplying and absorbing reactive power taking into account the technical characteristics of the synchronous power-generating module;

   (b) with regard to voltage control, they shall be equipped with a voltage control system capable of maintaining constant alternator terminal voltage at a selectable setpoint, without instability, across the entire operating range of the

synchronous power-generating module. The voltage control system shall include at least:

(i) an underexcitation limiter to prevent the automatic voltage regulator from reducing the alternator excitation to a level which would endanger angular stability;

(ii) an overexcitation limiter to ensure that the alternator excitation is not limited to less than the maximum value that can be achieved, whilst ensuring that the synchronous power-generating module is operating within its design limits.

3. With regard to robustness, type B synchronous power-generating modules shall be capable of providing post-fault active power recovery. The TSO shall specify the magnitude and time for active power recovery.

Article 26

Requirements for type C synchronous power-generating modules

1. Type C synchronous power-generating modules shall fulfil the requirements for Type A power-generating modules set out in Articles 14 to 18 and Article 24, for Type B power-generating modules set out in Article 20 and Article 25, and the additional requirements set out in this Article.

2. Type C synchronous power-generating modules shall fulfil the following additional requirements in relation to voltage stability:

(a) with regard to reactive power capability at maximum capacity:

(i) the relevant system operator in coordination with the TSO shall specify the reactive power provision capability requirements in the context of varying voltage. For that purpose, the relevant system operator shall specify a U-Q/P_{max}-profile within the boundaries of which the synchronous power-generating module shall be capable of providing reactive power at its maximum capacity. The specified U-Q/P_{max} profile may take any shape, having regard to the potential costs of delivering the capability to supply reactive power at high voltages and absorb reactive power at low voltages;

(ii) the relevant system operator in coordination with the TSO shall specify the U-Q/P_{max}-profile in conformity with the following principles:

(1) the U-Q/P_{max}-profile shall not exceed the U-Q/P_{max}-profile envelope, represented by the inner envelope in Figure 14;

(2) the dimensions of the U-Q/P_{max}-profile envelope (Q/P_{max} range and voltage range) shall be within the range specified for each synchronous area in Table 15;

(3) the position of the U-Q/P_{max}-profile envelope shall be within the limits of the fixed outer envelope in Figure 14.

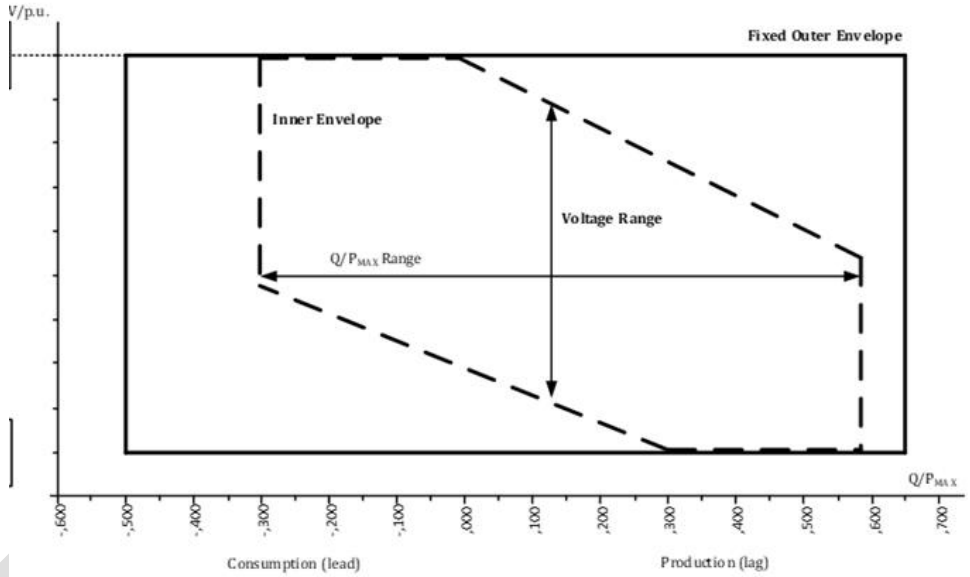
The voltage range represents the difference between the highest and lowest values at a specific value of Q/P_{max}. The full reactive power range is not expected to be available across the range of steady-state voltages;

(iii) the synchronous power-generating module shall be capable of moving to any operating point within its U-Q/P_{max} profile in sufficient time to achieve the values requested by the relevant system operator;

(b) with regard to reactive power capability below maximum capacity, when operating at an active power output below the maximum capacity (P < Pmax), the synchronous power-generating module shall be capable of operating at every possible operating point in the P-Q-capability diagram of the alternator of that synchronous power-generating module, at least down to minimum stable operating level, taking into account the auxiliary supply power and the active and reactive power losses of the step-up transformer, if applicable.

Figure 14

U-Q/P_{max}-profile of a synchronous power-generating module



The diagram represents boundaries of a U-Q/P_{max}-profile by the voltage, expressed by the ratio of its actual value and the reference 1 pu value, against the ratio of the reactive power (Q) and the maximum capacity (P_{max}). The position, size and shape of the inner envelope are indicative.

Table 15

Parameters for the inner envelope in Figure 14

Synchronous area	Maximum range of Q/P_{max}	Maximum range of steady-state voltage in PU
Continental Europe	0.95	0.225
Nordic	0.95	0.225
Ireland and Northern Ireland	1.08	0.218

Article 27

Requirements for type D synchronous power-generating modules

1. Type D synchronous power-generating modules shall fulfil the requirements for Type A power-generating modules set out in Article 14(1), point (a), Articles 15 to 18 and Article 24, for Type B power-generating modules set out in Article 20 and Article 25, for Type C power-generating modules set out in Article 22(1), (2), (4) and (5) and Article 26, for type D power-generating modules set out in Article 26, and the additional requirements set out in this Article.

2. Type D synchronous power-generating modules shall fulfil the following additional requirements in relation to voltage stability:

   (a) the TSO may specify the capacity above which a type D power-generating module shall be equipped with a power system stabiliser to attenuate power oscillations. Where required:

      (i) the PSS shall be capable to damp inter-area power oscillations in the frequency range of, at least, 0.1 Hz to 1.0 Hz;

      (ii) the TSO, in coordination with other TSOs of the synchronous area, shall specify the tuning of the PSS to dampen the inter-area oscillation mode based on frequency ranges;

   (b) the TSO may request the tuning of the PSS by the power-generating facility owner to dampen the local oscillation mode, in which the synchronous power-generating module is oscillating against the network;

   (c) with regard to voltage control, the relevant system operator, in coordination with the TSO, shall agree with the power-generating facility owner on the parameters of the voltage control systems. The agreement shall cover at least:

      (i) the specifications and performance of an AVR with regard to steady-state voltage and transient voltage control, and the specifications and performance of the excitation control;

      (ii) the specifications and performance of the AVR, including PSS, in order not to excite torsional oscillations on other power-generating modules connected to the network;

      (iii) the presence of a stator current limiter.

3. The TSO and the power-generating facility owner shall agree on the technical capabilities of the synchronous power-generating module to support angular stability under fault conditions.

4. Type D synchronous power-generating modules shall fulfil the following additional requirements in relation to frequency stability:

   (a) for synchronous power-generating modules with maximum capacity lower than 140 MW, the requirement set out in Article14(1), point (b), shall apply;

   (b) synchronous power-generating modules with maximum capacity larger than or equal to 140 MW shall be capable of remaining connected to the network and operating at the rate-of-change-of-frequency up to ±1.0 Hz/s over a period of 0.5 seconds;

   (c) the relevant system operator, in coordination with the TSO, and the power-generating facility owner may agree on a higher value of the rate-of-change-of-

frequency to ensure the best use of the technical capabilities of the power-generating module, if it is required to preserve or to restore system security;

(d) if the rate-of-change-of-frequency is used for loss of mains protection, the relevant system operator, in coordination with the TSO, shall specify the applicable threshold.

