

ACER draft amendments to the Network Code on HVDC

Fields marked with * are mandatory.

Introduction

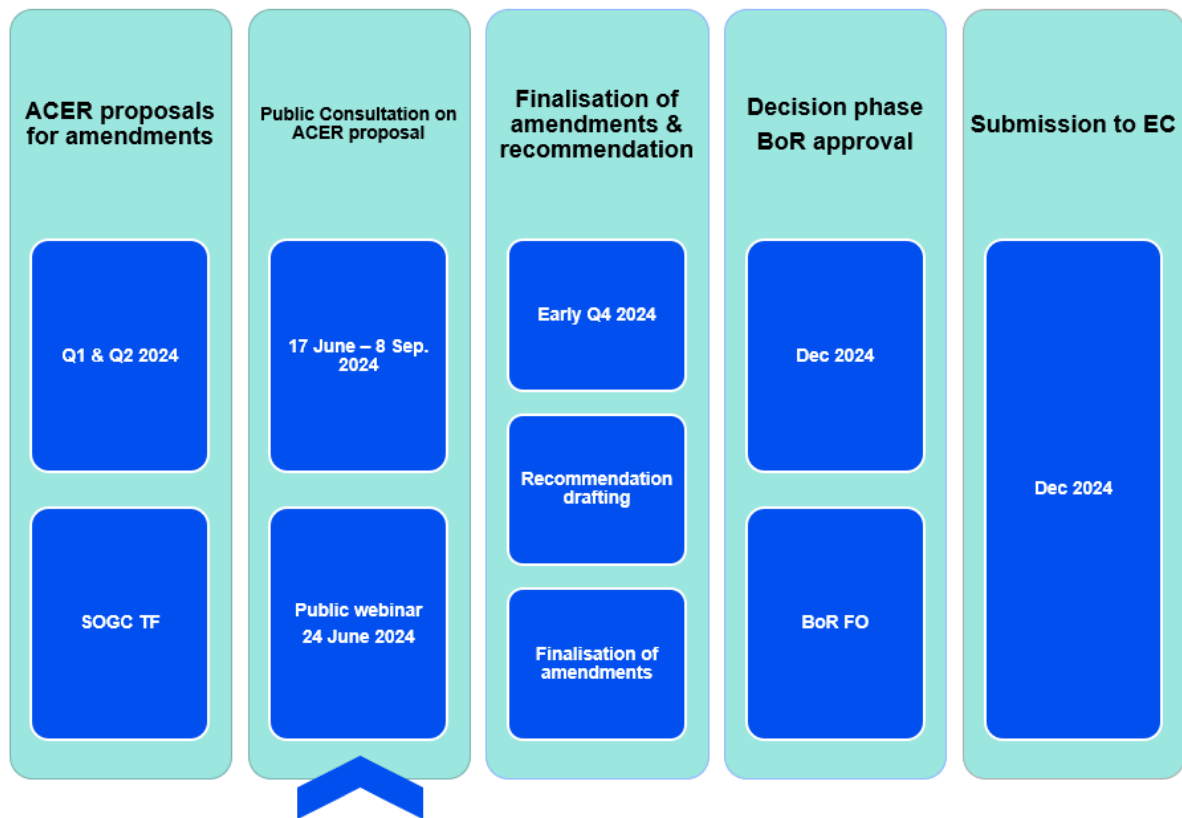
This consultation aims at presenting ACER's draft amendments to the **Commission Regulation (EU) 2016 /1447 of 26 August 2016 establishing a network code on requirements for grid connection of high voltage direct current systems and direct current-connected power park modules ('NC HVDC')**.

Responses to this consultation should be submitted by 8 September 2024.

Background

Important developments in the policies of decarbonisation of the European Union (EU) energy and transport sectors have taken place since the inception of the development of the first European Grid Connection Network Codes (GC NCs) in 2012.

In the framework of the [Grid Connection European Stakeholder Committee \(GC ESC\)](#), the European Commission proposed for ACER to initiate the process towards the amendment of the existing GC NCs in September 2022. The amendment process to the NC HVDC, as presented to the GC ESC is outlined in the Figure below:



In the context of [the ongoing revisions of the European grid connection network codes](#), ACER will consult with stakeholders to collect views on ACER's concrete amendment proposals to the network code on grid connection requirements for high voltage direct current systems and related power park modules ([NC HVDC](#)).

