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Comment: The structure and numbering of articles, figures and tables will be addressed by ACER after this public consultation and before recommendation to the Commission.

COMMISSION REGULATION (EU) 2016/631

of 14 April 2016

establishing a network code on requirements for grid connection of generators

(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](#) ~~Regulation (EC) No 714/2009~~ of the European Parliament and of the Council of ~~5 June 2019~~ ~~13 July 2009~~ ~~on the internal market for electricity (recast)~~ ~~on conditions for access to the network for cross-border exchanges in electricity and repealing Regulation (EC) No 1228/2003~~ ⁽¹⁾, and in particular Article ~~65~~⁹(~~13~~¹) thereof,

Whereas:

- (1) The swift completion of a fully functioning and interconnected internal energy market is crucial to maintaining security of energy supply, increasing competitiveness and ensuring that all consumers can purchase energy at affordable prices.
- (2) [Regulation \(EU\) 2019/943](#) ~~Regulation (EC) No 714/2009~~ sets out non-discriminatory rules governing access to the network for cross-border exchanges in electricity with a view to ensuring the proper functioning of the internal market in electricity. In addition Article ~~35~~³ of [Directive \(EU\) 2019/944](#) ~~Directive 2009/72/EC~~ of the European Parliament and of the Council ⁽²⁾ requires that Member States ~~or, where Member States have so provided, regulatory authorities~~ ^{shall} ensure, inter alia, ~~a level playing field where electricity undertakings are subject to transparent, proportionate and non-discriminatory rules~~ ^{that objective and non-discriminatory technical rules are developed which establish minimum technical design and operational requirements for the connection to the system, fees and treatment}. Where requirements constitute terms and conditions for connection to national networks, Article ~~59~~³⁷(~~76~~⁷⁶) of the same Directive requires regulatory authorities to be responsible for fixing or approving at least the ^{national} methodologies used to calculate or establish them. In order to provide system security within the interconnected transmission system, it is essential to establish a common understanding of the requirements applicable to power-generating modules. Those requirements that contribute to maintaining,

Comentado [A1]: The references to the Regulation have been updated.

preserving and restoring system security in order to facilitate proper functioning of the internal electricity market within and between synchronous areas, and to achieve cost efficiencies, should be regarded as cross-border network issues and market integration issues.

- (3) Harmonised 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 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.

(s1) Equally, electricity storage plays a key role in the system as different energy storage technologies have a dual behaviour of being able to consume electricity from or inject electricity into the grid at different times and scales. For this reason, and due to the specific characteristics of storage and impact on the system, it is necessary to introduce requirements for the grid connection of electricity storage modules. The requirements on electricity storage are considered to be the same as those on power generation modules unless explicitly stated otherwise in this Regulation. In the case of electrical equipment such as synchronous compensators, flywheels and regenerative braking systems which do not fall onto the definition of a power generating module or electricity storage module, the relevant TSO system operator may define the technical requirements that apply.

(s2) For the purpose of this regulation, electricity storage includes electric vehicles and associated supply equipment that comply with the definition of electricity storage. Nevertheless, fully harmonised rules for grid connection for electric vehicles and associated supply equipment are set out to provide for a free movement of electric vehicles across the EU.

- (4) 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.
- (5) Secure system operation is only possible if there is close cooperation between power-generating facility owners and system operators. In particular, the functioning of the system under abnormal operating conditions depends on the response of power-generating modules to deviations from the reference 1 per unit (pu) values of voltage and nominal frequency. 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.
- (6) Regulatory authorities should consider the reasonable costs effectively incurred by system operators in the implementation of this Regulation when fixing or approving transmission or distribution tariffs or their methodologies or when approving the terms and conditions for connection and access to national networks in accordance

Comentado [A2]: Several stakeholders, including the Expert Group Storage, proposed to include this recital along with the relevant requirements.

Comentado [A3]: The Regulation effectively targets connection requirements for V2G technologies only.

with Article 5937(1) and (76) of Directive (EU) 2019/944Directive 2009/72/EC and with Article 184 of Regulation (EU) 2019/943Regulation (EC) No 714/2009.

(7) 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 as required by Article 598(16) and (2) of Regulation (EU) 2019/943Regulation (EC) No 714/2009.

(8) In view of the need to provide regulatory certainty, the requirements of this Regulation should apply to new generating facilities but should not apply to existing generating modules and generating modules already at an advanced stage of planning but not yet completed unless the relevant regulatory authority or Member State decides otherwise based on evolution of system requirements and a full cost-benefit analysis, or where there has been substantial modernisation of those generating facilities.

(9) The significance of power-generating modules should be based on their size and their effect on the overall system. Synchronous machines should 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, such as combined-cycle gas turbine installation, should be assessed on the whole capacity of that installation. ~~such as separate alternators driven by the separate gas and steam turbines of a single combined cycle gas turbine installation. For a facility including several such combined cycle gas turbine installations, each should be assessed on its size, and not on the whole capacity of the facility.~~ Non-synchronously connected power-generating units ~~of the same any underlying technology and any primary energy source~~, where they are collected together to form an economic unit and where they have a single connection point ~~should~~ shall be assessed ~~based on their aggregated capacity, the agreed maximum continuous active power export capacity at the point of connection, irrespective of their installed aggregated capacity. Moreover, to ensure an appropriate harmonisation or rules for mass-market products, capacities of units of different classes, for instance, photovoltaic, electricity storage, combined heat and power installations, or V2G electric vehicles, should not be aggregated for the purpose of the determination of significance.~~ Electricity storage integrated to a power-generating module, where module is either non-synchronously connected to the network or connected through power electronics, used solely for the purpose of meeting the requirements of this Regulation should be considered as part of such power generating module ~~while its capacity should not count towards the power-generating module capacity while its maximum capacity (Pmax ESM) shall not count towards the power generating module capacity for the determination of significance.~~

Comentado [A4]: Several stakeholders propose to clarify the notion of synchronous power generating module.

(10) In view of the different voltage level at which generators are connected and their maximum generating capacity, this Regulation should make a distinction between different types of generators by establishing different levels of requirements. This Regulation does not set the rules to determine the voltage level of the connection point to which the power-generating module shall be connected.

(**) Power-generating modules are subject to the requirements of this Regulation regardless of whether they are part of an energy community as defined in Regulation (EU) 2019/943, another entity, or a form of system users aggregation, unless such

Comentado [A5]: ACER proposal to clarify the notion of non-synchronously connected PGMs based on stakeholders proposal.

energy community, another entity, or a form of system users aggregation constitutes a fully autonomous energy island.

Comentado [A6]: Amendment proposal aimed to capture autonomous energy communities

- (11) The requirements applicable to type A power-generating modules should be set at the basic level necessary to ensure capabilities of generation with limited automated response and minimal system operator control. They should ensure that there is no large-scale loss of generation over system operational ranges, thereby minimising critical events, and include requirements necessary for widespread intervention during system-critical events.
- (12) The requirements applicable to type B power-generating modules should provide for a wider range of automated dynamic response with greater resilience to operational events, in order to ensure the use of this dynamic response, and a higher level of system operator control and information to utilise those capabilities. They ensure an automated response to mitigate the impact of, and maximise dynamic generation response to, system events.
- (13) The requirements applicable to type C power-generating modules should provide for a refined, stable and highly controllable real-time dynamic response aiming to provide principle ancillary services to ensure security of supply. Those requirements should cover all system states with consequential detailed specification of interactions of requirements, functions, control and information to utilise those capabilities and ensure the real-time system response necessary to avoid, manage and respond to system events. Those requirements should also provide for sufficient capability of generating modules to respond to both intact and system disturbed situations, and should provide the information and control necessary to utilise generation in different situations.
- (14) The requirements applicable to type D power-generating modules should be specific to higher voltage connected generation with an impact on control and operation of the entire system. They should ensure stable operation of the interconnected system, allowing the use of ancillary services from generation Europe-wide.
- (15) The requirements 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, and avoid unnecessary investments in some geographical areas in order to take into account their respective regional specificities. Transmission system operators ('TSOs') and distribution system operators ('DSOs') including closed distribution system operators ('CDSOs') can take those differences into account when defining the requirements in accordance with the provisions of this Regulation, whilst recognising that the thresholds which determine whether a system is a transmission system or a distribution system are established at the national level.
- (16) 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 such as the synchronous areas of Continental Europe, Great Britain, Ireland-Northern Ireland and Nordic and the power systems of Lithuania, Latvia and Estonia, together referred to as 'Baltic'. 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 all other Member States. Considering the evolution of the

Comentado [A7]: Removed due to the withdrawal of the UK from the EU

Comentado [A8]: This text was in the definition of "synchronous area" but given its explanatory nature it better fits the Whereas

European networks, delineation of synchronous areas may change as a result of establishing or terminating synchronous interconnection of transmission systems. Requirements for the connection of power generating modules should appropriately be adjusted to reflect the interconnections resulting from such change.

Comentado [A9]: This text anticipates the merge of Baltic with Continental SA in 2026

- (17) To ensure system security, it should be possible for power-generating modules in each synchronous area of the interconnected system to remain connected to the system for specified frequency and voltage ranges.

(x) In the same vein, due to the physical interdependencies of interconnected systems and to ensure system stability, as well as, the efficient and secure operation of electricity systems across the Union, this regulation specifies requirements for the synchronous area Ireland-Northern Ireland. 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 connecting the territories.

Comentado [A10]: This recital is added due to the withdrawal of the UK from the EU and the need to ensure system stability in the synchronous area Ireland-Northern Ireland

- (18) This Regulation should provide for ranges of parameters for national choices for fault-ride-through capability to maintain a proportionate approach reflecting varying system needs such as the level of renewable energy sources ('RES') 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 entity, as designated by the Member State to approve the requirements of this Regulation, to verify that a longer requirement is necessary before approving it.

- (19) When defining the pre-fault and post-fault conditions for the fault-ride-through capability, taking into account system characteristics such as network topology and generation mix, the relevant TSO should decide whether priority is given to pre-fault operating conditions of power-generating modules or to longer fault clearance times.

(**) In order to avoid potential critical system situations caused by overvoltage, it should be possible for power-generating modules to remain connected to the system for a specified high voltage-against-time profile.

Comentado [A11]: Introducing a recital for the high voltage ride through requirement.

- (20) 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 case of disturbances to the system. Protection schemes can prevent aggravation of disturbances and limit their consequences.

- (21) 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.

- (22) In emergency situations which could endanger system stability and security, system operators should have the possibility to instruct that the output of power-generating modules be adjusted in a way which allows system operators to meet their responsibilities for system security.

(**) Escalating environmental risks might hamper safe generation and secure system operation. Adequate and proportionate measures to increase the resilience of power-generating modules could be considered, reflecting the specificities of generation technologies as well as the geographical and climatic particularities of each Member State. Such measures could benefit the preparedness of the system to withstand climate change consequences, facilitate the use of power-generating module flexibility and promote the use of distributed energy resources to improve grid resilience to extreme events. This is without prejudice to the weather hazards resilience requirements in accordance with Regulation (EU) 2017/2196, Regulation (EU) 2019/941 and other relevant Union legal acts.

(23) 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. Failure to specify voltage ranges could lead to widespread uncertainty in planning and operation of the system with respect to operation beyond normal operating conditions.

(24) 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 could put constraints on the design and operation of power-generating facilities. Therefore, it is important that the capabilities actually required for efficient system operation be thoroughly assessed.

(25) Synchronous power-generating modules have an inherent capability to resist or slow down frequency deviations, a characteristic which many RES technologies do not have. Therefore countermeasures should be adopted, to avoid a larger rate of change of frequency during high RES production. Synthetic inertia could facilitate further expansion of RES, which do not naturally contribute to inertia.

(**) Rapidly increasing penetration of dispersed generation and converted-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.

The regulator shall consider if such advanced capabilities are to be provided as in accordance with mandatory requirements, or if some of these shall be provided as ancillary services according to EU directive 2019/944 of 5 June 2019. Those capabilities to be provided as in accordance with mandatory requirements shall be supported by a full, publicly consulted cost-benefit analysis.

(26) Appropriate and proportionate compliance testing should be introduced so that system operators can ensure operational security.

Comentado [A12]: Due to the climate change, ACER considers that the issue of PGMs' weather resilience shall be duly addressed in the RfG 2.0 for the efficient electric power system design.

ACER also agrees that the underlying assets should be considered at a local (regional) level, and that relevant system operators and power-generating facility owners should take due account of possible extraordinary climate parameters. At the same time, further specifications of the possible events shall be avoided as they may prove inefficient at the European level.

Additionally, ACER emphasises the need for a proportionate approach and performance of the CBA when establishing weather resilience requirements.

The text is partly based on the VGBE proposal.

Comentado [A13]: Grid forming and RoCoF withstand capabilities are increasingly needed in the systems with high numbers of converter-based PGMs.

(27) The regulatory authorities, Member States 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 involving European standardisation organisations; therefore, permitting the evolution of product standards and, as a consequence, the adoption of the same by the industry.

Comentado [A14]: A higher degree of harmonisation, benefitting the EU consumer, will be achieved if the development of the non-exhaustive requirements, for example addressing the capabilities of mass-produced PGMs, is carried out involving European standardisation organisations.

(28) A process for derogating from the rules should be set out in this Regulation to take into account local circumstances where exceptionally, for example, compliance with those rules could jeopardise the stability of the local network or where the safe operation of a power-generating module might require operating conditions that are not in line with the Regulation. In the case of particular combined heat and power plants, which bring wider efficiency benefits, applying the rules set out in this Regulation could result in disproportionate costs and lead to the loss of those efficiency benefits.

(29) Subject to approval by the relevant regulatory authority, or other authority where applicable in a Member State, system operators should be allowed to propose derogations for certain classes of power-generating modules.

(30) This Regulation has been adopted on the basis of Regulation (EU) 2019/943 ~~Regulation (EC) No 714/2009~~, which it supplements and of which it forms an integral part. References to Regulation (EU) 2019/943 ~~Regulation (EC) No 714/2009~~ in other legal acts should be understood as also referring to this Regulation.

(31) The measures provided for in this Regulation are in accordance with the opinion of the Committee referred to in Article ~~67~~²³(1) of Regulation (EU) 2019/943 ~~Regulation (EC) No 714/2009~~.

(32) This Regulation establishes requirements which go beyond those of Commission Regulation (EU) 2016/631 of 14 April 2016 and could burden existing power generating modules significantly, if applicable to them. To ensure that this burden does not materialise, those requirements should not apply to power-generating modules existing at the entry into force of this Regulation or to those where the power-generating facility owner has concluded a final and binding contract for the purchase of the main generating plant by two years after the entry into force of this Regulation. Instead, the requirements under Commission Regulation (EU) 2016/631 should continue to apply to the power-generating modules which exist at the entry into force of this Regulation and fall within the scope of Commission Regulation (EU) 2016/631.

Comentado [A15]: Recital added to clarify the addition of transitional provisions to ensure legal certainty for the requirements applicable to existing power-generating modules - this recital may depend on what will be the approach for the amendments and will require further discussion.

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, therefore, helps to ensure 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 2012/27/EU of the European Parliament and of the Council ⁽³⁾, Article 2 of [Regulation \(EU\) 2019/943](#) ~~Regulation (EC) No 714/2009~~, Article 2 of Commission Regulation (EU) 2015/1222 ⁽⁴⁾ Article 2 of Commission Regulation (EU) No 543/2013 ⁽⁵⁾ and Article 2 of [Directive \(EU\) 2019/944](#) ~~Directive 2009/72/EC~~ shall apply.

In addition, the following definitions shall apply:

- (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 TSOs; ~~such as the synchronous areas of Continental Europe, Great Britain, Ireland Northern Ireland and Nordic and the power systems of Lithuania, Latvia and Estonia, together referred to as 'Baltic' which are part of a wider synchronous area;~~
- (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' means a facility that converts primary energy into electrical energy and which consists of one or more power-generating modules connected to a network at one or more connection points;
- (7) 'power-generating facility owner' means a natural or legal entity owning a power-generating facility;
- (8) 'main generating plant' means one or more of the principal items of equipment required to convert the primary source of energy into electricity;

Comentado [A16]: Removed as it presents examples only and may create confusion in case of synchronous areas merge. To that end, recital (16) was edited in the Whereas section.

Comentado [A17]: Changes to the definition for clarity.

(9) 'synchronous power-generating module' means ~~an indivisible set of machines which cannot be operated independently from each other and installations which~~ 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;

Comentado [A18]: Several stakeholders propose to clarify the notion of synchronous power generating module.

(10) '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;

(10a) supply equipment document or 'SED' means a document provided by the 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;

(11) 'relevant TSO' means the TSO in whose control area a power-generating module, a demand facility, a distribution system or a HVDC system is or will be connected to the network at any voltage level;

(12) 'network' means a plant and apparatus connected together in order to transmit or distribute electricity;

(13) 'relevant system operator' means the transmission system operator or distribution system operator to whose system a power-generating module, demand facility, distribution system or HVDC system is or will be connected;

(14) '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;

(15) 'connection point' means the 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 identified in the connection agreement or as agreed between the relevant system operator and the demand facility owner, power-generating facility owner or HVDC system owner, or determined by other appropriate means, where an agreement is not required;

Comentado [A20]: Amendments aim to cover cases where there is no connection agreement (connection agreement is not required by the NC RfG).

(16) 'maximum capacity' or 'Pmax' means the maximum continuous active power which a power-generating module can ~~produce export while all units are available~~, less any demand or losses associated solely with facilitating the operation of that power-generating module ~~and not fed into the network~~ as specified in the connection agreement or as agreed between the relevant system operator and the power-generating facility owner, or determined by other appropriate means, where an agreement is not required and which may differ from the aggregated installed capacity of a power generating module;

Comentado [A19]: Stakeholders propose to clarify that Pmax is not the net power at the connection point but the output power of the generator less auxiliary power and losses (in dedicated infrastructure such as step-up, feeders of wind farms, ...), where this is inseparable from the generator output.

Electricity storage integrated to a power-generating module should be considered as part of such module while its capacity should not count towards the power-generating module capacity, unless the connection agreement is modified by the PGFO (Power generator facility owner).

(17) 'power park module' or 'PPM' means a unit or ensemble of units that can generate electricity, export electrical energy by different technologies or, if applicable, additionally store electrical energy by different technologies, which is not a synchronous power-generating module and which is either non-synchronously connected to the network or connected through power electronics, and that also has a single connection point to a transmission system, distribution system including closed distribution system or HVDC system, and if they have a coordinated control to behave as single plant.

(18) 'offshore power park module' means a power park module located offshore with an offshore connection point;

(19) 'synchronous compensation operation' means the operation of an alternator without prime mover to regulate voltage dynamically by production or absorption of reactive power;

(20) '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');

(21) '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;

(22) ~~'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. Its nominal value is 50Hz;~~

'frequency' means the inverse of the period of a periodic electrical quantity. It is calculated on the basis of measurable electrical quantities such as current or voltage. The fundamental frequency of the periodic electrical quantity is decisive for the generation, transport and use of electrical energy. Its nominal value is 50 Hz. The fundamental frequency is to be determined over a gliding time window of not more than 200ms.
For any frequency-related requirements about grid forming, synthetic inertia and fast-fault-current injections the relevant TSO shall publish a specific definition of 'frequency' in accordance with applicable IGDs, which suits the sub-cycle character of these phenomena.

(23) 'droop' means the ratio of a steady-state change of frequency to the resulting steady-state change in active power output, expressed in percentage terms. 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;

(24) 'minimum regulating level' means the minimum active power, as specified in the connection agreement or as agreed between the relevant system operator and the

Comentado [A21]: This is to allow for consideration of Storage

Comentado [A22]: In accordance with ENTSO-E Amendment 50.
The definitions used in the network code to categorize a PGM as a SPGM or PPM are based on the wording "non-synchronously connected" and "connected through power electronics" for PPMs and "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" for SPGMs. The categorization is straightforward in the context of conventional thermal plant incorporating synchronous generation (i.e. SPGM), or in the context of full-size converter wind farms or PV inverters (i.e. PPM). However, for some other technologies (Asynchronous generator, DFAG, ...) interpretation in the application of the network code is more ambiguous. Therefore, these technologies could potentially fall into either SPGM or PPM categorisation depending on national interpretation and implementation of the NC which was not the intention.
The wording "which is not a synchronous power-generating module and" is added in the definition of PPM to clarify that if a PGM does not fall into the definition of SPGM ("the frequency of the generated voltage, the generator speed and the frequency of network voltage are in a constant ratio and thus in synchronism") then it is by default a PPM. This will clarify unambiguously that DFAG & induction generators are PPMs.
The coherence of the NC requirements for DFAG being categorized as PPMs has also been reassessed. It is confirmed that DFAG have technical capabilities closer to those of a full converter installation than a SPGM.

power-generating facility owner, down to which the power-generating module can control active power;

- (25)'setpoint' means the target value for any parameter typically used in control schemes;
- (26)'instruction' means any command, within its authority, given by a system operator to a power-generating facility owner, demand facility owner, distribution system operator or HVDC system owner in order to perform an action;
- (27)'secured fault' means a fault which is successfully cleared according to the system operator's planning criteria;
- (28)'reactive power' means the imaginary component of the apparent power at fundamental frequency, usually expressed in kilovar ('kVAr') or megavar ('MVar');
- (29)'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;
- (30)'alternator' means a device that converts mechanical energy into electrical energy by means of a rotating magnetic field;
- (31)'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;
- (32)'stator' means the portion of a rotating machine which includes the stationary magnetic parts with their associated windings;
- (33)'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;
- (34)'synthetic inertia' means the facility provided by a power park module or HVDC system to replace the effect of inertia of a synchronous power-generating module to a prescribed level of performance;
- (35)'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;
- (36)'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;
- (37)'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;
- (38)'limited frequency sensitive mode — underfrequency' or '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;
- (39)'frequency response deadband' means an interval used intentionally to make the frequency control unresponsive;

- (40) '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;
- (41) '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;
- (42) 'steady-state stability' means the ability of a network or a synchronous power-generating module to revert and maintain stable operation following a minor disturbance;
- (43) '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;
- (44) '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;
- (45) '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;
- (46) '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 ⁽⁶⁾;
- (47) '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. The equipment certificate defines the scope of its validity at a national or other level at which a specific value is selected from the range allowed at a European level. For the purpose of replacing specific parts of the compliance process, the equipment certificate may include models that have been verified against actual test results;
- (48) 'excitation control system' means a feedback control system that includes the synchronous machine and its excitation system;
- (49) '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;
- (50) '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;
- (51) 'overexcitation limiter' means a control device within the AVR which prevents the rotor of an alternator from overloading by limiting the excitation current;

- (52) '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;
- (53) '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;
- (54) '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;
- (55) '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;
- (56) 'power factor' means the ratio of the absolute value of active power to apparent power;
- (57) '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;
- (58) 'offshore grid connection system' means the complete interconnection between an offshore connection point and the onshore system at the onshore grid interconnection point;
- (59) 'onshore grid interconnection point' means the point at which the offshore grid connection system is connected to the onshore network of the relevant system operator;
- (60) '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;
- (61) '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;
- (62) '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;
- (63) '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;

(64) '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;

(65) '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 modification or loss of capability resulting in non-compliance with the relevant specifications and requirements.

(66) 'electricity storage' means the conversion of electrical energy into a form of energy which can be stored, the storing of that energy, and the subsequent reconversion of that energy back into electrical energy;

(67) 'electricity storage module' or 'ESM' means a synchronous power-generating module or a power park module which can inject and consume active power to and from the network for electricity storage, excluding pump-storage power-generating modules. A V2G electric vehicle and associated V2G electric vehicle supply equipment with a bidirectional functionality is regarded as an electricity storage module. Electricity storage integrated to a power-generating module should be considered as part of such module while its capacity should not count towards the power-generating module capacity, unless the connection agreement is modified by the PGFO (Power generator facility owner);

(68) 'maximum consumption capacity' means the maximum continuous active power which a demand unit or electricity storage module can consume, less any demand or losses associated solely with facilitating the operation of that demand unit or electricity storage module, 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 determined by other appropriate means, where an agreement is not required.

(69) 'V1G electric vehicle' means the vehicle that is powered, fully or in part, with electricity and can only withdraw electricity from the grid.

(70) 'V2G electric vehicle' means the vehicle that is powered, fully or in part, with electricity and is equipped with technology enabling the vehicle to provide electricity to the grid.

(71) 'V1G electric vehicle supply equipment' means the infrastructure necessary to safely conduct electrical energy from the electricity supply grid to the electric vehicle with demand-only behaviour. Electrical wirings are not deemed part of an electric vehicle supply equipment.

(72) 'V2G electric vehicle supply equipment' means the infrastructure necessary to conduct electrical energy safely from the electricity supply grid to the electric vehicle and from the electric vehicle to the electricity supply grid with both generation and

Comentado [A23]: Proposed by several stakeholders, e.g. ENTSO-E, ... EG Storage

Comentado [A24]: Proposed by several stakeholders, e.g. ENTSO-E, ... EG Storage

Comentado [A25]: Because of the sheer installed volume, electricity storage modules have an increasing significance for the power system. Designed properly, they possess capability to provide several grid supporting functions without significant cost implications.

ACER proposal is to a large extent based on the final report by the [Storage Expert Group](#) taking into account comments received during a dedicated ACER Workshop on Storage, 11 May 2023.

Comentado [A26]: Proposed by several stakeholders, e.g. ENTSO-E, ... EG Storage. Amended so that it can be used in the NC DC as well

demand behaviour. Electrical wirings are not deemed part of an electric vehicle supply equipment.

(73) 'V1G electrical charging park' means the installation that has a single connection point to the relevant network and where three or more V1G electric vehicles can be simultaneously connected.

(74) 'V2G electrical charging park' means the installation that has a single connection point to the relevant network and where one or more V2G electric vehicles can be simultaneously connected.

(75) 'Electrical charging park owner' means a natural or legal entity owning a V1G or V2G electrical charging park.

(76) 'generic model' means a model for the simulation of the electrical performance of a component, based on a generic structure and software modules (e.g. protection and control systems), which may deviate from specific manufacturer system. The models shall easily be parameterized to represent a manufacturer specific system but taking into account generic model has less accuracy than user-written model.

(77) 'user-written model' means a model made by the manufacturer for the simulation of the electrical performance of a component, based on the algorithms and parameterization used in the component. It reflects the electrical behaviour more accurately than a generic model.

(78) 'Inherent energy storage' means an amount of energy, expressed in MWs or MWh, available in physical components of a PPM, which can be used as determined by the power-generating facility owner, without effecting the design of the physical components of individual units;

(79) "grid-forming" means.....

Article 3

Scope of application

1. ~~The connection requirements set out in~~ this Regulation shall apply to new power-generating modules, which are considered significant in accordance with Article 5, unless otherwise provided.

The relevant system operator shall refuse to allow 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, or other authority where applicable in a Member State pursuant to Article 60. 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.

2. This Regulation shall 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 of which the systems are not operated synchronously at 50 Hz with either the Continental Europe, Great Britain, Nordic, Ireland and Northern Ireland or Baltic synchronous area;

Comentado [A27]: This is to clarify that networks operating at 16.7 Hz are out of scope of this Regulation

Comentado [A28]: Removed due to the withdrawal of the UK from the EU

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

Comentado [A29]: To capture fully autonomous energy islands.

(c) power-generating modules that do not have a permanent connection point and are used by the system operators to temporarily provide power when normal system capacity is partly or completely unavailable;

(d) ~~storage devices except for pump-storage power-generating modules in accordance with Article 6(2))~~ fully integrated network components owned by system operators.

Comentado [A30]: The removal allows for including electricity storage in this Regulation

3. Following the establishment or termination of the synchronous interconnection of transmission systems, the delineation of the synchronous areas shall change accordingly. Where two synchronous areas are merged, connection requirements set out for the larger synchronous area shall apply to new power-generating modules.

Comentado [A31]: 'fully integrated network components', included in Directive (UE) 2019/944 (network components integrated into the transmission or distribution system, including storage facilities, which are used for the sole purpose of ensuring secure and reliable operation of the transmission or distribution system, and not for balancing or congestion management purposes). These devices are out of scope of this Regulation same as any other transmission assets.

Article 4

Application to existing power-generating modules

1. Existing power-generating modules are not subject to the requirements of this Regulation, except where:

(a) ~~a type C or type D the existing~~ power-generating module has been subject to a significant modernisation in accordance with the proposal developed according to Article 4a; or modified to such an extent that its connection agreement must be substantially revised in accordance with the following procedure:

Comentado [A32]: ACER proposal on significant modernisation. Addition of article 4a. Introducing a new article to deal with significant modernisation since article 4 only deal with existing PGMs, while significant modernisation could also be relevant for PGM connected after the entry into force of this Regulation that would be subject to modernisation in the future.

~~(i) power-generating facility owners who intend to undertake the modernisation of a plant or replacement of equipment impacting the technical capabilities of the power-generating module shall notify their plans to the relevant system operator in advance;~~

~~if the relevant system operator considers that the extent of the modernisation or (ii) replacement of equipment is such that a new connection agreement is required, the system operator shall notify the relevant regulatory authority or, where applicable, the Member State; and~~

~~(iii) the relevant regulatory authority or, where applicable, the Member State shall decide if the existing connection agreement needs to be revised or a new connection agreement is required and which requirements of this Regulation shall apply; or~~

(b) a regulatory authority or, where applicable, a Member State decides to make an existing power-generating module subject to all or some of the requirements of this

Regulation, following a proposal from the relevant TSO in accordance with paragraphs 3, 4 and 5.

2. For the purposes of this Regulation, a power-generating module shall be considered existing if:

(a) it is already connected to the network on the date of entry into force of this Regulation; or

(b) the power-generating facility owner has concluded a final and binding contract for the purchase of the main generating plant by two years after the entry into force of the Regulation. ~~The power-generating facility owner must notify the relevant system operator and relevant TSO of conclusion of the contract within 30 months after the entry into force of the Regulation.~~

~~The notification submitted by the power-generating facility owner to the relevant system operator and to the relevant TSO shall at least indicate the contract title, its date of signature and date of entry into force and the specifications of the main generating plant to be constructed, assembled or purchased.~~

A Member State may provide that in specified circumstances the regulatory authority may determine whether the power-generating module is to be considered an existing power-generating module or a new power-generating module.

3. Following a public consultation in accordance with Article 10 and in order to address significant factual changes in circumstances, such as the evolution of system requirements including penetration of renewable energy sources, smart grids, distributed generation or demand response, the relevant TSO may propose to the regulatory authority concerned, or where applicable, to the Member State to extend the application of this Regulation to existing power-generating modules.

For that purpose, ~~the relevant TSO shall carry out~~ a sound and transparent quantitative cost-benefit analysis ~~shall be carried out~~, in accordance with Articles 38 and 39. The analysis shall indicate:

(a) the costs, in regard to existing power-generating modules, of requiring compliance with this Regulation;

(b) the socioeconomic benefit resulting from applying the requirements set out in this Regulation; and

(c) the potential of alternative measures to achieve the required performance.

4. Before carrying out the quantitative cost-benefit analysis referred to in paragraph 3, the relevant TSO shall:

(a) carry out a preliminary qualitative comparison of costs and benefits;

(b) obtain approval from the relevant regulatory authority or, where applicable, the Member State ~~to proceed with a quantitative cost-benefit analysis based on the preliminary qualitative comparison of costs and benefits.~~

5. The relevant regulatory authority or, where applicable, the Member State shall decide on the extension of the applicability of this Regulation to existing power-generating modules within six months of receipt of the report and the recommendation of the relevant TSO in accordance with Article 38(4). The decision of the regulatory authority or, where applicable, the Member State shall be published.

Comentado [A33]: To clarify the paragraph and provide legal certainty based also on the text added in the grid forming provision.

Comentado [A34]: Wording clarification

6. The relevant TSO shall take account of the legitimate expectations of power-generating facility owners as part of the assessment of the application of this Regulation to existing power-generating modules.

7. The relevant TSO may assess the application of some or all of the provisions of this Regulation to existing power-generating modules every three years in accordance with the criteria and process set out in paragraphs 3 to 5.

Article 4a

Significant modernisation

1. Proposals for defining significant modernisation of power-generating modules and the requirements applicable in those cases shall be subject to approval by the relevant regulatory authority or, where applicable, the Member State.

In developing the proposals, the TSO shall coordinate with relevant DSOs and conduct a public consultation in accordance with Article 10.

2. The definition of significant modernisation shall take into account at least the following criteria:

(a) an increase above the existing maximum capacity of the power-generating module, whether this increase results from one modernisation or several successive modernisations, of a minimum percentage to be defined in the range 5-20% 20% or more (within this range, different percentages may be set defined for different technologies depending on their constraints);

~~— a deviation from the reactive power capability of the power-generating module, whether this deviation results from one modernisation or several successive modernisations, of a minimum percentage to be defined in the range X-Y%;~~

~~— a change in frequency stability and active power management capabilities, whether this change results from one modernisation or several successive modernisations, of the power-generating module; and~~

(b) a change of components/assets- the main generating plant of a power-generating module or electricity storage module apart from maintenance and repair activities and spare parts, whether or not those parts are purchased new at the time of their incorporation in the power-generating module in a percentage higher than 70%;

~~In the proposal, TSO can propose additional criteria defining a significant modernisation. For the purposes provided for in this article, the main generating plant will be understood as:~~

~~a) In the case of synchronous power generation modules, the assembly formed by the prime mover and the alternator;~~

~~b) In the case of power park modules, the assembly formed by the inverter and the power generating unit, if the latter has a relevant impact on the technical capabilities of the power park module.~~

Comentado [A35]: ACER proposal on significant modernisation. Addition of Article 4a. Introducing a new article to deal with significant modernisation since Article 4 only deal with existing PGMs, while significant modernisation could also be relevant for PGM connected after the entry into force of this Regulation that would be subject to modernisation in the future.

Comentado [A36]: We are inviting stakeholders to propose adequate range here.

- In wind power park modules, the wind turbine will be considered as the power generating unit, which, for these purposes, will be understood as the assembly formed by the tower, the blades and the nacelle.
- In PV power park modules, only the inverter will be considered the main generating plant, while the equipment or components of the direct current side will not be considered as part of the main generating plant

3. For each criterion listed in paragraph 2 above, the TSO's proposal shall specify the requirements of this Regulation that shall apply to the entire modernised power-generating module or only to the modernised part of the power-generating module.

Article 5

Determination of significance

1. The power-generating modules shall comply with the requirements on the basis of the voltage level of their connection point and their maximum capacity according to the categories set out in paragraph 2.