CHAPTER 3

Requirements for power park modules

Article 28

Requirements for type A power park modules

1. Type A power park modules shall fulfil the requirements for Type A power-generating modules set out in Articles 14 to 18 and the additional requirements set out in this Article.
2. The Type A power park module shall be capable of remaining connected to the network and operating stably after the power system has been disturbed by symmetrical faults on the transmission system when the voltage is above the voltage-against-time-profile in accordance with Figure 10 and with the parameters set out in Table 16 and Table 17.
3. Each TSO, in coordination with the relevant system operator, shall specify the pre-fault and post-fault conditions for the fault-ride-through capability in terms of the following:
   (a) the calculation of the pre-fault minimum short circuit capacity at the connection point;
   (b) pre-fault active and reactive power operating point of the power-generating module at the connection point and voltage at the connection point;
   (c) calculation of the post-fault minimum short circuit capacity at the connection point.
4. The power park module shall be capable of recovering to its pre-fault active power output level after the fault has been cleared and the network voltage recovers to a value within the range of 0.85pu – 1.1pu. The recovery time shall not exceed 1 second.
5. The relevant system operator in coordination with the TSO shall specify the following requirements applicable after the start of the network disturbance:
   (a) the temporal parameters of the dynamic performance regarding voltage stability;
   (b) any additional requirements regarding contribution of active and reactive power, where current limitation is necessary.

Table 16

Voltage parameters for Figure 10 for fault-ride-through capability of Type A power park modules

Voltage parameters (pu)	
U_{ret}:	0.05
U_{clear}:	U_{ret}
U_{rec1}:	U_{clear}
U_{rec2}:	0.85

Table 17

Time parameters for Figure 10 for fault-ride-through capability of Type A power park modules

Time parameters (seconds)	
t_{clear}:	0.15
t_{rec1}:	t_{clear}
t_{rec2}	t_{rec1}
t_{rec3}	3.0

Article 29

Grid forming capability

1. With regard to grid forming capability of power park modules, the TSO, in coordination with the distribution system operators, shall, by [date of entry into force of this Regulation plus two years], submit to the regulatory authority a proposal for a national roadmap.

   The roadmap shall include analysis of at least:

   (a) future power system needs in terms of frequency and voltage stability;

   (b) effects on distribution system operation of high penetration of grid forming power park modules such as:

      (i) risk of local network island operation and oscillations;

      (ii) impact on protection systems;

      (iii) mitigation measures and alternative solutions.

The roadmap shall define the network readiness for a time-phased start of application of requirements related to grid forming capability for power park modules of Type A and B as well as for EV3 V2G EVSE.

2. Based on the roadmap referred to in paragraph 1, the regulatory authority shall determine the date from which the requirements set out in paragraph 3 become mandatory for Type A and B power park modules.

   The regulatory authority may require the roadmap to be updated periodically to take account of changes in technology or other relevant circumstances.

3. Where grid forming capability is rendered mandatory in accordance with paragraph 2 of this Article, or is required pursuant to Articles 31 and 32, a power park module shall be capable of providing grid forming capability as specified in paragraphs 4, 5 and 6 of this Article, considering the sub-cycle character of the physical quantities and the power park module's capability, including current limits and energy storage capability of each individual unit, where appropriate.

4. Within the power park module's current and energy limits, the power park module shall be capable of behaving, at the terminals of the individual unit(s), as a voltage source behind an internal impedance (Thevenin source), during normal operating conditions (non-disturbed network conditions) and at the start of a network disturbance (including voltage, frequency and voltage phase angle disturbance). The Thevenin source is characterised by its internal voltage amplitude, voltage phase angle, frequency and internal impedance.

5. At the start of a network disturbance and while the power park module capabilities and current limits are not exceeded, the instantaneous AC voltage characteristics of the internal Thevenin source referred to paragraph 4 shall be capable of not changing its amplitude and voltage phase angle while positive sequence voltage phase angle steps or voltage magnitude steps are occurring at the connection point. The current exchanged between the power park module and the network shall flow naturally according to the main generating plant and converter impedances and the voltage difference between the internal Thevenin source and the voltage at the connection point.

6. After the start of a network disturbance in voltage magnitude, frequency or voltage phase angle, the power park module shall be capable of stable operation when reaching the power park module current limits, without interruption, in a continuous manner and returning to the behaviour described in paragraph 5 as soon as the limitations are no longer active, within the power park module's capability, including current limits and energy storage capabilities of each individual unit.

7. The relevant system operator in coordination with the TSO shall specify the temporal parameters of the dynamic performance regarding voltage stability applicable after the start of a network disturbance in voltage magnitude, frequency or voltage phase angle. Where current limitation is necessary, the relevant system operator in coordination with the TSO may specify additional requirements regarding contribution of active and reactive power at the point of connection.

8. In the context of grid forming, the energy storage capability shall be understood as the inherent energy capability available in physical components of a power park module, which has not necessarily been designed to suit the grid forming requirements of paragraphs 3 to 6, but may be used for such purposes, without affecting the design of the physical components of individual units.

Article 30

Requirements for type B power park modules

1. Type B power park modules shall fulfil the requirements set out in Articles 14 to 18, Article 20 and Article 28, and the additional requirements set out in this Article.
2. With regard to reactive power capability, Type B power park modules shall be capable of supplying and absorbing reactive power, if required by the relevant system operator.
3. The following type B power park modules shall fulfil the requirements set out in Article 29(3) to (6) and paragraph 5 of this Article with regard to grid forming capability:
    (a) type B power park modules connected at 110 kV level or above;
    (b) type B power park modules of P_{max} of 10 MW or above, connected below 110 kV to a feeder dedicated to one or more power park modules connected to a substation with transformation to 110 kV or above.
4. Type B power park modules other than those in paragraph 3 of this Article shall fulfil the requirements set out in Article 29(3) to (6) and paragraph 5 of this Article, subject to the decision by the regulatory authority in accordance with Article 29(2).
5. Where grid forming capability is required pursuant to paragraph 3 or 4, with regard to synthetic inertia:
    (a) the TSO in coordination with the relevant system operator shall specify the level of synthetic inertia required from Type B power park modules;
    (b) Type B power park modules shall be capable of contributing to limiting the transient frequency deviation under high frequency conditions;
    (c) Type B electricity storage module shall be capable of contributing to limiting the transient frequency deviation under low frequency conditions.
6. Where grid forming capability is not required pursuant to paragraph 3 or 4, the relevant system operator, in coordination with the TSO, may require that a power park module be capable of providing fast fault current in the case of symmetrical (3-phase) faults. If required, the relevant system operator, in coordination with the TSO, shall specify:
    (a) how and when a voltage deviation is to be determined, including the end of the voltage deviation;
    (b) the characteristics of the fast fault current, including the time domain for measuring the voltage deviation and fast fault current and the method for measuring current and voltage, if different from the method specified in Article 2;
    (c) the timing and accuracy of the fast fault current, which may include several stages during a fault and after its clearance;
    (d) the method of activating the supply of fast fault current, which shall be either of the following:
        (1) ensuring the supply of the fast fault current at the connection point or
        (2) measuring voltage deviations at the terminals of the equipment and providing a fast fault current at their terminals.
7. Where grid forming capability is not required pursuant to paragraph 3 or 4, with regard to the supply of fast fault current in the case of asymmetrical (1-phase or 2-phase) faults, the

relevant system operator, in coordination with the TSO, may require asymmetrical current injection.

8. The TSO shall specify the following post-fault active power recovery parameters with regard to robustness:

   (a) time when the post-fault active power recovery begins, based on a voltage criterion;

   (b) a maximum allowed time for active power recovery;

   (c) a magnitude and accuracy for active power recovery.