The revisions to the NC HVDC aim to:

- Enhance the existing grid connection regulatory framework.
- Align the code with the [ACER Recommendation](#) on reasoned proposals for amendments to the network codes on requirements for grid connection of generators and on demand connection.
- Ensure the interconnected system is adapted to emerging trends, such as the increasing generation capacity of offshore networks (AC hubs) and the connection of new system users (storage, demand facilities, including power-to-gas demand units).

Stakeholder's details

ACER is highly committed in processing personal data in a lawful way.

Find out more how we process your data: <https://www.acer.europa.eu/the-agency/about-acer/data-protection>

* Name of the stakeholder:

ENTSO-E

* Contact person:

* Contact person's email address:

* Country of the stakeholder's headquarters or main country of operation:

* Type of the stakeholder:

- ☐ Generator (including association)
- ☐ Consumer (including association)
- ☒ Transmission system operator (including association)
- ☐ Distribution system operator (including association)
- ☐ Manufacturers (including association)
- ☐ Academia/research institution
- ☐ Regulatory authority
- ☐ Other (please, elaborate)

Please, elaborate on your answer above, if necessary:

* Do you consent to the publication of the stakeholder's name?

- ☒ Yes
- ☐ No

* Do you consent to the publication of provided answers?

- ☒ Yes
- ☐ No (please, note that your answer, without your name and organization, may be shared with the EU institutions and national authorities)

Instructions

Stakeholders are invited to submit their comments to the **NC HVDC articles** amended by ACER in three mandatory steps:

1. download the ACER draft amendments in the Word file provided below. The file could also be accessed on the right panel of the consultation form under the Background Documents;
2. comment on the ACER's draft amendments through this online consultation form and adding your alternative text proposals to the table, if any; and
3. uploading the alternative amendment proposals to the **entire NC HVDC** document using the Track Changes mode in the ACER draft amendments file downloaded from Step 1.

Where the stakeholder does not have any comments regarding the amendments, the relevant cells in the consultation form can be left blank.

The mandatory steps for submitting the comments are listed below.

Step 1

Please see ACER's draft amendments in the Word file provided below. The file could also be accessed on the right panel of the consultation form under the Background Documents.


[Download ACER draft amendments to the NC HVDC here](#)

Step 2

Kindly note that this consultation form follows the structure of the NC HVDC amended legal text provided by ACER in Step 1.

The paragraph numbering in the form reflects paragraph numbers in the amended legal text. Nevertheless, stakeholders can comment on the deleted paragraphs/articles/titles, which are marked as [deleted]. New articles and titles are marked as [new].

Please use this form to comment on ACER draft amendments and/or to provide an alternative text proposal. The instructions are the following:


Please write your comments on the ACER draft amendments and your alternative text proposals, if any, in the table below 

Includes new articles

	Comment on the ACER draft amendments	Alternative text amendment proposal (if applicable)
Article 1	1	2
Article 3		
Article 4		
Article 5		
Article 6		
Article 7		
Article 8		
Article 9		
Article 10		

Please write your amendment proposals, if any, in the table below

	Text amendment proposal (if applicable)	3
New article		

Please upload figures or tables if necessary 

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Select file(s) to upload

4

1. Leave comments on the ACER draft amendment proposals.
2. Propose (if any) alternative wording of the relevant provision, as you provided in the Word file.
3. Provide (if any) your proposals for adding new provisions to the relevant section of the NC HVDC, as you provided in the Word file.
4. Upload figures or tables if necessary; text inputs should be provided directly in the consultation form.

Step 3

Where the stakeholder would like to propose an alternative amendment to the entire **NC HVDC**, please upload the Word file (**downloaded from Step 1**) containing all your alternative amendment proposals in the Track Changes mode to the next **FILE UPLOAD** section and rename it with your stakeholder's name ("ACER_draft_HVDC_stakeholder_name"). You can also upload your justification documents, where applicable.

In case the file size exceeds the 1MB limit, which is a consultation tool limit, kindly send the document to the functional mailbox shown on the right panel of the consultation form. Please rename the file with your stakeholder's name as indicated above and send it with the subject "ACER draft HVDC legal text [stakeholder name]". Note that only submissions sent within the consultation deadline will be considered.

To facilitate the process, please, make sure that the **alternative text proposals provided in this consultation form are consistent**, to the extent possible, **with those in the Word file** you are uploading, taking into account the character limitations of each cell (max 5000 characters).