2. Power-generating modules, excluding V2G electric vehicles and associated V2G electric vehicle supply equipment below 1 MW maximum capacity, within the following categories shall be considered as significant:

(a) connection point below 110 kV and maximum capacity of 0,8 kW or more (type A);

(b) where the capacity of the power-generating module is below the threshold specified in accordance with the procedure laid out in paragraph 4:

(i) maximum capacity at or above a threshold specified by each relevant TSO in accordance with paragraph 3 type B threshold contained in Table 1 (type B). This threshold shall not be above the limits for type B power generating modules contained in Table 1;

(ii) maximum capacity at or above a threshold specified by each relevant TSO in accordance with paragraph 3 (type C). This threshold shall not be above the limits for type C power generating modules contained in Table 1; or

(iii) maximum capacity at or above a threshold specified by each relevant TSO in accordance with paragraph 3 (type D). This threshold shall not be above the limits for type D power generating modules contained in Table 1;

connection point below 110 kV and maximum capacity at or above a threshold proposed by each relevant TSO in accordance with the procedure laid out in paragraph 3 (type B). This threshold shall not be above the limits for type B power-generating modules contained in Table 1;

(c) where the capacity of the power-generating module is above or equal to the threshold specified in accordance with the procedure laid out in paragraph 4:

(i) connection point below 110 kV and maximum capacity at or above type B threshold contained in Table 1;

Comentado [A37]: Electric powered ferries, lorries, trucks and extra high power charging points/parks would be considered here via an PGM/ESM definition.

Comentado [A38]: ACER proposal based on ENTSO-E and other stakeholders amendment proposals. The stakeholders' proposal is based on the Mixed Customer Sites Expert Group which was formed to assess a solution to the issue of determination of significance.

(c)(ii) connection point below 110 kV and maximum capacity at or above a threshold specified by each relevant TSO in accordance with paragraph 3 (type C). This threshold shall not be above the limits for type C power-generating modules contained in Table 1; or

(d)(iii) connection point at 110 kV or above (type D). A power-generating module is also of type D if its connection point is below 110 kV and its maximum capacity is at or above a threshold specified in accordance with paragraph 3. 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		Limit for a maximum capacity threshold of maximum capacity from which a power-generating module is of type B	Limit for a maximum capacity threshold of maximum capacity from which a power-generating module is of type C	Limit for a maximum capacity threshold of maximum capacity from which a power-generating module is of type D
Continental Europe		0.5 MW	50 MW	75 MW
Great Britain	0.1 MW		50 MW	75 MW
Nordic		1,5 MW	10 MW	30 MW
Ireland and Northern Ireland		0,1 MW	5 MW	10 MW
Baltic		0,5 MW	10 MW	15 MW

3. Proposals for maximum capacity thresholds for types B, C and D power-generating modules shall be subject to approval by the relevant regulatory authority or, where applicable, the Member State. In forming proposals, the relevant TSO shall coordinate with adjacent TSOs and DSOs and shall conduct a public consultation in accordance with Article 10. A proposal by the relevant TSO to change the thresholds shall not be made sooner than three years after the approval of the previous proposal.

4. For the purposes of the determination of significance as set out in paragraph 2, voltage level at the connection point shall be considered when maximum capacity of a power-generating module is above a default threshold of 10 MW. The relevant TSO This threshold may be propose to amended this threshold upon proposal of the relevant TSO as follows:

Comentado [A39]: Several stakeholders (VGBE, Volkswagen, undisclosed stakeholder, EDISON, EUROPGEN, EUGINE, smartEn, CharIN) proposed a certain harmonisation of banding values. ACER agrees that a harmonisation of mass-market smaller-sized PGMs would facilitate the acceptance of Type A unit certificates all over the EU and reduce the costs for the energy transition by bringing economies of scale. However, there are a couple of aspects that speak against the reducing the type A/B threshold. First, more onerous compliance regime and data exchange requirements (via SO Regulation) would apply to higher number of PGMs. Second, arguably, the harmonisation of banding values would bring the claimed economies of scale only if married with associated full harmonisation of type A requirements; however Member States like Italy applies, today, a very low banding value (11 kW) because of the system needs and should the banding value be harmonised at a higher value along with the harmonisation of requirements this would negatively affect them. Nevertheless, given that the Baltic synchronous area (SA) is scheduled to be synchronised with the Continental Europe SA by 2026, ACER proposes to harmonise the threshold between type A and B at 0,5 MW in these two SAs.

Comentado [A40]: Removed due to the withdrawal of the UK from the EU

(a) The threshold may be decreased below 10MW down to either:

- 5MW or

- the capacity threshold at which a power-generating module is of type C as set in paragraph 3.

whichever of the two values is higher; or

(b) The threshold may be set above 10MW up to the capacity threshold at which a power-generating module is of type D as set in paragraph 3.

In forming proposals, the relevant TSO shall coordinate with adjacent TSOs and DSOs and shall conduct a public consultation in accordance with Article 10. A proposal by the relevant TSO to change the thresholds shall not be made sooner than three years after the approval of the previous proposal.

Such a proposal shall be subject to approval by the relevant regulatory authority or, where applicable, the Member State.

54. Power-generating facility owners shall assist this process and provide relevant data as requested by the relevant TSO.

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

(a) maximum capacity larger than or equal to 0.8 kW and less than 2,4 kW (type EV1);

(b) maximum capacity larger than or equal to 2,4 kW and less than or equal to 42 kW (type EV2);

(c) maximum capacity larger than 42 kW and less than 1 MW (type EV3).

Requirements applicable to types EV1 and EV2 V2G electric vehicles and associated V2G electric vehicle supply equipment are set out exhaustively in Article 13a. Type EV1 V2G electric vehicles and associated V2G electric vehicle supply equipment shall possess equipment certificates, proving compliance with this regulation. Type EV2 V2G electric vehicles and associated V2G electric vehicle supply equipment follow compliance provisions of Article 30a only, whereas requirements applicable to type EV3 V2G electric vehicles and associated V2G electric vehicle supply equipment are set out exhaustively in Article 14a and follow compliance provisions of Article 30b only.

765. If, as a result of modification of the thresholds, a power-generating module qualifies under a different type, the procedure laid down in Article 4(3) concerning existing power-generating modules shall apply before compliance with the requirements for the new type is required.

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

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

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

2. Pump-storage power-generating modules in generating operation, pumping operation and synchronous compensation mode shall fulfil the following requirements: ~~Pump storage power-generating modules shall fulfil all the relevant requirements in both generating and pumping operation mode. Synchronous compensation operation of pump storage power-generating modules shall not be limited in time by the technical design of power-generating modules. Pump storage variable speed power-generating modules shall fulfil the requirements applicable to synchronous power-generating modules as well as those set out in point (b) of Article 20(2), if they qualify as type B, C or D:~~

(a) the technical design of power-generating modules shall not limit in time the synchronous compensation operation of pump-storage power-generating modules: ~~shall not be limited in time by the technical design of power-generating modules. Synchronous compensation operation of full-converter variable speed machines is performed by the converters;~~

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

(c) pump-storage power-generating modules with variable speed machines shall be considered as power park modules. For doubly-fed induction machines, the parameters in Tables 3.1.1 and 3.1.2, or Tables 7.1.1, 7.1.2, and 7.2.1 shall apply to define the voltage-against-time profile with regard to fault-ride-through capability;

(d) the requirements of this Regulation that apply to pump-storage power-generating modules in pumping operation mode and concern active power, shall result in the same effect as the response of active power generation;

(e) in pumping operation mode, no technical capability to remain connected and continue operation is requested if the frequency is below 49 Hz, unless the relevant TSO defines a higher value;

(f) to pump-storage power-generating modules with fixed speed machines in pumping operation mode and synchronous compensation operation mode, Articles 13(2), 13(3), 13(4), 13(5), 13(7), 14(2), 15(2), 15(5) and 15(6) (e) shall not apply. In pumping operation mode, the second sentence of Article 17(3) shall

Comentado [A41]: Changes follow ENTSO-E amendment proposal No. 7.

The title is updated to clarify which PGMs are covered by article 6. Referring to "power-generating modules" and not explicitly to "offshore power-generating modules" creates confusion in the applicability of this article.

Additionally, the NC RfG is not of application to industrial sites but to "power-generating modules embedded in the networks of industrial sites"

Finally, with the addition of electromobility within the scope of the RfG and within the scope of this article changes in title are needed.

not apply; in synchronous compensation operation mode, Article 17(3) shall not apply;

(g) to pump-storage power-generating modules with single shaft ternary machines in pumping operation mode, Articles 13(4), 13(5) and 15(5) shall not apply. In addition, Articles 13(2), 13(3), 13(7), 14(2), 15(2), 15(6)(e) and the second sentence of Article 17(3) shall not apply, if only pumps are operated. Where Articles 13(2) or 15(2) apply, the reference active power for LFSM-O or LFSM-U respectively is the maximum capacity of the turbine;

(h) to pump-storage power-generating modules with single shaft ternary machines in synchronous compensation operation mode, Articles 13(2), 13(3), 13(4), 13(5), 13(7), 14(2), 15(2), 15(5), 15(6)(e) and 17(3) shall not apply;

(i) to pump-storage power-generating modules with variable speed machines in pumping operation mode, Articles 13(4), 13(5) and 15(5) shall not apply;

(j) to pump-storage power-generating modules with variable speed machines, the power generating facility owner shall provide technical evidence demonstrating why a longer time is needed, if the maximum response time ~~Tresp~~ according to Article 13(32)(g) is greater than the value set out in Article 13(32)(g). The power-generating facility owner and the relevant system operator shall agree on the acceptable response time.

(k) to pump-storage power-generating modules with variable speed machines in synchronous compensation operation mode, Articles 13(2), 13(3), 13(4), 13(5), 13(7), 14(2), 15(2), 15(5) and 15(6)(e) shall not apply.

3. With respect 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 shall have the right to agree on conditions for disconnection of such power-generating modules together with critical loads, which secure production processes, from the relevant system operator's network. The exercise of this right shall be coordinated with the relevant TSO.

4. Except for requirements under paragraphs 2 and 4 of Article 13 or where otherwise stated in the national framework, requirements of this Regulation relating to the capability to maintain constant active power output or to modulate active power output shall not apply to power-generating modules of facilities for combined heat and power production embedded in the networks of industrial sites, 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, ~~that is to say~~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 or, in the case of the Nordic synchronous area, type D in accordance with points (a) to (c) of Article 5(2).

5. Combined heat and power-generating facilities shall be assessed on the basis of their electrical maximum capacity.

Comentado [A42]: According to ENTSO-E amendment proposal No. 8 on pump-storage hydro. The review of the technical requirements defined by NC RfG with regard to their applicability to Pump Storage Hydro power generating modules has demonstrated that a distinction between the relevant generation technologies and the operation modes is necessary for assessing and evaluating whether these requirements can reasonably be applied. An Expert group was established to clarify the issues.

6. Electricity storage modules and V2G electric vehicles and associated V2G electric vehicle supply equipment shall be capable of satisfying the relevant requirements of this Regulation both when the electricity storage module or V2G electric vehicle and associated V2G electric vehicle supply equipment injects and consumes active power to and from the network.

Comentado [A43]: Based on based on the proposal by several stakeholders and ENTSO-E amendment 49 on storage and the ESC EG Storage

7. Notwithstanding provisions of paragraph 2, the technical design of power-generating modules shall not limit in time the power generating modules operation in synchronous compensation mode shall not be limited in time by the technical design of power-generating modules. Synchronous compensation operation of full-converter variable speed machines is performed by the converters. Relevant system operators shall specify appropriate technical requirements applicable to these modules operating in synchronous compensation mode.

Comentado [A44]: The changes follow VGBE proposal on technology neutral provisions on synchronous compensation mode.

Article 7

Regulatory aspects

1. The requirements of general application to be established by relevant system operators or TSOs under this Regulation shall be subject to approval by the entity designated by the Member State and be published. The designated entity shall be the regulatory authority unless otherwise provided by the Member State.

2. For site specific requirements to be established by relevant system operators or TSOs under this Regulation, Member States may require approval by a designated entity.

3. When applying this Regulation, Member States, competent 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 TSO in order to ensure system security, including as required by national legislation;
- (e) consult with relevant DSOs and take account of potential impacts on their system;

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

Comentado [A45]: Based on stakeholders proposal to take into consideration ENTSO-E IGDs and relevant nuclear safety rules.

(g) take into consideration local system needs in specifying power-generating modules capabilities where necessary.

Comentado [A46]: This is to take into consideration identified local system needs.

4. The relevant system operator or TSO shall submit a proposal for requirements of general application, ~~or and~~ the methodology used to calculate or establish them, ~~together with an implemented validation scheme~~, for approval by the competent designated entity within ~~two-three~~ years of entry into force of this Regulation. ~~The Member State may provide for a shorter time period for all or parts of the requirements or the methodologies. In this case, the Member State shall communicate the shorter time period to the European Union Agency for the Cooperation of Energy Regulators (ACER).~~

Comentado [A47]: This editorial change serves to align the wording with Article 7(1) RfG ("designated entity").

Comentado [A48]: Serves to allow a more rapid implementation of the non-exhaustive requirements on national level. The accelerating connection of renewables and the decommissioning of conventional power plants may make a rapid implementation of requirements like Grid Forming capability (see new Articles Y(5) to (8) and Articles 20 to 22 RfG 2.0.) pivotal for grid stability.

5. Where this Regulation requires the relevant system operator, relevant TSO, power-generating facility owner and/or the distribution system operator 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 parties. If no agreement has been found within this time frame, each party may request the relevant regulatory authority to issue a decision within six months.

6. Competent entities shall take decisions on proposals for requirements or methodologies within six months following the receipt of such proposals.

7. If the relevant system operator or TSO deems an amendment to requirements or methodologies as provided for and approved under paragraph 1 and 2 to be necessary, the requirements provided for in paragraphs 3 to 8 shall apply to the proposed amendment. System operators and TSOs proposing an 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.

8. Any party having a complaint against a relevant system operator or TSO in relation to that relevant system operator's or TSO'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.

9. Where the requirements under this Regulation are to be established by a relevant system operator that is not a TSO, Member States may provide that instead the TSO be responsible for establishing the relevant requirements.

Article 8

Multiple TSOs

1. Where more than one TSO exists in a Member State, this Regulation shall apply to all those TSOs.

2. Member States may, under the national regulatory regime, provide that the responsibility of a TSO to comply with one or some or all obligations under this Regulation is assigned to one or more specific TSOs.

Article 9

Recovery of costs

1. The costs borne by system operators subject to network tariff regulation and stemming from the obligations laid down in this Regulation shall be assessed by the relevant regulatory authorities. Costs 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 referred to in paragraph 1 shall, within three months of the request, provide the information necessary to facilitate assessment of the costs incurred.

Article 10

Public consultation

1. Relevant system operators and relevant TSOs shall carry out [a public](#) consultation with stakeholders, including the competent authorities of each Member State, on [the](#) proposals to extend the applicability of this Regulation to existing power-generating modules in accordance with Article 4(3), for the proposal for thresholds in accordance with Article 5(3), and on the report prepared in accordance with Article 38(3) and the cost-benefit analysis undertaken in accordance with Article 63(2). The consultation shall last at least for a period of one month.

2. The relevant system operators or relevant TSOs shall duly take into account the views of the stakeholders resulting from the consultations prior to the submission of the draft proposal for thresholds, the report or cost benefit analysis for approval by the regulatory authority or, if applicable, the Member State. 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 ([ACERthe Agency](#)), in close cooperation with the European Network of Transmission System Operators for Electricity (ENTSO for Electricity), shall 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 notably related to the requirements for grid connection of power-generating facilities.

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, regulatory authorities or entities subject to the provisions of this Regulation.

3. Confidential information received by the persons, regulatory authorities or entities referred to in paragraph 2 in the course of their duties may not be divulged to any other person or authority, without prejudice to cases covered by national law, the other provisions of this Regulation or other relevant Union law.

4. Without prejudice to cases covered by national or Union law, regulatory authorities, entities or persons who receive confidential information pursuant to this Regulation may 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

1. ~~Type A~~ power-generating modules shall fulfil the requirements set out in this article.

2. ~~The~~ following requirements relating to frequency stability apply:

(a) With regard to frequency ranges:

(i) a power-generating module shall be capable of remaining connected to the network and operate stably within the frequency ranges and time periods specified in Table 2;

(ii) the relevant system operator, in coordination with the relevant 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 a power-generating module, if it is required to preserve or to restore system security;

(iii) the power-generating facility owner shall not unreasonably withhold consent to apply wider frequency ranges or longer minimum times for operation, taking account of their economic and technical feasibility.

(b) ~~With regard to the rate of change of frequency withstand capability, a power generating module shall be capable of staying connected to the network and operate at rates of change of frequency up to a value specified by the relevant TSO, unless disconnection was triggered by rate of change of frequency type loss of mains protection. The relevant system operator, in coordination with the relevant TSO, shall specify this rate of change of frequency type loss of mains protection.~~

With regard to the rate-of-change-of-frequency withstand capability:

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

- ±2,0 Hz/s over a period of 0,5 s,
- ±1,5 Hz/s over a period of 1 s, and
- ±1,25 Hz/s over a period of 2 s;

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

- ±4.0 Hz/s over a period of 0,25 s,
- ±2.0 Hz/s over a period of 0,5 s,
- ±1.5 Hz/s over a period of 1 s, and

Comentado [A49]: These editorial changes allow for other articles (e.g. Article 14) to refer to Article 13 in order to set out clearly the requirements for higher types of PGMs

Comentado [A50]: To take into account ENTSO-E proposal to include another sentence in article 1(c) which is a duplication of article 13(1)(a)(i).

Comentado [A51]: Based on EUROPGEN comment that even small SPGMs cannot withstand RoCoF values of 4Hz/s.

- $\pm 1,25 \text{ Hz/s}$ over a period of 2 s;

(iii) Without prejudice to Article 13(a) paragraph (ii), a power generating power park module shall also be capable of staying connected to the network and operate at the sequence of rates-of-change-of-frequencies which are defined considering the overfrequency against time profiles given in Figure XX.a and the underfrequency against time profiles given in Figure XX.b;

Figure XX.a

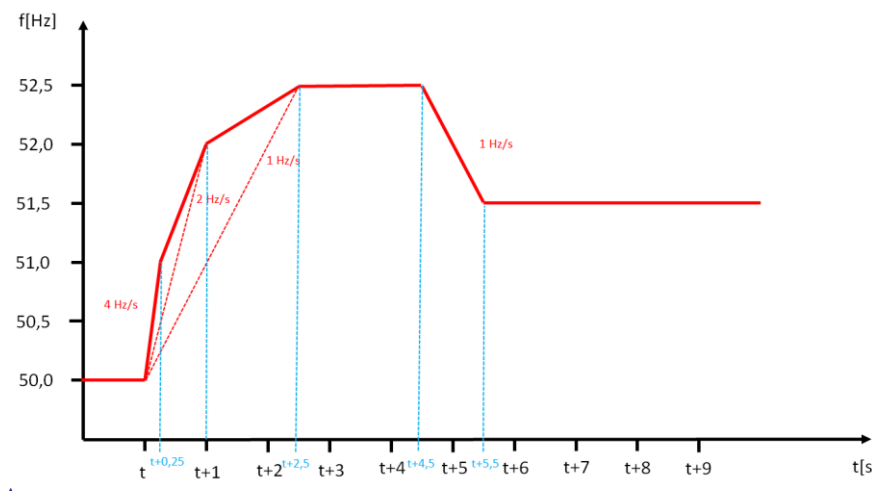
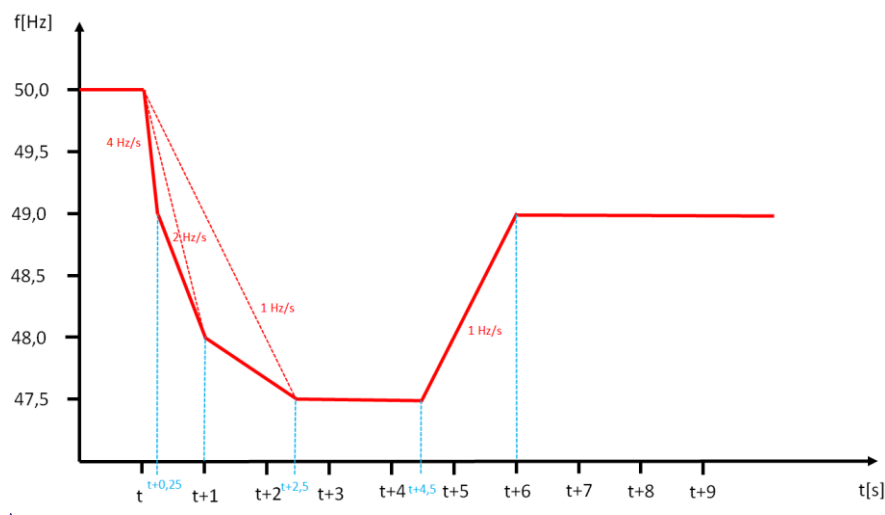


Figure XX.b

Comentado [A52]: Local RoCoF values can be severely higher than the average within an islanded system (following a system split such as for example in 2006 and 2021). A common study of the German TSO (LoGlo study) shows, that local values of 2 Hz/s can be expected for an average of 1 Hz/s over 500 ms. That validates the existing approach. However, the differences of local RoCoF stress increase for smaller time periods. To increase transparency and system security a RoCoF withstand capability of 4 Hz/s over 250 ms should be introduced.

When a system split is occurring, frequency in the overfrequency island can transiently overshoot before it is stabilized to a value according to the droop settings (a simulation plot is attached below). If, during that transient, all generation is tripped due to transient overfrequency, the island will black out, even if it would have been possible to stabilize the frequency below 51.5 Hz. This system behaviour will be aggravated with decreasing system inertia. The proposed modification delays the tripping of the generation during the transient and therefore prevents the island from blacking out. By this, it is increasing system resilience. It should be possible for both, PPM and SPGM to withstand this short frequency transient. (ENTSO-E)

Código de campo cambiado



Código de campo cambiado

(iviii) If the rate-of-change-of-frequency is used for loss of mains protection, the relevant system operator, in coordination with the relevant TSO, shall specify the threshold of this rate-of-change-of-frequency-type loss of mains protection.

(c) -Protection schemes, other than those specifically referred in paragraph b(iii) above, shall not jeopardise frequency-ride-through performance specified in paragraph (b).

Table 2

Minimum time periods for which a power-generating module has to be capable of operating on different frequencies, deviating from a nominal value, without disconnecting from the network.

Synchronous area	Frequency range	Time period for operation
Continental Europe	47,5 Hz-48,5 Hz	To be specified by each TSO, but not less than 30 minutes <u>and not more than 90 minutes</u>
	48,5 Hz-49,0 Hz	To be specified by each TSO, but not less than the period for 47,5 Hz-48,5 Hz
	49,0 Hz-51,0 Hz	Unlimited
	51,0 Hz-51,5 Hz	30 minutes

Comentado [A53]: The value of the rate-of-change-of-frequency (RoCoF) as set out in Article 13(1)(b) is defining a level of resilience against fast frequency changes. However, acknowledging issues in some distribution grids ENTSO-E and EU DSO proposed that the threshold shall be specified by the relevant system operator in coordination with the relevant TSO.

Comentado [A54]: Change for freq range 47.5-48.5 follows EUROPGEN proposal

Comentado [A55]: Boundary conditions are proposed for frequency operation, aligning with EN 50549-2. (EUROPGEN)

Nordic	47,5 Hz-48,5 Hz	30 minutes
	48,5 Hz-49,0 Hz	To be specified by each TSO, but not less than 30 minutes
	49,0 Hz-51,0 Hz	Unlimited
	51,0 Hz-51,5 Hz	30 minutes
Great Britain	47,0 Hz-47,5 Hz	20 seconds
	47,5 Hz-48,5 Hz	90 minutes
	48,5 Hz-49,0 Hz	To be specified by each TSO, but not less than 90 minutes
	49,0 Hz-51,0 Hz	Unlimited
	51,0 Hz-51,5 Hz	90 minutes
	51,5 Hz-52,0 Hz	15 minutes
Ireland and Northern Ireland	47,5 Hz-48,5 Hz	90 minutes
	48,5 Hz-49,0 Hz	To be specified by each TSO, but not less than 90 minutes
	49,0 Hz-51,0 Hz	Unlimited
	51,0 Hz-51,5 Hz	90 minutes
Baltic	47,5 Hz-48,5 Hz	To be specified by each TSO, but not less than 30 minutes and not more than 90 minutes
	48,5 Hz-49,0 Hz	To be specified by each TSO, but not less than the period for 47,5 Hz-48,5 Hz
	49,0 Hz-51,0 Hz	Unlimited

Comentado [A56]: Removed due to the withdrawal of the UK from the EU

Comentado [A57]: Following a change for the CE SA, this change is needed here to account for the synchronisation of Baltic and CE SAs in 2026.

	51,0 Hz-51,5 Hz	To be specified by each TSO, but not less than 30 minutes
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Comentado [A58]: Following a change for the CE SA, this change is needed here to account for the synchronisation of Baltic and CE SAs in 2026.

(d) the power-generating module shall be capable of remaining connected to the network and operate at the frequency between 51.5 Hz – 52.5 Hz for 10 seconds.

Comentado [A59]: When a system split is occurring, frequency in the overfrequency island can transiently overshoot before it is stabilized to a value according to the droop settings (a simulation plot is attached below). If, during that transient, all generation is tripped due to transient overfrequency, the island will black out, even if it would have been possible to stabilize the frequency below 51.5 Hz. This system behaviour will be aggravated with decreasing system inertia. The proposed modification delays the tripping of the generation during the transient and therefore prevents the island from blacking out. By this, it is increasing system resilience. It should be possible for both, PPM and SPGM to withstand this short frequency transient. The adverse effect of tripping to household becoming more difficult has to be accepted, but can partly be mitigated. (ENTSO-E)

32. With regard to the limited frequency sensitive mode — overfrequency (LFSM-O), the following shall apply, as determined by the relevant TSO for its control area in coordination with the TSOs of the same synchronous area to ensure minimal impacts on neighbouring areas:

(a) the power-generating module shall be capable of activating the provision of active power frequency response according to figure 1 at a frequency threshold and droop settings specified by the relevant TSO;

(b) instead of the capability referred to in paragraph (a), the relevant TSO may choose to allow within its control area automatic disconnection and reconnection of power-generating modules of Type A at randomised frequencies, ideally uniformly distributed, above a frequency threshold, as determined by the relevant TSO where it is able to demonstrate to the relevant regulatory authority, and with the cooperation of power-generating facility owners, that this has a limited cross-border impact and maintains the same level of operational security in all system states;

(c) the frequency threshold shall be 50Hz+Δf₁, where Δf₁ is defined in Table X of Article 15(2)(d) between 50,2 Hz and 50,5 Hz inclusive;

Comentado [A60]: ACER is proposing a harmonisation of frequency thresholds based on default values proposed by ENTSO-E

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

(e) the start of active power decrease (initial delay time T_{id} (Figure XX)) by the power-generating module shall not be intentionally delayed. The power-generating module shall be capable of activating a power frequency response with an initial delay that is as short as possible. If that delay is greater than two seconds, the power-generating facility owner shall justify the delay, providing technical evidence to the relevant TSO;

Comentado [A61]: Changes to Article 13(2) follow ENTSO-E Amendment 47.

(f) the relevant TSO may require that upon reaching minimum regulating level, the power-generating module be capable of either:

LFSM-O is an important function to keep the frequency constant in a synchronous area. It is therefore also important that the function is used in the same way by all TSOs in a synchronous zone so that there are no undesirable interferences. To ensure this, the different parameters must be harmonised. No response time is defined in the current RfG. Therefore, the definition of the response time has been added here.

(i) continuing operation at this level; or

(ii) further decreasing active power output;

(g) the power-generating module shall be capable of operating stably during LFSM-O operation. When LFSM-O is active, the LFSM-O setpoint will prevail over any other active power setpoints which would result in an increase of power above the LFSM-O setpoint. The power-generating module shall be able to receive and react on an external signal allowing the relevant system operator to block active power LFSM-O mode in real-time. The TSO in coordination with the RSO shall define the framework conditions for the use of this function.

Comentado [A62]: It is necessary to provide the possibility for the TSO to block the LFSM-O function. In a load-driven congestion in distribution system mitigated by PGM during an overfrequency event, LFSM-O is decreasing the PGMs' active power output and thus increasing the flow on already overloaded line. LFSM-O has to be blocked by the congestion management signal. The DSO with the relevant TSO shall define the framework condition for the use of this function. (ENTSO-E)

(h) The response time, T_{resp} in Figure XX, for active power decrease in case of increasing frequency, shall be as fast as technically feasible and as described below:

(i)— for synchronous power-generating module: less or equal to 8 seconds for an active power setpoint change of 45% maximum power.

(ii)— for power park module: less or equal to 2 seconds for an active power setpoint change of 50% maximum power.

If the response time is greater than stated above, the power-generating facility owner shall justify the delay, providing technical evidence to the relevant TSO.

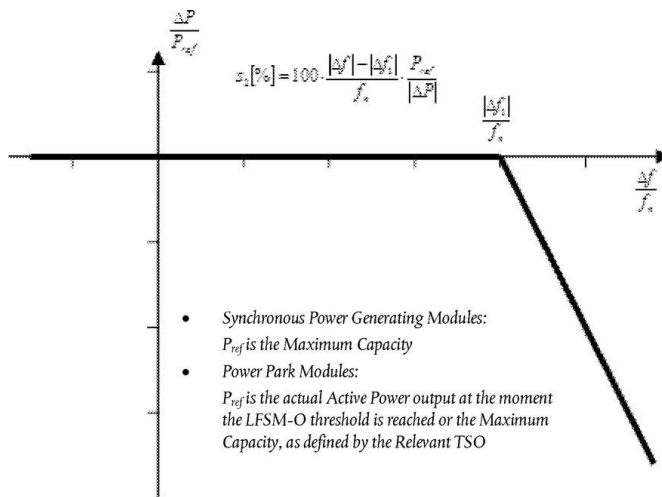
(h) An electricity storage module shall be capable of activating the provision of active power frequency response from the current active power input or output automatically up to the maximum consumption capacity according to the indicative Figure 1 to the extent that is technically feasible. A frequency threshold and a droop setting specified by the relevant TSO in accordance with paragraph (3)(a) of this Article shall apply.

The electricity storage module shall consume power up to filling the maximum energy that it is able to store, then it may cease consumption. The relevant TSO may define a different characteristic or establish that the electricity storage module, when consuming active power, will maintain the consumption level even during the overfrequency event.

Switching from consumption to generation and vice versa should be as fast as technically feasible. The relevant system operator has the right to request the demonstration of technical evidence of the required switching time.

Figure 1

Active power frequency response capability of power-generating modules in LFSM-O



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 is the frequency deviation in the

Comentado [A63]: Added so as to cover charging characteristics close to 0 and 100 % battery capacities.

Comentado [A64]: To clarify that an ESM shall respond to an overfrequency event whether consuming or injecting active power.

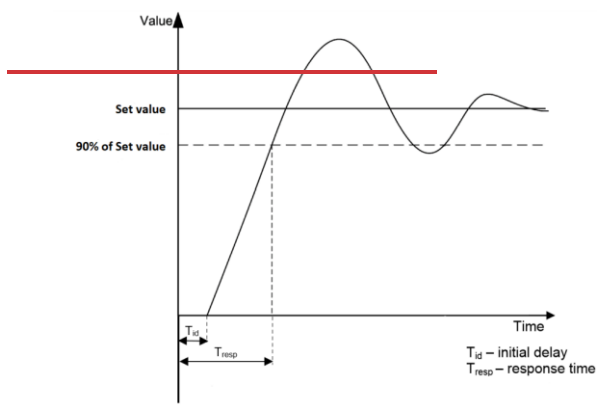
Comentado [A65]: Added based on the request of several stakeholders (ACER amending ENTSO-E proposal to cover both injecting and consuming active energy)

network. At overfrequencies where Δf is above Δf_c , the power-generating module has to provide a negative active power output change according to the droop S_v .

In the case of electricity storage modules, P_{ref} could be the actual active power at the moment the LFSM-O threshold is reached or the maximum capacity or maximum consumption capacity, as specified by the relevant system operator.

Comentado [A66]: Added based on the request of several stakeholders and EG Storage.

Figure XX



43. The power-generating module shall be capable of maintaining constant output at its target active power value regardless of changes in frequency, except where output follows the changes specified in the context of paragraphs 2 and 4 of this Article or points (c) and (d) of Article 15(2) as applicable.

45. The relevant TSO shall specify admissible active power reduction from maximum output with falling frequency in its control area as a rate of reduction falling within the boundaries, illustrated by the full lines in Figure 2:

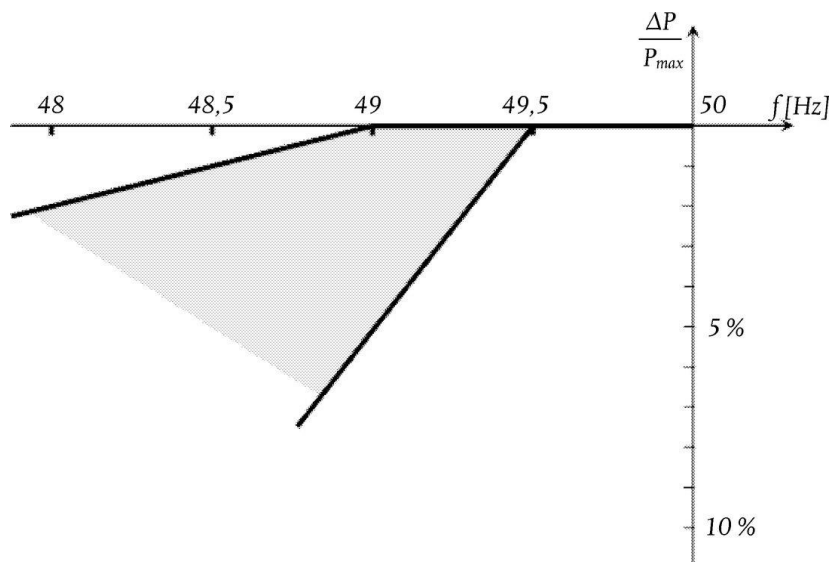
- (a) below 49 Hz falling by a reduction rate of 2 % of the maximum capacity at 50 Hz per 1 Hz frequency drop;
- (b) below 49,5 Hz falling by a reduction rate of 10 % of the maximum capacity at 50 Hz per 1 Hz frequency drop.

56. The admissible active power reduction from maximum output shall:

- (a) clearly specify the ambient conditions applicable;
- (b) take account of the technical capabilities of power-generating modules.

Figure 2

Maximum power capability reduction with falling frequency



The diagram represents the boundaries in which the capability can be specified by the relevant TSO.

67. The power-generating module shall be equipped with a logic communication interface (input port) in order to ease-reduce, without undue delay, active power output within five seconds following an instruction being received at the input port.

The electricity storage modules shall be capable of modulating, without undue delay, active power output and input following an instruction being received at the input port.

The relevant system operator shall have the right to specify requirements for equipment to make this power-generating module facility operable remotely.