   The specifications referred to in the first subparagraph shall take into account the following:

   (a) interdependency between fast fault current requirements referred to in paragraphs 6 and 7 and active power recovery;

   (b) dependence between active power recovery times and duration of voltage deviations;

   (c) adequacy between the level of voltage recovery and the minimum magnitude for active power recovery;

   (d) appropriate damping of active power oscillations.

Article 31

Requirements for type C power park modules

1. Type C power park modules shall fulfil the requirements set out in Articles 14 to 18, Article 20, Article 22(1), (2), (4) and (5), Article 28, Article 29(3) to (6) and Article 30, and the additional requirements set out in this Article.

2. Type C power park modules shall fulfil the following additional requirements in relation to voltage stability:

   (a) with regard to reactive power capability at maximum capacity:

      (i) the relevant system operator in coordination with the TSO shall specify the reactive power provision capability requirements in the context of varying voltage. For that purpose, the relevant system operator shall specify a U-Q/P_{max}-profile within the boundaries of which the power park module shall be capable of providing reactive power at its maximum capacity. The specified U-Q/P_{max} profile may take any shape, having regard to the potential costs of delivering the capability to supply reactive power at high voltages and absorb reactive power at low voltages;

      (ii) the relevant system operator in coordination with the TSO shall specify the U-Q/P_{max}-profile in conformity with the following principles:

         (1) the U-Q/P_{max}-profile shall not exceed the U-Q/P_{max}-profile envelope, represented by the inner envelope in Figure 15;

         (2) the dimensions of the U-Q/P_{max}-profile envelope (Q/P_{max} range and voltage range) shall be within the values specified for each synchronous area in Table 18;

(3) the position of the U-Q/P_{max}-profile envelope shall be within the limits of the fixed outer envelope set out in Figure 15.

The voltage range represents the difference between the highest and lowest values at a certain value of Q/P_{max}. The full reactive power range is not expected to be available across the range of steady-state voltages;

(b) with regard to reactive power capability below maximum capacity:

(i) the relevant system operator in coordination with the TSO shall specify the reactive power provision capability requirements and shall specify a P-Q/P_{max}-profile that may take any shape within the boundaries of which the power park module shall be capable of providing reactive power below maximum capacity;

(ii) the P-Q/P_{max}-profile shall be specified by each relevant system operator in coordination with the TSO, in conformity with the following principles:

(1) the P-Q/P_{max}-profile shall not exceed the P-Q/P_{max}-profile envelope, represented by the inner envelope in Figure 16;

(2) the Q/P_{max} range of the P-Q/P_{max}-profile envelope is specified for each synchronous area in Table 18;

(3) the active power range of the P-Q/P_{max}-profile envelope at zero reactive power shall be 1 pu;

(4) the P-Q/P_{max}-profile may be of any shape and shall include conditions for reactive power capability at zero active power;

(5) the position of the P-Q/P_{max}-profile envelope shall be within the limits of the fixed outer envelope set out in Figure 16;

(iii) when operating at an active power output below maximum capacity ($P<P_{max}$), the power park module shall be capable of providing reactive power at any operating point inside its P-Q/P_{max}-profile, if all units of that power park module which generate power are technically available, namely they are not out of service due to maintenance or failure;

(iv) the synchronous power-generating module shall be capable of moving to any operating point within its P-Q/P_{max} profile in sufficient time to achieve the values requested by the relevant system operator;

(c) with regard to reactive power control modes:

(i) for the purposes of voltage control mode, the power park module shall be capable of operating stably in voltage control mode and contributing to voltage control by supply or absorbing the reactive power to and from the network. The setpoint voltage shall cover 0.95 pu to 1.05 pu in steps no greater than 0.01 pu, with a slope range of at least 2% to 7% in steps no greater than 0.5%. The reactive power output shall be zero when the grid voltage value equals the voltage setpoint;

(ii) the setpoint may be operated with or without a frequency response deadband selectable in a range from zero to ± 5% of reference 1 pu network voltage in steps no greater than 0.5%;

(iii) following a step change in voltage, the power park module shall be capable of achieving 90% of the change in reactive power output within a time t_1 to

be specified by the relevant system operator in the range of 1 to 5 seconds, and shall settle at the value specified by the slope within a time t_2 to be specified by the relevant system operator in the range of 5 to 60 seconds, with a steady-state reactive tolerance no greater than 5% of the maximum reactive power;

(iv) for the purposes of reactive power control mode, the power park module shall be capable of setting the reactive power setpoint anywhere in the reactive power range, if required in accordance with Article 30(2) and Article 31(2), points (a) and (b), with setting steps no greater than 5 MVAr or 5% (whichever is smaller) of maximum reactive power, controlling the reactive power at the connection point to an accuracy within ±5 MVAr or ±5% (whichever is smaller) of the maximum reactive power;

(v) for the purposes of power factor control mode, the power park module shall be capable of controlling the power factor within the required reactive power range, if required in accordance with Article 30(2) or Article 31(2), points (a) and (b), with a target power factor in steps no greater than 0.01. The relevant system operator shall specify the target power factor value, its tolerance and the time to achieve the target power factor following a sudden change of active power output. The tolerance of the target power factor shall be expressed through the tolerance of its corresponding reactive power. This reactive power tolerance shall be expressed by either an absolute value or by a percentage of the maximum reactive power of the power park module. Relevant system operator may specify another behaviour of a power park module when operating at close to zero active power;

(vi) for the purposes of active power-related power factor control mode, the power park module shall be capable of controlling the power factor within the required reactive power range, if required in accordance with Article 30(2) or Article 31(2), points (a) and (b). The relevant system operator shall specify the power factor setpoint resulting from a change in active power output. The relevant system operator shall specify its tolerance and the time to achieve the setpoint;

(vii) the relevant system operator, in coordination with the TSO and with the power park module owner, shall specify which of the above four reactive power control mode options and associated setpoints is to apply, and what further equipment is needed to make the adjustment of the relevant setpoint or to change the applied reactive power control mode operable remotely;

(d) with regard to prioritising active or reactive power contribution, the TSO shall specify which one has priority during faults for which fault-ride-through capability is required. If priority is given to active power contribution, the provision of active power shall begin no later than 150 milliseconds after the start of the fault;

(e) with regard to power oscillations damping control, the TSO may require a power park module to have a power oscillation damping function. The power oscillation damping shall be capable of damping inter-area oscillations in the range of at least 0.1 Hz to 1.0 Hz. The TSO may prioritise the power oscillation damping over the voltage and reactive power control actions.

3. Where the frequency of oscillations is between 0.1 Hz and 20 Hz and when system conditions are within the frequency ranges specified in Table 2 and voltage ranges specified in Table 6, the control systems and design characteristics of Type C power park modules shall fulfil the following requirements related to the total active power and current forced oscillations:

   (a) the forced oscillations shall not continuously exceed the higher of the following:

      (i) a limit specified by the TSO within the range of ±0.1% to ±1% of the maximum capacity. The default limit shall be ±0.5%;

      (ii) a limit specified by the TSO within the range of 200 kW to 500 kW. The default limit shall be 500 kW;

   (b) where the limits specified in point (a) are temporarily exceeded, forced oscillations shall:

      (i) not exceed a limit specified by the TSO within the range of ±0.5% to ±3% of the maximum capacity. The default limit shall be ±2.5%;

      (ii) be within the limits specified in point (a) for the time specified by the TSO within a range of 100 to 180 seconds. The default limit shall be 180 seconds;

      (iii) be damped to be lower than 50% of the limit specified in point (i) within 50% of the time limit specified in point (ii);

   (c) the occurrence of the forced oscillations exceeding limits specified in point (a) and which are damped in more than 10 seconds shall be allowed for:

      (i) a maximum percentage of time per day, as specified by the TSO within the range of 1% to 2%. The default limit shall be ±1%;

      (ii) 2 to 4 times per hour, based on the maximum of the range of the 85th to 95th percentile of hourly exceedances measured over one week, as specified by the TSO. The default shall be 3 times and default percentile shall be 95;

   (d) forced oscillations originating from system support requests by the relevant system operator, such as power oscillation damping, are excluded from requirements set out in points (a), (b) and (c).