File upload

Please upload your file here

The maximum file size is 1 MB

Only files of the type pdf,doc,docx,odt,txt,rtf are allowed

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Kindly note that in case the file size exceeds 1MB, the file can be sent to the functional mailbox shown on the right panel of the consultation form under Contact. Please ensure that the file name and email subject are consistent with the instructions in Step 3.

Please also upload any other document (i.e. **justifications**) below, if relevant.

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Due to the significant length of this survey:

- you have the possibility to edit your answer after submission. When clicking on "Submit" button, you will be given a Contribution ID which you can then use to access your answers and edit them, if necessary.
- we kindly suggest that you download the entire survey as .pdf (link on the right), prepare your answers and then upload them at once in the EU Survey Tool, to avoid a session timeout on submission.

The maximum length of each cell is 5000 characters. This is the maximum technical limit set by the EUsurvey tool, which cannot be increased.

Whereas Section

Please write your comments on the ACER draft amendments and your alternative text proposals, if any, in the table below

Numbers in the first column correspond to the recitals of the amended version of NC HVDC Whereas section, including new recitals

	Comment on the ACER draft amendments	Alternative text amendment proposal (if applicable)
(1)		
(2)		
(3)		
(4)		
(5)		
(6)		
(7)		
(8)		
(9)		
(10)		
(11)		
(12)		
(13)		
(14)		
(15)		
(16)		
(17)		
(18)		
(19)		

Please write your amendment proposals, if any, in the table below

	Text amendment proposal (if applicable)
New recital	

Definitions (Article 2)

Please write your comments on the ACER draft amendments and your alternative text proposals, if any, in the table below

Includes new definitions

	Comment on the ACER draft amendments	Alternative text amendment proposal (if applicable)
Article 2(1)		
Article 2(2)[deleted]		
Article 2(2)	ENTSO-E would propose for consistency to change "a demand facility" to "an asynchronously connected demand facility, an asynchronously connected power-to-gas demand unit"	‘embedded HVDC system’ means an HVDC system connected within a control area that is not installed for the purpose of connecting an asynchronously connected power park module or an asynchronously connected electricity storage module at the time of installation, nor installed for the purpose of connecting an asynchronously connected demand facility or an asynchronously connected power-to-gas demand unit;
Article 2(3)		
Article 2(5)[deleted]		
Article 2(6)[deleted]		
Article 2(4)		
Article 2(5)		
Article 2(6)		
Article 2(7)		

Article 2(8)[NEW]	<p>ENTSO-E believes that an isolated AC network could be built on a physical member state island (and not synchronously connected to a synchronous), or on an artificial member state island (like in Belgium case).</p> <p>Up to date there is the case of Danish Island Bornholm which is physical island and which Germany is also connected via HVDC. We may have also the Belgian or future Dutch of Danish artificial islands. For those physical or artificial islands, two or three countries may be tapping via HVDC, and a certain harmonization is required.</p> <p>Therefore, we need NC HVDC 2.0 to regulate it as there cases would have cross border impact. The proposal of ACER excludes that physical or artificial island will be called isolated AC network. It may create huge issue as stakeholders may not accept NC HVDC 2.0 applicability, advocating that they consider it as member state island possibly according to Art. 3 (7)(b). On the other hand, a member state island such as Sardinia, which is existing and has significant load, is excluded by Art. 3 (7). Therefore, we propose to delete this sentence.</p> <p>Due to limitations and time constraint from the summer consultation period, a legal text proposal improvement will be provided by 30.9.2024 for consideration of ACER.</p>	<p>'isolated AC network' means an AC network which is not part of a synchronous area, which is connected to a synchronous area via one or more HVDC systems.</p>
Article 2(9)[NEW]		
Article 2(10)[NEW]		
Article 2(11)[NEW]	<p>ENTSO-E would recommend to introduce all abbreviations in the definitions and then use the abbreviations through the code in order to improve readability</p>	

Article 2(12)[NEW]		
Article 2(13)[NEW]		
Article 2(14)[NEW]		
Article 2(15)[NEW]		
Article 2(16)[NEW]		
Article 2(17)[NEW]		
Article 2(18)[NEW]		