78. The technical capability of the power-generating module to connect to the network, taking into consideration the availability of primary resource, shall be as follows: ~~The relevant TSO shall specify the conditions under which a power-generating module is capable of connecting automatically to the network. Those conditions shall include:~~

(a) Voltage range at the grid connection point: within the voltage range that is defined for unlimited time operation if so applicable; frequency ranges within which an automatic connection is admissible, and a corresponding delay time; and

(b) Frequency range of 47.5 Hz ≤ f ≤ 51 Hz; maximum admissible gradient of increase in active power output.

(c) Adjustable observation time: from 0 to 300 s;

(d) Adjustable limitation of the gradient of active power increase ≤ 20 % of P_{max}/min; and,

(e) Synchronizing conditions.

89. Within the capability defined in paragraph (7), the default settings for an autonomous connection, taking into consideration the availability of primary resource, shall be as follows:

Comentado [A67]: Changes follow EU DSO proposal.

Already many type A PGMs are in some member states now being connected on flexible connection contracts where the generation owner and the DSO have agreed a connection contract whereby the DSO can reduce the PGM output to avoid DSO (and even TSO) network overloading.

It will be very useful for the DSO to have the possibility for active power control type A.

Comentado [A68]: These changes follow discussions and inputs by the Expert Group Storage and dedicated ACER workshop on Storage. In general, stakeholders see added value of modulating the active output power over an abrupt "disconnection" of the PGM.

Comentado [A69]: Changes in this paragraph follow ENTSO-E proposal clarifying situations in which the autonomous connection should take place.

Comentado [A70]: This inclusion is needed because ENTSO-E wording assumes voltage ranges for type A PGMs be defined at the Member State level.

(a) Voltage range: $0.9 \text{ pu} \leq U \leq 1.1 \text{ pu}$;

(b) Frequency range:

— Continental Europe: $47.5 \text{ Hz} \leq f \leq 50.1 \text{ Hz}$

— Other synchronous areas $47.5 \text{ Hz} \leq f \leq 50.5 \text{ Hz}$

(c) Minimum observation time: 60 s;

(d) Maximum gradient of active power increase $\leq 20 \%$ of $P_{\text{max}}/\text{min}$

(e) Condition on voltage phase angle difference measured on each side of the circuit breaker: $\Delta\theta < 10^\circ$

(f) Condition on the voltage magnitude difference measured on each side of the circuit breaker: $\Delta U < 0.04 \text{ pu}$; and

(g) Condition on the frequency difference measured on each side of the circuit breaker: $\Delta f < 0.2 \text{ Hz}$

Automatic/Autonomous connection is allowed unless specified otherwise by the relevant system operator in coordination with the relevant TSO.

108. The power generating module shall be equipped with voltage control that can provide contribute to constant terminal voltage when generating power at a selectable setpoint without instability over the entire operating range of the power-generating module. The relevant system operator shall have the right to specify the capability of a power-generating module to supply or absorb reactive power both when importing or exporting active power with P-Q capability chart to be defined by the relevant system operator with boundaries not wider than Article 15, Figure 9;

119. The following requirements shall apply to electricity storage modules with regard to limited frequency sensitive mode – underfrequency (LFSM-U-ESM):

(a) An electricity storage module shall be capable of activating the provision of active power frequency response from the current active power input or output automatically up to the maximum capacity according to the indicative Figure YY. The relevant TSO shall specify a frequency threshold and a droop setting:

(i) The droop shall be adjustable between 0.2% to 5%. The default droop s shall be 1%;

(ii) The frequency threshold shall be adjustable between 49.8 Hz and 49.5 Hz inclusive. The default frequency threshold shall be 50 Hz reduced by Δf_1 where Δf_1 is defined in Table X of Article 15.2.d.

Figure YY

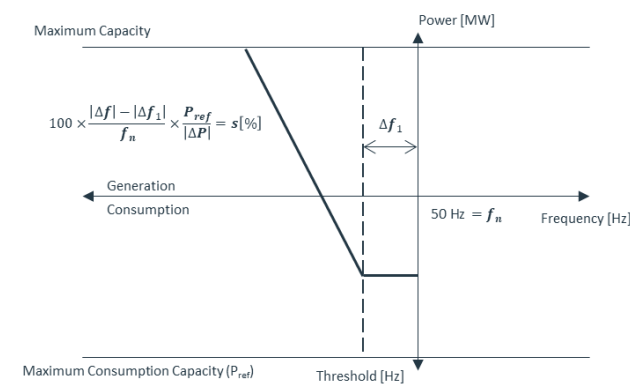
Comentado [A71]: ENTSO-E proposed to use an undefined term "synchrocoupler", this is an alternative wording.

Comentado [A72]: idem

Comentado [A73]: idem

Comentado [A74]: This requirement is based on EU-DSO input and clarifies the stability requirement over the entire range of the voltage control.

Comentado [A75]: These requirements follow to an extent the ENTSO-E proposal and were discussed with stakeholders during the ACER workshop on Storage, 11.5.2023.



(b) The electricity storage module shall stay and operate stably in this specific mode as long as the frequency is below the frequency threshold according to its content of energy. If the frequency recovers the electricity storage module shall follow the same power-frequency characteristic until it is back to its prior state of active power input/output.

(c) Instead of the capability referred to in paragraph (a), the relevant TSO may choose to allow electricity storage modules of Type A in consumption mode within its control area automatic disconnection at randomized frequencies, ideally uniformly distributed, between the frequency threshold and 49 Hz.

(d) the initial delay time T_{id} (Figure xx in Article 13.2) by the electricity storage modules shall not be intentionally delayed.

(e) The response time T_{resp} (Figure xx in Article 13.2) for LFSM-U-ESM shall be as described below:

— for SPGM: less or equal to 8 s for an active power setpoint change of 1 pu of capacity excluding the time for switching from consumption to generation or vice versa.

— for PPM: less or equal to 0.5 s for an active power setpoint change of 1 pu of capacity excluding the time for switching from consumption to generation or vice versa.

Switching from consumption to generation and vice versa should be as fast as technically feasible. The relevant system operator has the right to request the demonstration of technical evidence of the required switching time.

120. With regard to voltage stability, unless otherwise provided in this Regulation, the power-generating module shall be capable of staying connected to the network and operate continuously within the range of 0.85 pu - 1.1 pu at the connection point should that be at or below 400V. Conversely, the power-generating module shall be capable of staying connected to the network and operate continuously within the range of 0.9 pu - 1.1 pu at the connection point should that be above 400V and below 110 kV.

Comentado [A76]: ACER believes certain voltage withstand capabilities need to be included in the RfG as of type A PGM onwards. However, ACER does not agree with ENTSO-E proposal for RSOs to define voltage ranges at the Member State level as this could lead to non-harmonised rules for mass-produced PGMs. Instead, ACER proposes to apply ranges as currently specified in EN 50549-1 and -2 standards

134. With regard to weather-related hazards, the relevant system operator or TSO may specify weather hazards resilience requirements based on the cost-benefit analysis undertaken in accordance with Article 39. Those requirements shall reflect the specificities of generation technologies as well as the geographical and climatic particularities of each Member State.

14. The power-generating modules shall fulfil the following requirements in relation to robustness:

(a) with regard to fault-ride-through capability:

(i) synchronous power generating modules shall fulfil the requirements laid down in Article X;

(ii) power park modules shall fulfil the requirements laid down in Article Y;

(b) with regard to grid forming capability, power park modules shall fulfil the requirements laid down in Article Y.

Article 13a

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

1. Type EV1 and EV2 V2G electric vehicles and associated V2G electric vehicle supply equipment shall fulfil the following requirements relating to frequency stability:

(a) With regard to frequency ranges, type EV1 and EV2 V2G electric vehicles and associated V2G electric vehicle supply equipment shall be capable of remaining connected to the network and operate within the frequency ranges and time periods specified in Table XY;

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

(i) A type EV1 and EV2 V2G electric vehicle and associated V2G electric vehicle supply equipment shall be capable of staying connected to the network and operate at rates-of-change-of-frequency up to the following values:

- $\pm 4,0$ Hz/s over a period of 0,25 s
- $\pm 2,0$ Hz/s over a period of 0,5 s
- $\pm 1,5$ Hz/s over a period of 1 s
- $\pm 1,25$ Hz/s over a period of 2 s

(ii) Without prejudice to paragraph Article 13a(1)(a), type EV1 and EV2 V2G electric vehicles and associated V2G electric vehicle supply equipment shall be capable of staying connected to the network and operate at the sequence of rates-of-change-of-frequencies which are defined considering the overfrequency against time profiles given in figure XX.a and the underfrequency against time profiles given in figure XX.b;

Comentado [A77]: Due to the climate change, ACER considers that the issue of PGMS' weather resilience shall be duly addressed in the RfG 2.0 for the efficient electric power system design.

ACER also agrees that the underlying assets should be considered at a local (regional) level, and that relevant system operators and power-generating facility owners should take due account of possible extraordinary climate parameters. At the same time, further specifications of the possible events shall be avoided as they may prove inefficient at the European level.

Additionally, ACER emphasises the need for a proportionate approach and performance of the CBA when establishing weather resilience requirements. This provision is partly based on the VGBE proposal.

Comentado [A78]: The number of installed Type A generation has reached a level where the operation of this equipment has a major impact on system security. In most MS this concerns mainly PV systems of the PPM type A. As elaborated in the Expert Group BftA, fault-ride-through (FRT) requirements for PPM type A should therefore be mandatory.

As the type A SPGM penetration is not comparable to the general and expected future type A PPM penetration the need for FRT requirements for type A SPGM is currently sufficient to include as a "non-mandatory requirement" in the RfG.

For system security reasons, like preventing large-scale loss of generation, it is proposed to extend the FRT requirement to type A PPMs. This requirement demands the ability of the PPM to remain connected to the system during faults within a defined voltage-time profile, and thus avoiding disconnection of the power generating module. Furthermore a benchmarking of other grid codes shows that system needs has been acknowledged in other power systems or even at national level in some EU countries. (ENTSO-E)

Comentado [A79]: Because of the sheer installed volume, electricity storage modules have an increasing significance for the power system. Designed properly, they possess capability to provide several grid supporting functions without significant cost implications.

Electric vehicles and associated V2G electric vehicle supply equipment are interacting with the grid in the same way as the battery-based electricity storage modules do and thus also need to be considered in the revised RfG NC.

ACER proposal is to an extent based on the final report by the [Storage Expert Group](#) with an important distinction, i.e. full-harmonisation of all pertaining requirements facilitating seamless cross-border trade and transit of electric vehicles.

(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 higher values than the ones defined in point:

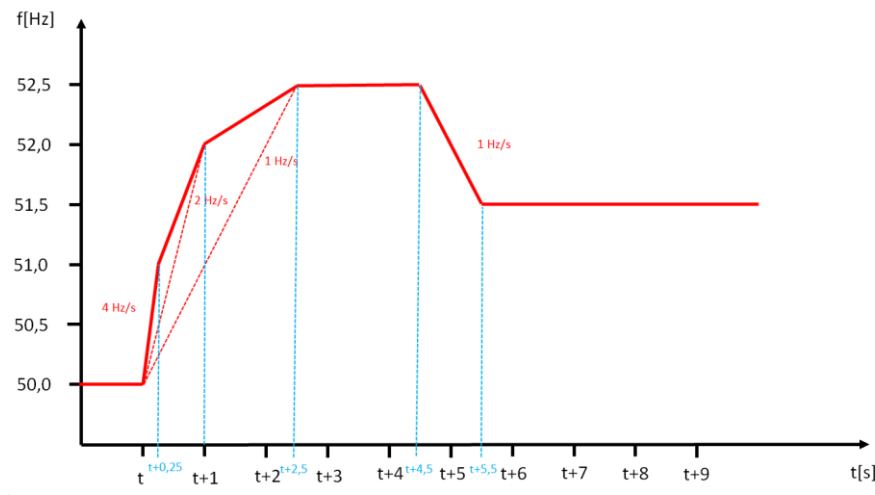
(c) The protection schemes shall not jeopardise frequency-ride-through performance specified in paragraph (b).

Table XY

Minimum time periods for which a type EV1 and EV2 V2G electric vehicle and an associated V2G electric vehicle supply equipment has to shall be capable of operating on different frequencies, deviating from a nominal value, without disconnecting from the network:

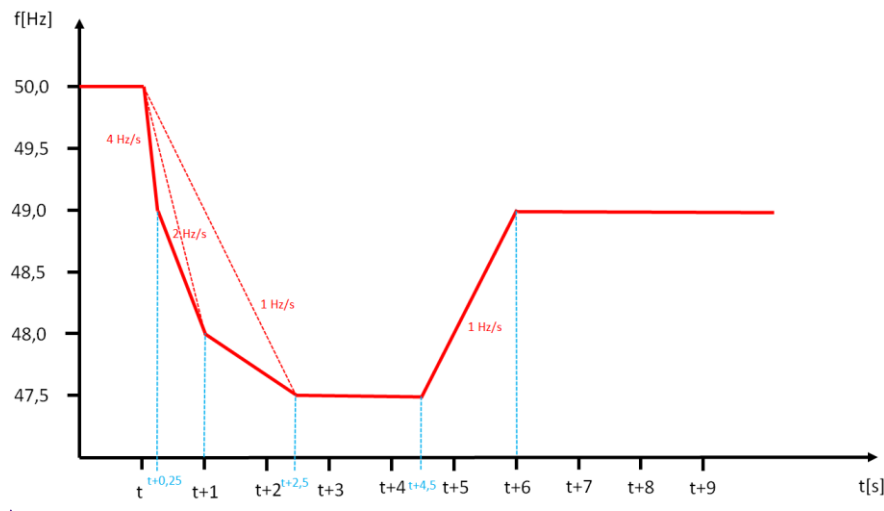
<u>Frequency range</u>	<u>Time period for operation</u>
<u>47,5 Hz-48,5 Hz</u>	<u>30 minutes</u>
<u>48,5 Hz-49,0 Hz</u>	<u>30 minutes</u>
<u>49,0 Hz-51,0 Hz</u>	<u>Unlimited</u>
<u>51,0 Hz-51,5 Hz</u>	<u>30 minutes</u>
<u>51,5 Hz-52,5 Hz</u>	<u>10 seconds</u>

Figure XX.a



Código de campo cambiado

Figure XX.b



Código de campo cambiado

2. A V2G electric vehicle supply equipment shall be equipped with a cyber-protected data exchange interface in order to modulate, without undue delay, active power output and input following an instruction being received at the input port. The relevant system operator shall have the right to specify requirements for equipment to make this facility operable remotely.

3. A type EV1 and EV2 V2G electric vehicles and associated V2G electric vehicle supply equipment may autonomously connect to the network under the following conditions:

(a) Frequency range $49.8 \text{ Hz} \leq f \leq 50.2 \text{ Hz}$;

(b) Minimum observation time: 5 s.

4. A type EV1 and EV2 V2G electric vehicle and associated V2G electric vehicle supply equipment may autonomously reconnect to the network after tripping due to a system disturbance under the following conditions:

(a) Frequency range $49.8 \text{ Hz} \leq f \leq 50.2 \text{ Hz}$;

(b) Minimum observation time: 60 s.

5. With regard to the limited frequency sensitive mode – underfrequency (LFSM-U-EV):

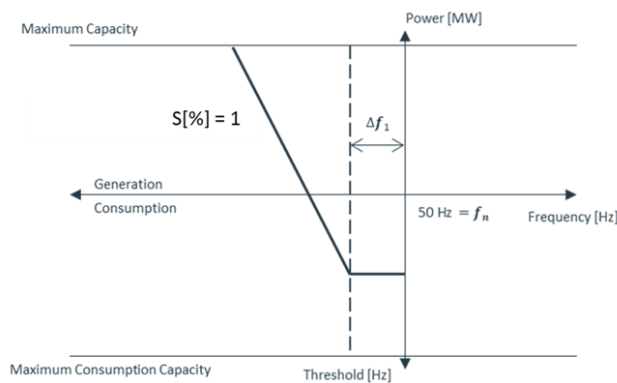
(a) A type EV1 and EV2 V2G electric vehicle and associated V2G electric vehicle supply equipments shall be capable of activating the provision of active power frequency response from the current active power input/output automatically up to the maximum capacity according to the indicative Figure YY at a frequency threshold and with the droop setting;

(b) The droop setting shall be 5%;

- (c) The frequency threshold Δf_1 shall be 49.8 Hz inclusive, except for synchronous area IE where the frequency threshold shall be 49.5 Hz inclusive;
- (d) A type EV1 and EV2 V2G electric vehicle and associated V2G electric vehicle supply equipment shall stay and operate stably in this specific mode as long as the frequency is below the frequency threshold and according to its content of energy. If the frequency recovers, the V2G electric vehicle and associated V2G electric vehicle supply equipment shall follow the same power-frequency characteristic until it is back to its prior state of active power input/output;
- (e) The response time, T_{resp} in Figure XX, shall be less or equal to 0.5 s for an active power setpoint change of 1 pu of P_{max} excluding the time for switching from consumption to generation or vice versa;
- (f) Switching from consumption to generation and vice versa should be as fast as technically feasible.

Figure YY

Active power frequency response capability of type EV1 and EV2 V2G electric vehicles and associated V2G electric vehicle supply equipment in LFSM-U-EV



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

6. With regard to limited frequency sensitive mode – overfrequency (LFSM-O-EV):

- (a) A type EV1 and EV2 V2G electric vehicle and associated V2G electric vehicle supply equipment which is consuming active power during an overfrequency event shall increase the level of active power consumed according to the LFSM-O characteristic, to the extent that is technically feasible. The type EV1 and EV2 V2G electric vehicle and associated V2G electric vehicle supply equipment shall absorb power up to filling the maximum energy that it is able to store, then it may cease consumption.
- (b) A Type EV1 and EV2 V2G electric vehicles and associated V2G electric vehicle supply equipment, which is injecting active power during an overfrequency event, shall activate the provision of active power frequency response according to Figure 1X at

the frequency threshold Δf_1 equal to 50.2 Hz (inclusive), except for synchronous area IE where Δf_1 shall be 50.5 Hz (inclusive);

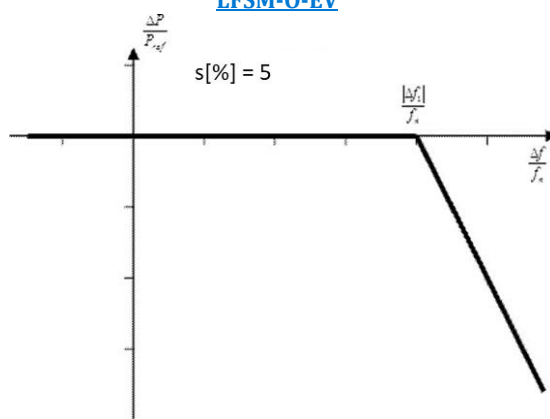
(c) The droop setting shall be 5-%;

(d) Any unintentional delay shall be as short as possible;

(a)(e) The type EV1 and EV2 V2G electric vehicle and associated V2G electric vehicle supply equipment shall be capable of operating stably during LFSM-O operation. When LFSM-O is active, the LFSM-O setpoint will prevail over any other active power setpoints which would result in an increase of power above the LFSM-O setpoint;

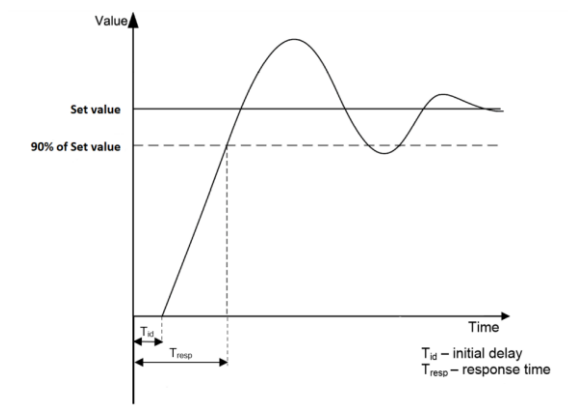
(f) The response time T_{resp} (Figure XX) for active power decrease in case of increasing frequency, shall be as fast as technically feasible and less or equal to 2 seconds for an active power setpoint change of 50% maximum power.

Figure 1X
Active power frequency response capability of type EV1 and EV2 V2G electric vehicles and associated V2G electric vehicle supply equipment in LFSM-O-EV



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

Figure XX



7. A type EV1 and EV2 V2G electric vehicle and associated V2G electric vehicle supply equipment shall be capable of maintaining constant output at its target active power value regardless of changes in frequency, except where output follows the changes specified in the context of paragraphs 2 and 4 of this Article.

8. With regard to voltage stability, a type EV1 and EV2 V2G electric vehicle and associated V2G electric vehicle supply equipment shall be capable of staying connected to the network and operate continuously within the range of 0.85 pu - 1.1 pu at the connection point. Beyond these voltage range values, the under voltage ride through immunity limits as specified in paragraph 10 apply.

9. A type EV1 and EV2 V2G electric vehicle and associated V2G electric vehicle supply equipment, when operating above the minimum stable operating level, shall be capable of staying connected to the network and continuing to operate stably after the power system has been disturbed by faults in the transmission network according to a voltage-against-time-profile in line with Figure 3 at the connection point and with the set points in Tables X.1.1 and X.1.2.

Comentado [A80]: This is what the standard EN 50549-1 specifies. There should be no exceptions so as to allow for harmonisation.

Table x.1.1

Voltage parameters for Figure 3 for fault-ride-through capability of type EV1 and EV2 V2G electric vehicle and associated V2G electric vehicle supply equipment

<u>Voltage parameters (pu)</u>	
$U_{ret,i}$	<u>0.15</u>
$U_{clear,i}$	<u>0.15</u>
$U_{rec1,i}$	<u>0.15</u>
$U_{rec2,i}$	<u>0.85</u>

Table X.1.2

Time parameters for Figure 3 for fault-ride-through capability of type EV1 and EV2 V2G electric vehicle and associated V2G electric vehicle supply equipment

<u>Time parameters (seconds)</u>	
$t_{clear,i}$	<u>0.15</u>
$t_{rec1,i}$	<u>0.15</u>
$t_{rec2,i}$	<u>0.15</u>
t_{rec3}	<u>3.0</u>

10. The voltage-against-time-profile expresses a lower limit of the profile of the phase-to-phase voltages [or single phase to neutral voltages for single phase type EV1 and EV2 V2G electric vehicles and associated V2G electric vehicle supply equipment] on the network voltage level during a symmetrical fault, as a function of time before, during and after the fault.

Comentado [A81]: Based on EU DSO proposal to capture single phase installations. Inclusion of this sentence in FRT capability in Articles X and Y.

11. When the network voltage resumes, after the fault has been cleared, to a value within the voltage range of 0.85 pu – 1.1 pu, a type EV1 and EV2 V2G electric vehicle and associated V2G electric vehicle supply equipment shall recover its active power output level to its pre-fault value. The recovery time shall not exceed a maximum of 1s.

Article 14

General requirements for type B power-generating modules

1. Type B power-generating modules shall fulfil the requirements for type A power-generating modules set out in Article 13, except for Article 13(2)(b) and Article 13(9).

2. Type B power-generating modules shall fulfil the following requirements in relation to frequency stability:

Comentado [A82]: Deletion follows the amendment to Article 13(6)

(a) to control active power output, the power-generating module shall be equipped with an interface (input port) in order to be able to reduce active power output following an instruction at the input port; and

(b) the relevant system operator shall have the right to specify the requirements for further equipment to allow active power output to be remotely operated.

2. The Type B power-generating module shall fulfil the following requirements relating to voltage stability:

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

(i) unless otherwise provided in this Regulation, a power-generating module shall be capable of staying connected to the network and operating within the ranges of the network voltage at the connection point, expressed by the voltage at the connection point related to the reference 1 pu voltage, and for the time periods specified in Tables XX.1 and XX.2 or, for rated voltages not included in the tables and above voltage level 110 kV as specified by the relevant system operator in coordination with the relevant TSO;

(ii) the relevant TSO may specify shorter periods of time during which power-generating modules shall be capable of remaining connected to the network in the event of simultaneous overvoltage and underfrequency or simultaneous undervoltage and overfrequency;

(iii) notwithstanding the provisions of paragraph (i), the relevant TSO in Spain may require power-generating modules to be capable of remaining connected to the network in the voltage range between 1,05 pu and 1,0875 pu for an unlimited period;

(iv) for the 400 kV grid voltage level (or alternatively commonly referred to as 380 kV level), 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;

(v) the relevant TSOs in the Baltic synchronous area may require power-generating modules to remain connected to the 400 kV network in the voltage range limits and for the time periods that apply in the Continental Europe synchronous area;

(vi) the relevant system operator, in coordination with the relevant 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 a power-generating module, if it is required to preserve or to restore system security.

Beyond the voltage range values specified above, the under and over voltage ride through immunity limits as specified in paragraphs (3)-(a) and (c)-apply.

The power-generating facility owner shall not unreasonably withhold consent to apply wider voltage ranges or longer minimum times for operation, taking account of their economic and technical feasibility;

Table XX.1

Synchronous area	Rated Voltage	Voltage range	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
	132 kV	0.85 pu-0.90 pu	60 minutes
		0.90 pu-1.098 pu	Unlimited
		1.098 pu-1.15 pu	To be specified by each TSO, but not less than 20 minutes and not more than 60 minutes
	150 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
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
	132 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
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
Baltic	110 kV	0.85 pu-0.90 pu	30 minutes
		0.90 pu-1.118 pu	Unlimited
		1.118 pu-1.15 pu	20 minutes
	220 kV	0.85 pu-0.90 pu	30 minutes
		0.90 pu-1.113 pu	Unlimited

		1.113 pu-1.15 pu	20 minutes
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The table shows the minimum time periods during which a power-generating module shall ~~must~~ be capable of operating for voltages deviating from the reference 1 pu value at the connection point without disconnecting from the network, where the voltage base for pu values is from 110 kV to (not including) 300 kV.

Table XX.2

Synchronous area	Rated Voltage	Voltage range	Time period for operation
Continental Europe	330 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
	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	330 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
	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	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
Baltic	330 kV	0.88 pu-0.90 pu	20 minutes
		0.90 pu-1.097 pu	Unlimited
		1.097 pu-1.15 pu	20 minutes

400 kV	0.88 pu-0.90 pu	20 minutes
	0.90 pu-1.05 pu	Unlimited
	1.05 pu-1.15 pu	20 minutes

The table shows the minimum time periods during which a power-generating module shall be capable of operating for voltages deviating from the reference 1 pu value at the connection point without disconnecting from the network where the voltage base for pu values is from 300 kV to 400 kV (included).

3. The Type B power-generating module shall fulfil the following requirements in relation to robustness:

(a) with regard to fault-ride-through capability of power-generating modules:

- (i) each TSO shall specify a voltage-against-time-profile in line with Figure 3 at the connection point for fault conditions, which describes the conditions in which the power-generating module, when operating above the minimum stable operating level, is capable of staying connected to the network and continuing to operate stably after the power system has been disturbed by secured faults on the transmission system;
- (ii) the voltage-against-time-profile shall express a lower limit of the actual course of the phase-to-phase voltages on the network voltage level at the connection point during a symmetrical fault, as a function of time before, during and after the fault;
- (iii) the lower limit referred to in point (ii) shall be specified by the relevant TSO using the parameters set out in Figure 3, and within the ranges set out in Tables 3.1.1, 3.1.2, and 3.2.1 and 3.2.2;
- (iv) each TSO shall specify and make publicly available the pre-fault and post-fault conditions for the fault-ride-through capability in terms of:
 - the calculation of the pre-fault minimum short circuit capacity at the connection point,
 - pre-fault active and reactive power operating point of the power-generating module at the connection point and voltage at the connection point, and
 - calculation of the post-fault minimum short circuit capacity at the connection point;
- (v) 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 at the connection point as specified in point (iv) regarding:
 - pre-fault minimum short circuit capacity at each connection point expressed in MVA,
 - pre-fault operating point of the power-generating module expressed in active power output and reactive power output at the connection point and voltage at the connection point, and

Comentado [A83]: Based on proposals from several stakeholders: amendments to the voltage ranges relating to the need to maintain sufficient levels of system robustness. It is deemed necessary to amend the upper limit of the voltage range as this corresponds to too onerous requirement for 400kV connected PGMs.

Comentado [A84]: Changes to Article 14(3) follow ENTSO-E amendment proposal No. 16.

Wording of the current version of the NC leads to non-uniform interpretation of this NC during national implementation.

It seems important that the text, figure and table are unambiguous, and for this reason, the link between time and voltage parameters should not appear in the tables but only in the figures. It is therefore proposed to split the tables into separate tables for voltage parameters and tables for time parameters.

Some changes are associated to ENTSO-E amendment 48 of coherence between FRT profiles and time-limited requirement of the voltage withstand capability.

Comentado [A85]: Based on Enercon proposal. The fault-ride-through capability should not apply when the PGM is operating below the agreed minimum stable operating level.

—post-fault minimum short circuit capacity at each connection point expressed in MVA.

Alternatively, the relevant system operator may provide generic values derived from typical cases;

Figure 3

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

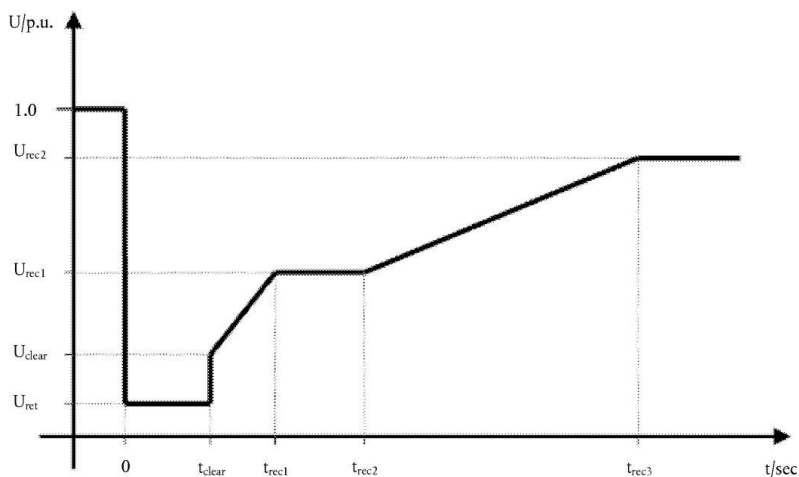


Table 3.1.1

Voltage Parameters for Figure 3 for fault-ride-through capability of synchronous power-generating modules

Voltage parameters (pu)		Time parameters (seconds)	
U_{ret} :	0,05-0,3	t_{clear} :	0,14-0,15 (or 0,14-0,25 if system protection and secure operation)

			so require)
U_{clear} :	0,7-0,9 and $\leq U_{rec2}$	t_{rec1}	t_{clear}
U_{rec1} :	U_{clear}	t_{rec2}	$t_{rec1}-0,7$
U_{rec2} :	Minimum voltage specified in paragraph (2) 0,85-0,9 and $\geq U_{clear}$	t_{rec3}	$t_{rec2}-1,5$

Table 3.1.2

Time parameters for Figure 3 for fault-ride-through capability of synchronous power-generating modules

Time parameters (seconds)	
t_{clear} :	0,14-0,15 (or 0,14-0,25 if justified by the system protection and secure operation needs)
t_{rec1} :	t_{clear}
t_{rec2} :	$t_{rec1}-0,7$
t_{rec3} :	$t_{rec2}-1,5$

Comentado [A86]: Amendment based on the proposal from Eurelectric and Swedenergy. It should be clearly specified in RfG that a value outside the default interval may only be required under certain conditions for specific PGMs.

Table 3.2.1

Voltage parameters for Figure 3 for fault-ride-through capability of power park modules

Voltage parameters (pu)		Time parameters (seconds)	
U_{ret} :	0,05-0,15	t_{clear}	0,14-0,15 (or 0,14-0,25 if system protection and secure operation so require)
U_{clear} :	$U_{ret}-0,15$	t_{rec1}	t_{clear}

U_{rec1} :	U_{clear}	t_{rec2}	t_{rec3}
U_{rec2} :	Minimum voltage specified in paragraph (2) 0,85	t_{rec2}	1,5-3,0

Table 3.2.2
Time parameters for Figure 3 for fault-ride-through capability of power park modules

Time parameters (seconds)	
t_{clear}	0.14-0.15 (or 0.14-0.25 if justified by the system protection and secure operation needs)
t_{rec1}	t_{clear}
t_{rec2}	t_{rec1}
t_{rec3}	1.5-3.0

Comentado [A87]: Amendment based on the proposal from Eurelectric and Swedenergy. It should be clearly specified in RfG that a value outside the default interval may only be required under certain conditions for specific PGMs.

(vi) the power-generating module shall be capable of remaining connected to the network and continuing to operate stably when the actual course of the phase-to-phase voltages on the network voltage level at the connection point during a symmetrical fault, given the pre-fault and post-fault conditions in points (iv) and (v) of paragraph 3(a), remain above the lower limit specified in point (ii) of paragraph 3(a), 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 must not jeopardise fault-ride-through performance capabilities of a power-generating module, in line with the requirements set out in this Regulation;

Comentado [A88]: Amendment for consistency reason, see Article 14(5)(b).

(vii) without prejudice to point (vi) of paragraph 3(a), undervoltage protection (either fault-ride-through capability or minimum voltage specified at the connection point voltage) shall be set by the power-generating facility owner according to the widest possible technical capability of the power-generating module, unless the relevant system operator requires narrower settings in accordance with point (b) of paragraph 5. The settings of the widest possible technical capability of the power-generating module shall be justified by the power-generating facility owner in accordance with this principle;

Comentado [A89]: Editorial change so as to ensure clarity.

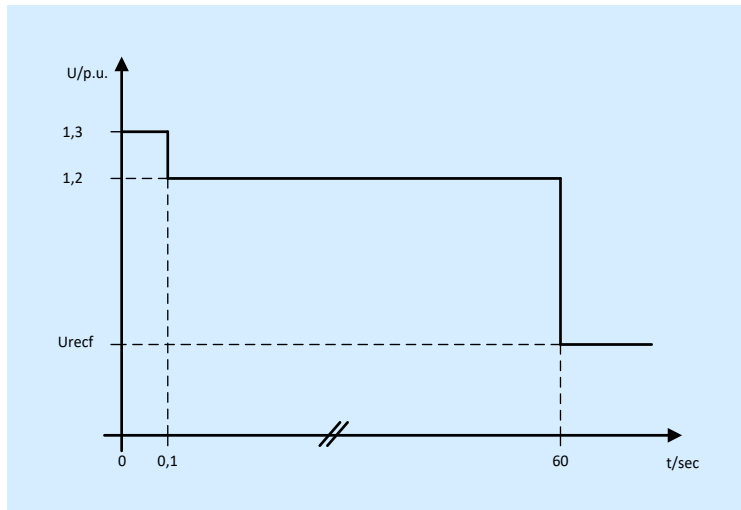
(b) fault-ride-through capabilities in case of asymmetrical faults shall be specified by each TSO.