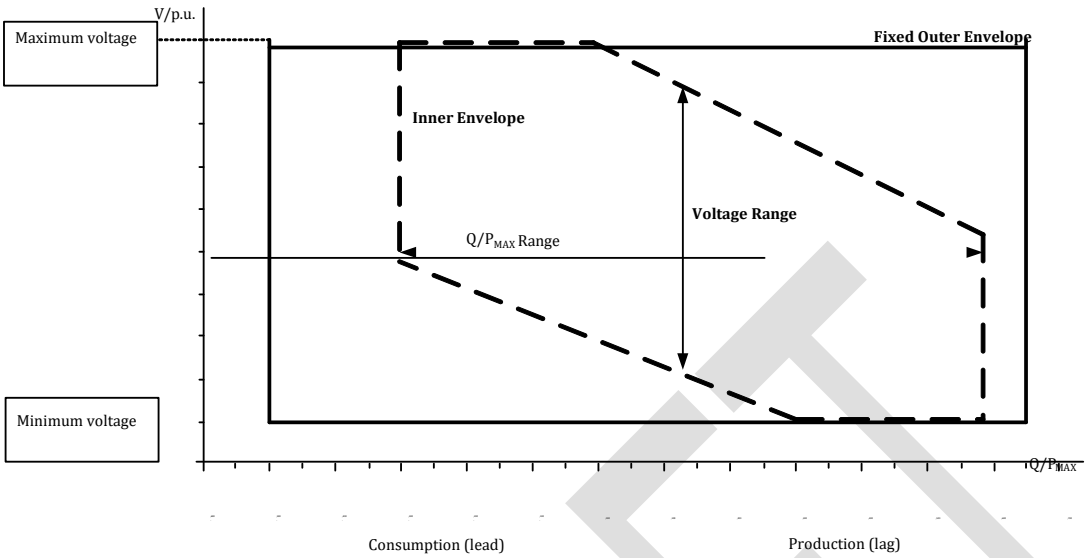
4. With regard to grid forming capability:

   (a) the TSO, in coordination with the relevant system operator, shall specify the level of synthetic inertia. The power park module shall be capable of limiting the transient frequency deviation under high and low frequency conditions;

   (b) the TSO, in coordination with the relevant system operator, may require the provision of additional energy beyond the inherent energy storage of the power generating module.

Figure 15

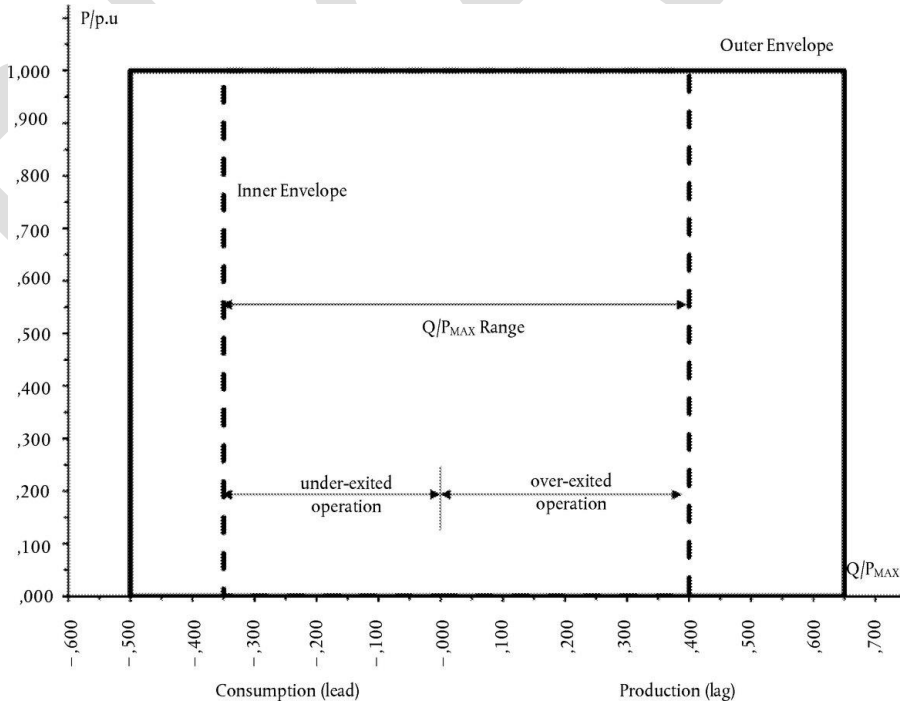
U-Q/P_{max}-profile of a power park module



The diagram represents boundaries of a U-Q/P_{max}-profile by the voltage, expressed by the ratio of its actual value and its reference 1 pu value, against the ratio of the reactive power (Q) and the maximum capacity (P_{max}). The position, size and shape of the inner envelope are indicative.

Figure 16

P-Q/P_{max}-profile of a power park module



The diagram represents boundaries of a P-Q/P_{max}-profile by the active power, expressed by the ratio of its actual value and the maximum capacity pu, against the ratio of the reactive power (Q) and the maximum capacity (P_{max}). The position, size and shape of the inner envelope are indicative.

Table 18

Parameters for the inner envelope in Figures 15 and 16

Synchronous area	Maximum range of Q/P_{max}	Maximum range of steady-state voltage in PU
Continental Europe	0.75	0.225
Nordic	0.95	0.225
Ireland and Northern Ireland	0.66	0.218

Article 32

Requirements for type D power park modules

1. Type D power park modules shall fulfil the requirements set out in Articles 14 to 18, Article 20, Article 22(1), (2), (4) and (5), Article 23, Article 28, Article 29(3) to (6), Article 30 and Article 31, and the additional requirements set out in this Article.
2. Type D power park modules shall be equipped with a power oscillation damping function, which shall be capable of damping inter-area oscillations in the range of, at least, 0.1 Hz to 1.0 Hz.
3. Type D power park modules shall be capable of either damping the inter-area or local oscillations defined by the TSO. The TSO in coordination with the relevant system operator shall request either of the following:
    (a) the tuning of the power oscillation damping by the power-generating facility owner to damp the inter-area oscillation mode based on frequency ranges specified by the TSO in coordination with the TSOs of the same synchronous area;
    (b) the tuning of the power oscillation damping by the power-generating facility owner to damp the local oscillation mode, in which the power park modules is oscillating against the network.
4. The power oscillation damping control shall be agreed between the TSO and the power-generating facility owner.

CHAPTER 4

Requirements for offshore power park modules

Article 33

General provisions

1. Unless otherwise provided for in this Chapter, AC-connected offshore power park modules shall meet the requirements for power park modules.

2. An AC-connected power park module located offshore which does not have an offshore connection point shall be considered power park module.

Article 34

Voltage stability requirements applicable to AC-connected offshore power park modules

With regard to the reactive power capability at maximum capacity, an AC-connected offshore power park module shall be capable of operating in accordance with the parameters set out in Table 19.