Please write your amendment proposals, if any, in the table below

	Text amendment proposal (if applicable)
New definition	<p>Justification: ENTSO-E has proposed in following articles the term STATCOM which should be included in the definitions section accordingly. One such proposal is made in Art. 2 (19).</p> <p>(19) A STATic synchronous COMpensator (STATCOM) is a fast-acting device capable of providing or absorbing reactive current and thereby regulating the voltage at the point of connection to a power grid. It is categorized under Flexible AC transmission system (FACTS) devices. The technology is based on VSCs with semi-conductor valves in a modular multi-level configuration.</p>

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TITLE I - GENERAL PROVISIONS

Please write your comments on the ACER draft amendments and your alternative text proposals, if any, in the table below

Includes new articles

	Comment on the ACER draft amendments	Alternative text amendment proposal (if applicable)
Article 1		
Article 3	<p>ENTSO-E would emphasize the importance of using the terms asynchronously connected power park modules, asynchronously connected demand facilities, asynchronously connected power-to-gas demand units and asynchronously connected electricity.</p> <p>ENTSO-E would like to propose an editorial change. The term HVDC interface shall be removed from the code and replaced by interface point.</p>	<p>Article 3(1)(b) connecting asynchronously connected power park modules, asynchronously connected demand facilities, asynchronously connected power-to-gas demand units and asynchronously connected electricity storage modules to a transmission network or a distribution network, pursuant to paragraph 2;</p> <p>Article 3(5) The connection requirements for asynchronously connected power park modules, asynchronously connected demand facilities, asynchronously connected power-to-gas demand units, asynchronously connected electricity storage modules and remote-end HVDC converter stations provided for in Title III shall apply at interface point of such systems, except the requirements provided for in Article 39(1)(a) and Article 47(2), which apply at the connection point in the synchronous area to which frequency response is being provided.</p>
		<p>Article 4(1) Except for Article 26, Article 31, Article 33 and Article 50, existing HVDC systems and existing asynchronously connected power park modules, asynchronously connected demand facilities, asynchronously connected power-to-gas demand units and asynchronously connected electricity storage modules are not subject to the requirements of this Regulation, unless:</p> <p>(a) the HVDC system or asynchronously</p>

Article 4

connected power park module, asynchronously connected demand facility, asynchronously connected power-to-gas demand unit, asynchronously connected electricity storage module has been modified that its electrical and grid-dynamic characteristics, relating to paragraph (1)(c), have significantly altered. In these cases, prior to carrying out a modification:

- (i) the HVDC system or asynchronously connected power park module, asynchronously connected demand facility, asynchronously connected power-to-gas demand unit, asynchronously connected electricity storage module owners who intend to undertake the modernisation of a plant or replacement of equipment affecting the electrical characteristics of the HVDC system or asynchronously connected power park module, asynchronously connected demand facility, asynchronously connected power-to-gas demand unit, asynchronously connected electricity storage module shall notify their plans to the relevant system operator in advance;
 - (ii) if the relevant system operator considers that the extent of the modernisation or replacement of equipment is significant, in respect of any of the criteria in paragraph (1)(c) below, 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

	<p>ENTSO-E proposes to check the wording in Article 4.1 due to the presence of three negations in the same sentence.</p> <p>ENTSO-E proposes that this article shall be split between HVDC and A-PPM, A-DF, A-PtG-DU. For the case of A-PPM and A-ESM the same requirement shall apply in NC RfG 2.0. As in Article 4.a. Here, it shall be only referred and made applicable for A-PPM. For A-DF, Article 4.a of NC DC 2.0 shall apply. For A-PtG-DU, the same as Article 4.a of NC DC 2.0. In this case, it shall be for all demand units.</p> <p>ENTSO-E believes that the part (c) as in the document of ACER shall be deleted by ACER as it does not fit for the purpose of HVDC systems. Instead of this, we proposed the following legal text. HVDC systems are transmission systems and are built with fixed transmission capacity, reactive power capability that cannot be changed during the lifecycle. Therefore, the legal text proposal aims to leave it for national regulations.</p> <p>ENTSO-E is of the view that the terms "a change of the underlying technology of the HVDC system" need more clarification. Therefore we propose to clearly state a change of LCC to VSC, or MCC as recommended in our legal text proposal.</p>	<p>Member State decides to make an existing HVDC system or existing asynchronously connected power park module, asynchronously connected demand facility, asynchronously connected power-to-gas demand unit, asynchronously connected electricity storage 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.</p> <p>(c) For the purposes of this Article a significant alteration of an asynchronously connected power park module or asynchronously connected electricity storage module shall be defined according to Article 4a of NC RfG 2.0.</p> <p>(d) For the purposes of this Article a significant alteration of asynchronously connected demand facility and asynchronously connected power-to-gas demand unit shall be defined according to Article 4a of NC DC 2.0.</p> <p>(e) if the relevant system operator considers that the extent of the modernisation or replacement of the HVDC system 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;</p> <p>(f) a change of the underlying technology of the HVDC system from thyristor-based line commutated HVDC converter technology to voltage source HVDC converter technology.</p>
Article 5		
Article 6		
Article 7		
Article 8		