(c) 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 defined in Figure X at the agreed connection point. The

relevant system operator, in coordination with the relevant TSO, shall define higher longer times for operation, if it is required to preserve or to restore system security.

Figure X

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 at the connection point, before, during and after a fault. Urefc is the maximum voltage specified in paragraph 2.

4. ~~They~~^{type B} power-generating modules shall fulfil the following requirements relating to system restoration:

(a) ~~the use of autonomous connection function shall be subject to prior authorisation by the relevant system operator and to the reconnection conditions specified by the relevant TSO; the relevant TSO shall specify the conditions under which a power-generating module is capable of reconnecting to the network after an incidental disconnection caused by a network disturbance; and~~

(b) ~~within the capability defined in Article 13(7), the relevant TSO, in coordination with the relevant system operator, shall specify the settings for an autonomous connection. If no settings are specified, the default settings for an autonomous connection of Article 13(8) shall apply. installation of automatic reconnection systems shall be subject both to prior authorisation by the relevant system operator and to the reconnection conditions specified by the relevant TSO.~~

(c) ~~in case of change in the network leading to the minimum short-circuit level as defined in the connection agreement, the PGM shall be able to ensure robustness to its control system. Minimum short-circuit level shall be clearly specified by the TSO/RSO in the connection agreement.~~

5. ~~They~~^{type B} power-generating modules shall fulfil the following general system management requirements:

(a) with regard to control schemes and settings:

Comentado [A90]: ENTSO-E amendment proposal No. 55. It is important that power generating modules stay connected during overvoltage situations as they contribute to both frequency stability and voltage support. In case of disconnection, voltage will degrade even more, impacting other equipment's connected to the network.

Comentado [A92]: According to ENTSO-E amendment proposal No. 20. Automatic reconnection may be required for two reasons:
- switching 'on' the power generating unit to work (synchronization)
- switching 'on' the power generating unit to work after disturbance
The existing RfG already formulates requirements for this, but the requirements are not clearly defined from each other.
The two "switching on's" are something really different concerning frequency stability. Whereas the normal starting operation occurs under stable system conditions, the coming back after a disturbance is under semi-stable conditions. For the sake of stability, this needs to be clarified.

Comentado [A91]: According to ENTSO-E amendment proposal No. 20. Stability of the PGM in the case of reduction of the system strength (low short-circuit level), robustness of the controller of the PGMs should be ensured in case of outage in the network

(i) 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 shall be coordinated and agreed between the relevant TSO, the relevant system operator and the power-generating facility owner;

(ii) any changes to the schemes and settings, mentioned in point (i), of the different control devices of the power-generating module shall be coordinated and agreed between the relevant TSO, the relevant system operator and the power-generating facility owner, in particular if they apply in the circumstances referred to in point (i) of paragraph 5(a);

(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 power-generating module. The protection schemes needed for the power-generating module and the network as well as the settings relevant to the power-generating module shall be coordinated and agreed between the relevant system operator and the power-generating facility owner. The protection schemes and settings for internal electrical faults must not jeopardise the technical capabilities performance of a power-generating module, in line with the requirements set out in this Regulation;

(ii) electrical protection of the power-generating module shall take precedence over operational controls, taking into account the security of the system and the health and safety of staff and of the public, as well as mitigating any damage to the power-generating module;

(iii) protection schemes may cover the following aspects:

- external and internal short circuit,
- asymmetric load (negative phase sequence),
- stator and rotor overload,
- over-/underexcitation,
- over-/undervoltage at the connection point,
- over-/undervoltage at the alternator terminals,
- inter-area oscillations,
- inrush current,
- asynchronous operation (pole slip),
- protection against inadmissible shaft torsions (for example, subsynchronous resonance),
- power-generating module line protection,
- ~~unit~~ transformer protection,
- back-up against protection and switchgear malfunction,
- overfluxing (U/f),
- ~~reverse~~ reverse power,
- rate of change of frequency, and

Comentado [A93]: Based on VGBE amendment proposal. For clarification as the phrase 'performance of a PGM' can be confusing.

Comentado [A94]: In accordance with ENTSO-E amendment proposal No. 15. The term "unit" is only used in the RfG in connection with a single wind turbine. It does not occur in any other context. "transformer protection" is adequately defined as a single term. Therefore, the term "unit" is removed.

Comentado [A95]: Amendment follows VGBE proposal. For clarity.

— neutral voltage displacement.

(iv) changes to the protection schemes needed for the power-generating module and the network, ~~and as well as, the relevant to the settings relevant concerning to~~ the power-generating module shall be agreed between the system operator and the power-generating facility owner, and agreement shall be reached before any changes are made;

Comentado [A96]: Editorial changes so as to ensure clarity.

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

- (i) network and power-generating module protection;
- (ii) synthetic inertia, if applicable;
- (iii) frequency control (active power adjustment);
- (iv) power restriction; and
- (v) power gradient constraint;

(d)with regard to information exchange:

- (i) power-generating facilities shall be capable of exchanging information with the relevant system operator or the relevant TSO in real time ~~or periodically with time stamping~~, as specified by the relevant system operator or the relevant TSO. ~~The content of real-time data shall be consistent with the data exchange requirements laid down in Title 2 of Regulation (EU) 2017/1485;~~
- (ii) power-generating facilities shall be capable of exchanging real time data for metering with the relevant system operator or the relevant TSO; ~~the relevant system operator, in coordination with the relevant TSO, shall specify the content of information exchanges including a precise list of data to be provided by the power-generating facility.~~
- (iii) if required by the relevant system operator power-generating facilities shall be able capable to provide fault recording for the following parameters:
 - voltage,
 - active power,
 - reactive power, and
 - frequency;
- (iv) 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 relevant TSO;
- (v) the facilities for quality of supply and dynamic system behaviour monitoring shall include arrangements for the power-generating facility owner, and the relevant system operator and the relevant TSO to access the information. ~~The communications protocols for recorded data shall be agreed between the power-generating facility owner, the relevant system operator and the relevant TSO.~~

Comentado [A97]: Changes follow ENTSO-E amendment proposal No. 18.

The text "periodical data exchange (with time stamping)" is left out of the article. Instead a reference to the SO GL is made. The existing text of (ii) is left completely as data provision is also addressed in SO GL. New text for (ii) is drafted.

Periodic data with a timestamp is a different type of real-time data, so we suggest removing this term. It is also imprecise in the context of solutions specified in SO GL. The real-time data exchange capability should be determined by the NC RfG (see i)). The information content (data range) of real-time data as well as structural and scheduled data is determined by SO GL and related documents (for the real-time data exchange see Art.47.1 of SO GL)

Comentado [A98]: Amendment follows the proposal from the EU DSO Entity.

The capabilities of modern protection relays make it possible in almost all new installations that there is disturbance information stored in these relays. This suggestion is to draft an option to allow the RSO to place an obligation on the generation owner to provide fault recording information from such, or other, facilities.

Article 14a

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

1. Type EV3 electric vehicles and associated V2G electric vehicle supply equipment shall fulfil the requirements set out in Article 13a for type EV1 and EV2 V2G electric vehicles and associated V2G electric vehicle supply equipment, except for Article 13a(9) and 13a(10).

2. A type EV3 electric vehicle and associated V2G electric vehicle supply equipment shall fulfil the following requirements relating to voltage stability:

a) With regard to voltage stability, a type EV3 electric vehicle and associated V2G electric vehicle supply equipment shall be capable of staying connected to the network and operate continuously within the range of 0.9 pu - 1.1 pu at the connection point should that be above 400V and below 110 kV. Beyond these voltage range values, the under and over voltage ride through immunity limits, as specified in Article 14(3)(a) and (c) apply:

b) With regard to voltage ranges of 110 kV and above:

(i) unless otherwise provided in this Regulation, a type EV3 electric vehicle and associated V2G electric vehicle supply equipment shall be capable of staying connected to the network and operating within the ranges of the network voltage at the connection point, expressed by the voltage at the connection point related to the reference 1 pu voltage, and for the time periods specified in Tables XX.1 and XX.2 or, for rated voltages not included in the tables and above voltage level 110 kV as specified by the relevant system operator in coordination with the relevant TSO;

(ii) the relevant TSO may specify shorter periods of time during which type EV3 electric vehicles and associated V2G electric vehicle supply equipment shall be capable of remaining connected to the network in the event of simultaneous overvoltage and underfrequency or simultaneous undervoltage and overfrequency;

(iii) notwithstanding the provisions of paragraph (i), the relevant TSO in Spain may require type EV3 electric vehicles and associated V2G electric vehicle supply equipment to be capable of remaining connected to the network in the voltage range between 1.05 pu and 1.0875 pu for an unlimited period;

(iv) for the 400 kV grid voltage level (or alternatively commonly referred to as 380 kV level), 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;

(v) the relevant TSOs in the Baltic synchronous area may require type EV3 electric vehicles and associated V2G electric vehicle supply equipment to remain connected to the 400 kV network in the voltage range limits and for the time periods that apply in the Continental Europe synchronous area;

Comentado [A99]: Changed to reflect modification in article 14(2)(a)(i)

(vi) the relevant system operator, in coordination with the relevant TSO, and the 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 electric vehicles and associated V2G electric vehicle supply equipment, if it is required to preserve or to restore system security.

The electrical charging park owner shall not unreasonably withhold consent to apply wider voltage ranges or longer minimum times for operation, taking account of their economic and technical feasibility;

3. Type EV3 electric vehicles and associated V2G electric vehicle supply equipment shall fulfil the following requirements in relation to robustness:

(a) with regard to fault-ride-through capability:

(i) each TSO shall specify a voltage-against-time-profile in line with Figure 3 at the connection point for fault conditions, which describes the conditions in which a type EV3 electric vehicle and associated V2G electric vehicle supply equipment, when operating above the minimum stable operating level, is capable of staying connected to the network and continuing to operate stably after the power system has been disturbed by secured faults on the transmission system;

(ii) the voltage-against-time-profile shall express a lower limit of the actual course of the phase-to-phase voltages on the network voltage level at the connection point during a symmetrical fault, as a function of time before, during and after the fault;

(iii) the lower limit referred to in point (ii) shall be specified by the relevant TSO, in co-ordination with the relevant system operator, using the parameters set out in Figure 3, and within the ranges set out in Tables 3.1.1, 3.1.2, 3.2.1 and 3.2.2;

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

— the calculation of the pre-fault minimum short circuit capacity at the connection point,

— pre-fault active and reactive power operating point of the type EV3 electric vehicles and associated V2G electric vehicle supply equipment at the connection point and voltage at the connection point, and

— calculation of the post-fault minimum short circuit capacity at the connection point;

(v) at the request of an 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 at the connection point as specified in point (iv) regarding:

— pre-fault minimum short circuit capacity at each connection point expressed in MVA,

— pre-fault operating point of the type EV3 electric vehicles and associated V2G electric vehicle supply equipment expressed as active power output and reactive power output at the connection point and voltage at the connection point, and

—post-fault minimum short circuit capacity at each connection point expressed in MVA.

Alternatively, the relevant system operator may provide generic values derived from typical cases:

Table 3.2.1

Voltage parameters for Figure 3 for fault-ride-through capability of type EV3 electric vehicles and associated V2G electric vehicle supply equipment

<u>Voltage parameters (pu)</u>			
$\underline{U}_{\text{ret}}$	0.05-0.15		
$\underline{U}_{\text{clear}}$	$\underline{U}_{\text{ret}}-0.15$		
$\underline{U}_{\text{rec1}}$	$\underline{U}_{\text{clear}}$		
$\underline{U}_{\text{rec2}}$	Minimum voltage specified in paragraph (2)		

Table 3.2.2

Time parameters for Figure 3 for fault-ride-through capability of type EV3 electric vehicles and associated V2G electric vehicle supply equipment

<u>Time parameters (seconds)</u>	
t_{clear}	0.14-0.15 (or 0.14-0.25 if justified by the system protection and secure operation needs)
t_{rec1}	t_{clear}
t_{rec2}	t_{rec1}
t_{rec3}	1.5-3.0

(vi) the type EV3 electric vehicle and associated V2G electric vehicle supply equipment shall be capable of remaining connected to the network and continuing to operate stably when the actual course of the phase-to-phase voltages on the network voltage level at the connection point during a symmetrical fault, given the pre-fault and post-fault conditions in points (iv) and (v) of paragraph 3(a), remain above the lower limit specified in point (ii) of paragraph 3(a), unless the protection scheme for internal electrical faults requires the disconnection of the type EV3 electric vehicle and associated V2G electric vehicle supply equipment from the network.

The protection schemes and settings for internal electrical faults must not jeopardise fault-ride-through capabilities of a type EV3 electric vehicle and associated V2G electric vehicle supply equipment, in line with the requirements set out in this Regulation;

(vii) without prejudice to point (vi) of paragraph 3(a), undervoltage protection (either fault-ride-through capability or minimum voltage specified at the connection point voltage) shall be set by the electrical charging park owner according to the widest possible technical capability of the type EV3 electric vehicles and associated V2G electric vehicle supply equipment, unless the relevant system operator requires narrower settings in accordance with point (b) of paragraph 5. The settings shall be justified by the electrical charging park owner in accordance with this principle;

(b) fault-ride-through capabilities in case of asymmetrical faults shall be specified by each TSO.

4. Type EV3 electric vehicles and associated V2G electric vehicle supply equipment shall fulfil the following requirements relating to system restoration:

(a) the relevant TSO shall specify the conditions under which a type EV3 electric vehicles and associated V2G electric vehicle supply equipment is capable of reconnecting to the network after an incidental disconnection caused by a network disturbance; and

(b) installation of automatic reconnection systems shall be subject both to prior authorisation by the relevant system operator and to the reconnection conditions specified by the relevant TSO.

5. Type EV3 electric vehicles and associated V2G electric vehicle supply equipment shall fulfil the following general system management requirements:

(a) with regard to control schemes and settings:

(i) the schemes and settings of the different control devices of the type EV3 electric vehicles and associated V2G electric vehicle supply equipment that are necessary for transmission system stability and for taking emergency action shall be coordinated and agreed between the relevant TSO, the relevant system operator and the electrical charging park owner;

(ii) any changes to the schemes and settings, mentioned in point (i), of the different control devices of the type EV3 electric vehicles and associated V2G electric vehicle supply equipment shall be coordinated and agreed between the relevant TSO, the relevant system operator and the electrical charging park owner, in particular if they apply in the circumstances referred to in point (i) of paragraph 5(a);

(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 electric vehicles and associated V2G electric vehicle supply equipment. The protection schemes needed for the type EV3 electric vehicles and associated V2G electric vehicle supply equipment and the network as well as the settings relevant to the type EV3 electric vehicles and associated V2G electric vehicle supply equipment shall be coordinated and agreed between the relevant system operator and the electrical charging park owner. The protection schemes and settings for internal

electrical faults must not jeopardise the technical capabilities of a type EV3 electric vehicles and associated V2G electric vehicle supply equipment, in line with the requirements set out in this Regulation;

(ii) electrical protection of the type EV3 electric vehicles and associated V2G electric vehicle supply equipment shall take precedence over operational controls, taking into account the security of the system and the health and safety of staff and of the public, as well as mitigating any damage to the EV3 electric vehicles and associated V2G electric vehicle supply equipment;

(iii) protection schemes may cover the following aspects:

- external and internal short circuit,
- asymmetric load (negative phase sequence),
- over-/underexcitation,
- over-/undervoltage at the connection point,
- over-/undervoltage at the alternator terminals,
- inter-area oscillations,
- inrush current,
- asynchronous operation,
- line protection,
- transformer protection,
- back-up against protection and switchgear malfunction,
- overfluxing (U/f),
- rate of change of frequency, and
- neutral voltage displacement.

(iv) changes to the protection schemes needed for the type EV3 electric vehicles and associated V2G electric vehicle supply equipment and the network and to the settings relevant to the type EV3 electric vehicles and associated V2G electric vehicle supply equipment shall be agreed between the system operator and the electrical charging park owner, and agreement shall be reached before any changes are made;

(c) the electrical charging park owner shall organise its protection and control devices in accordance with the following priority ranking (from highest to lowest):

- (i) network and EV3 electric vehicles and associated V2G electric vehicle supply equipment protection;
- (ii) synthetic inertia, if applicable;
- (iii) frequency control (active power adjustment);
- (iv) power restriction; and
- (v) power gradient constraint;

(d) with regard to information exchange:

(i) V2G electrical charging parks shall be capable of exchanging information with the relevant system operator or the relevant TSO in real time, as specified by the relevant system operator or the relevant TSO. The content of real-time data shall be

consistent with the data exchange requirements laid down in Title 2 of Regulation (EU) 2017/1485;

(ii) V2G electrical charging parks shall be capable of exchanging real time data for metering with the relevant system operator or the relevant TSO;

(iii) if required by the relevant system operator the V2G electrical charging park shall be able to provide fault recording for the following parameters:

- voltage,
- active power,
- reactive power, and
- frequency;

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

(v) the facilities for quality of supply and dynamic system behaviour monitoring shall include arrangements for the electrical charging park owner, and the relevant system operator and the relevant TSO to access the information. The communications protocols for recorded data shall be agreed between the electrical charging park owner, the relevant system operator and the relevant TSO.

6. Type EV3 electric vehicles and associated V2G electric vehicle supply equipment shall fulfil the following additional requirements in relation to voltage stability:

(a) with regard to reactive power capability, the relevant system operator shall have the right to specify the capability of a type EV3 electric vehicles and associated V2G electric vehicle supply equipment to supply and absorb reactive power;

(b) the relevant system operator in coordination with the relevant TSO shall have the right to specify that a type EV3 electric vehicles and associated V2G electric vehicle supply equipment be capable of providing fast fault current at the connection point in case of symmetrical (3-phase) faults, regarding the following:

(i) the type EV3 electric vehicles and associated V2G electric vehicle supply equipment shall be capable of activating the supply of fast fault current either by:

- ensuring the supply of the fast fault current at the connection point, or
- measuring voltage deviations at the terminals of the individual type EV3 electric vehicle and associated V2G electric vehicle supply equipment and providing a fast fault current at their terminals;

(ii) the relevant system operator in coordination with the relevant TSO shall specify:

- how and when a voltage deviation is to be determined as well as the end of the voltage deviation,
- the characteristics of the fast fault current, including the time domain for measuring the voltage deviation and fast fault current, for which current and voltage may be measured differently from the method specified in Article 2,

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

(c)with regard to the supply of fast fault current in case of asymmetrical (1-phase or 2-phase) faults, the relevant system operator in coordination with the relevant TSO shall have the right to specify a requirement for asymmetrical current injection.

7. Type EV3 electric vehicles and associated V2G electric vehicle supply equipment shall fulfil the following additional requirements in relation to robustness:

(a)the relevant TSO shall specify the post-fault active power recovery that the type EV3 electric vehicle and associated V2G electric vehicle supply equipment is capable of providing and shall specify:

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

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

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

(b)the specifications shall be in accordance with the following principles:

(i)interdependency between fast fault current requirements according to points (b) and (c) of paragraph 2 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; and

(v) adequate damping of active power oscillations.

8. The relevant TSO shall have the right to request grid forming capability at its connection point from type EV3 electric vehicles and associated V2G electric vehicle supply equipment as listed in Article Y.

Article 15

General requirements for type C power-generating modules

1. Type C power-generating modules shall fulfil the requirements laid down in Articles 13 and 14, except for Article 13(2)(b) and (6) and ~~Article 14(5)(d)(iii)~~Article 14(2).

2. Type C power-generating modules shall fulfil the following requirements relating to frequency stability:

(a)with regard to active power controllability and control range, the power-generating module control system shall be capable of adjusting an active power setpoint in line with instructions given to the power-generating facility owner by the relevant system operator or the relevant TSO.

The relevant system operator or the relevant TSO shall establish the period within which the adjusted active power setpoint must be reached. The relevant TSO shall specify a tolerance (subject to the availability of the prime mover resource) applying to the new setpoint and the time within which it must be reached;

(b) manual local measures shall be allowed in cases where the automatic remote control devices are out of service.

The relevant system operator or the relevant TSO shall notify the regulatory authority of the time required to reach the setpoint together with the tolerance for the active power;

(c) In addition to Article 13(23), the following requirements shall apply to type C power-generating modules 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 at a frequency threshold and with a droop specified by the relevant TSO in coordination with the TSOs of the same synchronous area as follows:

- the frequency threshold ~~specified by the TSO~~ shall be $50\text{Hz} + \Delta f$, where Δf is defined in Table X between 49,8 Hz and 49,5 Hz inclusive,
- the droop settings ~~specified by the TSO~~ shall be in the range 2-12 %.

This is represented graphically in Figure 4;

(ii) the actual delivery of active power frequency response in LFSM-U mode shall be capable of taking into account, if applicable:

- ambient conditions when the response is to be triggered,
 - the operating conditions of the power-generating module, in particular limitations on operation near maximum capacity at low frequencies and the respective impact of ambient conditions according to paragraphs 4 and 5 of Article 13, and
 - the availability of the primary energy sources.
- ~~— an external signal allowing the relevant system operator to block the LFSM-U mode in real-time.~~

(iii) ~~the start of active power increase (initial delay time T_{id} (Figure XX)) by the power-generating module shall not be intentionally delayed. Any unintentional delay shall be as short as possible, the activation of active power frequency response by the power-generating module shall not be unduly delayed. In the event of any delay greater than two seconds, the power-generating facility owner shall justify it to the relevant TSO;~~

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

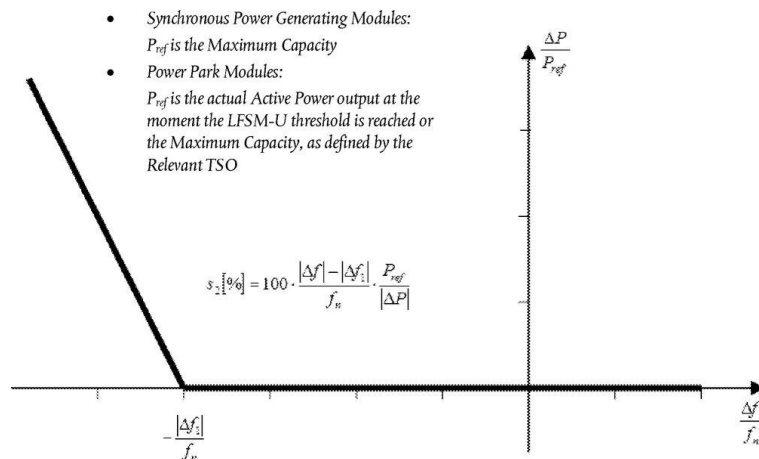
(v) stable operation of the power-generating module during LFSM-U operation shall be ensured;

Figure 4

Active power frequency response capability of power-generating modules in LFSM-U

Comentado [A100]: Changes to Article 15(2)(c) follow ENTSO-E amendment proposals No. 21 and 22. LFSM-U threshold should be harmonized at synchronous area level and aligned between FSM and LFSM-U also the response time for LFSM-U is not defined. To ensure a harmonized and stable behaviour dynamic parameters need to be defined.

Comentado [A101]: It is already mentioned above that the droop will be specified by the TSO.



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 is the frequency deviation in the network. At underfrequencies where Δf is below Δf_i the power-generating module has to provide a positive active power output change according to the droop S_2 . [In the case of electricity storage modules, \$P_{ref}\$ could be the maximum capacity or the maximum consumption capacity at the moment the LFSM-U threshold is reached or the maximum capacity or maximum consumption capacity as agreed with the relevant system operator.](#)

(vi) [The response time \$T_{resp}\$ \(Figure XX\) for LFSM-U shall be as fast as technically feasible and as described below:](#)

— [For SPGM: less or equal to 5 min for an active power setpoint change of 20% maximum power.](#)

— [For PPM: less or equal to 10 s for an active power setpoint change of 50% maximum power.](#)

[If the response time is greater than stated above, the power-generating facility owner shall justify the higher response times, providing technical evidence to the relevant TSO.](#)

(d in addition to point (c) of paragraph 2, the following shall apply cumulatively when) frequency sensitive mode ('FSM') is operating:

(i the power-generating module shall be capable of providing active power frequency) response in accordance with the parameters specified by each relevant TSO within the ranges shown in Table 4 [and Table X](#). In specifying those parameters, the relevant TSO shall take account of the following facts:

—in case of overfrequency, the active power frequency response is limited by the minimum regulating level. [In 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 \(as declared by the manufacturer\) that the electricity storage module can store in its operative](#)

Comentado [A102]: Changes to Article 15(2)(d) follow ENTSO-E amendment proposal No. 53. Other stakeholders proposals, such as WindEurope's and EU Turbine's have also been taken into account. Frequency is shared in the same synchronous area, thus it is important to have the same behaviour regarding the frequency control functions to maintain frequency stability. LFSM-U and LFSM-O thresholds should be harmonized at synchronous area level and aligned with FSM settings. To ensure a harmonized and stable behaviour dynamic parameters need to be defined. It is also important that the function is used in the same way by all TSOs in a synchronous zone so that there is no unwanted interference. To ensure this, frequency ranges and droops must be harmonised.

condition or as agreed between the power generating facility and the relevant TSO irrespective to whether the electricity storage module is independently connected to the transmission or distribution network or within a power park module sharing a single network connection with other power generating modules of lower energy content or of lower export power capacity.

—in case of underfrequency, the active power frequency response is limited by maximum capacity, and, in case of electricity storage modules, also by the maximum consumption capacity or maximum energy content of the electricity storage module in its operative condition (as declared by manufacturer) or as agreed between the power generating facility and the relevant TSO irrespective to whether the electricity storage module is independently connected to the transmission or distribution network or within a power park module sharing a single network connection with other power generating modules or demand of lower energy content or maximum consumption capacity.

—the actual delivery of active power frequency response depends on the operating and ambient conditions, as well as, on the underlying energy storage technology for the, of the power-generating module when this response is triggered, in particular, but not limited to, limitations on operation near maximum capacity at low frequencies according to paragraphs 4 and 5 of Article 13 and available primary energy sources;

- the TSO shall take into account the time needed for some technologies of electricity storage modules to switch from consumption mode to generating mode or vice versa and also the fact that the droop primary frequency control characteristic in consumption and generating mode could be different.

Comentado [A103]: Added based on WindEurope proposal.

Comentado [A104]: Added based on WindEurope proposal.

Comentado [A105]: This is to cater for nascent technologies e.g. using hydrogen

Comentado [A106]: Added based on EUTurbine and EG Storage proposal.

Comentado [A107]: Changes to Table 4 follow ENTSO-E amendment proposals No. 23 and 25. Frequency is common parameter for whole synchronous area, the stability of this global variable is strongly linked to the insensitivity and to the dead band. For safety reason this variable needs to be as smaller as possible.

Table 4

Parameters for active power frequency response in FSM (explanation for Figure 5)

Parameters	Ranges	
Active power range related to maximum capacity $\frac{ \Delta P_1 }{P_{\max}}$	1,5-10 %, except for electricity storage module. 1.5-100% for electricity storage module.	
Maximum combined effect of inherent frequency response insensitivity and possible intentional frequency response dead band for power-generating modules providing FSM Frequency response insensitivity	$ \Delta f_i $	10-30-15 mHz
	$\frac{ \Delta f_i }{f_n}$	0,02-0,06 %

Frequency response deadband	0-500 mHz
Droop s_1	2- 12 27 %

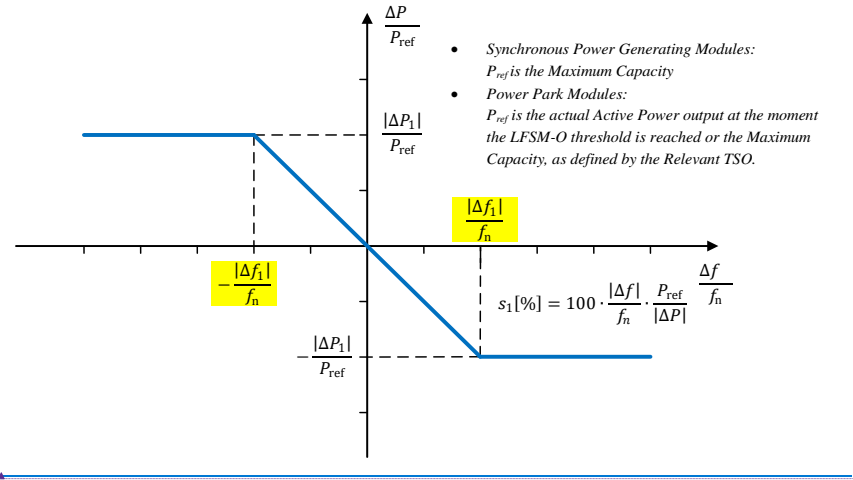
Table X

Definition of Δf1 used for FSM, LFSM-O and LFSM-U (explanation for Figure 1, 4 and 5)

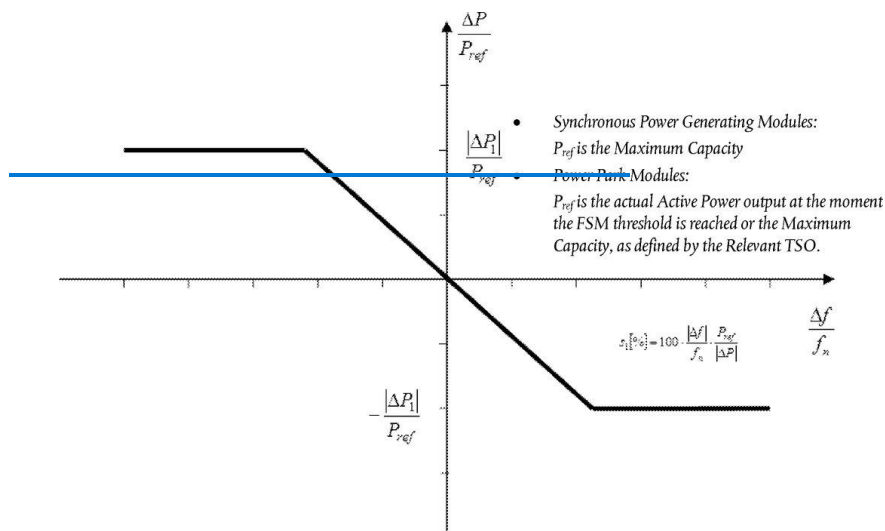
Synchronous area	Δf1 thresholds
Continental Europe	0,2 Hz
Nordic	0,5 Hz
Ireland and Northern Ireland	0,2 Hz (for LFSM-O and FSM), 0,5 Hz (LFSM-U)
Baltic	0,2 Hz

Figure 5

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



Código de campo cambiado



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

- (ii) the frequency response deadband of frequency deviation and droop must be able to be reselected repeatedly;
- (iii) 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 full line shown in Figure 6 in accordance with the parameters specified by each TSO (which shall aim at avoiding active power oscillations for the power-generating module) within the ranges given in Table 5. The combination of choice of the parameters specified by the TSO shall take possible technology-dependent limitations into account;
- (iv) the initial activation of active power frequency response required shall be as short as possible not be unduly delayed.

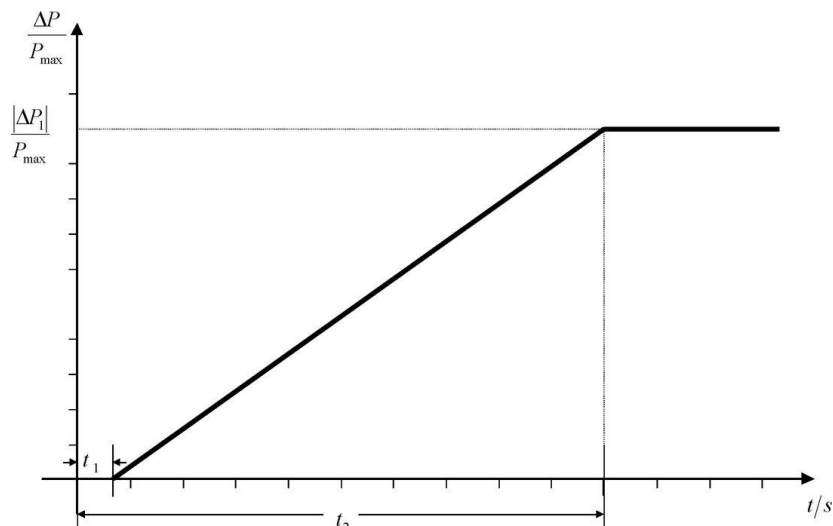
If the delay in initial activation of active power frequency response is greater than two seconds, the power-generating facility owner shall provide technical evidence demonstrating why a longer time is needed.

For power-generating modules without inertia, the relevant TSO may specify a shorter time than two seconds. If the power-generating facility owner cannot meet this requirement they shall provide technical evidence demonstrating why a longer time is needed for the initial activation of active power frequency response;

Figure 6

Comentado [A108]: In accordance with ENTSO-E Amendment 24. Delay for active power response is a crucial parameter for stopping and preventing the change of frequency during system incidents. Due to this, it is important that this parameter is as small as possible, especially for a PPM's.

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 has to 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 relevant TSO according to Table 5. t_1 is the initial delay. t_2 is the time for full activation.

- (v) the power-generating module shall be capable of providing full active power frequency response for a period of between 15 and 30 minutes as specified by the relevant TSO in coordination with the TSOs of the same synchronous area. ~~It specifying the period, the TSO shall have regard to active power headroom and Unless, where agreed between the relevant TSO and the power-generating facility owner, contribution is limited only by the maximum energy content of the electricity storage module or~~ primary energy source of the power-generating module;
- (vi) within the time limits laid down in point (v) of paragraph 2(d), active power control must not have any adverse impact on the active power frequency response of power-generating modules;
- (vii) the parameters specified by the relevant TSO in accordance with points (i), (ii), (iii), (iv) and (v) shall be notified to the relevant regulatory authority. The modalities of that notification shall be specified in accordance with the applicable national regulatory framework;
- (viii) stable operation of the power-generating module during FSM operation shall be ensured.

Comentado [A109]: In accordance with ENTSO-E Amendment 28. FCR parameters have to be notified to the NRA, with this version not all parameters are notified.