Table 19

Parameters for Figure 15

Synchronous area	Maximum range of Q/P_{max}	Maximum range of steady-state voltage in PU
Continental Europe	0.75	0.225
Nordic	0.95	0.225
Ireland and Northern Ireland	0.66	0.218

Article 35

Forced oscillations requirements applicable to AC-connected offshore power park modules

1. Where the frequency of oscillations is between 2.0 Hz and 20 Hz, the system stability requirements set out in Article 31(3) shall apply to AC-connected offshore power park modules.
2. Where the frequency of oscillations is between 0.1 Hz and 2.0 Hz and when system conditions are within the frequency ranges set out in Table 2 and voltage ranges specified in Table 6, the control systems and design characteristics of power park modules shall fulfil the following requirements related to the total active power and current forced oscillations
    (a) the forced oscillations shall not continuously exceed the higher of the following:
        (i) a limit specified by the TSO within the range of ±0.5% to ±2% of the actual value. The default limit shall be ±1%;
        (ii) a limit specified by the TSO within the range of ±0.25% to ±1% of the maximum capacity. The default limit shall be ±0.5%;
    (b) where the limits specified in point (a) are temporarily exceeded, forced oscillations shall:
        (i) not exceed a limit specified by the TSO within the range of ±2.5% to ±5% of the maximum capacity. The default limit shall be ±4%;

(ii) be within the limits specified in point (a) for the time specified by the TSO within a range of 100 to 180 seconds. The default limit shall be 180 seconds;

(iii) be damped to be lower than 50% of the limit specified in point (i) within 50% of the time limit specified in point (ii);

(c) the occurrence of the forced oscillations exceeding limits specified in point (a) and which are damped in more than 10 seconds shall be allowed in accordance with Article 31(3), point (c).

3. Forced oscillations originating from system support requests by the relevant system operator, such as power oscillation damping, are excluded from the requirements provided for in paragraph 2.

TITLE III

OPERATIONAL NOTIFICATION PROCEDURE FOR CONNECTION

CHAPTER 1

Connection of new power-generating modules

Article 36

General provisions

1. The power-generating facility owner shall demonstrate to the relevant system operator that it complies with the requirements set out in Title II of this Regulation by completing successfully the operational notification procedure provided for in this Chapter.
2. The relevant system operator shall clarify and make publicly available the details of the operational notification procedure.
3. The relevant system operator shall ensure that the commissioning of power-generating modules can be notified electronically.
4. The operational notification procedure for connection of each new power-generating module shall allow the use of equipment certificates issued by an authorised certifier.

Article 37

Operational notification procedure for Type A power-generating modules and for type EV1 and EV2 V2G EV and V2G EVSE

1. The power-generating facility owner shall submit an installation document to the relevant system operator for connection of each new Type A power-generating module. Separate installation documents shall be provided for each power-generating module within the power-generating facility.
2. The V2G electrical charging park owner shall submit an installation document for connection of each new type EV1 and EV2 V2G EV and V2G EVSE to the relevant system operator.
3. The relevant system operator shall ensure that the required information can be submitted by third parties on behalf of the power-generating facility owner or by the V2G electrical charging park owner.

4. The relevant system operator shall specify the content of the installation document, which shall include at least the following information:
    (a) the location at which the connection is made;
    (b) the date of the connection;
    (c) the maximum capacity of the installation in kW;
    (d) the type of primary energy source;
    (e) reference to equipment certificates issued by an authorised certifier used for equipment that is in the site installation;
    (f) the contact details of the power-generating facility owner and the installer.
5. The regulatory authority may decide that the relevant system operator, on acceptance of a complete and adequate installation document, shall issue a final operational notification as soon as possible and not later than within 2 months.

Article 38

Operational notification procedure for type EV3 V2G EVSE

1. The V2G electrical charging park owner shall submit a supply equipment document for connection of each new type EV3 V2G EVSE to the relevant system operator and shall include a statement of compliance.
2. The relevant system operator shall specify the content and format of the SED using established European technical standards. The relevant system operator shall require at least the following information in the SED:
    (a) protection and control settings;
    (b) an itemised statement of compliance;
    (c) detailed technical data of the EV3 V2G EVSE;
    (d) equipment certificates issued by an authorised certifier in respect of type EV3 V2G EVSE, where those are relied upon as part of the evidence of compliance.
3. The relevant system operator may require the following additional information in the SED:
    (a) compliance test reports demonstrating steady-state and dynamic performance as required by the national compliance scheme, including use of actual measured values during testing;
    (b) studies demonstrating steady-state and dynamic performance as required by the national compliance scheme.
4. The regulatory authority may decide that the relevant system operator, on acceptance of a complete and adequate SED, shall issue a final operational notification to the V2G electrical charging park owner as soon as possible and not later than within 2 months.
5. The regulatory authority may provide that the SED shall be issued by an authorised certifier.

Article 39

Operational notification procedure for Type B and C power-generating modules

1. The power-generating facility owner shall submit a power-generating module document for connection of each new Type B and C power-generating module to the relevant system operator and shall include a statement of compliance.

   For each power-generating module within the power-generating facility, a separate independent PGMD shall be submitted.

2. The relevant system operator shall specify the content and format of the PGMD. The relevant system operator shall require at least the following information in the PGMD:

   (a) protection and control settings;

   (b) an itemised statement of compliance;

   (c) detailed technical data of the power-generating module with relevance to the grid connection as required by the relevant system operator;

   (d) equipment certificates issued by an authorised certifier in respect of power-generating modules, where those are relied upon as part of the evidence of compliance.

3. The relevant system operator may require the following additional information in the PGMD:

   (a) for Type C power-generating modules, simulation models as provided for in Article 22(5), point (c);

   (b) compliance test reports demonstrating steady-state and dynamic performance as required by the national compliance scheme, including use of actual measured values during testing;

   (c) studies demonstrating steady-state and dynamic performance as required by the national compliance scheme referred to in Article 49.

4. The relevant system operator, on acceptance of a complete and adequate PGMD, shall issue a final operational notification to the power-generating facility owner as soon as possible and no later than within 2 months.

5. The regulatory authority may provide that the PGMD shall be issued by an authorised certifier.

Article 40

Operational notification procedure for Type D power-generating modules

The operational notification procedure for connection of each new Type D power-generating module shall comprise:

(a) energisation operational notification;

(b) interim operational notification;

(c) final operational notification.

Article 41

Energisation operational notification procedure for Type D power-generating modules

1. The relevant system operator shall issue an EON, subject to completion of preparations, including agreement on the protection and control settings relevant to the connection point between the relevant system operator and the power-generating facility owner.
2. After an EON has been issued, the power-generating facility owner may energise its internal network and auxiliaries for the power-generating modules by using the grid connection that is specified for the connection point.

Article 42

Interim operational notification procedure for Type D power-generating modules

1. The relevant system operator shall issue an ION, following the completion of the data and study review process by the power-generating facility owner, as specified in paragraph 3.
2. After an ION has been issued, the power-generating facility owner may operate the power-generating module and generate power by using the grid connection for a limited period of time.
3. The relevant system operator may require the following with regard to the data and study review:
    (a) itemised statement of compliance;
    (b) detailed technical data on the power-generating module of relevance to the grid connection;
    (c) equipment certificates issued by an authorised certifier in respect of power-generating modules, where they are relied upon as part of the evidence of compliance;
    (d) simulation models, as provided for in Article 22(5), point (c);
    (e) studies demonstrating the expected steady-state and dynamic performance, as required by the national compliance scheme;
    (f) details of intended compliance tests in accordance with the national compliance scheme.
4. The relevant system operator shall specify a validity period for the ION. The default period shall be 24 months. An extension of the ION shall be granted only if the power-generating facility owner has made substantial progress towards full compliance and any outstanding issues are clearly identified at the time of requesting extension.

Article 43

Final operational notification procedure for Type D power-generating modules

1. The relevant system operator shall issue a FON, following the resolution of all outstanding issues identified during the ION procedure and following the completion of the data and study review process by a power-generating facility owner as specified in paragraph 3.
2. After a FON has been issued, the power-generating facility owner may operate a power-generating module by using the grid connection.

3. The relevant system operator may require the following with regard to the data and study review:

   (a) an itemised statement of compliance;

   (b) an update of applicable technical data, simulation models and studies as referred to in Article 42(3), points (b), (d) and (e), including the use of actual measured values during testing.

4. If outstanding issues are identified during the FON procedure, the relevant system operator may grant a derogation upon a request from power-generating facility owner, in accordance with the derogation procedure laid down in Title V. A FON shall be issued by the relevant system operator if the power-generating module complies with the provisions of the derogation.