Article 9		
Article 10		

Please write your amendment proposals, if any, in the table below

	Text amendment proposal (if applicable)
New article	

Please upload figures or tables if necessary

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TITLE II - GENERAL REQUIREMENTS FOR HVDC CONNECTIONS

Please write your comments on the ACER draft amendments and your alternative text proposals, if any, in the table below

	Comment on the ACER draft amendments	Alternative text amendment proposal (if applicable)
Article 11		
Article 12		
Article 13	ENTSO-E proposes to include requirement for Freeze frequencies for LFSM-O/U. There is a need on EU level to have a regulated approach on how LFSM would work in case that HVDC systems connecting two synchronous areas are both instantaneously saturated given that both sides reach max values of DP. Due to limited time, ENTSO-E would like to propose to ACER legal text solution by 30.9.2024 for further discussion in the framework of the NC HVDC amendment.	
Article 14	ENTSO-E proposes that the use of the term synthetic inertia is done according to the NC RfG 2.0. Indeed, in NC RfG 2.0, synthetic inertia is specified also for grid forming. Please replace the term inertial response with synthetic inertia to align it with NC RfG 2.0.	Article 14(4) If grid forming capability as prescribed in paragraph 1 is requested and if specified by the relevant system operator, in coordination with the relevant TSO, the HVDC system shall be capable of contributing to limit the transient frequency deviation by providing an synthetic inertia response both in low and/or high frequency regimes. The synthetic inertia response shall be provided without delay. In that case the contribution to synthetic inertia shall be specified in accordance with paragraphs (1)(b) (iv) and (1)(c)(iv). The synthetic inertia shall be provided with a damped system response and the energy needed for this function shall be coordinated with sources external to the HVDC system and if applicable within the isolated AC network's design and operational limits;
Article 15		

Article 16		
Article 17		
Article 18		
Article 19	ENTSO-E would propose to either delete the word "converter" or change back to "fast fault current" in the (c). In the (b) is also used "fast fault current" so maintaining consistency would be good for reader.	
Article 20		
Article 21		
Article 22	The interpretation of this article is not same for all TSOs. Some TSOs interpret that HVDC system shall have the three options as mandatory and other only one or two of them. Therefore, given that the power factor control is not commonly used, we recommend to add the word if applicable.	<p>Article 22(1) An HVDC converter station shall be capable of operating in one or more of the three following control modes, as specified by the relevant system operator in coordination with the relevant TSO:</p> <ul style="list-style-type: none"> (a) voltage control mode; (b) reactive power control mode; (c) power factor control mode, if applicable.
Article 23		
Article 24		

Article 25	<p>ENTSO-E would like to ask ACER to check cross references. Need to add NC RfG 2.0 reference.</p> <p>ENTSO-E proposes that since the article 25 applies also to Remote End HVDC station via article 46, the connection point shall be removed from here, given that for article 46 refers to the interface point.</p> <p>ENTSO-E would like to highlight that in the same way as in NC RfG 2.0. future system needs demand for overvoltage ride through capability of the HVDC system. Therefore, we propose to add a non-exhaustive requirement to be specified by the relevant TSO.</p>	<p>Article 25(1) The relevant TSO shall specify, while respecting Article 18, a voltage-against time profile as set out in Annex V and having regard to the voltage-against-time-profile specified for power park modules according to Regulation (EU) 2016/631 . This profile shall apply for f fault conditions, under which the HVDC converter station shall be capable of staying connected to the network and continuing stable operation after the power system has recovered following fault clearance. 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. Any ride through period beyond trec2 shall be specified by the relevant TSO consistent with Article 18.</p> <p>Article 25(7) The HVDC converter station 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 as defined by the relevant TSO. In any case, the HVDC system shall withstand a fault clearance leading to overvoltages in the network.</p>
Article 26		
Article 27		
Article 28		
Article 29		
Article 30		
Article 31		
Article 32		