Comentado [A110]: Based on ENTSO-E Amendment No 60: PGMs should exhibit a stable control behaviour in different modes of operation and in switching between modes. Therefore, it should be appropriately reflected in the technical requirements

Table 5

Parameters for full activation of active power frequency response resulting from frequency step change (explanation for Figure 6)

Parameters	Ranges or values
Active power range related to maximum capacity (frequency response range) $\frac{ \Delta P_1 }{P_{\max}}$	1,5-10 %
For power-generating modules with inertia, the maximum admissible initial delay t_1 unless justified otherwise in line with Article 15(2)(d)(iv)	2 seconds
For power-generating modules without inertia, the maximum admissible initial delay t_1 unless justified otherwise in line with Article 15(2)(d)(iv)	as specified by the relevant TSO.
Maximum admissible choice of full activation time t_2 , unless longer activation times are allowed by the relevant TSO for reasons of system stability	30 seconds, for SA Continental Europe and SA Nordic , 5 sec for SA Ireland and Northern Ireland

(e) with regard to frequency restoration control, the power-generating module shall provide functionalities complying with specifications [as](#) specified by the relevant TSO, aiming at restoring frequency to its nominal value or maintaining power exchange flows between control areas at their scheduled values;

(f) with regard to disconnection due to underfrequency, power-generating facilities capable of acting as a load, including [hydro](#)—pump-storage power-generating ~~facilities~~[modules and electricity storage modules](#), shall be capable of disconnecting their load in case of underfrequency. The requirement referred to in this point does not extend to auxiliary supply;

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

(i) to monitor the operation of active power frequency response, the communication interface shall be equipped to transfer in real time and in a secured manner from the power-generating facility to the network control centre of the relevant system operator or the relevant TSO, at the request of the relevant system operator or the relevant TSO, at least the following signals:

- status signal of FSM (on/off),
- scheduled active power output,
- actual value of the active power output,
- actual parameter settings for active power frequency response,

Comentado [A111]: Based on ENTSO-E amendment proposal No. 27.
The wording of the article 15.2.d.vii regarding the maximum admissible choice of full activation time allows the TSO to require longer activation time. The IGD suggests the TSO to require faster response in case of local needs (e.g. 10s for GB and 15s for IE/NI). The current wording of RfG is in contradiction with what IGD suggests.
Alignment with Irish Grid Code.

— droop and deadband;

- (ii) the relevant system operator and the relevant TSO shall 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 of participating power-generating modules.

~~3. With regard to voltage stability, type C power-generating modules shall be capable of automatic disconnection when voltage at the connection point reaches levels specified by the relevant system operator in coordination with the relevant TSO.~~

~~The terms and settings for actual automatic disconnection of power-generating modules shall be specified by the relevant system operator in coordination with the relevant TSO.~~

34. Type C power-generating modules shall fulfil the following requirements relating to robustness:

- (a) in the event of power oscillations, power-generating modules shall retain steady-state stability when operating at any operating point of the P-Q-capability diagram;
- (b) without prejudice to paragraph 4 and 5 of Article 13, power-generating modules shall be capable of remaining connected to the network and operating without power reduction, as long as voltage and frequency remain within the specified limits pursuant to this Regulation;
- (c) power-generating modules 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 point (b) of Article 14(5).

45. Type C power-generating modules shall fulfil the following requirements relating to system restoration:

(a) with regard to black start capability:

- (i) black start capability is not mandatory without prejudice to the Member State's rights to introduce obligatory rules in order to ensure system security;
- (ii) power-generating facility owners shall, at the request of the relevant TSO, provide a quotation for providing black start capability. The relevant TSO may make such a request if it considers system security to be at risk due to a lack of black start capability in its control area;
- (iii) a power-generating module with black start capability shall be capable of starting from shutdown without any external electrical energy supply within a time frame specified by the relevant system operator in coordination with the relevant TSO;
- (iv) a power-generating module with black start capability shall be able to synchronise within the frequency limits laid down in point (a) of Article 13(24) and within the voltage limits laid down in Article 14(2) and, where applicable, voltage limits specified by the relevant system operator or in Article 16(2);
- (v) a power-generating module with black start capability shall be capable of automatically regulating the voltage at the connection point to limit the magnitude of voltage changes ~~dips in voltage~~ caused by connection of demand;

Comentado [A112]: Changes to paragraph 15(3) follow ENTSO-E amendment proposal No. 29.

The system needs are that power generating modules shall stay connected and control voltage within defined ranges. Taking into account reactive power capabilities and voltage control capabilities of power generating units, an automatic disconnection is the worst for the system stability. No utilisation of such capability has been identified by TSO has used/needs in the future and for these reasons, the initial text of article 15.3 of NC RfG has been deleted. ENTSO-E is proposing to delete only the first sentence of this paragraph but the second sentence also refers to the same topic and therefore it is proposed to delete it as well.

Comentado [A113]: Based on ENTSO-E amendment proposal No. 34.

Comentado [A114]: Following ENTSO-E amendment proposal No. 30.

The wording "regulating voltage dips" makes the requirement unclear. The proposed change in Article 15.4.a (v) refers to the automatic voltage regulation at the PoC and clarifies the purpose of the requirement, i.e. to keep the voltage value at the PoC within the limits in case of the voltage changes caused by demand connection. The proposed modification allows to make reference to minimum regulating level (defined for FSM only) or other regulating level for PGMs with black start capability shall be clearly specified (Article 15.4.a (vi)).

(vi) a power-generating module with black start capability shall at least:

- be capable of regulating load connections in block load,
- be capable of operating in LFSM-O and LFSM-U during the system restoration phase, as specified in point (c) of paragraph 2 and Article 13(32),
- 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 level,
- be capable of parallel operation of a few power-generating modules within one island, and
- control voltage automatically during the system restoration phase;

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

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

- the frequency limits for island operation shall be those established in accordance with point (a) of Article 13(24),
- the voltage limits for island operation shall be those established in accordance with paragraph Article 15(3) or Article 14(2)16(2), where applicable;

(ii) power-generating modules shall be able to operate stably in FSM during island operation, as specified in point (d) of paragraph 2.

In the event of a power surplus, power-generating modules shall be capable of reducing the active power output from a previous operating point to any new operating point within the P-Q-capability diagram. In that regard, the power-generating module shall be capable of reducing active power output as much as inherently technically feasible, but to at least 55 % of its maximum capacity;

(iii) the voltage control system of a SPGM, as specified in Article 17 (2) (b) and 19 (2), or voltage control mode of a PPM, as specified in Article 21 (5) (d), shall be able to stably operate during island operation; the method for detecting a change from interconnected system operation to island operation shall be agreed between the power-generating facility owner and the relevant system operator in coordination with the relevant TSO. The agreed method of detection must not rely solely on the system operator's switchgear position signals;

(iv) power-generating modules shall be able to operate stably in LFSM-O and LFSM-U during island operation, as specified in point (c) of paragraph 2 and Article 13(32);

(v) the power-generating module control schemes, including FSM, LFSM-O, LFSM-U and voltage control system (synchronous power-generating modules) or voltage control mode (power park modules) shall be able to continuously and stably operate during the transition from interconnected system operation to island operation without relying on information provided by the relevant system operator. Information on how robustness is achieved during the transition from interconnected system operation to island operation shall be shared with the relevant system operator or TSO.

Comentado [A115]: Following ENTSO-E amendment proposal No. 30 as above.

Comentado [A116]: Based on VGBE proposal.

Comentado [A117]: Changes to Article 15(5)(b) follow ETNSO-E Amendment 31 & amendment from EU-DSO entity. The article 15.4.b (iii) is removed to promote the controller stability being independent from the detection of island operation.

The reason for amending the articles 15.4.b (ii), 15.4.b (iii), 15.4.b (iv) and 15.4.b (v) is the need to request stability of the frequency and voltage controls in island operation as well as during switching from interconnected operation to island operation, without relying on information provided by the RSO (e.g. switchgear position) or an internal method for detection. There are mutual benefits of these requirements with the general requirements and justification regarding the stability of controllers in interconnected operation as explained in the Amendment C12.

The reason for adding the article 15.4.b (vi) is to increase the flexibility during the system restoration, therefore speed up the process of system restoration. This way, system operator can activate more generators in parallel to support active power balance and voltage in small islands.

(vi) power-generation module shall be capable to regulate active power between houseload operation level and minimum stable operating level for a minimum operation time. The minimum operation time shall be specified by the relevant system operator in coordination with the relevant TSO, taking into consideration the specific characteristics of prime mover technology.

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

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

(ii) a power-generating module with a minimum re-synchronisation time greater than 15 minutes after its disconnection from any external power supply must be designed 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 ~~system operator's switchgear position signals~~;

(iii) power-generating modules shall be capable of continuing operation following tripping to houseload, 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 relevant TSO, taking into consideration the specific characteristics of prime mover technology.

(iv) Power-generating module capable of tripping to houseload shall, at the request of the relevant TSO, be able to provide:

—houseload operation during a prolonged period of time, as agreed between the relevant TSO and the power-generating facility owner, that is longer than the minimum operation time as required in point (iii) of paragraph Article 15(4)(c), and

—the capabilities defined in paragraph Article 15(4)(a)(iv), (v) and (vi).

56. ~~Type C~~ he power-generating modules shall fulfil the following general system management requirements:

(a) with regard to loss of angular stability or loss of control, a power-generating module shall be capable of disconnecting automatically from the network in order to help preserve system security or to prevent damage to the power-generating module. The power-generating facility owner and the relevant system operator in coordination with the relevant 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 with a facility to provide fault recording and monitoring of dynamic system behaviour. This facility shall record the following parameters:

- voltage,
- active power,
- reactive power, and

Comentado [A118]: Follows ENTSO-E amendment proposal No. 32.

Article 15.4.c (ii)

This requirement has a wording issue: - "on the system operator's switchgear position signals;" should be changed to "on the position signals of the system operator's switchgear"

Article 15.4.c (iv)

The restoration of the network can be performed with the help from the power-generating units with black start capabilities. However, by introducing this amendment, the restoration of the network can also be started and supported by power-generating units with prolonged houseload operation. Those are units that had been in normal operation, disconnected due to the event, but managed the switch to houseload operation. They are available virtually immediately after blackout (no blackstart required).

— frequency.

The relevant system operator shall have the right to specify quality of supply parameters to be complied with on condition that reasonable prior notice is given;

~~(ii) 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 relevant TSO;~~

(iii) the dynamic system behaviour monitoring shall include an oscillation trigger specified by the relevant system operator in coordination with the relevant TSO, with the purpose of detecting poorly damped power oscillations;

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

(c) with regard to the simulation models:

(i) at the request of the relevant system operator or the relevant TSO, the power-generating facility owner shall provide simulation models which properly reflect the behaviour of the power-generating module for the relevant study purpose in both steady-state and dynamic simulations ~~(50 Hz component root mean square)~~ or in electromagnetic transient simulations. The simulation model requirements and data provided shall not violate manufactures 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 Chapters 2, 3 and 4 of Title IV, and shall notify the results of the verification to the relevant system operator or relevant TSO. The TSO shall define, subject to public consultation and approval of relevant stakeholders, the verification standards and acceptance criteria considering state-of-the-art international standards. Member States 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:

— alternator and prime mover,

— speed and power control,

— voltage control, including, if applicable, power system stabiliser ('PSS') function and excitation control system,

— power-generating module protection models, as agreed between the relevant system operator and the power-generating facility owner; ~~and~~

~~— converter models for power park modules;~~

(iii) For the purpose of electromechanical dynamic simulations (RMS simulation studies) the relevant system operator or the relevant TSO shall have the right to specify the power park modules simulation model requirements. Without prejudice to the Member State's rights to introduce additional requirements, the

Comentado [A119]: Deletion follows the insertion of identical text in in Article 14(5)(d)(iv) and (v).

Comentado [A120]: Based on ENTSO-E amendment proposal No. 33 and also on the EG ISSM report. The specification on the model type (black box, open source, generic, etc.) and quality to fit purposes of model use (interaction studies, system integration, compliance simulation, etc.) are lacking. This is mainly an issue for PPM but also for SPGM (e.g. multi-mass shaft model for SSTI studies).

simulation models of the power park modules provided by the power generation facility owner shall:

- be valid for the specified operating range and all control modes of the power-generating facility;
- include a proper representation of the converter modules and its control systems (including the synchronization module) that influence the dynamic behaviour of the power-generating module in the specified time frame;
- be open source generic model for cross border network stability studies;
- in the case that encrypted detailed RMS models are accepted by the relevant TSO, the relevant TSO shall specify the requirements of the model encryption according to national regulations (for example use of source code, the model structure and the signal interfaces to be observable in the network studies);
- include the relevant protection function models;

(iv) For the purpose of time domain electromagnetic transient (EMT) simulations the relevant system operator or the relevant TSO shall have the right to specify the model requirements of the power park module-model requirements. Without prejudice to the Member State's rights to introduce additional requirements, the models shall contain the following:

- be valid in the frequency range 0.2 Hz – 2500 Hz for relevant interaction studies. The validity of the PPM model shall be ensured for the given frequency range at the connection point;
- be valid for specified operating range and control modes of the PPM in the positive, negative and in the zero phase sequence;
- reproduce the detailed response of the power-generating module and its control blocks during balanced and unbalanced AC network faults in the valid frequency range;
- include the power plant level control and the power plant relevant functionalities if applicable;
- include the frequency dependence of the lines and/or cables in the power-generating facility;
- represent the PPM transformers model including saturation, resistors, filter, breaker and AC arrester in the valid frequency;
- include all the relevant protection function models for the relevant interaction studies;
- be capable to be used for the numerical calculation of the frequency dependent impedance of PPM at the connection point (impedance amplitude and impedance phase angle) in the frequency range that the model is valid);

In the case that encrypted detailed EMT models are accepted by the relevant system operator or the relevant TSO, the relevant system operator or the relevant

TSO shall have the right to specify the model encryption based on national regulations (for example the model structure and the signal interfaces to be observable in the network studies);

- (v) For the purpose of frequency domain simulations for the risk assessment of the resonance stability of the power park module, the relevant system operator or the relevant TSO shall have the right to request from the power-generating facility owner the frequency dependent impedance model of the power-generating facility at the connection point. Without prejudice to the Member State's rights to introduce additional requirements, the following requirements shall apply:

- The impedance model of the power-generating facility shall be requested at least in the range 5.0 Hz - 2500Hz; As an additional requirement, the relevant system operator or the relevant TSO can extend the required applicability of the model to up to 9 000 Hz.

- The relevant system operator or the relevant TSO shall have the right to request the calculation of the impedance model of the power-generating facility either numerically (using the EMT model) or analytically (using transfer function);

- The relevant system operator or the relevant TSO shall have the right to request the impedance profile of the power-generating facility at the connection point through the whole operating range and control modes of operation;

- The impedance model of the power-generating facility shall be provided for the positive, negative and for the zero phase sequence;

- The power-generating facility owner shall take into account the influence of the power-generating module control and measurement system as other parts of the power-generating module which influences 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) and (ii) shall be coordinated with the relevant TSO. It shall include:

- the format in which models are to be provided,
- the provision of documentation on a model's structure and block diagrams,
- an estimate of the minimum and maximum short circuit capacity at the connection point, expressed in MVA, as an equivalent of the network;

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

- (d) with regard to the installation of devices for system operation and devices for system security, if the relevant system operator or the relevant TSO considers that it is necessary to install additional devices in a power-generating facility in order to preserve or restore system operation or security, the relevant system operator or

relevant TSO and the power-generating facility owner shall investigate that matter and agree on an appropriate solution;

(e) the relevant system operator shall specify, in coordination with the relevant TSO, minimum and maximum limits on rates of change of active power output (ramping limits) in both an up and down direction of change of active power output for a power-generating module, taking into consideration the specific characteristics of prime mover technology;

(f) earthing arrangement of the neutral-point at the network side of step-up transformers shall comply with the specifications of the relevant system operator.

Article 16

General requirements for type D power-generating modules

1. ~~Type D power-generating modules shall fulfil the requirements laid down in Articles 13, 14 and 15, except for In addition to fulfilling the requirements listed in Article 13, except for Article 13(2)(b), (6) and (7), Article 14(5)(d)(iii) and Article 14, except for Article 14(2), and Article 15, except for Article 15(3), type D power-generating modules shall fulfil the requirements set out in this Article.~~

2. ~~With regard to voltage stability and without prejudice to Article 14(3)(219), the relevant system operator in coordination with the relevant TSO shall have the right to specify voltages at the connection point at which type D power-generating module is 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. Type D power-generating modules shall fulfil the following requirements relating to voltage stability:~~

~~(a) with regard to voltage ranges:~~

~~(i) without prejudice to point (a) of Article 14(3) and point (a) of paragraph 3 below, a power-generating module shall be capable of staying connected to the network and operating within the ranges of the network voltage at the connection point, expressed by the voltage at the connection point related to the reference 1 pu voltage, and for the time periods specified in Tables 6.1 and 6.2;~~

~~(ii) the relevant TSO may specify shorter periods of time during which power-generating modules shall be capable of remaining connected to the network in the event of simultaneous overvoltage and underfrequency or simultaneous undervoltage and overfrequency;~~

~~(iii) notwithstanding the provisions of point (i), the relevant TSO in Spain may require power-generating modules to be capable of remaining connected to the network in the voltage range between 1,05 pu and 1,0875 pu for an unlimited period;~~

~~(iv) for the 400 kV grid voltage level (or alternatively commonly referred to as 380 kV level), 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;~~

~~(v) notwithstanding the provisions of point (i), the relevant TSOs in the Baltic synchronous area may require power-generating modules to remain connected to~~

Comentado [A121]: New requirement in Article 14(5)(d)(iii) is less onerous than the one in Article 15(5)(b)(i).

Comentado [A122]: Based on proposals from several stakeholders: amendments to the voltage ranges relating to the need to maintain sufficient levels of system robustness. It is deemed necessary to amend the upper limit of the voltage range as this corresponds to too onerous requirement for 400kV connected PGMs.

the 400 kV network in the voltage range limits and for the time periods that apply in the Continental Europe synchronous area;

Table 6.1

Synchronous area	Voltage range	Time period for operation
Continental Europe	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
Nordic	0,90 pu-1,05 pu	Unlimited
	1,05 pu-1,10 pu	60 minutes
Great Britain	0,90 pu-1,10 pu	Unlimited
Ireland and Northern Ireland	0,90 pu-1,118 pu	Unlimited
Baltic	0,85 pu-0,90 pu	30 minutes
	0,90 pu-1,118 pu	Unlimited
	1,118 pu-1,15 pu	20 minutes

The table shows the minimum time periods during which a power generating module must be capable of operating for voltages deviating from the reference 1 pu

value at the connection point without disconnecting from the network, where the voltage base for pu values is from 110 kV to 300 kV.

Table 6.2

Synchronous area	Voltage range	Time period for operation
Continental Europe	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	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
Great Britain	0,90 pu-1,05 pu	Unlimited
	1,05 pu-1,10 pu	15 minutes
Ireland and Northern Ireland	0,90 pu-1,05 pu	Unlimited
Baltic	0,88 pu-0,90 pu	20 minutes

	0,90 pu- 1,097 pu	Unlimited
	1,097 pu- 1,15 pu	20 minutes

The table shows the minimum time periods during which a power generating module must be capable of operating for voltages deviating from the reference 1 pu value at the connection point without disconnecting from the network where the voltage base for pu values is from 300 kV to 400 kV.

(b) wider voltage ranges or longer minimum time periods for operation may be agreed between the relevant system operator and the power generating facility owner in coordination with the relevant TSO. If wider voltage ranges or longer minimum times for operation are economically and technically feasible, the power generating facility owner shall not unreasonably withhold an agreement;

(c) without prejudice to point (a), the relevant system operator in coordination with the relevant TSO shall have the right to specify voltages at the connection point at which a power generating module is 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. Type D power-generating modules shall fulfil the following requirements in relation to robustness:

(a) with regard to fault-ride-through capability:

(i) power-generating modules, when operating above their minimum stable operating level, shall be capable of staying connected to the network and continuing to operate stably after the power system has been disturbed by secured faults. That capability shall be in accordance with a voltage-against-time profile at the connection point for fault conditions specified by the relevant TSO.

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

That lower limit shall be specified by the relevant TSO, using the parameters set out in Figure 3 and within the ranges set out in Tables 7.1.1, 7.1.2, 7.2.1, and 7.2.2 in Tables 7.1 and 7.2 for type D power-generating modules connected at or above the 110 kV level.

That lower limit shall also be specified by the relevant TSO, using parameters set out in Figure 3 and within the ranges set out in Tables 3.1.1, 3.1.2, 3.2.1 and 3.2.2 for type D power-generating modules connected below the 110 kV level;

(ii) each TSO shall specify the pre-fault and post-fault conditions for the fault-ride-through capability referred to in point (iv) of Article 14(3)(a). The specified pre-fault and post-fault conditions for the fault-ride-through capability shall be made publicly available;

Table 7.1.1

Comentado [A123]: Changes to Article 16(3) follow ENTSO-E amendment proposal No. 16.

Wording of the current version of the NC leads to non-uniform interpretation of this NC during national implementation.

It seems important that the text, figure and table are unambiguous, and for this reason, the link between time and voltage parameters should not appear in the tables but only in the figures. It is therefore proposed to split the tables into separate tables for voltage parameters and tables for time parameters.

Some changes are associated to ENTSO-E amendment 48 of coherence between FRT profiles and time-limited requirement of the voltage withstand capability.

Voltage parameters for Figure 3 for fault-ride-through capability of synchronous power-generating modules

Voltage parameters (pu)		Time parameters (seconds)	
U_{ret} :	0	t_{clear} :	0,14-0,15 (or 0,14-0,25 if system protection and secure operation so require)
U_{clear} :	0,25	t_{rec1} :	t_{clear} -0,45
U_{rec1} :	0,5-0,7	t_{rec2} :	t_{rec1} -0,7
U_{rec2} :	Minimum voltage specified in Article 14(2) 0,85-0,9	t_{rec3} :	t_{rec2} -1,5

Table 7.1.2

Time parameters for Figure 3 for fault-ride-through capability of synchronous power-generating modules

Time parameters (seconds)	
t_{clear} :	0,14-0,15 (or 0,14-0,25 if justified by the system protection and secure operation needs)
t_{rec1} :	t_{clear} -0,45
t_{rec2} :	t_{rec1} -0,7
t_{rec3} :	t_{rec2} -1,5

Table 7.2.1

Voltage parameters for Figure 3 for fault-ride-through capability of power park modules

Voltage parameters (pu)		Time parameters (seconds)	
U_{ret} :	0	t_{clear} :	0,14-0,15 (or 0,14-0,25 if system protection and secure operation so require)
U_{clear} :	U_{ret}	t_{rec1} :	t_{clear}
U_{rec1} :	U_{clear}	t_{rec2} :	t_{rec1}
U_{rec2} :	Minimum voltage specified in Article 14(2)0,85	t_{rec3} :	1,5-3,0

Table 7.2.2
Time parameters for Figure 3 for fault-ride-through capability of power park modules

Time parameters (seconds)	
t_{clear} :	0,14-0,15 (or 0,14-0,25 if justified by the system protection and secure operation needs)
t_{rec1} :	t_{clear}
t_{rec2} :	t_{rec1}
t_{rec3} :	1,5-3,0

(b) 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 at the connection point as specified in point (iv) of Article 14(3)(a) regarding:

- (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 as active power output and reactive power output at the connection point and voltage at the connection point; and
 - (iii) post-fault minimum short circuit capacity at each connection point expressed in MVA;
- (c) fault-ride-through capabilities in case of asymmetrical faults shall be specified by each TSO.
4. Type D power-generating modules shall fulfil the following general system management requirements:
- (a) with regard to synchronisation, when starting a power-generating module, synchronisation shall be performed by the power-generating facility owner only after authorisation by the relevant system operator;
 - (b) the power-generating module shall be equipped with the necessary synchronisation facilities;
 - (c) synchronisation of power-generating modules shall be possible at frequencies within the ranges set out in Table 2;
 - (d) the relevant system operator and the power-generating facility owner shall agree on the settings of synchronisation devices to be concluded prior to operation of the power-generating module. This agreement shall cover:
 - (i) voltage;
 - (ii) frequency;
 - (iii) phase angle range;
 - (iv) phase sequence;
 - (v) deviation of voltage and frequency.

CHAPTER 2

Requirements for synchronous power-generating modules

Article X

Requirements for type A synchronous power-generating modules

1. Type A synchronous power-generating modules shall fulfil the requirements listed in Article 13.

21. The relevant TSO shall specify if fault-ride-through capabilities shall be required for Type A synchronous power generating modules. Where fault-ride-through capability of a Type A synchronous power generating module is required by the relevant TSO, the relevant TSO shall specify the following capabilities:

(a) The synchronous power generating module shall be capable of staying connected to the network and continuing to operate stably after the power system has been

Comentado [A124]: Based on ENTSO-E amendment proposal No. 54.

The number of installed Type A generation has reached a level where the operation of this equipment has a major impact on system security.

In most MS this concerns mainly PV systems of the PPM type A. As elaborated in the EG BftA, FRT requirements for PPM type A should therefore be mandatory.

As the type A SPGM penetration is not comparable to the general and expected future type A PPM penetration the need for FRT requirements for type A SPGM is currently sufficient to include as a "non-mandatory requirement" in the RfG.

For system security reasons, like preventing large-scale loss of generation, it is proposed to extend the FRT requirement to type A PPMs. This requirement demands the ability of the PPM to remain connected to the system during faults within a defined voltage-time profile, and thus avoiding disconnection of the power generating module.

The enacted version of NC RfG includes ranges of voltage and time that have led to a wide variety of national FRT profiles, depending on the protection schemes predominant at the national level where the distributed installed capacity also needs to be considered carefully.

Acknowledging the mass production of type A generating modules, the recommendation for type A PPM FRT capabilities is an exhaustive requirement as a harmonised and predefined voltage-time profile as illustrated in figure. In combination with the FRT requirement, it is essential that the maximum time in which the active power from the PPMs affected by a fault shall recover, understanding that even if they stay connected, they may reduce their active power during, and just after, the clearance of the fault.

Comentado [A125]: This is not needed given updates in Art 5

disturbed by faults on the transmission system according to a voltage-against-time-profile in line with Figure 3 at the connection point and with the set points in Tables X.1.1 and X.1.2:

(b) the voltage-against-time-profile expresses a lower limit of 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 at the connection point during a symmetrical fault, as a function of time before, during and after the fault:

(c) each TSO in coordination with the relevant system operator shall specify and make publicly available the pre-fault and post-fault conditions for the fault-ride-through capability in terms of:

- the calculation of the pre-fault minimum short circuit capacity at the connection point.
- pre-fault active and reactive power operating point of the power-generating module at the connection point and voltage at the connection point, and
- calculation of the post-fault minimum short circuit capacity at the connection point;

Comentado [A126]: Added following the comment from EU DSO.

Table x.1.1

Voltage parameters for Figure 3 for fault-ride-through capability of synchronous power-generating modules

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

Table X.1.2

Time parameters for Figure 3 for fault-ride-through capability of synchronous power-generating modules

Time parameters (seconds)	
<u>t_{clear}:</u>	<u>0.15</u>
<u>t_{rec1}:</u>	<u>t_{clear}</u>
<u>t_{rec2}:</u>	<u>0.7</u>

(d) the synchronous power-generating module shall be capable of remaining connected to the network and continuing to operate stably when the actual course of the phase-to-phase voltages on the network voltage level at the connection point during a symmetrical fault, given the pre-fault and post-fault conditions in points (iv) and (v) of paragraph 3(a), remain above the lower limit specified in point (ii) of paragraph 3(a), 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 must not jeopardise fault-ride-through performance:

(e) without prejudice to paragraph (vi) of paragraph 3(a), undervoltage protection (either fault-ride-through capability or minimum voltage specified at the connection point voltage) shall be set by the power-generating facility owner according to the widest possible technical capability of the power-generating module, unless the relevant system operator requires narrower settings in accordance with point (b) of paragraph 5. The settings shall be justified by the power-generating facility owner in accordance with this principle.

Article 17

Requirements for type B synchronous power-generating modules

1. Type B synchronous power-generating modules shall fulfil the requirements listed in Articles 13, except for Article 13(2)(b), [Article 13\(8\)](#), and [Article 14](#).

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

(a) with regard to reactive power capability, the relevant system operator shall have the right to specify the capability of a synchronous power-generating module to [supply and absorb](#) ~~provide~~ reactive power;

(b) with regard to ~~the voltage control system~~, [type B](#) synchronous power-generating modules shall be equipped with a [permanent automatic excitation voltage](#) control system that can provide constant alternator terminal voltage at a selectable setpoint without instability over 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 \('AVR'\) 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 relevant TSO shall specify the magnitude and time for active power recovery.

Comentado [A127]: In accordance with ENTSO-E amendment proposal No. 35.

Supply of reactive power is ambiguous and a clarification should be added so the requirement covers both "supply and absorb" which are both needed for the system. The word "provide" is the proposed to be replaced by "supply and absorb".
Changes are also made in Article 20.

Comentado [A128]: Changes to Article 17(2)(b) follow ENTSO-E amendment proposal No. 19.

SPGMs have to be prevented from operating in under- and overexcitation in order to avoid angular instability or the surpass of thermal design limits. This can be achieved by simply disconnecting the SPGM in such situations. Typically, in these situations the grid voltage is either near its lower or its higher limit and therefore, the reactive power contribution from the SPGM is crucial for maintaining voltage stability. Therefore, losing the SPGM in such situations shall be avoided.

The alternative to the disconnection is the controlled limitation of the excitation current. This is a standard feature of AVRs and is therefore available at no additional cost. Requesting this capability from Type B on is a low hanging fruit in terms of ensuring voltage stability. Inline with the modification made in Article 19, the structure and wording of article 19.2 is modified. Article 19.2.a focuses on the functionalities of the AVR and article 19.2.b focuses on the coordination on parameter and settings.

Article 18

Requirements for type C synchronous power-generating modules

1. Type C synchronous power-generating modules shall fulfil the requirements laid down in Articles 13, 14, 15 and 17, except for Article 13(2)(b), ~~and Article 13(6), Article 13(8), Article 14(2)~~ and Article 17(2)(a).

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, the relevant system operator may specify supplementary reactive power to be provided if the connection point of a synchronous power-generating module is neither located at the high-voltage terminals of the step-up transformer to the voltage level of the connection point nor at the alternator terminals, if no step-up transformer exists. This supplementary reactive power shall compensate the reactive power demand of the high-voltage line or cable between the high-voltage terminals of the step-up transformer of the synchronous power-generating module or its alternator terminals, if no step-up transformer exists, and the connection point and shall be provided by the responsible owner of that line or cable;

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

(i) the relevant system operator in coordination with the relevant 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 ~~provide supply~~ reactive power ~~production~~ at high voltages and ~~absorb~~ reactive power ~~consumption~~ at low voltages;

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

- the U - Q/P_{\max} -profile shall not exceed the U - Q/P_{\max} -profile envelope, represented by the inner envelope in Figure 7,
- 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 8, and
- the position of the U - Q/P_{\max} -profile envelope shall be within the limits of the fixed outer envelope in Figure 7;

Figure 7

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

Comentado [A129]: Changes to Article 18(2) follow ENTSO-E amendment proposal No. 36.

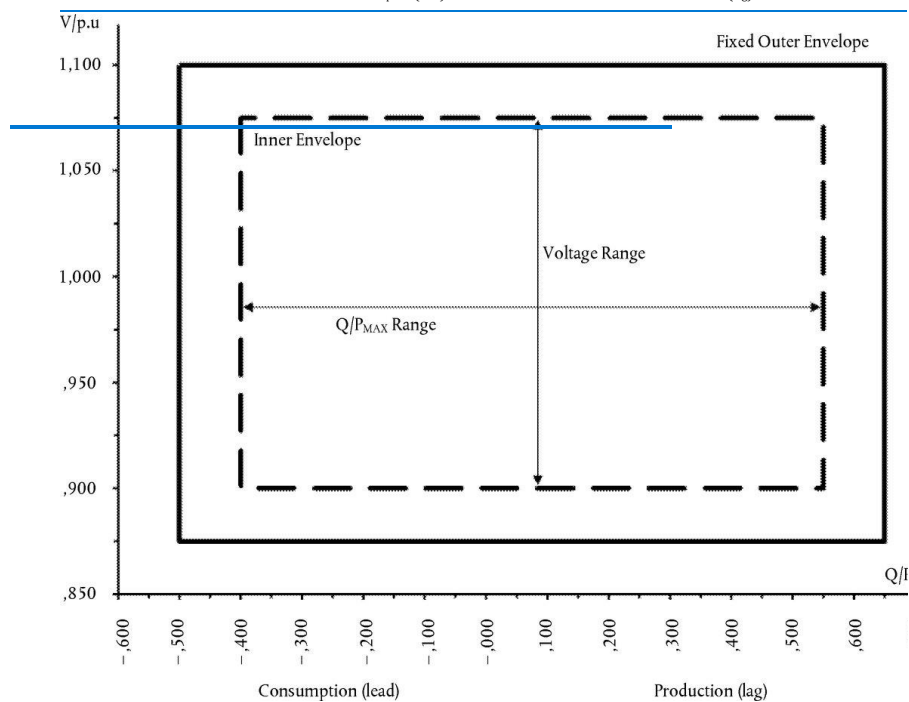
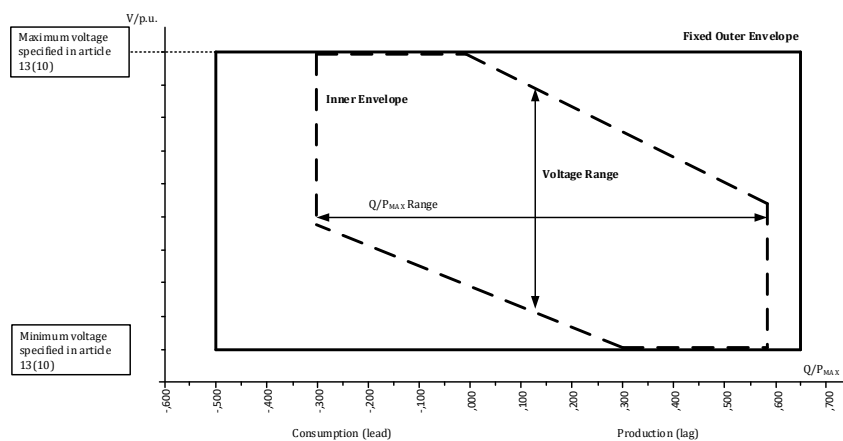
There is an unregulated area between minimum voltage ranges when power generating unit must be capable to operate (table 6.1), and the voltage profile in U - Q/P_{\max} profile (figure 7 and figure 8)

The outer envelope voltage range for the 110 kV and 220 kV levels is too narrow and does not match the voltage ranges as of Article 13 (10) (a) in the initial figure. Additionally, the definition of the voltage range represented in the figure is not clear.

For these reasons, the following is recommended:

- Removing the scale and instead link to the voltage ranges set out in Article 13(10)a.
- Adapting the indicative figure so that it is clear that the voltage range represents the difference between the highest and lowest values at a certain value of Q/P_{\max} .
- Amending the text in the same manner.

Comentado [A130]: The reference in the figure needs to be changed from Article 13(10) to Article 14(2)



The diagram represents boundaries of a U - Q/P_{\max} -profile by the voltage at the connection point, 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 8

Parameters for the inner envelope in Figure 7

Synchronous area	Maximum range of Q/P _{max}	Maximum range of steady-state voltage level in PU
Continental Europe	0,95	0,225
Nordic	0,95	0,225
Great Britain	0,95	0,225
Ireland and Northern Ireland	1,08	0,218
Baltic	1,0	0,220

Comentado [A131]: In accordance with ENTSO-E amendment proposal No. 38. Title of variable provided in table does not correspond to content of table. Table 8: "Maximum range of steady-state voltage level in PU". => "Maximum range of steady-state voltage in PU". For this reason, the following is recommended: The title "steady-state voltage level" is replaced by "steady-state voltage" to correct the error. Same changes are performed for RfG and HVDC code.