   Where a request for a derogation is rejected, the relevant system operator may refuse to allow the operation of the power-generating module until the power-generating facility owner and the relevant system operator resolve the incompatibility and the relevant system operator considers that the power-generating module complies with this Regulation.

   If the relevant system operator and the power-generating facility owner do not resolve the incompatibility within a reasonable time frame, which shall not exceed six months after the notification of the rejection of the request for a derogation, each party may refer the issue for decision to the regulatory authority.

Article 44

Limited operational notification procedure for Type D power-generating modules

1. Power-generating facility owners to whom a FON has been granted shall inform the relevant system operator immediately in either of the following circumstances:

   (a) the facility is temporarily subject to either significant modernisation or loss of capability affecting its performance;

   (b) equipment failure leading to non-compliance with some relevant requirements.

2. The power-generating facility owner shall apply to the relevant system operator for a LON, if the power-generating facility owner reasonably expects the circumstances referred to in paragraph 1 to persist for more than three months.

3. The relevant system operator shall issue a LON which shall contain the following, clearly identifiable information:

   (a) the unresolved issues justifying the granting of the LON;

   (b) the responsibilities and timescales for the expected solution;

   (c) a maximum period of validity which shall not exceed 12 months. The initial period granted may be shorter with the possibility of an extension if sufficient evidence is submitted to the relevant system operator demonstrating that substantial progress has been made towards achieving full compliance.

4. The relevant system operator shall suspend the FON during the period of validity of the LON with regard to the items for which the LON has been issued.

5. The relevant system operator may grant a further extension of the period of validity of the LON upon a request made before the expiry of the initial LON period, in accordance with the derogation procedure laid down in Title V.

6. The relevant system operator shall refuse to allow the operation of the power-generating module once the LON is no longer valid. In such cases, the FON shall also automatically become invalid.

CHAPTER 2

COST-BENEFIT ANALYSIS

Article 45

Application of certain requirements to already connected power-generating modules

1. By [date of entry into force of this Regulation plus two years], in each Member State, the TSO in coordination with the DSOs shall carry out a cost-benefit analysis in accordance with Article 46, in order to evaluate the need to apply all or some requirements of this Regulation to existing power-generating modules and submit the proposal to the regulatory authority in accordance with paragraph 5 of this Article.

2. The regulatory authority may require the TSO to carry out further cost-benefit analyses, as needed, according to changing system needs. The TSO shall carry out such analyses in accordance with the requirements and procedures established in this Article.

3. Power-generating facility owners and DSOs including CDSOs shall assist and contribute to the cost-benefit analysis and provide the necessary data as requested by the relevant system operator or the TSO within three months of receiving a request.

4. On receipt of the requested data, the TSO in coordination with the DSOs shall issue a report which shall:

   (a) set out and justify the scope of the cost-benefit analyses as regards the power-generating modules and technical requirements;

   (b) include the cost-benefit analysis, its results and a recommendation on how to proceed;

   (c) include a proposal for a transitional period before the start of application of the requirements;

   (d) be subject to public consultation in accordance with Article 10.

5. The TSO shall submit to the regulatory authority a proposal that includes the following:

   (a) a recommendation on whether to apply certain technical requirements to existing power-generating modules, specifying:

      (i) which requirements should apply;

      (ii) which categories or types of existing power-generating modules should be subject to those requirements;

   (b) a proposed implementation timeline, including:

      (i) the date from which the requirements should apply;

      (ii) any transitional arrangements;

(c) the report prepared pursuant to paragraph 4;

(d) a report containing the results of the public consultation and an assessment of potential challenges to the implementation of the requirements, along with proposed mitigation measures.

6. The regulatory authority shall decide whether certain requirements of this Regulation apply to existing power-generating modules within six months of receipt of the proposal from the TSO.

Article 46

Principles of cost-benefit analysis

A cost-benefit analysis referred in Article 45 shall at least:

(a) quantify socioeconomic benefits in terms of improvement in security of supply and shall include at least:

(i) the associated reduction in probability of loss of supply over the lifetime of the modification;

(ii) the probable extent and duration of such loss of supply;

(iii) the societal cost per hour of such loss of supply;

(b) quantify the benefits to the internal market in electricity, cross-border trade and integration of renewable energies, including at least:

(i) the active power frequency response;

(ii) the balancing reserves;

(iii) the reactive power provision;

(iv) congestion management;

(v) improvement to the measures in the system defence plan as referred in the Regulation (EU) 2017/2196;

(c) quantify the costs of applying the necessary rules to existing power-generating modules, including at least:

(i) the direct costs incurred in implementing a requirement;

(ii) the costs associated with attributable loss of opportunity;

(iii) the costs associated with resulting changes in maintenance and operation.

TITLE IV
COMPLIANCE
CHAPTER 1

Compliance monitoring

Article 47

Responsibility of the power-generating facility owner

1. The power-generating facility owner shall ensure that each power-generating module complies with the requirements applicable under this Regulation for its lifetime.
2. For Type A power-generating modules, V2G EV and associated V2G EVSE, the power-generating facility owner shall use equipment certificates, issued in accordance with Regulation (EC) No 765/2008 for the purpose of demonstrating compliance with this Regulation.
3. For Type B, C and D power-generating modules, instead of carrying out the relevant tests, power-generating facility owners may rely upon equipment certificates issued by an authorised certifier to demonstrate compliance with the relevant requirement. In such a case, power-generating facility owners shall provide the equipment certificates to the relevant system operator.
4. The power-generating facility owner shall notify the relevant system operator of any planned modification of the technical capabilities of a power-generating module which may affect its compliance with the requirements applicable under this Regulation, before initiating that modification.
5. The power-generating facility owner shall notify the relevant system operator of any operational incidents or failures of a power-generating module that affect its compliance with the requirements of this Regulation, without undue delay, after the occurrence of those incidents or failures.
6. The power-generating facility owner shall notify the relevant system operator of the planned test schedules and procedures to be followed for verifying the compliance of a power-generating module with the requirements of this Regulation, in due time and prior to their launch. The relevant system operator may request adjustments and shall approve in advance the planned test schedules and procedures if it does not endanger operational security. Such approval by the relevant system operator shall be provided in a timely manner and shall not be unreasonably withheld.
7. The relevant system operator may participate in such tests and record the performance of the power-generating modules.
8. The power-generating facility owner may delegate the performance of compliance testing to third parties. In such cases, the power-generating facility owner shall continue to ensure that the provisions of Article 12 are applied.

Article 48

Responsibilities of the relevant system operator

1. The relevant system operator shall assess the compliance of a power-generating module with the requirements applicable under this Regulation. The power-generating facility owner shall be informed of the outcome of this assessment.

   For Type A power-generating modules and V2G EV and associated V2G EVSE, the relevant system operator shall accept equipment certificates issued by an authorised certifier for this assessment.

2. The relevant system operator may request that the power-generating facility owner carries out compliance tests and simulations in accordance with a repeat plan or general scheme or after any failure, modification or replacement of any equipment that may have an impact on the power-generating module's compliance with the requirements of this Regulation.

3. The relevant system operator shall make publicly available a list of information and documents to be provided as well as the requirements to be fulfilled by the power-generating facility owner within the framework of the compliance process. The list shall cover at least the following:

   (a) all the documentation and certificates to be provided by the power-generating facility owner;

   (b) details of the technical data on the power-generating module of relevance to the grid connection;

   (c) requirements for models for steady-state and dynamic system studies;

   (d) timeline for the provision of system data required to perform the studies;

   (e) studies by the power-generating facility owner to demonstrate the expected steady-state and dynamic performance in accordance with the national compliance scheme;

   (f) scope, conditions and procedures for registering equipment certificates;

   (g) conditions and procedures for the use of relevant equipment certificates issued by an authorised certifier by the power-generating facility owner.