Article 33	<p>ENTSO-E would like to raise the attention that the word multi-terminal is used in the Art. 33 (2). However, this is not properly defined in NC HVDC as such definition. In addition, any HVDC system with more than two HVDC stations (therefore multiterminal) is actually included in the definition of the HVDC system as defined in Art. 2 (1). Therefore, we propose to remove the part multiterminal or embedded since this is covered from Art. 2 (1) and Art (3). The way it is written today, is understood that if an HVDC system is not multiterminal or not embedded, then this requirement isn't relevant which it shall not be the case.</p> <p>Future grid development scenarios foresee that HVDC systems with more than two HVDC converter stations, known else as multi-terminal will be developed across Europe. Those systems would be used either for grid connection of GW scale offshore wind power generation or for embedded in one or different control zones. Therefore, DC side disturbances would need, if specified by the relevant TSO, to ensure either continues operation of healthy part of the HVDC system or at least continuously transition to STATCOM mode of the HVDC system. This would limit the impact on the AC voltage stability. The requirement is proposed as non-mandatory.</p>	<p>Article 33</p> <ol style="list-style-type: none"> 1. The HVDC system shall be capable of finding stable operation points with a minimum change in active power flow and voltage level, during and after any planned or unplanned change in the HVDC system or AC network to which it is connected. The relevant TSO shall specify the changes in the system conditions for which the HVDC systems shall remain in stable operation. 2. The HVDC system owner shall ensure that the tripping or disconnection of an HVDC converter station, does not result in transients at the connection point beyond the limit specified by the relevant TSO. 3. If specified by the relevant TSO, the HVDC system owner shall ensure that an HVDC converter station being part of an HVDC system, shall be capable of switching continuously to Static Synchronous Compensator (STATCOM) operation mode when subject to DC disturbances. 4. The HVDC system shall withstand transient faults on HVAC lines in the network adjacent or close to the HVDC system, and shall not cause any of the equipment in the HVDC system to disconnect from the network due to auto- reclosure of lines in the network. 5. The HVDC system owner shall provide information to the relevant system operator on the resilience of the HVDC system to AC and DC system disturbances.
Article 34		

Article 35	<p>Please check the references to the articles. The Article 14 has been changed compared to the EG CROS, hence need to be checked the links. Also Art. 14b is added according to ENTSO-E proposal.</p> <p>ENTSO-E believes there is a typo in the (d) from ACER proposal. This is covered in Art. 35 (2) (e)</p>	<p>Article 35</p> <p>1. A control scheme, specified by the HVDC system owner consisting of different control modes, including the settings of the specific parameters, shall be coordinated and agreed between the relevant TSO, the relevant system operator and the HVDC system owner.</p> <p>2. With regard to priority ranking of protection and control, the HVDC system owner shall organise its protections and control devices in compliance with the following priority ranking, listed in decreasing order of importance, unless otherwise specified by the relevant TSOs, in coordination with the relevant system operator:</p> <ul style="list-style-type: none"> (a) network system and HVDC system protection; (b) grid forming capability as defined in Article 14(1) to (3), if applicable active power control for emergency assistance; (c) synthetic inertia as in Article 14(4), if applicable or fast frequency control capability as specified in Article 14b; (d) active power control for emergency assistance; (e) automatic remedial actions as specified in Article 13(3); (f) FSM and LFSM-O/U; and (g) power gradient constraint.
Article 36		
Article 37		

Please write your amendment proposals, if any, in the table below

	Text amendment proposal (if applicable)
	<p>Justification for a new Article 12b: ENTSO-E would like to emphasize that the withstand capability of the HVDC system to AC voltage phase angle jumps is not included in the existing version of NC HVDC but is considered a system need to limit the risks of trips of HVDC systems. Therefore a new legal text proposal for the immunity of HVDC systems to voltage phase angle jumps is proposed for consideration.</p> <p>Article 12b Voltage phase angle jump withstand capability</p> <p>1. Without prejudice to Article 12, the relevant TSO may specify that the HVDC system shall be capable of remaining connected without disconnection during voltage phase angle jumps.</p> <p>2. If the capabilities set out in paragraph 1 are set, the relevant TSO shall specify the associated performance parameters and the maximum voltage phase angle jump referred to in paragraph 1</p> <p>Justification for a new Article 14b: ENTSO-E would like to ask ACER to check article 52, fast frequency control and Article 35. We propose that the Article 14 (5) would be a separate article, termed as fast frequency control. Moreover, ENTSO-E proposes the following changes to avoid restricting the ability to implement a Fast Frequency Control that accommodates the Nordic SA needs for damping of frequency oscillations. The proposed changes do not limit the capability initially intended applicable in CE SA, while also allowing Nordic SA to adapt the specification to their system needs. Overall it is a legal text proposal to make it fit for all SA.</p> <p>Article 14b Fast frequency Control Capability The relevant TSO may specify that an HVDC system shall be capable of performing fast frequency control to contribute to limiting the transient frequency deviation by adjusting its active power as a function of the measured</p>