Comentado [A132]: Change follows ENTSO-E amendment proposal No. 37. Change of Nordic synchronous area exhaustive range from 0,15 pu to 0,225 pu. For this reason, the following is recommended:

- Harmonization of basic generator requirements.
- Creating the possibility of utilizing already existing generator capabilities.
- Harmonizing national requirements where TSO operate in both the CE and N synchronous areas.

Comentado [A133]: Removed due to the withdrawal of the UK from the EU

(iii) the reactive power provision capability requirement applies at the connection point. The voltage range represents the difference between the highest and lowest values at a certain value of Q/P_{max}. For profile shapes other than rectangular, the voltage range represents the highest and lowest values. The full reactive power range is therefore not expected to be available across the range of steady-state voltages;

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

(c) with regard to reactive power capability below maximum capacity, when operating at an active power output below the maximum capacity ($P < P_{max}$), the synchronous power-generating modules 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. Even at reduced active power output, reactive power supply at the connection point shall correspond fully to the P-Q-capability diagram of the alternator of that synchronous power-generating module, taking the auxiliary supply power and the active and reactive power losses of the step-up transformer, if applicable, into account.

Article 19

Requirements for type D synchronous power-generating modules

1. Type D synchronous power-generating modules shall fulfil the requirements laid down in Article 13, except for Article 13(2)(b), Article 13(6), Article 13 and (7) and Article 13(8). Article 14, except for Article 14(2), Article 15, except for Article 15(3), Article 16, Article 17, except for Article 17(2) and Article 18.

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

(a) equipped with an AVR having:

Comentado [A134]: Changes to Article 19(2) follow ENTSO-E amendment proposals No. 19 and 62. SPGMs have to be prevented from operating in under- and overexcitation in order to avoid angular instability or the surpass of thermal design limits. This can be achieved by simply disconnecting the SPGM in such situations. Typically, in these situations the grid voltage is either near its lower or its higher limit and therefore, the reactive power contribution from the SPGM is crucial for maintaining voltage stability. Therefore, losing the SPGM in such situations shall be avoided. The alternative to the disconnection is the controlled limitation of the excitation current. This is a standard feature of AVRs and is therefore available at no additional cost. Inline with the modification made in Article 17, the structure and wording of article 19.2 is modified. Article 19.2.a focuses on the functionalities of the AVR and article 19.2.b focuses on the coordination on parameter and settings. Oscillatory stability has to be tackled from a system-wide perspective, as system damping can vary notably, depending on system power flows, system topology, type of load, demand, etc. Power system stabilisers (PSS) contribute to system damping if they are properly tuned. Adding stabilising power to the system would improve system stability and allow improvement of the power flow transfers throughout the system, easing market integration and system decarbonization.

(i) an underexcitation limiter to prevent the AVR 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;

(iii) a PSS function to attenuate power oscillations. The PSS shall have the capability to damp inter-area power oscillations in the frequency range of, at least, 0,1 Hz – 1,0 Hz. The relevant TSO shall have the right to request and approve the tuning of the PSS by the power-generating facility owner to damp the inter-area oscillation mode based on frequency ranges specified by the relevant TSO in coordination with adjacent TSO or TSOs. The relevant TSO shall have right to request the tuning of the PSS by power-generating facility owner to damp the local oscillation mode, in which the synchronous power-generating modules is oscillating against the grid.

(b) having a voltage control system with parameters and settings of the components specified by an agreement between the power-generating module owner and the relevant system operator, in coordination with the relevant TSO. 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) bandwidth limitation of the output signal to ensure that the highest frequency of response cannot excite torsional oscillations on other power-generating modules connected to the network;

(iii) the presence of a stator current limiter.

(a) the parameters and settings of the components of the voltage control system shall be agreed between the power-generating facility owner and the relevant system operator, in coordination with the relevant TSO;

(b) the agreement referred to in subparagraph (a) shall cover the specifications and performance of an automatic voltage regulator ('AVR') with regard to steady-state voltage and transient voltage control and the specifications and performance of the excitation control system. The latter shall include:

(i) bandwidth limitation of the output signal to ensure that the highest frequency of response cannot excite torsional oscillations on other power-generating modules connected to the network;

(ii) an underexcitation limiter to prevent the AVR from reducing the alternator excitation to a level which would endanger synchronous stability;

(iii) 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;

(iv) a stator current limiter; and

(v) a PSS function to attenuate power oscillations, if the synchronous power-generating module size is above a value of maximum capacity specified by the relevant TSO.

3. The relevant TSO and the power-generating facility owner shall enter into an agreement regarding technical capabilities of the power-generating module to aid angular stability under fault conditions.

4. With regard to frequency stability:

(a) requirement laid down in Article 13(2)(b) shall not apply to a synchronous power-generating modules with maximum capacity larger than or equal to 400 MW;

(b) synchronous power-generating modules with maximum capacity larger than or equal to 400 MW shall be capable of staying connected to the network and operate at rate-of-change-of-frequency up to $\pm 1,0$ Hz/s over a period of 0,5 s;

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

Comentado [A135]: Based on EU Turbine proposal that large SPGMs cannot withstand high values of RoCoF. [Text may be amended based on ongoing discussions between ENTSO-E and relevant stakeholders.]

CHAPTER 3

Requirements for power park modules

Article Y

Requirements for type A power park modules

1. Type A power park modules shall fulfil the requirements listed in Article 13.

12. The power park module shall be capable of staying connected to the network and continuing to operate stably after the power system has been disturbed by faults on the transmission system according to a voltage-against-time-profile in line with Figure 3 at the connection point and with the set points in Tables X.24.1 and X.24.2.

23. The voltage-against-time-profile expresses a lower limit of the actual profile of the phase-to-phase voltages (or single phase to neutral voltages for single phase type A power park modules) on the network voltage level at the connection point during a symmetrical fault, as a function of time before, during and after the fault.

34. Each TSO, in coordination with the relevant system operator, shall specify and make publicly available the pre-fault and post-fault conditions for the fault-ride-through capability in terms of:

(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 and

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

45. When the network voltage resumes, after the fault has been cleared, to a value within the voltage range of 0.85pu – 1.1pu, the power park module shall recover its active power output level to its pre-fault value. The recovery time shall not exceed a maximum of 1s.

Comentado [A136]: Based on ENTSO-E amendment proposal No. 54.

The number of installed Type A generation has reached a level where the operation of this equipment has a major impact on system security.

In most MS this concerns mainly PV systems of the PPM type A. As elaborated in the EG BftA, FRT requirements for PPM type A should therefore be mandatory.

As the type A SPGM penetration is not comparable to the general and expected future type A PPM penetration the need for FRT requirements for type A SPGM is currently sufficient to include as a "non-mandatory requirement" in the RfG.

For system security reasons, like preventing large-scale loss of generation, it is proposed to extend the FRT requirement to type A PPMs. This requirement demands the ability of the PPM to remain connected to the system during faults within a defined voltage-time profile, and thus avoiding disconnection of the power generating module.

The enacted version of NC RfG includes ranges of voltage and time that have led to a wide variety of national FRT profiles, depending on the protection schemes predominant at the national level where the distributed installed capacity also needs to be considered carefully.

Acknowledging the mass production of type A generating modules, the recommendation for type A PPM FRT capabilities is an exhaustive requirement as a harmonised and predefined voltage-time profile as illustrated in figure. In combination with the FRT requirement, it is essential that the maximum time in which the active power from the PPMs affected by a fault shall recover, understanding that even if they stay connected, they may reduce their active power during, and just after, the clearance of the fault.

Table x.2.1

Voltage parameters for Figure 3 for fault-ride-through capability of power park modules

<u>Voltage parameters (pu)</u>	
<u>U_{ret}</u> :	<u>0.15</u>
<u>U_{clear}</u> :	<u>U_{ret}</u>
<u>U_{rec1}</u> :	<u>U_{clear}</u>
<u>U_{rec2}</u> :	<u>0.85</u>

Table X.2.2

Time parameters for Figure 3 for fault-ride-through capability of power park modules

<u>Time parameters (seconds)</u>	
<u>t_{clear}</u> :	<u>0.15</u>
<u>t_{rec1}</u> :	<u>t_{clear}</u>
<u>t_{rec2}</u> :	<u>t_{rec1}</u>
<u>t_{rec3}</u> :	<u>3.0</u>

56. With regard to grid forming capability, the relevant TSO in coordination with the relevant system operator may specify that type A shall technically justify that power park modules shall be capable of providing grid forming capability at the connection point.

67. By way of derogation from Article 4(2), a power park module shall be considered existing if

- (a) it is already connected to the network on the date of entry into force of this Regulation; or
- (b) the power-generating facility owner has concluded a final and binding contract for the purchase of the main generating plant by three years after the entry into force of the Regulation.

78. The relevant system operator may specify that the activation of grid forming mode is subject to necessary adaptations to the system operator's network and operating and

maintenance procedures. The Member State or the entity designated by the Member State may set provide the formal and substantive conditions under which the relevant system operator may conduct such specification.

89. A If technically justified by the relevant TSO in accordance to Article Y(5), a pPower park module shall be capable of providing grid forming capability at the connection point, if the primary resource is available, as listed below.

(a) 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 grid conditions) and upon inception of a grid disturbance (including voltage, frequency and voltage phase angle disturbance). The Thevenin source is characterized by its internal voltage amplitude, voltage phase angle, frequency and internal impedance.

(b) Upon inception of a grid disturbance and while the power park module capabilities and current limits are not exceeded, the instantaneous AC voltage characteristics of the internal Thevenin source according to paragraph (a) 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.

(c) After inception of a network disturbance in voltage magnitude, frequency or voltage phase angle, the following shall apply within the power park module's capability, including current limits and inherent energy storage capabilities of each individual unit.

~~(i) The relevant system operator in coordination with the TSO shall specify the temporal parameters of the dynamic performance regarding voltage control.~~

(ii) Where current limitation is necessary, the relevant system operator may specify additional requirements regarding contribution of active and reactive power at the point of connection.

(iii) 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 (b) as soon as the limitations are no longer active. If reaching the current limit, the grid forming behaviour must be maintained for responses as specified in paragraph (b) for disturbances that require the current to vary in the opposite direction of the current limitation.

~~Inherent energy storage means an energy reserve available in physical components of a power park module, which has not necessarily been designed to suit the grid forming requirements of this article, but may be used for such purposes, without effecting the design of the physical components of individual units.~~

~~(d) The power park module shall have the capability to activate or deactivate grid-forming mode.~~

Article 20

Requirements for type B power park modules

1. Type B power park modules shall fulfil the requirements laid down in Articles 13, ~~Article 14, and Article Y(5), (67), (78) and (89)~~, except for Article 13(2)(b) ~~and Article 13(8). Requirement laid down in Article Y(8)(d) shall not apply to type C power park modules with maximum capacity larger than or equal to 10 MW.~~

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

(a) with regard to reactive power capability, the relevant system operator shall have the right to specify the capability of a power park module to ~~supply and absorb~~ **provide** reactive power;

(b) the relevant system operator in coordination with the relevant TSO shall have the right to specify that a power park module be capable of providing fast fault current at the connection point in case of symmetrical (3-phase) faults, under the following conditions:

(i) the power park module shall be capable of activating the supply of fast fault current either by:

- ensuring the supply of the fast fault current at the connection point, or
- measuring voltage deviations at the terminals of the individual units of the power park module and providing a fast fault current at the terminals of these units;

(ii) the relevant system operator in coordination with the relevant TSO shall specify:

- how and when a voltage deviation is to be determined as well as the end of the voltage deviation,
- the characteristics of the fast fault current, including the time domain for measuring the voltage deviation and fast fault current, for which current and voltage may be measured differently from the method specified in Article 2,
- the timing and accuracy of the fast fault current, which may include several stages during a fault and after its clearance;

(c) with regard to the supply of fast fault current in case of asymmetrical (1-phase or 2-phase) faults, the relevant system operator in coordination with the relevant TSO shall have the right to specify a requirement for asymmetrical current injection.

3. Type B power park modules shall fulfil the following additional requirements in relation to robustness:

(a) the relevant TSO shall specify the post-fault active power recovery that the power park module is capable of providing and shall specify:

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

Comentado [A137]: Based on the proposal by the ESC EG ACPPM.

Recent studies have shown that a stable and robust power system operation of interconnected transmission systems can be ensured under the high penetration of non-synchronous power generation modules if grid forming capabilities are ensured during system operation. Grid forming capabilities for power park modules (PPMs) are required to ensure stable operation with the high penetration of non-synchronous generation. Grid-forming capability shall be described in the network codes to facilitate the aligned requirements' availability throughout European member states, in order to start and accelerate the process of grid-forming implementation. Further specifications in national implementations of the CNC requirements may depend on the location and urgency in each member state. For these reasons, a new provision in the NC RfG for grid forming capability followed by a provision for fast frequency control is added.

Comentado [A138]: By this provision we remove the onus on certification of larger PPMs for operation mode without grid forming capability. Larger PPMs will be installed in networks that can accommodate grid forming capability.

Comentado [A139]: In accordance with ENTSO-E amendment proposal No. 35

Comentado [A140]: Based on the ESC EG ACPPM proposal. Deleted due to the introduction of grid forming.

Comentado [TRC141R140]: 20.2.b and 20.2.c should not be eliminated

- (ii) a maximum allowed time for active power recovery; and
 - (iii) a magnitude and accuracy for active power recovery;
- (b) the specifications shall be in accordance with the following principles:
- (i) interdependency between fast fault current requirements according to points (b) and (c) of paragraph 2 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; and
 - (v) adequate damping of active power oscillations.

4. With regard to grid forming capability, if technically justified by the relevant TSO in accordance to Article Y(5), type B power park modules shall fulfil the following additional requirements in relation to grid forming capability:

(a) The relevant, TSO in coordination with the relevant system operator, shall specify the contribution to synthetic inertia. The power park module shall be capable of contributing to limiting the transient frequency deviation under high frequency conditions. Additionally, the electricity storage module shall be capable of contributing to limiting the transient frequency deviation under low frequency conditions.

(b) The dynamic performance according to Article Y(8)(c)(i) shall reflect their specified contribution to synthetic inertia.

Comentado [A142]: Based on the ESC EG ACPPM proposal on grid forming.

Article 21

Requirements for type C power park modules

1. Type C power park modules shall fulfil the requirements listed in Articles 13, Article 14, Article 15, Article Y(5), (67), (8) and (89) and Article 20, except for Article 13(2)(b) Article 13 and (6) and Article 13(8) and, Article 14, except for Article 14(2), Article 1578 and Article 20, except for Article 20(2)(a), unless referred to otherwise in point (v) of paragraph 3(d) and Article Y(6) and (7). Requirement laid down in Article Y(9)(d) shall not apply to type C power park modules with maximum capacity larger than or equal to 10 MW.

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

- (a) the relevant TSO shall have the right to specify that power park modules be capable of providing synthetic inertia during very fast frequency deviations;
- (b) the operating principle of control systems installed to provide synthetic inertia and the associated performance parameters shall be specified by the relevant TSO.

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

Comentado [A143]: By this provision we remove the onus on certification of larger PPMs for operation mode without grid forming capability. Larger PPMs will be installed in networks that can accommodate grid forming capability.

Comentado [A144]: Based on the ESC EG ACPPM proposal. Deleted due to the introduction of grid forming.

Comentado [TRC145R144]: Original Article 21.2 from Regulation (UE) 2016/631 has to be maintained to cover grid following PPMs

(a) with regard to reactive power capability, the relevant system operator may specify supplementary reactive power to be provided if the connection point of a power park module is neither located at the high-voltage terminals of the step-up transformer to the voltage level of the connection point nor at the convertor terminals, if no step-up transformer exists. This supplementary reactive power shall compensate the reactive power demand of the high-voltage line or cable between the high-voltage terminals of the step-up transformer of the power park module or its convertor terminals, if no step-up transformer exists, and the connection point and shall be provided by the responsible owner of that line or cable.

This requirement is not applicable in those cases where the national legislation imposes obligations for several power park modules, even when they are from different owners, to use and share the same electrical infrastructure up to the point of connection, and additional supplementary reactive power has not been requested by the relevant Authority when authorizing this shared use.

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

(i) the relevant system operator in coordination with the relevant TSO shall specify the reactive power provision capability requirements in the context of varying voltage. To that end, it shall specify a $U-Q/P_{\max}$ -profile that may take any shape within the boundaries of which the power park module shall be capable of providing reactive power at its maximum capacity;

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

- the $U-Q/P_{\max}$ -profile shall not exceed the $U-Q/P_{\max}$ -profile envelope, represented by the inner envelope in Figure 8,
- 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 9,
- the position of the $U-Q/P_{\max}$ -profile envelope shall be within the limits of the fixed outer envelope set out in Figure 8, and
- the specified $U-Q/P_{\max}$ profile may take any shape, having regard to the potential costs of delivering the capability to ~~provide supply~~ reactive power ~~production~~ at high voltages and ~~absorb~~ reactive power ~~consumption~~ at low voltages;

Figure 8

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

Comentado [A146]: Changes to Article 21(3)(b) follow ENTSO-E amendment proposal No. 36.

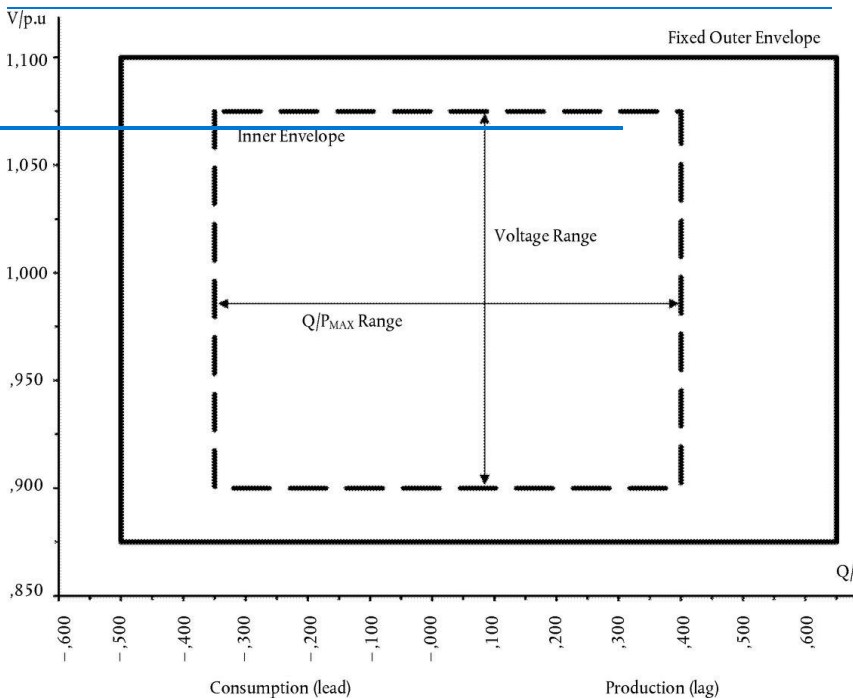
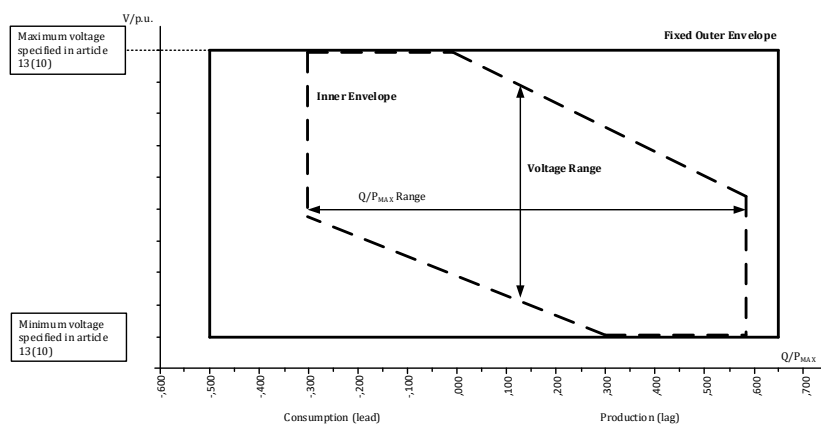
There is an unregulated area between minimum voltage ranges when power generating unit must be capable to operate (table 6.1), and the voltage profile in $U-Q/P_{\max}$ profile (figure 7 and figure 8)

The outer envelope voltage range for the 110 kV and 220 kV levels is too narrow and does not match the voltage ranges as of Article 13 (10) (a) in the initial figure. Additionally, the definition of the voltage range represented in the figure is not clear.

For these reasons, the following is recommended:

- Removing the scale and instead link to the voltage ranges set out in Article 13(10)a.
- Adapting the indicative figure so that it is clear that the voltage range represents the difference between the highest and lowest values at a certain value of Q/P_{\max} .
- Amending the text in the same manner.

Comentado [A147]: The reference in the figure needs to be changed from Article 13(10) to Article 14(2).



The diagram represents boundaries of a U-Q/P_{max}-profile by the voltage at the connection point, 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.

Table 9

Parameters for the inner envelope in Figure 8

Synchronous area	Maximum range of Q/P_{\max}	Maximum range of steady-state voltage level in PU
Continental Europe	0,75	0,225
Nordic	0,95	0,225
Great Britain	0,66	0,225
Ireland and Northern Ireland	0,66	0,218
Baltic	0,80	0,220

Comentado [A148]: In accordance with ENTSO-E amendment proposal No. 38

Comentado [A149]: Based on ENTSO-E amendment proposal No. No 37: change of the maximum range of voltage for Nordic SA. This will help the harmonization of basic generator requirements and harmonize national requirements where TSO operate in both the CE and N synchronous areas

Comentado [A150]: Removed due to the withdrawal of the UK from the EU

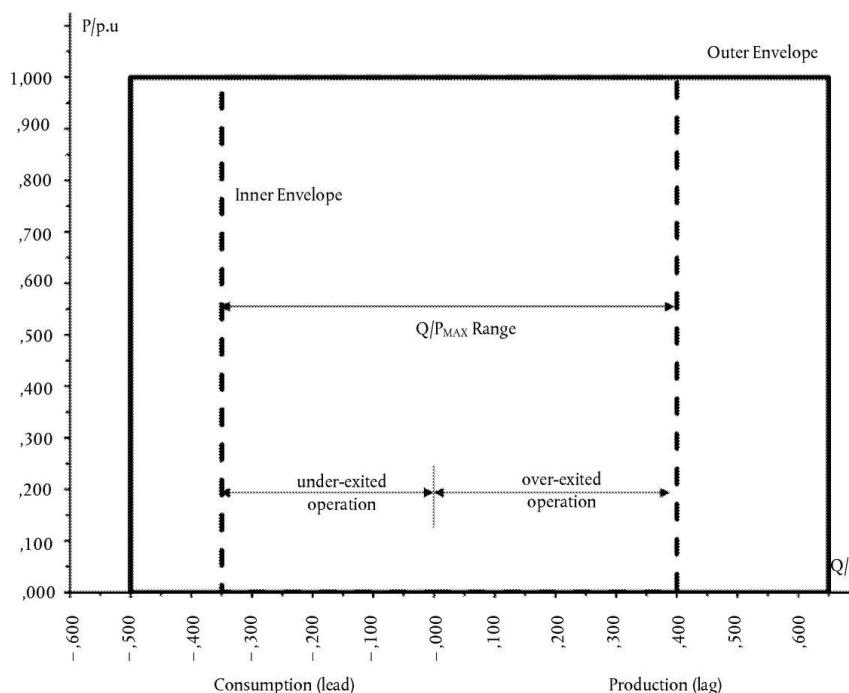
(iii) the reactive power provision capability requirement applies at the connection point. The voltage range represents the difference between the highest and lowest values at a certain value of Q/P_{\max} . For profile shapes other than rectangular, the voltage range represents the highest and lowest values. The full reactive power range is therefore not expected to be available across the range of steady-state voltages;

(c with regard to reactive power capability below maximum capacity:

-)
- (i) the relevant system operator in coordination with the relevant 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 relevant TSO, in conformity with the following principles:
 - the $P-Q/P_{\max}$ -profile shall not exceed the $P-Q/P_{\max}$ -profile envelope, represented by the inner envelope in Figure 9,
 - the Q/P_{\max} range of the $P-Q/P_{\max}$ -profile envelope is specified for each synchronous area in Table 9,
 - the active power range of the $P-Q/P_{\max}$ -profile envelope at zero reactive power shall be 1 pu,
 - the $P-Q/P_{\max}$ -profile can be of any shape and shall include conditions for reactive power capability at zero active power, and
 - the position of the $P-Q/P_{\max}$ -profile envelope shall be within the limits of the fixed outer envelope set out in Figure 9;
 - (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, that is to say namely they are not out of service due to maintenance or failure, otherwise there may be less reactive power capability, taking into consideration the technical availabilities;

Figure 9

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



The diagram represents boundaries of a P-Q/ P_{\max} -profile at the connection point 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.

(iv) the power park module shall be capable of moving to any operating point within its P-Q/ P_{\max} profile in appropriate timescales to target values requested by the relevant system operator;

(d) with regard to reactive power control modes:

(i) the power park module shall be capable of providing reactive power automatically by ~~either~~ voltage control mode, reactive power control mode, ~~or~~ power factor control mode or active power-related power factor control mode, as specified by the relevant system operator, in coordination with the relevant TSO and with the power park module owner;

(ii) for the purposes of voltage control mode, the power park module shall be capable of contributing to voltage control at the connection point by provision of reactive power exchange with the network with a setpoint voltage covering 0,95 pu to 1,05 pu in steps no greater than 0,01 pu, with a slope having a range of at least 2 % to 7 % in steps no greater than 0,5 %. The reactive power output shall be zero when the

Comentado [A151]: Changes for consistency - result from amending paragraph (viii)

grid voltage value at the connection point equals the voltage setpoint. Stable operation in voltage control mode operation shall be ensured;

(iii) the setpoint may be operated with or without a deadband selectable in a range from zero to $\pm 5\%$ of reference 1 pu network voltage in steps no greater than 0,5 %;

(iv) 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 must 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. The relevant system operator shall specify the time specifications;

(v) for the purpose of reactive power control mode, the power park module shall be capable of setting the reactive power setpoint anywhere in the reactive power range, specified by point (a) of Article 20(2) and by points (a) and (b) of Article 21(3), with setting steps no greater than 5 MVar or 5 % (whichever is smaller) of ~~full-maximum~~ reactive power, controlling the reactive power at the connection point to an accuracy within plus or minus 5 MVar or plus or minus 5 % (whichever is smaller) of the ~~full-maximum~~ reactive power;

(vi) for the purpose of power factor control mode, the power park module shall be capable of controlling the power factor at the connection point within the required reactive power range, specified by the relevant system operator according to point (a) of Article 20(2) or specified by points (a) and (b) of Article 21(3), 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 period of 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. The relevant system operator shall consider the appropriate requirements when specifying power factor control at operation close to zero active power;

(vii) for the purpose of active power-related power factor control mode, the power park module shall be capable of controlling the power factor at the connection point within the required reactive power range, specified by the relevant system operator according to point (a) of Article 20(2) or specified by points (a) and (b) of Article 21(3). The relevant system operator shall specify power factor set point resulting from a change in active power output. The relevant system operator shall specify its tolerance and the period of time to achieve the setpoint;

(viii) the relevant system operator, in coordination with the relevant TSO and with the power park module owner, shall specify which of the above ~~four~~ three 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;

(e) with regard to prioritising active or reactive power contribution, the relevant TSO shall specify whether active power contribution or reactive power contribution has

Comentado [A152]: Based on ENTSO-E amendment proposal No 60. PGMs should exhibit a stable control behaviour in different modes of operation and in switching between modes. Therefore, it should be appropriately reflected in the technical requirements

Comentado [A153]: Based on ENTSO-E amendment proposal No. 40: it aims to ensure stable behaviour of PGMs regarding voltage and frequency control.

priority during faults for which fault-ride-through capability is required. If priority is given to active power contribution, this provision has to be established no later than 150 ms from the fault inception;

- (f) with regard to power oscillations damping control, if specified by the relevant TSO a power park module shall have a power oscillation damping function which, through the control of the active power, reactive power, or both, helps to attenuate the power oscillations-be capable of contributing to damping power oscillations. The power oscillation damping shall be able to damp inter-area oscillations in the range of, at least, 0,1 Hz – 1,0 Hz. The voltage and reactive power control characteristics of power park modules must not adversely affect the damping of power oscillations.

34. In relation to system stability, type C power park modules shall not impose forced oscillations to the power system as periodic variation outside nominal frequency of any electrical quantity related to the power output at the connection point.

45. With regard to grid forming capability, if technically justified by the relevant TSO in accordance to Article Y(5), type C power park modules shall fulfil the following additional requirements in relation to grid forming capability:

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

- (b) For the provision of additional energy above the inherent energy storage, the relevant TSO may apply to the regulatory authority NRA for the right to require the provision of additional energy beyond the inherent energy storage in coordination with the relevant system operator.

Comentado [A154]: Based on WindEurope proposal and consistency change following amendments to Article 22(2): System stability is crucial in view of the system decarbonisation where a greater proportion of power electronics connected generation will be present in the system, displacing other conventional technologies such as synchronous generators. Therefore, it is important for such devices to aid the damping of system oscillations.

Comentado [A155]: [Changes pending the results of the ongoing discussion between SOs and relevant stakeholders] Based on ENTSO-E amendment proposal No. 52: proposal addresses the issue of active power forced oscillations that have an adverse impact on system operation.

Article 22

Requirements for type D power park modules

1. Type D power park modules shall fulfil the requirements listed in Articles 13, Article 14, Article 15, Article Y(5), (67) and (89), Article 20, and Article 21, except for Article 13(2)(b), Article 13-(6), and Article 13-(7), Article 13(8), Article 14, except for Article 14(2), Article 15, except for Article 15(3), Article Y(8)(d) and Article 16, Article Y(7) and (8), Article 20 except for Article 20(2)(a) and Article 21.
2. With regard to power oscillations damping control, if specified by the relevant TSO, type D power park modules shall have a power oscillation damping function which helps to attenuate the power oscillations- through the control of the active power, reactive power, or both, helps to attenuate the power oscillations. The power oscillation damping shall be able to damp inter-area oscillations in the range of, at least, 0,1 Hz – 1,0 Hz. The relevant TSO shall have the right to request and approve 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 relevant TSO in coordination with adjacent TSO or TSOs. The relevant TSO shall have

Comentado [A156]: By this we remove the onus on certification of larger PPMs for operation mode without grid forming capability. Larger PPMs will be installed in networks that can accommodate grid forming capability.

Comentado [A157]: Provision reworded for clarity.

the right to request the tuning of the power oscillation damping by power-generating facility owner to damp the local oscillation mode, in which the power park modules is oscillating against the grid.

The proposed power oscillation damping control shall be approved by the relevant TSO.

Comentado [A158]: Based on ENTSO-E amendment proposal No. 63: Adding stabilising power to the system would improve system stability and allow improvement of the power flow transfers throughout the system, easing market integration and system decarbonization.

CHAPTER 4

Requirements for offshore power park modules

Article 23

General provisions

1. The requirements set out in this Chapter apply to the connection to the network of AC-connected power park modules located offshore. An AC-connected power park module located offshore which does not have an offshore connection point shall be considered as an onshore power park module and thus shall comply with the requirements governing power park modules situated onshore.
2. The offshore connection point of an AC-connected offshore power park module shall be specified by the relevant system operator.
3. AC-connected offshore power park modules within the scope of this Regulation shall be categorised in accordance with the following offshore grid connection system configurations:
 - (a) configuration 1: AC connection to a single onshore grid interconnection point whereby one or more offshore power park modules that are interconnected offshore to form an offshore AC system are connected to the onshore system;
 - (b) configuration 2: meshed AC connections whereby a number of offshore power park modules are interconnected offshore to form an offshore AC system and the offshore AC system is connected to the onshore system at two or more onshore grid interconnection points.

Article 24

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

AC-connected offshore power park modules shall fulfil the requirements relating to frequency stability laid down in Articles 13, 15(2) and 21(2), except for Article 13(2)(b), (6) and (7) respectively.

The frequency stability requirements laid down respectively in Article 13(1) to (5), except for Article 13(2)(b), Article 15(2) and Article 21(2) shall apply to any AC-connected offshore power park module.

Comentado [A159]: Based on VGBE's proposal: article was reworded for clarity.

Article 25

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

1. Without prejudice to point (a) of Article 14(3) and point (a) of Article 16(3), an AC-connected offshore power park module shall be capable of staying connected to the network and operating within the ranges of the network voltage at the connection point, expressed by the voltage at the connection point related to reference 1 pu voltage, and for the time periods specified in Table 10 or, for voltage level below 110kV as specified by the relevant system operator.

2. Notwithstanding the provisions of paragraph 1, the relevant TSO in Spain may require AC-connected offshore power park modules to remain connected to the network in the voltage range between 1,05 pu and 1,0875 pu for an unlimited period.

3. Notwithstanding the provisions of paragraph 1, the relevant TSOs in the Baltic synchronous area may require AC-connected offshore power park modules to remain connected to the 400 kV network in the voltage range and for the time periods that apply to the Continental Europe synchronous area.

Comentado [A161]: Based on proposals from several stakeholders: amendments to the voltage ranges relating to the need to maintain sufficient levels of system robustness. It is deemed necessary to amend the upper limit of the voltage range as this corresponds to too onerous requirement for 400kV connected PGMs.