4. The relevant system operator shall make public the allocation of responsibilities between the power-generating facility owner and the system operator for compliance testing, simulation and monitoring.

5. The relevant system operator may fully or partially delegate the performance of its compliance monitoring to third parties. In such cases, the relevant system operator shall continue ensuring compliance with Article 12.

6. If compliance tests or simulations cannot be carried out as agreed between the relevant system operator and the power-generating facility owner due to reasons attributable to the relevant system operator, then the relevant system operator shall issue the operational notification referred to in Title III without undue delay.

Article 49

Compliance schemes

1. By [the date of entry into force of this Regulation plus one year], the ENTSO for Electricity, in coordination with the EU DSO Entity, shall develop a common structure for the national compliance schemes. The common structure for national compliance scheme shall include at least:

    (a) the list of requirements to be tested to determine the compliance for each type of power-generating modules;

    (b) the list of requirements to be simulated to determine the compliance for each type of power-generating modules;

    (c) the allocation of responsibilities between the TSO and the relevant system operator for compliance testing, simulation and monitoring;

    (d) the timeline for compliance assessment;

    (e) consideration on the specific characteristics of the prime mover technology.

2. The TSO in coordination with DSOs shall use the common structure referred to in paragraph 1 to develop, and update as needed, a proposal for a national compliance scheme including a certification scheme. The TSO shall submit that proposal for approval by the regulatory authority by [the date of entry into force of this Regulation plus 18 months]. The approved compliance scheme shall be published by the regulatory authority.

Article 50

Common provisions for compliance testing

1. Testing 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 requirements for compliance testing set out in the national compliance scheme, the relevant system operator may:

    (a) allow the power-generating facility owner to carry out an alternative set of tests, provided that those tests are efficient and suffice to demonstrate that a power-generating module complies with the requirements of this Regulation;

    (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 in relation to compliance testing under the national compliance scheme is not sufficient to demonstrate compliance with the requirements of this Regulation;

    (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 shall be responsible for carrying out the tests in accordance the national compliance scheme. 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 monitoring equipment necessary to record all 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.

Article 51

Common provisions for compliance simulation

1. Simulation of the performance of individual power-generating modules within a power-generating facility shall be carried out to demonstrate that the requirements of this Regulation have been fulfilled.
2. Notwithstanding the minimum requirements set out in the national compliance scheme 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 that a power-generating module complies with this Regulation;
    (b) require the power-generating facility owner to carry out additional or alternative sets of simulations in those cases where the information supplied to the relevant system operator in relation to compliance simulation under the national compliance scheme is not sufficient to demonstrate compliance with this Regulation.
3. To demonstrate compliance with this Regulation, the power-generating facility owner shall provide a report with the simulation results for each individual power-generating module within the power-generating facility. The power-generating facility owner shall provide a validated simulation model for a given power-generating module. The scope of the simulation models is set out in Article 22(5), point (c).
4. The relevant system operator may check that a power-generating module complies with this Regulation by carrying out its own compliance simulations based on the provided simulation reports, simulation models and compliance test measurements.
5. The relevant system operator shall provide the power-generating facility owner with technical data and a simulation model of the network, to the extent necessary to carry out the requested simulations in accordance with the national compliance scheme.

Article 52

Common provisions on equipment certificates

1. Any equipment certificate shall be based on a certification scheme established within a national compliance scheme. The equipment certificates may include power-generating unit certificates and component certificates. The equipment certificates shall demonstrate the conformity with the relevant technical requirements under this Regulation. The certification shall, to the extent possible, be harmonised with or provide unambiguous references to established technical standards or conformity assessment schemes.

2. Relevant system operators shall accept equipment certificates for power-generating units or components issued by authorised certifiers of Member States whose accreditation is given by the national affiliate of the European cooperation for Accreditation.

3. The scope of applicability of the PGU family and component family, including V2G EV family and V2G EVSE family, shall be set out in the national compliance scheme.

4. The compliance of V2G EV and V2G EVSE shall be based on individual type-test certificates issued in accordance with Regulation (EC) No 765/2008 regarding the V2G EVSE on one side and the V2G EV (in the case of AC connection of V2G EV) on the other side. The individual type-test certificates shall enable interoperability between different V2G EV and V2G EVSE. In this respect, certification schemes of the V2G EV and V2G EVSE shall be harmonised, cross linked and consist of associated procedures on data exchange, communication handshake and technical power transfer.

5. The compliance of V2G EV and V2G EVSE with the requirements set out in this Regulation shall be demonstrated in accordance with Annex III. During its period of application, Annex III shall constitute the exclusive reference for conformity assessment and certification of V2G EV and V2G EVSE within the scope of this Regulation. National compliance schemes established pursuant to Article 49 shall incorporate the requirements of Annex III for the period of its validity.

CHAPTER 2

Non-binding guidance and monitoring of implementation

Article 53

Non-binding guidance on implementation

1. No later than on [the date of entry into force of this Regulation plus six months] and every two years thereafter, the ENTSO for Electricity in coordination with the EU DSO Entity shall issue and provide non-binding written guidance to its members and other system operators concerning the requirements of this Regulation requiring national implementation.

2. ENTSO for Electricity shall consult the European Stakeholder Committee on the priorities, scope and content of the guidance before the public consultation.

3. The ENTSO for Electricity shall publish the guidance on its website.

4. The guidance shall explain the technical issues, conditions and interdependencies which need to be considered when complying with this Regulation at national level.

5. The European Stakeholder Committee organised pursuant to Article 11 shall share all the information relevant to the process of developing standards which allows and supports practical implementation and compliance monitoring.

Article 54

Monitoring

1. The Agency shall monitor the implementation of this Regulation in accordance with Article 32 of Regulation (EU) 2019/943. The monitoring shall cover in particular the following matters:

(a) identification of any divergences in the national implementation of this Regulation;

(b) assessment of whether the choice of values and ranges in the requirements applicable to power-generating modules under this Regulation continues to be appropriate.

The Agency may involve the European Stakeholder Committee established pursuant to Article 11 in the monitoring, where relevant.

2. TSOs and DSOs shall submit, without undue delay, the relevant information requested by the Agency to perform the tasks referred to in paragraph 1 through their national regulatory authority.

3. The ENTSO for Electricity shall maintain an up-to-date list of the relevant information to be communicated by ENTSO for Electricity to the Agency in accordance with Article 30(5) and Article 32(1) of Regulation (EU) 2019/943. The ENTSO for Electricity shall maintain a comprehensive, digital data archive of the information required by the Agency in a standardised format. TSOs and DSOs shall provide the ENTSO for electricity with the necessary information for this purpose.

4. The ENTSO for Electricity shall maintain a public online repository where relevant information regarding the progress on the implementation of this Regulation at national level shall be made available. Such information shall at least include legal texts, implementation monitoring files, summaries of all the proposals for non-exhaustive requirements, TSO and DSO requirements and compliance tests and process to be performed and links to the national implementation websites.

5. The EU DSO entity shall cooperate with the ENTSO for Electricity on the monitoring of implementation of this Regulation in accordance with Article 55(2), point (a), of Regulation (EU) 2019/943, among other activities, on the provision of information necessary for monitoring the implementation of this Regulation.

TITLE V

DEROGATIONS

Article 55

Power to grant derogations and general derogation criteria

1. Regulatory authorities may, at the request of a power-generating facility owner or prospective owner, grant derogations from one or more provisions of this Regulation for new and already connected power-generating modules, in accordance with Article 56 and 57.

2. Subject to Article 56, regulatory authorities shall base their derogation decisions on the following criteria:

(a) no or limited impact, immediate or in the longer term, on consumers and competition, including potential discrimination against other system users in the same situation;

(b) no or manageable impact, immediate or in the longer term, on system stability and system operation;

(c) any mitigating measures and the existence of a comprehensive implementation plan for restoring compliance;

(d) the limited duration of the derogation and the extent to which it is strictly necessary.