New article

frequency, as specified by the relevant TSO. Fast frequency Control shall be available in both in low and/or high frequency regimes as specified by the relevant TSO. The following shall apply:

- (a) the HVDC system shall be capable without intentional delay of adjusting the active power injected to or withdrawn from AC grid within its rated power. The Fast Frequency Control shall be provided with a damped system response and the energy needed for this function shall be coordinated with sources external to the HVDC system and if applicable within the isolated AC network's design and operational limits;
- (b) this active power adjustment shall be performed based on the measured frequency, as specified by the relevant TSO. The measurement method shall be agreed between the relevant TSOs and the HVDC system owner;
- (c) when the frequency has recovered, the operating point of the HVDC system shall return to its pre-disturbance active power value or an operating point according to the power available for transmission through the HVDC system;
- (d) the requirements regarding measurement of frequency and/or rate-of-change-of-frequency as well as the dynamic performance parameters of rapidly adjusted active power injected to or withdrawn from AC grid shall be agreed between the relevant TSOs and the HVDC system owner.

Justification for new article on HVDC system
Passivity (Article 30b)

Future standard HVDC system design trends at the moment in Europe go up to 2GW HVDC system capacity per connection point. This will be including also the potential of meshing on the DC side ending up with more than 3GW of HVDC transmission capacity embedded in a control area, connecting synchronous areas or being used for offshore wind connection of offshore isolated AC networks or energy hubs. Therefore, previously local harmonic stability and resonance stability issues of HVDC systems will in future become a cross border issue, therefore a EU level regulation is needed.

This article shall aim to ensure that HVDC systems connected across various countries will

not put into risk the security of supply of the CE SA while ensuring that evolved parties take the necessary mitigation measures beforehand in the project design and project specification phase following EU wide connection requirement on it. The article would set the framework in EU level and leaves open for further detail specification either on national or on project specific level.

Due to limited time and pending discussions, ENTSO-E would like to submit to ACER a legal text proposal as per 30.9.2024.

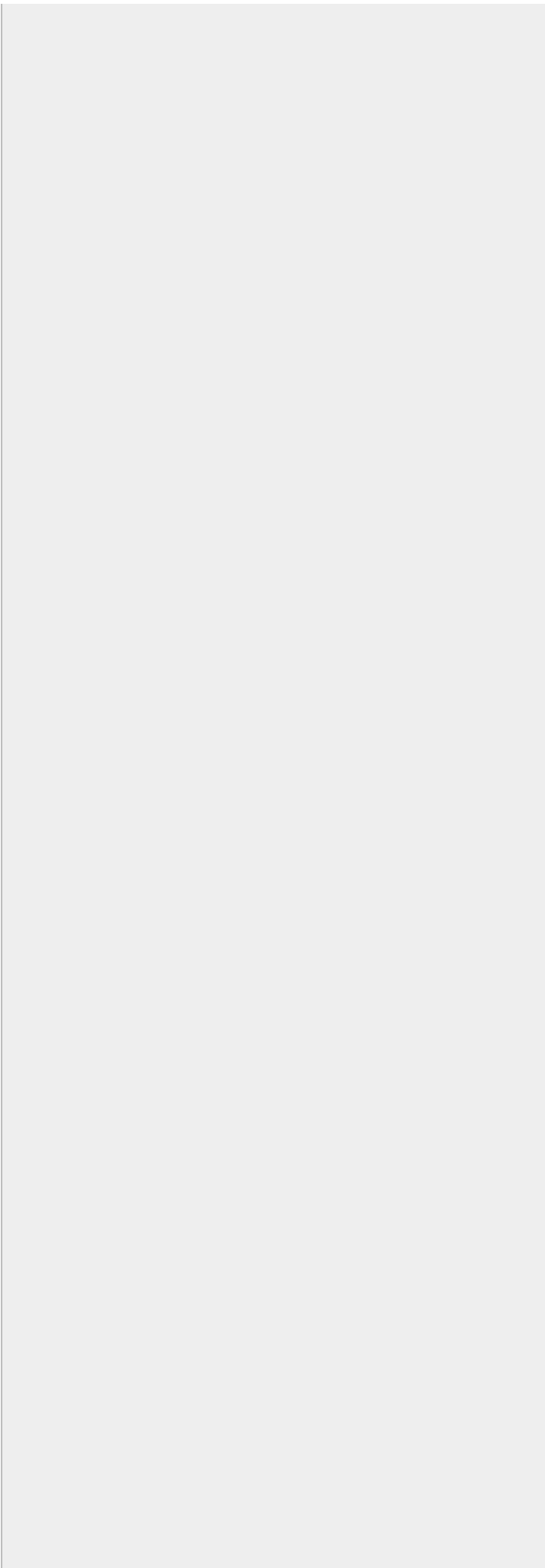
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TITLE III - REQUIREMENTS FOR ASYNCHRONOUSLY CONNECTED POWER PARK MODULES, ASYNCHRONOUSLY CONNECTED DEMAND FACILITIES, ASYNCHRONOUSLY CONNECTED POWER-TO-GAS DEMAND UNITS, ASYNCHRONOUSLY CONNECTED ELECTRICITY STORAGE MODULES AND REMOTE-END HVDC CONVERTER STATIONS