Table 10

Synchronous-area	Voltage range	Time period for operation
Continental Europe	0,95 pu-0,90 pu	60 minutes
	0,9 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
	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	0,90 pu-1,05 pu	Unlimited
	1,05 pu-1,10 pu (-)	60 minutes

	1,05 pu-1,10 pu (-)	To be specified by each TSO, but not more than 60 minutes	
Great Britain	0,90 pu-1,10 pu (-)	Unlimited	
	0,90 pu-1,05 pu (-)	Unlimited	
	1,05 pu-1,10 pu (-)	15 minutes	
Ireland and Northern Ireland	0,90 pu-1,10 pu	Unlimited	
Baltic	0,85 pu-0,90 pu (-)	30 minutes	
	0,90 pu-1,118 pu (-)	Unlimited	
	1,118 pu-1,15 pu (-)	20 minutes	
	0,88 pu-0,90 pu (-)	20 minutes	
	0,90 pu-1,097 pu (-)	Unlimited	
	1,097 pu-1,15 pu (-)	20 minutes	
Synchronous area	Rated Voltage	Voltage range	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

	132 kV	0.85 pu-0.90 pu	60 minutes
		0.90 pu-1.098 pu	Unlimited
		1.098 pu-1.15 pu	To be specified by each TSO, but not less than 20 minutes and not more than 60 minutes
	150 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	0.85 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
	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	0.90 pu-1.05 pu	Unlimited
		1.05 pu-1.10 pu	60 minutes
	132 kV	0.90 pu-1.05 pu	Unlimited
		1.05 pu-1.10 pu	60 minutes

	220 kV	0.90 pu-1.05 pu	Unlimited
		1.05 pu-1.10 pu	60 minutes
	330 kV	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
	400 kV	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
Great Britain	132 kV	0.90 pu – 1.09 pu	Unlimited
	275 kV	0.90 pu – 1.09 pu	Unlimited
	400 kV	0.90 pu – 1.05 pu	Unlimited
		1.05 pu – 1.10 pu	15 minutes
Ireland and Northern Ireland	110 kV	0.90 pu-1.10 pu	Unlimited
	220 kV	0.90 pu-1.10 pu	Unlimited
	275 kV	0.90 pu – 1.09 pu	Unlimited
	400 kV	0.90 pu – 1.10 pu	Unlimited
Baltic	110 kV	0.85 pu-0.90 pu	30 minutes
		0.90 pu-1.118 pu	Unlimited
		1.118 pu-1.15 pu	20 minutes
	220 kV	0.85 pu-0.90 pu	30 minutes
		0.90 pu-1.113 pu	Unlimited
		1.113 pu-1.15 pu	20 minutes
	330 kV	0.88 pu-0.90 pu	30 minutes

Comentado [A160]: Removed due to the withdrawal of the UK from the EU

		0.90 pu-1.097 pu	Unlimited
		1.097 pu-1.15 pu	20 minutes
	400 kV	0.88 pu-0.90 pu	30 minutes
		0.90 pu-1.05 pu	Unlimited
		1.05 pu-1.15 pu	20 minutes

The table shows the minimum period during which an AC-connected offshore power park module ~~must~~ shall be capable of operating over different voltage ranges deviating from the reference 1 pu value without disconnecting.

4. AC-connected offshore power park modules shall fulfil the requirements relating to voltage stability laid down in Article 20(2)(b) and (c), and Article 21(3) respectively.

The voltage stability requirements specified respectively in points (b) and (c) of Article 20(2) as well as in Article 21(3) shall apply to any AC-connected offshore power park module.

5. The reactive power capability at maximum capacity specified in point (b) of Article 21(3) shall apply to AC-connected offshore power park modules, except for Table 9. Instead, the requirements of Table 11 shall apply.

Table 11

Parameters for Figure 8

Synchronous area	Maximum range of Q/P _{max}	Maximum range of steady-state voltage level in PU
Continental Europe	0,75	0,225
Nordic	0,95	0, 225 <u>150</u>
<u>Great Britain</u>	0,33	0,225
Ireland and Northern Ireland	0,66	0,218
Baltic	0,8	0,22

Comentado [A162]: Amendments introduced for consistency with the new wording of Article 24.

Comentado [A163]: In accordance with ENTSO-E amendment proposal No. 38

Comentado [A164]: Based on ENTSO-E amendment proposal No. 37: change of the maximum range of voltage for Nordic SA. This will help the harmonization of basic generator requirements and harmonize national requirements where TSO operate in both the CE and N synchronous areas.

Comentado [A165]: Removed due to the withdrawal of the UK from the EU.

Article 26

Robustness requirements applicable to AC-connected offshore power park modules

1. AC-connected offshore power park modules shall fulfil the requirements relating to robustness laid down in Articles 14(3)(a), 15(4), 16(3)(a), and 20(3) respectively.

The robustness requirements of power-generating modules laid down in Article 15(4) and Article 20(3) shall apply to AC-connected offshore power park modules.

2. The fault-ride-through capability requirements laid down in point (a) of Article 14(3) and point (a) of Article 16(3) shall apply to AC-connected offshore power park modules.

Article 27

System restoration requirements applicable to AC-connected offshore power park modules

AC-connected offshore power park modules shall fulfil the requirements relating to system restoration laid down in Articles 14(4) and 15(5) respectively.

The system restoration requirements laid down respectively in Article 14(4) and Article 15(5) shall apply to AC-connected offshore power park modules.

Article 28

General system management requirements applicable to AC-connected offshore power park modules

AC-connected offshore power park modules shall fulfil the requirements relating to system management laid down in Articles 14(5), 15(6), 16(4) respectively.

The general system management requirements laid down in Article 14(5), Article 15(6) and Article 16(4) shall apply to AC-connected offshore power park modules.

Comentado [A166]: Amendments introduced for consistency with the new wording of Article 24.

TITLE III

OPERATIONAL NOTIFICATION PROCEDURE FOR CONNECTION

CHAPTER 1

Connection of new power-generating modules

Article 29

General provisions

1. The power-generating facility owner shall demonstrate to the relevant system operator that it has complied with the requirements set out in Title II of this Regulation by completing successfully the operational notification procedure for connection of each power-generating module described in Articles 30 to 37.

2. The relevant system operator shall clarify and make publicly available the details of the operational notification procedure.

3. The power-generating facility owner shall notify the relevant system operator or the competent authority of the Member State about the permanent decommissioning of a power-generating module in accordance with national legislation. Where appropriate,

~~4. The relevant system operator shall ensure that such notification can be made by third parties, including aggregators.~~

Comentado [A167]: Removing this cuts the red tape and improves harmonisation.

4. ~~Where applicable, the relevant system operator shall ensure that the commissioning and decommissioning of power-generating modules can be notified electronically.~~

Comentado [A168]: Removing this cuts the red tape and improves harmonisation.

Comentado [A169]: In accordance with ENTSO-E amendment proposal No. 42

Article 30

Operational notification of type A power-generating modules

1. The operational notification procedure for connection of each new type A power-generating module shall consist of submitting an installation document. The power-generating facility owner shall ensure that the required information is ~~filled in~~ provided on an installation document obtained from the relevant system operator and is submitted to the system operator. Separate installation documents shall be provided for each power-generating module within the power-generating facility.

The relevant system operator shall ensure that the required information can be submitted by third parties on behalf of the power-generating facility owner.

2. The relevant system operator shall specify the content of the installation document, which shall have 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) the classification of the power-generating module as an emerging technology according to Title VI of this Regulation;
- (f) reference to equipment certificates issued by an authorised certifier used for equipment that is in the site installation;
- (g) as regards equipment used, for which an equipment certificate has not been received, information shall be provided as directed by the relevant system operator; and
- (h) the contact details of the power-generating facility owner and the installer and their signatures.

~~3. The power-generating facility owner shall ensure that the relevant system operator or the competent authority of the Member State is notified about the permanent decommissioning of a power-generating module in accordance with national legislation.~~

~~The relevant system operator shall ensure that such notification can be made by third parties, including aggregators.~~

Article 30a

Procedure for type EV2 associated V2G electric vehicle supply equipment

1. The operational notification procedure for connection of each new type EV2 associated V2G electric vehicle supply equipment shall consist of submitting an installation document. The electrical charging park owner shall ensure that the required information is filled in on an installation document obtained from the relevant system operator and is submitted to the system operator.

The relevant system operator shall ensure that the required information can be submitted by third parties on behalf of the electrical charging park owner.

2. The relevant system operator shall specify the content of the installation document, which shall have 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) reference to equipment certificates issued by an authorised certifier used for equipment that is in the site installation;
- (e) as regards equipment used, for which an equipment certificate has not been received, information shall be provided as directed by the relevant system operator; and
- (f) the contact details of the electrical charging park owner and the installer, and their signatures.

Article 30b

Procedure for type EV3 associated V2G electric vehicle supply equipment

1. For the purpose of operational notification for connection of each new type EV3 V2G electric vehicle supply equipment, a supply equipment document ('SED') shall be provided by the electrical charging park owner to the relevant system operator and shall include a statement of compliance.

2. The format of the SED and the information to be given therein shall be specified by the relevant system operator and use established European technical standards. The relevant system operator shall have the right to request that the electrical charging park owner includes the following in the SED:

(a) evidence of an agreement on the protection and control settings relevant to the connection point between the relevant system operator and the electrical charging park owner;

(b) an itemised statement of compliance;

(c) detailed technical data of the V2G electric vehicle supply equipment with relevance to the grid connection as specified by the relevant system operator;

(d) equipment certificates issued by an authorised certifier in respect of type EV3 associated V2G electric vehicle supply equipment, where these are relied upon as part of the evidence of compliance;

(e) compliance test reports demonstrating steady-state and dynamic performance as required by Chapters 2, 3 and 4 of Title IV, including use of actual measured values during testing, to the level of detail required by the relevant system operator; and

(f) studies demonstrating steady-state and dynamic performance as required by Chapters 5, 6 or 7 of Title IV, to the level of detail required by the relevant system operator.

Comentado [A171]: The relevant references both for tests and simulations are still to be drafted; these should follow the same structure as for type B PGMs.

3. The relevant system operator, on acceptance of a complete and adequate SED, shall issue a final operational notification to the electrical charging park owner.

4. Member States may provide that the SED shall be issued by an authorised certifier.

Article 31

Operational notification of type B, C and D power-generating modules

The operational notification procedure for connection of each new type B, C and D power-generating module shall allow the use of equipment certificates issued by an authorised certifier.

Article 32

Procedure for type B and C power-generating modules

1. For the purpose of operational notification for connection of each new type B and C power-generating module, a power-generating module document ('PGMD') shall be provided by the power-generating facility owner to the relevant system operator and shall include a statement of compliance.

For each power-generating module within the power-generating facility, separate independent PGMDs shall be provided.

2. The format of the PGMD and the information to be given therein shall be specified by the relevant system operator. The relevant system operator shall have the right to request that the power-generating facility owner include the following in the PGMD:

(a) evidence of an agreement on the protection and control settings relevant to the connection point between the relevant system operator and the power-generating facility owner;

(b) an itemised statement of compliance;

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

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

(e) for Type C power-generating modules, simulation models ~~pursuant to as specified by~~ point (c) of Article 15(6) and required by the relevant system operator;

Comentado [A172]: In accordance with ENTSO-E amendment proposal No. 44

(f) compliance test reports demonstrating steady-state and dynamic performance as required by Chapters 2, 3 and 4 of Title IV, including use of actual measured values during testing, to the level of detail required by the relevant system operator; and

(g) studies demonstrating steady-state and dynamic performance as required by Chapters 5, 6 or 7 of Title IV, to the level of detail required by the relevant system operator.

3. The relevant system operator, on acceptance of a complete and adequate PGMD, shall issue a final operational notification to the power-generating facility owner.

~~4. The power-generating facility owner shall notify the relevant system operator or the competent authority of the Member State about the permanent decommissioning of a power-generating module in accordance with national legislation.~~

~~5. Where applicable, the relevant system operator shall ensure that the commissioning and decommissioning of Type B and Type C power-generating modules can be notified electronically.~~

~~46.~~ Member States may provide that the PGMD shall be issued by an authorised certifier.

Comentado [A173]: In accordance with ENTSO-E amendment proposal No. 44.

Article 33

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 ('EON');
- (b) interim operational notification ('ION');
- (c) final operational notification ('FON').

Article 34

Energisation operational notification for type D power-generating modules

1. An EON shall entitle the power-generating facility owner to energise its internal network and auxiliaries for the power-generating modules by using the grid connection that is specified for the connection point.
2. An EON shall be issued by the relevant system operator, 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.

Article 35

Interim operational notification for type D power-generating modules

1. An ION shall entitle the power-generating facility owner to operate the power-generating module and generate power by using the grid connection for a limited period of time.
2. An ION shall be issued by the relevant system operator, subject to completion of the data and study review process as required by this Article.
3. With regard to the data and study review, the relevant system operator shall have the right to request that the power-generating facility owner provide the following:
 - (a) itemised statement of compliance;

- (b) detailed technical data on the power-generating module of relevance to the grid connection as specified by the relevant system operator;
- (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 specified by point (c) of Article 15(6) and required by the relevant system operator;
- (e) studies demonstrating the expected steady-state and dynamic performance as required by Chapter 5, 6 or 7 of Title IV; and
- (f) details of intended compliance tests in accordance with Chapters 2, 3 and 4 of Title IV.

4. The maximum period during which the power-generating facility owner may maintain ION status shall be 24 months. The relevant system operator is entitled to specify a shorter ION validity period. An extension of the ION shall be granted only if the power-generating facility owner has made substantial progress towards full compliance. Outstanding issues shall be clearly identified at the time of requesting extension.

~~5. An extension of the period during which the power-generating facility owner may maintain ION status, beyond the period established in paragraph 4, may be granted if a request for a derogation is made to the relevant system operator before the expiry of that period in accordance with the derogation procedure laid down in Article 60.~~

Comentado [A174]: Amendment follows the implementation challenges noted by Polish NRA (URE) in its July 2022 derogation decisions.

Article 36

Final operational notification for type D power-generating modules

1. A FON shall entitle the power-generating facility owner to operate a power-generating module by using the grid connection.
2. A FON shall be issued by the relevant system operator, upon prior removal of all incompatibilities identified for the purpose of ION status and subject to completion of the data and study review process as required by this Article.
3. For the purposes of the data and study review, the power-generating facility owner must submit the following to the relevant system operator:
 - (a) an itemised statement of compliance; and
 - (b) an update of applicable technical data, simulation models and studies as referred to in points (b), (d) and (e) of Article 35(3), including the use of actual measured values during testing.
4. If incompatibility is identified in connection with the issuing of the FON, a derogation may be granted upon a request made to the relevant system operator, in accordance with the derogation procedure described 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 shall have the right to 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 the provisions of this Regulation.

If the relevant system operator and the power-generating facility owner do not resolve the incompatibility within a reasonable time frame, but in any case not later than 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 37

Limited operational notification 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 the following circumstances:

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

(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 described in paragraph 1 to persist for more than three months.

3. A LON shall be issued by the relevant system operator and shall contain the following information which shall be clearly identifiable:

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

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

(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 evidence is submitted to the satisfaction of the relevant system operator demonstrating that substantial progress has been made towards achieving full compliance.

4. The FON shall be suspended during the period of validity of the LON with regard to the items for which the LON has been issued.

5. A further extension of the period of validity of the LON may be granted upon a request for a derogation made to the relevant system operator before the expiry of that period, in accordance with the derogation procedure described in Title V.

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

7. If the relevant system operator does not grant an extension of the period of validity of the LON in accordance with paragraph 5 or if it refuses to allow the operation of the power-generating module once the LON is no longer valid in accordance with paragraph 6, the power-generating facility owner may refer the issue for decision to the regulatory authority within six months after the notification of the decision of the relevant system operator.

CHAPTER 2

Cost-benefit analysis

Article 38

Identification of costs and benefits of application of requirements to existing power-generating modules

1. Prior to the application of any requirement set out in this Regulation to existing power-generating modules in accordance with Article 4(3), the relevant TSO shall undertake a qualitative comparison of costs and benefits related to the requirement under consideration. This comparison shall take into account available network-based or market-based alternatives. The relevant TSO may only proceed to undertake a quantitative cost-benefit analysis in accordance with paragraphs 2 to 5, if the qualitative comparison indicates that the likely benefits exceed the likely costs. If, however, the cost is deemed high or the benefit is deemed low, then the relevant TSO shall not proceed further.

2. Following [the](#) preparatory stage undertaken in accordance with paragraph 1, the relevant TSO shall carry out a quantitative cost-benefit analysis of any requirement under consideration for application to existing power-generating modules that have demonstrated potential benefits as a result of the preparatory stage according to paragraph 1.

3. Within three months of concluding the cost-benefit analysis, the relevant TSO shall summarise the findings in a report which shall:

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

(b) include a proposal for a transitional period for applying the requirement to existing power-generating modules. That transitional period shall not be more than two years from the date of the decision of the regulatory authority or where applicable the Member State on the requirement's applicability;

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

4. No later than six months after the end of the public consultation, the relevant TSO shall prepare a report explaining the outcome of the consultation and making a proposal on the applicability of the requirement under consideration to existing power-generating modules. The report and proposal shall be notified to the regulatory authority or, where applicable, the Member State, and the power-generating facility owner or, where applicable, third party shall be informed on its content.

5. The proposal made by the relevant TSO to the regulatory authority or, where applicable, the Member State pursuant to paragraph 4 shall include the following:

(a) an operational notification procedure for demonstrating the implementation of the requirements by the existing power-generating facility owner;

(b) a transitional period for implementing the requirements which shall take into account the category of the power-generating module as specified in Article 5(2) and Article 23(3) and any underlying obstacles to the efficient implementation of the equipment modification/refitting.

Article 39

Principles of cost-benefit analysis

1. Power-generating facility owners and DSOs including CDSOs shall assist and contribute to the cost-benefit analysis undertaken according to Articles [13](#), 38 and 63 and provide the necessary data as requested by the relevant system operator or relevant TSO

within three months of receiving a request, unless agreed otherwise by the relevant TSO. For the preparation of a cost-benefit-analysis by a power-generating facility owner, or prospective owner, assessing a potential derogation pursuant to Article 62, the relevant TSO and DSO, including CDSO, shall assist and contribute to the cost-benefit 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.

2. A cost-benefit analysis shall be in line with the following principles:

(a) the relevant TSO, relevant system operator, power-generating facility owner or prospective owner shall base its cost-benefit analysis on one or more of the following calculating principles:

- (i) the net present value;
- (ii) the return on investment;
- (iii) the rate of return;
- (iv) the time needed to break even;

(b) the relevant TSO, relevant system operator, power-generating facility owner or prospective owner shall also 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;

(c) the relevant TSO, relevant system operator, power-generating facility owner or prospective owner shall 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) defence measures [in accordance with the provisions established as per Article 59\(2\)\(d\) of Regulation \(EU\) 2019/943](#);

(d) the relevant TSO shall 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.

Comentado [A175]: Based on VGBE proposal related to the need for relevant reference for defence measures.

TITLE IV COMPLIANCE

CHAPTER 1

Compliance monitoring

Article 40

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 throughout the lifetime of the facility. For type A power-generating modules, the power-generating facility owner may rely upon equipment certificates, issued as per Regulation (EC) No 765/2008.
2. The power-generating facility owner shall notify to the relevant system operator 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.
3. 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.
4. 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 shall approve in advance the planned test schedules and procedures. Such approval by the relevant system operator shall be provided in a timely manner and shall not be unreasonably withheld.
5. The relevant system operator may participate in such tests and record the performance of the power-generating modules.

6. 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 compliance with that the provisions of Article 12 are applied, and may enter including entering into confidentiality commitments for this purpose with the third party assignee.

Article 41

Tasks 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, throughout the lifetime of the power-generating facility. The power-generating facility owner shall be informed of the outcome of this assessment.

For type A power-generating modules, the relevant system operator may rely upon equipment certificates issued by an authorised certifier for this assessment.

2. The relevant system operator shall have the right to request that the power-generating facility owner carry out compliance tests and simulations according to 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.

Comentado [A176]: Based on ENTSO-E amendment proposal No. 10, but moved the provision to article 40 to allow the flexibility for facility owners. It mirrors the provision in article 41(5) for SOs.

The power-generating facility owner shall be informed of the outcome of those compliance tests and simulations.

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 information, documents and requirements:

- (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 requirements set out in Chapters 5 and 6 of Title IV;
- (f) conditions and procedures, including the scope, for registering equipment certificates; and
- (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 totally 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, including entering into confidentiality commitments with the assignee.

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 not unreasonably withhold the operational notification referred to in Title III.

Article 42

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 complied with.

2. Notwithstanding the minimum requirements for compliance testing set out in this Regulation, the relevant system operator is entitled to:

- (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 provisions of Chapter 2, 3 or 4 of Title IV, is not sufficient to demonstrate compliance with the requirements of this Regulation; and

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

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

4. The relevant system operator may participate in the compliance testing either on site or remotely from the system operator's control centre. For that purpose, the power-generating facility owner shall provide the 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. The relevant system operator has sole discretion to decide about its participation.

5. Concerning V2G electric vehicle and V2G electric vehicle supply equipment compliance shall be based on individual type-test certificates issued as per Regulation (EC) No 765/2008 regarding the V2G electric vehicle supply equipment on one side and the V2G electric vehicle homologated platform on the other side. A certification shall include for instance the data exchange protocol, or system performance criteria, associating the V2G electric vehicle supply equipment and the V2G electric vehicle homologated platform.

Comentado [A177]: This is to ensure that the V2G electric vehicle and V2G electric vehicle supply equipment are certified separately. (Smarten)

Article 43

Common provisions on compliance simulation

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

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

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

(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 provisions of Chapter 5, 6 or 7 of Title IV, is not sufficient to demonstrate compliance with the requirements of this Regulation.

3. To demonstrate compliance with the requirements of 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 produce and provide a validated simulation model for a given power-generating module. The scope of the simulation models is set out in point (c) of Article 15(56).

4. The relevant system operator shall have the right to check that a power-generating module complies with the requirements of 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 Chapter 5, 6 or 7 of Title IV.

CHAPTER 2

Compliance testing for synchronous power-generating modules

Article 44

Compliance tests for type B synchronous power-generating modules

1. Power-generating facility owners shall undertake LFSM-O response compliance tests in relation to type B synchronous power-generating modules.

Instead of carrying out the relevant test, 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, the equipment certificates shall be provided to the relevant system operator.

2. The following requirements with regard to the LFSM-O response test shall apply:

(a) the power-generating module's technical capability to continuously modulate active power to contribute to frequency control in case of any large increase of frequency in the system shall be demonstrated. The steady-state parameters of regulations, such as droop and deadband, and dynamic parameters, including frequency step change response shall be verified;

(b) the test shall be carried out by simulating frequency steps and ramps big enough to trigger at least 10 % of maximum capacity change in active power, taking into account the droop settings and the deadband. If required, simulated frequency deviation signals shall be injected simultaneously at both the speed governor and load controller of the control systems, taking into account the scheme of those control systems;

(c) the test shall be deemed successful if the following conditions are fulfilled:

(i) the test results, for both dynamic and static parameters, meet the requirements set out in Article 13(23); and

(ii) undamped oscillations do not occur after the step change response.

Article 45

Compliance tests for type C synchronous power-generating modules

1. In addition to the compliance tests for type B synchronous power-generating modules described in Article 44, power-generating facility owners shall undertake the compliance tests set out in paragraphs 2, 3, 4 and 6 of this Article in relation to type C synchronous power-generating modules. Where a power-generating module provides black start capability, power-generating facility owners shall also undertake the tests referred to in paragraph 5. Instead of the relevant test, the power-generating facility owner may use equipment certificates issued by an authorised certifier to demonstrate compliance with the relevant requirement. In that case, the equipment certificates shall be provided to the relevant system operator.

2. The following requirements with regard to the LFSM-U response test shall apply:

- (a) it shall demonstrate that the power-generating module is technically capable of continuously modulating active power at operating points below maximum capacity to contribute to frequency control in case of a large frequency drop in the system;
- (b) the test shall be carried out by simulating appropriate active power load points, with low frequency steps and ramps big enough to trigger active power change of at least 10 % of maximum capacity, taking into account the droop settings and the deadband. If required, simulated frequency deviation signals shall be injected simultaneously into both the speed governor and the load controller references;
- (c) the test shall be deemed successful if the following conditions are fulfilled:
 - (i) the test results, for both dynamic and static parameters, comply with point (c) of Article 15(2); and
 - (ii) undamped oscillations do not occur after the step change response.

3. The following requirements with regard to the FSM response test shall apply:

- (a) it shall demonstrate that the power-generating module is technically capable of continuously modulating active power over the full operating range between maximum capacity and minimum regulating level to contribute to frequency control. The steady-state parameters of regulations, such as droop and deadband and dynamic parameters, including robustness through frequency step change response and large, fast frequency deviations shall be verified;
- (b) the test shall be carried out by simulating frequency steps and ramps big enough to trigger the whole active power frequency response range, taking into account the settings of droop and deadband, as well as the capability to actually increase or decrease active power output from the respective operating point. If required, simulated frequency deviation signals shall be injected simultaneously into the references of both the speed governor and the load controller of the unit or plant control system;
- (c) the test shall be deemed successful if the following conditions are fulfilled:
 - (i) the activation time of full active power frequency response range as a result of a frequency step change is no longer than required by point (d) of Article 15(2);
 - (ii) undamped oscillations do not occur after the step change response;
 - (iii) the initial delay time complies with point (d) of Article 15(2);

(iv) the droop settings are available within the range specified in point (d) of Article 15(2) and the deadband (threshold) is not higher than the value specified in that Article; and

(v) the insensitivity of active power frequency response at any relevant operating point does not exceed the requirements set out in point (d) of Article 15(2).

4. With regard to the frequency restoration control test the following requirements shall apply:

(a) the power-generating module's technical capability to participate in frequency restoration control shall be demonstrated and the cooperation of FSM and frequency restoration control shall be checked;

(b) the test shall be deemed successful if the results, for both dynamic and static parameters, comply with the requirements of point (e) of Article 15(2).

5. With regard to the black start capability test the following requirements shall apply:

(a) for power-generating modules with black start capability, this technical capability to start from shut down without any external electrical energy supply shall be demonstrated;

(b) the test shall be deemed successful if the start-up time is kept within the time frame set out in point (iii) of Article 15(54)(a).

6. With regard to the tripping to houseload test the following requirements shall apply:

(a) the power-generating modules' technical capability to trip to and ~~stably~~ operate stably on house load shall be demonstrated;

(b) the test shall be carried out at the maximum capacity and nominal reactive power of the power-generating module before load shedding;

(c) the relevant system operator shall have the right to set additional conditions, taking into account point (c) of Article 15(45);

(d) the test shall be deemed successful if tripping to house load is successful, stable houseload operation has been demonstrated in the time period set out in point (c) of Article 15(54) and re-synchronisation to the network has been performed successfully.

7. With regard to the reactive power capability test the following requirements shall apply:

(a) the power-generating module's technical capability to provide leading and lagging reactive power capability in accordance with points (b) and (c) of Article 18(2) shall be demonstrated;

(b) the test shall be deemed successful if the following conditions are fulfilled:

(i) the power-generating module operates at maximum reactive power for at least one hour, both leading and lagging, at:

— minimum stable operating level,

— maximum capacity, and

— an active power operating point between those maximum and minimum levels;

- (ii) the power-generating module's capability to change to any reactive power target value within the agreed or decided reactive power range shall be demonstrated.

Article 46

Compliance tests for type D synchronous power-generating modules

1. Type D synchronous power-generating modules are subject to the compliance tests for type B and C synchronous power-generating modules described in Articles 44 and 45.
2. Instead of the relevant test, the power-generating facility owner may use equipment certificates issued by an authorised certifier to demonstrate compliance with the relevant requirement. In such a case, the equipment certificates shall be provided to the relevant system operator.

CHAPTER 3

Compliance testing for power park modules

Article 47

Compliance tests for type B power park modules

1. Power-generating facility owners shall undertake LFSM-O and LFSM-U-ESM response compliance tests in relation to type B power park modules.

Instead of the relevant test, the power-generating facility owner may use equipment certificates issued by an authorised certifier to demonstrate compliance with the relevant requirement. In that case, the equipment certificates shall be provided to the relevant system operator.

2. With regard to type B power park modules, the LFSM-O and LFSM-U-ESM response tests shall reflect the choice of control scheme selected by the relevant system operator.

3. With regard to the LFSM-O and LFSM-U-ESM response tests the following requirements shall apply:

(a) the power park module's technical capability to continuously modulate active power to contribute to frequency control in case of increase of frequency in the system shall be demonstrated. The steady-state parameters of regulations, such as droop and deadband, and dynamic parameters shall be verified;

(b) the test shall be carried out by simulating frequency steps and ramps big enough to trigger at least 10 % of maximum capacity change in active power, taking into account the droop settings and the deadband. To perform this test, simulated frequency deviation signals shall be injected simultaneously into the control system references;

(c) the test shall be deemed successful in the event that the test results, for both dynamic and static parameters, comply with the requirements set out in Article 13(23) for LFSM-O and Article 13(119) for LFSM-U-ESM.

Comentado [A178]: Based on ENTSO-E amendment proposal No. 60. PGMs should exhibit a stable control behaviour in different modes of operation and in switching between modes. Verification of compliance with these requirements should be described.

Article 48

Compliance tests for type C power park modules

1. In addition to the compliance tests for type B power park modules described in Article 47, power-generating facility owners shall undertake the compliance tests set out in paragraphs 2 to 9 in relation to type C power park modules. Instead of the relevant test, the power-generating facility owner may use equipment certificates issued by an authorised certifier to demonstrate compliance with the relevant requirement. In such a case, the equipment certificate shall be provided to the relevant system operator.

2. With regard to the active power controllability and control range test the following requirements shall apply:

(a) the power park module's technical capability to operate at a load level below the setpoint set by the relevant system operator or the relevant TSO shall be demonstrated;

(b) the test shall be deemed successful if the following conditions are fulfilled:

(i) the load level of the power park module is kept below the setpoint;

(ii) the setpoint is implemented according to the requirements laid down in Article 15(2)(a); and

(iii) the accuracy of the regulation complies with the value specified in point (a) of Article 15(2).

3. With regard to the LFSM-U response test the following requirements shall apply:

(a) the power park module's technical capability to continuously modulate active power to contribute to frequency control in case of a large frequency drop in the system shall be demonstrated;

(b) the test shall be carried out by simulating the frequency steps and ramps big enough to trigger at least 10 % of maximum capacity active power change with a starting point of no more than 80 % of maximum capacity, taking into account the droop settings and the deadband;

(c) the test shall be deemed successful if the following conditions are fulfilled:

(i) the test results, for both dynamic and static parameters, comply with the requirements laid down in Article 15(2)(c); and

(ii) undamped oscillations do not occur after the step change response.

4. With regard to the FSM response test the following requirements shall apply:

(a) the power park module's technical capability to continuously modulate active power over the full operating range between maximum capacity and minimum regulating level to contribute to frequency control shall be demonstrated. [In the case of an electricity storage module, the full operating range, depending on the energy stored, is between maximum consumption capacity and maximum capacity.](#) The steady-state parameters of regulations, such as insensitivity, droop, deadband and range of regulation, as well as dynamic parameters, including frequency step change response shall be verified;

(b) the test shall be carried out by simulating frequency steps and ramps big enough to trigger the whole active power frequency response range, taking into account the droop settings and the deadband. Simulated frequency deviation signals shall be injected to perform the test;

Comentado [A179]: This is to cater for the operation point. The rest is following the proposal from several stakeholders.

- (c) the test shall be deemed successful if the following conditions are fulfilled:
- (i) the activation time of the full active power frequency response range as a result of a frequency step change is no longer than that required by point (d) of Article 15(2);
 - (ii) undamped oscillations do not occur after the step change response;
 - (iii) the initial delay is in line with point (d) of Article 15(2);
 - (iv) the droop settings are available within the ranges specified in point (d) of Article 15(2) and the deadband (threshold) is not higher than the value chosen by the relevant TSO; and
 - (v) the insensitivity of active power frequency response does not exceed the requirement set out in point (d) of Article 15(2).
5. With regard to the frequency restoration control test the following requirements shall apply:
- (a) the power park module's technical capability to participate in frequency restoration control shall be demonstrated. The cooperation of both FSM and frequency restoration control shall be checked;
 - (b) the test shall be deemed successful if the results for both dynamic and static parameters comply with the requirements of point (e) of Article 15(2).
6. With regard to the reactive power capability test the following requirements shall apply:
- (a) the power park module's technical capability to provide leading and lagging reactive power capability in accordance with points (b) and (c) of Article 21(32) shall be demonstrated;
 - (b) it shall be carried out at maximum reactive power, both leading and lagging, and shall verify the following parameters:
 - (i) operation in excess of 60 % of maximum capacity for 30 min;
 - (ii) operation within the range of 30-50 % of maximum capacity for 30 min; and
 - (iii) operation within the range of 10-20 % of maximum capacity for 60 min;
 - (c) the test shall be deemed successful if the following criteria are fulfilled:
 - (i) the power park module operates for a duration no shorter than the requested duration at maximum reactive power, both leading and lagging, in each parameter specified in [point paragraph 6\(b\) above](#);
 - (ii) the power park module's capability to change to any reactive power target value within the agreed or decided reactive power range is demonstrated; and
 - (iii) no protection action takes place within the operation limits specified by the reactive power capacity diagram.
7. With regard to the voltage control mode test the following requirements shall apply:
- (a) the power park module's capability to operate in voltage control mode referred to in the conditions set out in points (ii) to (iv) of Article 21(32)(d) shall be demonstrated;
 - (b) The voltage control mode test shall verify the following parameters:

- (i) the implemented slope and deadband according to Article 21(32)(d)(iii);
 - (ii) the accuracy of the regulation;
 - (iii) the insensitivity of the regulation; and
 - (iv) the time of reactive power activation;
- (c) The test shall be deemed successful if the following conditions are fulfilled:
- (i) the range of regulation and adjustable droop and deadband complies with the agreed or decided characteristic parameters set out in point (d) of Article 21(32);
 - (ii) the insensitivity of voltage control is not higher than 0,01 pu, in accordance with point (d) of Article 21(32); and
 - (iii) following a step change in voltage, 90 % of the change in reactive power output has been achieved within the times and tolerances specified in point (d) of Article 21(32).
8. With regard to the reactive power control mode test the following requirements shall apply:
- (a) the power park module's capability to operate in reactive power control mode, in accordance with point (v) of Article 21(32)(d), shall be demonstrated;
 - (b) the reactive power control mode test shall be complementary to the reactive power capability test;
 - (c) the reactive power control mode test shall verify the following parameters:
 - (i) the reactive power setpoint range and increment;
 - (ii) the accuracy of the regulation; and
 - (iii) the time of reactive power activation.
 - (d) the test shall be deemed successful if the following conditions are fulfilled:
 - (i) the reactive power setpoint range and increment are ensured in accordance with point (d) of Article 21(32); and
 - (ii) the accuracy of the regulation complies with the conditions set out in point (d) of Article 21(32).
9. With regard to the power factor control mode test the following requirements shall apply:
- (a) the power park module's capability to operate in power factor control mode in accordance with point (vi) of Article 21(32)(d) shall be demonstrated;
 - (b) the power factor control mode test shall verify the following parameters:
 - (i) the power factor setpoint range;
 - (ii) the accuracy of the regulation; and
 - (iii) the response of reactive power due to step change of active power;
 - (c) the test shall be deemed successful if the following conditions are cumulatively fulfilled:

- (i) the power factor setpoint range and increment are ensured in accordance with point (d) of Article 21(32);
- (ii) the time of reactive power activation as a result of step active power change does not exceed the requirement laid down in point (d) of Article 21(32); and
- (iii) the accuracy of the regulation complies with the value specified in point (d) of Article 21(32).

10. With regard to the tests referred to in paragraphs 7, 8 and 9, the relevant system operator may select only one of the three control options for testing.