Article 56

General provisions

1. Each regulatory authority may specify, after consulting relevant system operators and power-generating facility owners and other stakeholders, additional criteria for granting derogations. It shall publish those criteria on its website by [the date of entry into force of this Regulation plus nine months] and notify them to the Agency without undue delay.

2. If the regulatory authority deems it necessary due to a change in circumstances related to the evolution of system requirements, it may review and amend at most once every year the additional criteria for granting derogations in accordance with paragraph 1. Any changes to the criteria shall not apply to derogations for which a request has already been made. The amendment of those criteria shall not affect the derogations granted prior to the amendment, which shall continue to apply until the scheduled expiry date as detailed in the decision granting the derogation.

3. The regulatory authority may decide that power-generating modules for which a request for a derogation has been filed do not need to comply with the requirements under consideration for the derogation, from the day of filing the request until the regulatory authority's decision is issued.

Article 57

Request for a derogation by a power-generating facility owner

1. Power-generating facility owners, or prospective owners, may request a derogation to one or several requirements of this Regulation for power-generating modules within their facilities.

2. A request for a derogation shall be filed with the relevant system operator and shall include the following:

(a) an identification of the power-generating facility owner, or prospective owner, and a contact person for any communications;

(b) a description of the power-generating module or modules for which a derogation is requested;

(c) a reference to the provisions of this Regulation from which a derogation is requested and a detailed description of the requested derogation;

(d) detailed reasoning, with relevant supporting documents and cost-benefit analysis pursuant to the requirements of Article 46;

(e) demonstration that the requested derogation would have no adverse effect on cross-border trade.

3. Within two weeks of receipt of a request for a derogation, the relevant system operator shall confirm to the power-generating facility owner, or prospective owner, whether the request is complete. If the relevant system operator considers that the request is incomplete, the power-generating facility owner, or prospective owner, shall submit the additional required information within one month from the receipt of the request for

additional information. If the power-generating facility owner, or prospective owner, does not supply the requested information within that time limit, the request for a derogation shall be deemed withdrawn.

4. The TSO and relevant system operator, including CDSO, shall assist the power-generating facility owner or prospective owner in preparing a cost-benefit analysis assessing a potential derogation, contribute to that analysis and provide the necessary data as requested by the power-generating facility owner, or the prospective owner, within three months of receiving a request, unless agreed otherwise by the power-generating facility owner or the prospective owner.

5. The relevant system operator shall, in coordination with the TSO and any affected DSO or DSOs with the direct network connection, assess the request for a derogation and the provided cost-benefit analysis, taking into account the criteria determined by the regulatory authority pursuant to Article 56.

6. If a request for a derogation concerns a Type C or D power-generating module connected to a distribution system, including a closed distribution system, the relevant system operator's assessment shall be accompanied by an assessment of the request for a derogation by the TSO. The TSO shall provide its assessment within two months of being requested to do so by the relevant system operator.

7. Within six months of receipt of a request for a derogation, the relevant system operator shall forward the request to the regulatory authority and submit the assessment(s) prepared in accordance with paragraphs 4 and 5. That period may be extended by one month where the relevant system operator seeks further information from the power-generating facility owner or prospective owner, and by two months where the relevant system operator requests the TSO to submit an assessment of the request for a derogation.

8. The regulatory authority shall issue a reasoned decision concerning a request for a derogation. Where the regulatory authority grants a derogation, it shall specify its duration. The regulatory authority shall adopt that decision within six months of receipt of the request. That time limit may be extended where the regulatory authority requires further information from the power-generating facility owner, or prospective owner, or from any other interested parties. In such cases, the additional period of three months shall begin when the complete information has been received.

9. The power-generating facility owner, or prospective owner, shall submit any additional information requested by the regulatory authority within two months of such request. If the power-generating facility owner, or prospective owner, does not supply the requested information within that time limit, the request for a derogation shall be deemed withdrawn unless, before the expiry of the derogation, the regulatory authority decides to provide an extension.

10. The regulatory authority shall notify its decision to the relevant power-generating facility owner, or prospective owner, the relevant system operator and the TSO.

11. A regulatory authority may revoke a decision granting a derogation if the circumstances and underlying reasons no longer apply or upon a reasoned recommendation by the Agency pursuant to Article 59(2).

12. For Type A power-generating modules, a request for a derogation under this Article may be made by a third party on behalf of the power-generating facility owner, or prospective owner. Such a request may be for a single power-generating module or multiple, identical power-generating modules. In the latter case, and provided the cumulative maximum

capacity is specified, the third party may substitute the details required by paragraph 2, point (a), with their details.

Article 58

Register of derogations from the requirements of this Regulation

1. Regulatory authorities shall maintain an electronic register of all derogations they have granted or refused and shall provide the Agency with an updated and consolidated register at least once every six months. That register shall be publicly available.
2. The register shall contain, in particular:
   (a) the requirement or requirements for which the derogation is granted or refused;
   (b) the content of the derogation;
   (c) the reasons for granting or refusing the derogation;
   (d) the consequences resulting from granting the derogation.

Article 59

Monitoring of derogations

1. The Agency shall monitor the procedure of granting derogations with the cooperation of the regulatory authorities. The regulatory authorities shall provide the Agency with all the information necessary for that purpose.
2. The Agency may issue a reasoned recommendation to a regulatory authority to revoke a derogation due to non-alignment with the derogation criteria set out in Article 55.

TITLE VI
FINAL PROVISIONS

Article 60

Amendment of contracts and general terms and conditions

1. System operators and the regulatory authorities shall ensure that all relevant clauses in contracts and general terms and conditions related to the grid connection of power-generating modules are brought into compliance with the requirements of this Regulation.
2. Regulatory authorities shall ensure that national agreements between system operators and owners of new or existing power-generating facilities subject to this Regulation and related to grid connection requirements for power-generating facilities, in particular in national network codes, comply with the requirements set out in this Regulation.

Article 61

Repeal and transitional provisions

1. Regulation (EU) 2016/631 is repealed.
2. References to Regulation (EU) 2016/631 shall be construed as references to this Regulation .

3. Until the end of the power-generating module's lifetime or until it is significantly modernised pursuant to Article 4 of this Regulation, Articles 3, 5, 6 and 13 to 28 of Regulation (EU) 2016/631 shall continue to apply to the following power-generating modules:

   (a) those which were falling within the scope of application of Regulation (EU) 2016/631;

   (b) those which connect to the network between [the date of entry into force of this Regulation] and [the date of entry into force of this Regulation plus 24 months].

4. Articles 40 to 57 of Regulation (EU) 2016/631 shall continue to apply until [the date of entry into force of this Regulation plus 24 months].

5. Derogations granted under Article 60 of Regulation (EU) 2016/631 shall continue to apply.

Article 62

Entry into force and application

This Regulation shall enter into force on the twentieth day following that of its publication in the *Official Journal of the European Union*.

Articles 4, 6, 13 to 18, 20, 22 to 28, 30 to 35, and 47 to 52 shall apply to power-generating modules which connect to the network from [the date of entry into force of this Regulation plus 24 months].

Articles 19 and 21 shall apply from [the date of entry into force of this Regulation plus 48 months] to new V2G electric vehicles and V2G associated electric vehicle supply equipment placed on the market in the Union as of that date.

By way of derogation from the third paragraph of this Article, Articles 19 and 21 shall apply from [the date of entry into force of this Regulation plus 36 months] to new types of V2G for which an EU-type approval or national type-approval has been granted as of that date.

Annex III shall cease to apply on [the date of entry into force of this Regulation plus five years].

This Regulation shall be binding in its entirety and directly applicable in all Member States.

Done at Brussels,

For the Commission
The President
Ursula VON DER LEYEN