Article 49

Compliance tests for type D power park modules

1. Type D power park modules are subject to the compliance tests for type B and C power park modules in accordance with the conditions set out in Articles 47 and 48.
2. Instead of the relevant test, the power-generating facility owner may use equipment certificates issued by an authorised certifier to demonstrate compliance with the relevant requirement. In that case, the equipment certificates shall be provided to the relevant system operator.

CHAPTER 4

Compliance testing for offshore power park modules

Article 50

Compliance tests for offshore power park modules

Offshore power park modules are subject to the compliance tests for onshore power park modules in accordance with the conditions set out in Articles 47, 48 and 49. The compliance tests established in Article 44(2), as well as in paragraphs 2, 3, 4, 5, 7, 8 and 9 of Article 48 shall apply to offshore power park modules.

Comentado [A180]: Based on ENTSO-E amendment proposal No. 45. Appropriate references were missing.

CHAPTER 5

Compliance simulations for synchronous power-generating modules

Article 51

Compliance simulations for type B synchronous power-generating modules

1. Power-generating facility owners shall undertake LFSM-O response simulations in relation to type B synchronous power-generating modules. Instead of the relevant simulations, the power-generating facility owner may use equipment certificates issued by an authorised certifier to demonstrate compliance with the relevant requirement. In that case, the equipment certificates shall be provided to the relevant system operator.
2. With regard to the LFSM-O response simulation the following requirements shall apply:

(a) the power-generating module's capability to modulate active power at high frequency in accordance with Article 13(23) shall be demonstrated by simulation;

(b) the simulation shall be carried out by means of high frequency steps and ramps reaching minimum regulating level, ~~taking into account the droop settings and the deadband;~~

(c) the simulation shall be deemed successful in the event that:

(i) the simulation model of the power-generating module is validated against the compliance test for LFSM-O response described in Article 44(2); and

(ii) compliance with the requirement set out in Article 13(23) is demonstrated.

(d) The relevant TSO has the right to request a stability compliance for the LFSM-O control in a close loop operation set up of the synchronous power-generating module.

3. With regard to the reactive power capability simulation, the following requirements shall apply:

(a) The relevant TSO has the right to request a stability compliance for reactive power capability control in a close loop operation set up of the synchronous power-generating module.

(b) The simulation shall be deemed successful if compliance with the requirement set out in point (a) of Article 14(3) is demonstrated.

43. With regard to the simulation of fault-ride-through capability of type B synchronous power-generating modules, the following requirements shall apply:

(a) the power-generating module's capability to ride through faults in accordance with the conditions set out in subparagraph (a) of Article 14(3) shall be demonstrated by simulation;

(b) the simulation shall be deemed successful if compliance with the requirement set out in point (a) of Article 14(3) is demonstrated.

54. With regard to the post fault active power recovery simulation the following requirements shall apply:

(a) the power-generating module's capability to provide post fault active power recovery referred to in the conditions set out in Article 17(3) shall be demonstrated;

(b) the simulation shall be deemed successful if compliance with the requirement set out in Article 17(3) is demonstrated.

6. With regard to the simulations on the system restoration requirement in paragraph (c) of Article 14(4), the power-generating module shall demonstrate its technical capability to operate stably in case of a step change of external short-circuit power at the connection point defined by the relevant system operator.

Comentado [A181]: Based on ENTSO-E amendment proposal No. 60. PGMs should exhibit a stable control behaviour in different modes of operation and in switching between modes. Verification of compliance with these requirements should be described.

Article 52

Compliance simulations for type C synchronous power-generating modules

1. In addition to the compliance simulations for type B synchronous power-generating modules set out in Article 51, type C synchronous power-generating modules shall be subject to the compliance simulations detailed in paragraphs 2 to 5. Instead of all or part

Comentado [A182]: According to updated ENTSO-E amendment proposal No. 20. Stability of the PGM in the case of reduction of the system strength (low short-circuit level), robustness of the controller of the PGMs should be ensured in case of outage in the network.

of those simulations, the power-generating facility owner may use equipment certificates issued by an authorised certifier, which ~~must~~ shall be provided to the relevant system operator.

2. With regard to the LFSM-U response simulation the following requirements shall apply:

- (a) the power-generating module's capability to modulate active power at low frequencies in accordance with point (c) of Article 15(2) shall be demonstrated by RMS simulation;
- (b) the simulation shall be carried out by means of low frequency steps and ramps reaching maximum capacity, taking into account the droop settings and the deadband;
- (c) the simulation shall be deemed successful in the event that:
 - (i) the simulation model of the power-generating module is validated against the compliance test for LFSM-U response described in of Article 45(2); and
 - (ii) compliance with the requirement of point (c) of Article 15(2) is demonstrated.

(d) The relevant TSO has the right to request a stability compliance for the LFSM-U control in a close loop operation set up of the synchronous power-generating module.

3. With regard to the FSM response simulation the following requirements shall apply:

- (a) the power-generating module's capability to modulate active power over the full frequency range in accordance with point (d) of Article 15(2) shall be demonstrated by RMS simulation;
- (b) the simulation shall be carried out by simulating frequency steps and ramps big enough to trigger the whole active power frequency response range, taking into account the droop settings and the deadband;
- (c) the simulation shall be deemed successful in the event that:
 - (i) the simulation model of the power-generating module is validated against the compliance test for FSM response described in Article 45(3); and
 - (ii) compliance with the requirement of point (d) of Article 15(2) is demonstrated.

4. With regard to the island operation simulation the following requirements shall apply:

- (a) the power-generating module's performance during island operation referred to in the conditions set out in point (b) of Article 15(45) shall be demonstrated by RMS simulation; In addition to point (b) of Art 51(2) as well as point (c) of Art 52(2), the power-generating module shall demonstrate its technical capability to stably control stably the frequency within the frequency range specified in Table 2 in island operation in parallel to a load, based on FSM. Load steps leading to active power increase and decrease between 0% and 2% shall be considered; the control structure and parameters that are applied during normal grid operation shall be applied during island operation. If parameter changes are necessary, they shall not affect the damping or small-signal stability.
- (b) the simulation shall be deemed successful if the power-generating module reduces or increases the active power output from its previous operating point to any new operating point within the P-Q-capability diagram within the limits of point (b) of

Comentado [A183]: Proposed by VGBE, undisclosed stakeholder, EU Turbines, Vestas, WindEurope, CogenEurope and also in line with the EG ISSM report.

Comentado [A184]: Based on ENTSO-E amendment proposal No. 60: PGMs should exhibit a stable control behaviour in different modes of operation and in switching between modes. Verification of compliance with these requirements should be described.

Comentado [A185]: Proposed by VGBE, undisclosed stakeholder, EU Turbines, Vestas, WindEurope, CogenEurope and also in line with the EG ISSM report.

Comentado [A186]: Proposed by VGBE, undisclosed stakeholder, EU Turbines, Vestas, WindEurope, CogenEurope and also in line with the EG ISSM report.

Comentado [A187]: Based on ENTSO-E amendment proposal No. 60. PGMs should exhibit a stable control behaviour in different modes of operation and in switching between modes. Verification of compliance with these requirements should be described.

Article 15(45), without disconnection of the power-generating module from the island due to over- or underfrequency.

5. With regard to the reactive power capability simulation the following requirements shall apply:

(a) the power-generating module's capability to provide leading and lagging reactive power capability in accordance with the conditions set out in points (b) and (c) of Article 18(2) shall be demonstrated by simulation in the outer corners of the U-Q/Pmax diagram. In addition two simulations of the executed tests shall be performed with the real grid voltage and load points during the tests;

(b) the simulation shall be deemed successful if the following conditions are fulfilled:

(i) the simulation model of the power-generating module is validated against the compliance tests for reactive power capability, as far as these tests were accommodated (grid voltage deviations) described in Article 45(7) and allowed by the relevant system operator, described in Article 45(7); and

(ii) compliance with the requirements of points (b) and (c) of Article 18(2) is demonstrated.

Comentado [A188]: Proposed by VGBE, undisclosed stakeholder, EU Turbines, Vestas, WindEurope and also in line with the EG ISSM report.

Article 53

Compliance simulations for type D synchronous power-generating modules

1. In addition to the compliance simulations for type B and C synchronous power-generating modules set out in Articles 51 and 52, except for the simulation of fault-ride-through capability of type B synchronous power-generating modules referred to in Article 51(34), type D synchronous power-generating modules are subject to the compliance simulations set out in paragraphs 2 and 3. Instead of all or part of those simulations, the power-generating facility owner may use equipment certificates issued by an authorised certifier, which ~~must~~ shall be provided to the relevant system operator.

2. With regard to the power oscillations damping control simulation the following requirements shall apply:

(a) it shall be demonstrated that the power-generating module's performance in terms of its control system ('PSS function') is capable of damping active power oscillations in accordance with the conditions set out in paragraph 2 of Article 19;

(b) the tuning ~~shall~~ must result in improved damping of corresponding active power response of the AVR in combination with the PSS function, compared to the active power response of the AVR alone;

(c) the simulation shall be deemed successful if the following conditions are cumulatively fulfilled:

(i) the PSS function damps the existing active power oscillations of the power-generating module within a frequency range specified by the relevant TSO. That frequency range shall include the local mode frequencies of the power-generating module and the expected network oscillations; and

(ii) a sudden load reduction of the power-generating module from 1 pu to 0,6 pu of the maximum capacity does not lead to undamped oscillations in active or reactive power of the power-generating module.

3. With regard to the simulation of fault-ride-through capability of type D synchronous power-generating modules, the following requirements shall apply:

- (a) the power-generating module's capability to provide fault-ride-through in accordance with the conditions set out in point (a) of Article 16(3) shall be demonstrated;
- (b) the simulation shall be deemed successful if compliance with the requirement laid down in point (a) of Article 16(3) is demonstrated.

CHAPTER 6

Compliance simulations for power park modules

Article 54

Compliance simulations for type B power park modules

1. Type B power park modules are subject to the compliance simulations in paragraphs 2 to 5. Instead of all or part of those simulations, the power-generating facility owner may use equipment certificates issued by an authorised certifier, which ~~must~~ shall be provided to the relevant system operator.

2. With regard to the LFSM-O response simulation the following requirements shall apply:

(a) the power park module's capability to ~~stably~~ stably modulate ~~stably the~~ the active power at high frequency in accordance with Article 13(~~32~~) shall be demonstrated;

(b) the simulation shall be carried out by means of high frequency steps and ramps reaching minimum regulating level, taking into account the droop settings and the deadband;

(c) the simulation shall be deemed successful ~~provided that~~ in the event that:

(i) the simulation model of the power park module is validated against the compliance test for LFSM-O response set out in Article 47(3); and

(ii) compliance with the requirement laid down in Article 13(~~23~~) is demonstrated.

~~(d) the relevant TSO may request a stability compliance for the LFSM-O control in a close loop operation set up of the power park module.~~

~~3. With regard to the fast fault current injection simulation the following requirements shall apply:~~

~~(a) the power park module's capability to provide fast fault current injection in accordance with the conditions set out in point (b) of Article 20(2) shall be demonstrated;~~

~~(b) the simulation shall be deemed successful if compliance with the requirement laid down in point (b) of Article 20(2) is demonstrated.~~

~~34.~~ With regard to the fault-ride-through simulation capability of type B power park modules, the following requirements shall apply:

(a) the power park module's capability to ride through faults in accordance with the conditions set out in point (a) of Article 14(3) shall be demonstrated by simulation;

Comentado [A189]: Based on ENTSO-E amendment proposal No. 60. PGMs should exhibit a stable control behaviour in different modes of operation and in switching between modes. Verification of compliance with these requirements should be described.

Comentado [A190]: Deleted since the relevant provision in Article 20(2) is removed.

(b) the simulation shall be deemed successful if compliance with the requirement laid down in point (a) of Article 14(3) is demonstrated.

45. The following requirements with regard to the post fault active power recovery simulation shall apply:

(a) the power park module's capability to provide post fault active power recovery in accordance with the conditions set out in Article 20(3) shall be demonstrated;

(b) the simulation shall be deemed successful if compliance with the requirement laid down in Article 20(3) is demonstrated.

Article 55

Compliance simulations for type C power park modules

1. In addition to the compliance simulations for type B power park modules set out in Article 54, type C power park modules are subject to the compliance simulations set out in paragraphs 2 to 7. Instead of all or part of those simulations, the power-generating facility owner may use equipment certificates issued by an authorised certifier, which ~~must~~ shall be provided to the relevant system operator.

2. With regard to the LFSM-U response simulation the following requirements shall apply:

(a) the power park module's capability to stably modulate active power at low frequencies in accordance with point (c) of Article 15(2) shall be demonstrated;

(b) the simulation shall be carried out by simulating low frequency steps and ramps reaching maximum capacity, taking into account the droop settings and the deadband;

(c) the simulation shall be deemed successful in the event that:

(i) the simulation model of the power park module is validated against the compliance test for LFSM-U response set out in Article 48(3); and

(ii) compliance with the requirement laid down in point (c) of Article 15(2) is demonstrated.

(d) The relevant TSO has the right to request a stability compliance for the LFSM-U control in a close loop operation set up of the power park module.

3. With regard to the FSM response simulation the following requirements shall apply:

(a) the power park module's capability to modulate active power over the full frequency range as referred to in point (d) of Article 15(2) shall be demonstrated;

(b) the simulation shall be carried out by simulating frequency steps and ramps big enough to trigger the whole active power frequency response range, taking into account the droop settings and the deadband;

(c) the simulation shall be deemed successful ~~provided in the event~~ that:

(i) the simulation model of the power park module is validated against the compliance test for FSM response set out in Article 48(4); and

(ii) compliance with the requirement laid down in point (d) of Article 15(2) is demonstrated.

Comentado [A191]: Based on ENTSO-E amendment proposal No. 60. PGMs should exhibit a stable control behaviour in different modes of operation and in switching between modes. Verification of compliance with these requirements should be described.

4. With regard to the island operation simulation, the following requirements shall apply:

(a) the power park module's performance during island operation in accordance with the conditions set out in point (b) of Article 15(45) shall be demonstrated. In addition to point paragraph (b) of Article 54(2) as well as paragraph point (c)-e) of Article 55(2), the power-generating module shall demonstrate its technical capability to stably control stably the frequency within the frequency range specified in Table 2 in island operation in parallel to a load, based on FSM. The load steps leading to active power increase and decrease between 0% and 2% shall be considered;

(b) the simulation shall be deemed successful in the event that the power park module reduces or increases the active power output from its previous operating point to any new operating point, within the P-Q-capability diagram and within the limits set out in point (b) of Article 15(45), without disconnection of the power park module from the island due to over- or underfrequency.

(c) for the simulations of point paragraph (a) of Article 55(4) the relevant TSO should define an external short-circuit power and inertia to supplement the island scenario at the connection point.

5. With regard to the simulation of the capability of providing synthetic inertia, the following requirements shall apply:

(a) the model of the power park module's capability of providing synthetic inertia to a low and high frequency event as set out in point (a) of Article 21(42) shall be demonstrated;

(b) the simulation shall be deemed successful if the model demonstrates that it complies with the conditions set out in Article 21(42).

6. With regard to the reactive power capability simulation, the following requirements shall apply:

(a) the power park module shall demonstrate that it can provide leading and lagging reactive power capability as set out in points (b) and (c) of Article 21(23);

(b) the simulation shall be deemed successful if the following conditions are cumulatively fulfilled:

(i) the simulation model of the power park module is validated against the compliance tests for reactive power capability set out in paragraph 6 of Article 48; and

(ii) compliance with the requirements laid down in points (b) and (c) of Article 21(23) is demonstrated.

7. With regard to the power oscillations damping control simulation, the following requirements shall apply:

(a) the model of the power park module shall demonstrate that it can provide active power oscillations damping capability accordance with point (f) of Article 21(23);

(b) the simulation shall be deemed successful if the following conditions are cumulatively fulfilled; in the event that the model demonstrates compliance with the conditions described in point (f) of Article 21(3):

(i) the simulation model of the power park module is validated against the compliance tests for reactive power capability set out in paragraph 6 of Article 48; and

Comentado [A192]: Based on ENTSO-E amendment proposal No. 60, PGMs should exhibit a stable control behaviour in different modes of operation and in switching between modes. Verification of compliance with these requirements should be described.

(ii) compliance with the requirements laid down in points (b) and (c) of Article 21(23) is demonstrated.

(c) The relevant TSO has the right to request a stability compliance for reactive power capability control in a close loop operation set up of the power park module.

Comentado [A193]: Based on ENTSO-E amendment proposal No. 60. PGMs should exhibit a stable control behaviour in different modes of operation and in switching between modes. Verification of compliance with these requirements should be described.

Comentado [A194]: Based on ENTSO-E amendment proposal No. 60. PGMs should exhibit a stable control behaviour in different modes of operation and in switching between modes. Verification of compliance with these requirements should be described.

Article 56

Compliance simulations for type D power park modules

1. In addition to the compliance simulations for type B and C power park modules set out in Articles 54 and 55, except for the fault-ride-through capability of type B power park modules referred to in Article 54(4), type D power park modules are subject to the fault-ride-through capability of power park modules compliance simulation.
2. Instead of all or part of the simulations mentioned in paragraph 1, the power-generating facility owner may use equipment certificates issued by an authorised certifier, which must-shall be provided to the relevant system operator.
3. The model of the power park module shall demonstrate that it is suitable for simulating the fault-ride-through capability in accordance with point (a) of Article 16(3).
4. The simulation shall be deemed successful if the model demonstrates compliance with the conditions set out in point (a) of Article 16(3).

CHAPTER 7

Compliance simulations for offshore power park modules

Article 57

Compliance simulations applicable to offshore power park modules

The compliance simulations specified in paragraphs 3 and 5 of Article 54 as well as in paragraphs 4, 5 and 7 of Article 55 shall apply to any offshore power park module.

CHAPTER 8

Non-binding guidance and monitoring of implementation

Article 58

Non-binding guidance on implementation

1. No later than six months after the entry into force of this Regulation, the ENTSO for Electricity shall prepare and thereafter every two years provide non-binding written guidance to its members and other system operators concerning the elements of this Regulation requiring national decisions. The ENTSO for Electricity shall publish this guidance on its website.
2. ENTSO for Electricity shall consult stakeholders when providing non-binding guidance.

3. The non-binding guidance shall explain the technical issues, conditions and interdependencies which need to be considered when complying with the requirements of this Regulation at national level.

Article 59

Monitoring

1. ~~ACER shall monitor the implementation of this Regulation in accordance with Article 32 of Regulation (EC) No 2019/943. ENTSO for Electricity shall monitor the implementation of this Regulation in accordance with Article 8(9) of Regulation (EC) No 714/2009.~~ 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 valid.

ACER shall involve the European Stakeholder Committee in the monitoring, where relevant.

2. ~~ACER~~The Agency, in cooperation with ENTSO for Electricity, shall ~~produce by 12 months after the entry into force of this Regulation~~ maintain a list of the relevant information to be communicated by ENTSO for Electricity to ~~ACER~~the Agency in accordance with ~~Article 30(5) and 32(1) of Regulation (EC) No 2019/943~~ Article 8(9) and Article 9(1) of Regulation (EC) No 714/2009. The list of relevant information may be subject to updates and shall be in line with the information contained in the implementation monitoring files to be published in accordance with paragraph 3. ENTSO for Electricity shall maintain a comprehensive, standardised format, digital data archive of the information required by ~~ACER~~the Agency.

3. Relevant TSOs shall submit to ENTSO for Electricity the information required for ACER to perform the tasks referred to in paragraphs 1 and 2. TSOs shall ensure that the information is provided without undue delay and is up to date.

The EU DSO entity shall cooperate with ENTSO for Electricity on the monitoring of implementation of this Regulation in accordance with Article 55(2)(a) of Regulation (EU) 2019/943, among other activities, on the provision of information necessary for monitoring the implementation of this Regulation.

Based on a request of the regulatory authority, DSOs shall provide TSOs with information under paragraph 2 unless the information has already been obtained by the regulatory authority ~~yies, ACERthe Agency, the or ENTSO for Electricity or the EU DSO entity~~ in relation to their respective implementation monitoring tasks, with the objective of avoiding duplication of information. DSOs shall ensure that the information is provided without undue delay and is up to date.

ACER, in cooperation with ENTSO for Electricity, shall maintain a public online repository where relevant national information regarding the progress of implementation of this Regulation shall be made available. The information to be made available 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.

Comentado [A195]: Changes introduced to update the monitoring process following the entry into force of Regulation (EC) No 2019/943

Comentado [A196]: Editorial change to ensure clarity.

~~4. 4.~~ Where ENTSO for Electricity or ~~ACER~~^{the Agency} identify ~~establish~~ areas ~~subject to this Regulation wherein which~~, based on market developments or experience gathered in the application of this Regulation, further harmonisation of the requirements under this Regulation is advisable to promote market integration, they shall propose draft amendments to this Regulation pursuant to Article ~~760(24)~~ of Regulation (EU) 2019/943~~Regulation (EC) No 714/2009~~.

TITLE V

DEROGATIONS

Article 60

Power to grant derogations

1. Regulatory authorities may, at the request of a power-generating facility owner or prospective owner, relevant system operator or relevant TSO, grant power-generating facility owners or prospective owners, relevant system operators or relevant TSOs derogations from one or more provisions of this Regulation for new and existing power-generating modules in accordance with Articles 61 to 63.
2. Where applicable in a Member State, derogations may be granted and revoked in accordance with Articles 61 to 63 by other authorities than the regulatory authority.

Article 61

General provisions

1. Each regulatory authority shall specify, after consulting relevant system operators and power-generating facility owners and other stakeholders whom it deems affected by this Regulation, the criteria for granting derogations pursuant to Articles 62 and 63. It shall publish those criteria on its website and notify them to the Commission within nine months of the entry into force of this Regulation. The Commission may require a regulatory authority to amend the criteria if it considers that they are not in line with this Regulation. This possibility to review and amend the criteria for granting derogations shall not affect the derogations already granted which shall continue to apply until the scheduled expiry date as detailed in the decision granting the exemption.
2. If the regulatory authority deems that it is necessary due to a change in circumstances relating to the evolution of system requirements, it may review and amend at most once every year the 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.
3. The regulatory authority may decide that power-generating modules for which a request for a derogation has been filed pursuant to Articles 62 or 63 do not need to comply with the requirements of this Regulation from which a derogation has been sought from the day of filing the request until the regulatory authority's decision is issued.

Article 62

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 include:
 - (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 39;
 - (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 relevant system operator shall, in coordination with the relevant TSO and any affected adjacent DSO or DSOs, 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 61.
5. 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 ~~must~~ shall be accompanied by an assessment of the request for a derogation by the relevant TSO. The relevant TSO shall provide its assessment within two months of being requested to do so by the relevant system operator.
6. 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 relevant TSO to submit an assessment of the request for a derogation.
7. The regulatory authority shall adopt a decision concerning any request for a derogation within six months from the day after it receives the request. That time limit may be extended by three months before its expiry where the regulatory authority

requires further information from the power-generating facility owner, or prospective owner, or from any other interested parties. The additional period shall begin when the complete information has been received.

8. 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 its expiry:

- (a) the regulatory authority decides to provide an extension; or
- (b) the power-generating facility owner, or prospective owner, informs the regulatory authority by means of a reasoned submission that the request for a derogation is complete.

9. 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.

10. The regulatory authority shall notify its decision to the relevant power-generating facility owner, or prospective owner, the relevant system operator and the relevant 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 of the Commission or reasoned recommendation by the Agency pursuant to Article 65(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 case of the latter, and provided the cumulative maximum capacity is specified, the third party may substitute the details required by point (a) of paragraph 2 with their details.

Article 63

Request for a derogation by a relevant system operator or relevant TSO

1. Relevant system operators or relevant TSOs may request derogations for classes of power-generating modules connected or to be connected to their network.

2. Relevant system operators or relevant TSOs shall submit their requests for derogations to the regulatory authority. Each request for a derogation shall include:

- (a) identification of the relevant system operator or relevant TSO, and a contact person for any communications;
- (b) a description of the power-generating modules for which a derogation is requested and the total installed capacity and number of power-generating modules;
- (c) the requirement or requirements of this Regulation for which a derogation is requested, with a detailed description of the requested derogation;
- (d) detailed reasoning, with all relevant supporting documents;

(e) demonstration that the requested derogation would have no adverse effect on cross-border trade;

(f) a cost-benefit analysis pursuant to the requirements of Article 39. If applicable, the cost-benefit analysis shall be carried out in coordination with the relevant TSO and any adjacent DSO or DSOs.

3. Where the request for a derogation is submitted by a relevant DSO or CDSO, the regulatory authority shall, within two weeks from the day after receipt of that request, ask the relevant TSO to assess the request for a derogation in the light of the criteria determined by the regulatory authority pursuant to Article 61.

4. Within two weeks from the day after the receipt of such request for assessment, the relevant TSO shall confirm to the relevant DSO or CDSO whether the request for a derogation is complete. If the relevant TSO considers that it is incomplete, the relevant DSO or CDSO shall submit the required additional information within one month from the receipt of the request for additional information.

5. Within six months of receipt of a request for a derogation, the relevant TSO shall submit to the regulatory authority its assessment, including any relevant documentation. The six-month time limit may be extended by one month where the relevant TSO seeks further information from the relevant DSO or from the relevant CDSO.

6. The regulatory authority shall adopt a decision concerning a request for a derogation within six months from the day after it receives the request. Where the request for a derogation is submitted by the relevant DSO or CDSO, the six-month time limit runs from the day following receipt of the relevant TSO's assessment pursuant to paragraph 5.

7. The six-month time limit referred to in paragraph 6 may, before its expiry, be extended by an additional three months where the regulatory authority requests further information from the relevant system operator requesting the derogation or from any other interested parties. That additional period shall run from the day following the date of receipt of the complete information.

The relevant system operator shall provide any additional information requested by the regulatory authority within two months from the date of the request. If the relevant system operator does not provide the requested additional information within that time limit, the request for a derogation shall be deemed withdrawn unless, before expiry of the time limit:

(a) the regulatory authority decides to provide an extension; or

(b) the relevant system operator informs the regulatory authority by means of a reasoned submission that the request for a derogation is complete.

8. The regulatory authority shall issue a reasoned decision concerning a request for a derogation. Where the regulatory authority grants derogation, it shall specify its duration.

9. The regulatory authority shall notify its decision to the relevant system operator requesting the derogation, the relevant TSO and the Agency.

10. Regulatory authorities may lay down further requirements concerning the preparation of requests for derogation by relevant system operators. In doing so, regulatory authorities shall take into account the delineation between the transmission

system and the distribution system at the national level and shall consult with system operators, power-generating facility owners and stakeholders, including manufacturers.

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 of the Commission or reasoned recommendation by the Agency pursuant to Article 65(2).

Article 64

Register of derogations from the requirements of this Regulation

1. Regulatory authorities shall maintain a 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, a copy of which shall be given to ENTSO for Electricity. This 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.

Comentado [A197]: Based on VGBE proposal to include a relevant provision ensuring that the register is publicly available.

Article 65

Monitoring of derogations

1. The Agency shall monitor the procedure of granting derogations with the cooperation of the regulatory authorities or relevant authorities of the Member State. Those authorities or relevant authorities of the Member State 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 a lack of justification. The Commission may issue a reasoned recommendation to a regulatory authority or relevant authority of the Member State to revoke derogation due to a lack of justification.

3. The Commission may request the Agency to report on the application of paragraphs 1 and 2 and to provide reasons for requesting or not requesting derogations to be revoked.

TITLE VI

TRANSITIONAL ARRANGEMENTS FOR EMERGING TECHNOLOGIES

Article 66

Emerging technologies

1. With the exception of Article 30, the requirements of this Regulation shall not apply to power-generating modules classified as an emerging technology, in accordance with the procedures set out in this Title.

2. A power-generating module shall be eligible to be classified as an emerging technology pursuant to Article 69, provided that:

- (a) it is of type A;
- (b) it is a commercially available power-generating module technology; and
- (c) the accumulated sales of the power-generating module technology within a synchronous area at the time of application for classification as an emerging technology do not exceed 25 % of the maximum level of cumulative maximum capacity established pursuant to Article 67(1).

Article 67

Establishment of thresholds for classification as emerging technologies

1. The maximum level of cumulative maximum capacity of power-generating modules classified as emerging technologies in a synchronous area shall be 0,1 % of the annual maximum load in 2014 in that synchronous area.

2. Member States shall ensure that their maximum level of cumulative maximum capacity of power-generating modules classified as emerging technologies is calculated by multiplying the maximum level of cumulative maximum capacity of power-generating modules classified as emerging technologies of a synchronous area with the ratio of annual electrical energy generated in 2014 in the Member State to the total annual electrical energy generated in 2014 in the respective synchronous area to which the Member State belongs.

For Member States belonging to parts of different synchronous areas, the calculation shall be carried out on a pro rata basis for each of those parts and combined to give the total allocation to that Member State.

3. The source of the data for applying this Article shall be the ENTSO for Electricity's Statistical factsheet published in 2015.

Article 68

Application for classification as an emerging technology

1. Within six months of the entry into force of this Regulation manufacturers of Type A power-generating modules may submit to the relevant regulatory authority a request for classification of their power-generating module technology as an emerging technology.

2. In connection with a request pursuant to paragraph 1, the manufacturer shall inform the relevant regulatory authority of the accumulated sales of the respective power-generating module technology within each synchronous area at the time of application for classification as an emerging technology.

3. Proof that a request submitted pursuant to paragraph 1 complies with the eligibility criteria laid down in Articles 66 and 67 shall be provided by the manufacturer.

4. Where applicable in a Member State, assessment of requests and approval and withdrawal of classification as an emerging technology may be undertaken by authorities other than the regulatory authority.

Article 69

Assessment and approval of requests for classification as an emerging technology

1. By 12 months of the entry into force of this Regulation, the relevant regulatory authority shall decide, in coordination with all the other regulatory authorities of a synchronous area, which power generating modules, if any, should be classified as an emerging technology. Any regulatory authority of the relevant synchronous area may request a prior opinion from the Agency, which shall be issued within three months of receipt of the request. The decision of the relevant regulatory authority shall take into account the opinion of the Agency.

2. A list of power generating modules approved as emerging technologies shall be published by each regulatory authority of a synchronous area.

Article 70

Withdrawal of classification as an emerging technology

1. From the date of the decision of the regulatory authorities pursuant to Article 69(1), the manufacturer of any power generating module classified as an emerging technology shall submit to the regulatory authority every two months an update of the sales of the module per Member State for the past two months. The regulatory authority shall make publicly available the cumulative maximum capacity of power generating modules classified as emerging technologies.

2. In the event that the cumulative maximum capacity of all power generating modules classified as emerging technologies connected to networks exceeds the threshold established in Article 67, the classification as an emerging technology shall be withdrawn by the relevant regulatory authority. The withdrawal decision shall be published.

3. Without prejudice to the provisions of paragraphs 1 and 2, all regulatory authorities of a synchronous area may decide in a coordinated manner to withdraw a classification as an emerging technology. The regulatory authorities of the synchronous area concerned may request a prior opinion from the Agency, which shall be issued within three months of receipt of the request. Where applicable, the coordinated decision of the regulatory authorities shall take into account the opinion of the Agency. The withdrawal decision shall be published by each regulatory authority of a synchronous area.

Power generating modules classified as emerging technologies and connected to the network prior to the date of withdrawal of that classification as an emerging technology shall be considered as existing power generating modules and shall therefore only be subject to the requirements of this Regulation pursuant to the provisions of Article 4(32) and Articles 38 and 39.

TITLE VI TRANSITIONAL PROVISIONS

Article 70a Transitional provisions

Notwithstanding Article 71a, Commission Regulation (EU) 2016/631 shall continue to apply to power generating modules which fall within its the scope of application at the entry into force of this Regulation.

Comentado [A198]: Based on VGBE proposal, ACER considers that the transitional arrangements for emerging technologies have proved to have limited value.

Comentado [A199]: Provision added to ensure legal certainty for the requirements applicable to existing power generating modules

TITLE VII FINAL PROVISIONS

Article 71

Amendment of contracts and general terms and conditions

1. Regulatory authorities shall ensure that all relevant clauses in contracts and general terms and conditions relating to the grid connection of new power-generating modules are brought into compliance with the requirements of this Regulation.
2. All relevant clauses in contracts and relevant clauses of general terms and conditions relating to the grid connection of existing power-generating modules subject to all or some of the requirements of this Regulation in accordance with Article 4(1) shall be amended in order to comply with the requirements of this Regulation. The relevant clauses shall be amended within three years following the decision of the regulatory authority or Member State as referred to in Article 4(1).
3. Regulatory authorities shall ensure that national agreements between system operators and owners of new or existing power-generating facilities subject to this Regulation and relating to grid connection requirements for power-generating facilities, in particular in national network codes, reflect the requirements set out in this Regulation.

Article 71a

Repeal

This Regulation shall repeal Commission Regulation (EU) 2016/631. References to the repealed Regulation shall be construed as references to this Regulation and shall be read in accordance with the correlation table set out in Annex [].

Comentado [A200]: Provision added to ensure legal certainty with regard to Regulation (EU) 2016/631 - this provision may depend on what will be the approach for the amendments and will require further discussion.

Article 72

Entry into force

This Regulation shall enter into force on the twentieth day following that of its publication in the *Official Journal of the European Union*.

Without prejudice to Articles 4(2)(b), 7, 58, 59, 61 and Title VI, the requirements of this Regulation shall apply from three years after publication.

This Regulation shall be binding in its entirety and directly applicable in all Member States.

Done at Brussels, 14 April 2016.

For the Commission

The President

Jean-Claude JUNCKER

(¹) OJ L 211, 14.8.2009, p. 15; OJ L 158, 14.6.2019, p. 54.

(²) 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 (recast), Directive 2009/72/EC of the European Parliament and of the Council of 13 July 2009 concerning common rules for the internal market in electricity and repealing Directive 2003/54/EC (OJ L 211, 14.8.2009, p. 55) (OJ L 158, 14.6.2019, p. 125).

(³) Directive 2012/27/EU of the European Parliament and of the Council of 25 October 2012 on energy efficiency, amending Directives 2009/125/EC and 2010/30/EU and repealing Directives 2004/8/EC and 2006/32/EC (OJ L 315, 14.11.2012, p. 1).

(⁴) 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).

(⁵) 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).

(⁶) Regulation (EC) No 765/2008 of the European Parliament and of the Council of 9 July 2008 setting out the requirements for accreditation and market surveillance relating to the marketing of products and repealing Regulation (EEC) No 339/93 (OJ L 218, 13.8.2008, p. 30).

(⁷) The voltage base for pu values is below 300 kV.

(⁸) The voltage base for pu values is from 300 kV to 400 kV.

(⁹) At the offshore connection point for configuration 1.

(¹⁰) At the offshore connection point for configuration 2.