Please write your comments on the ACER draft amendments and your alternative text proposals, if any, in the

	Comment on the ACER draft amendments
Article 38	<p>ENTSO-E would like to highlight a type error related to power-to-gas demand units; asynchronously connect should be added.</p> <p>ENTSO-E would like to highlight that the overvoltage through requirements need to be specified in NC HVI separately.</p>



Article 39

ENTSO-E would like to request ACER to check the use of Abbreviations as it would help readability. There is everywhere repetition of same text that with an Abbreviation would be more readable.

ENTSO-E would like to highlight type errors related to power-to-gas demand units and to power-to-gas demand units owners; asynchronously connected should be added.

Regarding the (8)(c), ENTSO-E would like to propose inclusion of the Nordic threshold of 49.5 Hz for LFSM activation.

Regarding the (8)(e), ENTSO-E would like to emphasize that for isolated AC networks, there are risks if the line is a lot higher than 20% or intentionally kept high. This could lead to a high load disconnection and may exceed the ability of the remote End HVDC station to absorb imbalance. Therefore, we propose some additions in requirement applicable for PtG DU connected to isolated AC network.

demand unit shall be capable of reducing the consumption from the current active power input automatically down to the minimum technical operational level, according to the indicative Figure X-c at a frequency threshold and with a droop setting specified by the relevant TSO;

Figure X-c: LFSM-UC curve for a power-to-gas demand unit

- (b) the default setting of the droop slope (%) shall be specified by the relevant TSO;
- (c) the frequency threshold shall be 49,8 Hz (inclusive), except for synchronous area Nordic and IE and NI, where the frequency threshold shall be 49,5 Hz (inclusive);
- (d) the power-to-gas demand unit shall stay in this specific mode as long as the frequency is below the frequency threshold. If the frequency recovers, the asynchronously connected power to gas demand unit shall follow the same power-frequency characteristic until it is back to its prior state of active power input;
- (e) if the minimum technical operating level is between 20% and 50% of Pref the power-to-gas demand unit should disconnect when reaching its minimum technical operating level;
- (f) if disconnection occurred according to subparagraph (e), the following shall apply:
 - a. the frequency threshold that disconnection is allowed shall be 49 Hz or lower;
 - b. the relevant TSO shall specify the time delay that the disconnection shall occur;
 - c. On return of frequency above the frequency threshold Δf_1 , a random time delay of up to 5 minutes shall be initiated before normal operation resumes;
- (g) the requirements for frequency measurement

shall be:

- (i) maximum measuring time window: 100 ms
- (ii) accuracy: ± 30 mHz
- (h) stable operation of the power-to-gas demand unit during LFSM-UC operation shall be ensured;
- (i) the response time for LFSM-UC shall be less or equal to 0,5 seconds. The relevant system operator has the right to request the demonstration of technical evidence of the response time.

9. A capability for frequency sensitive mode for an asynchronously connected power park module and an asynchronously connected electricity storage module shall be determined in accordance with Article 15(2)(d) of RfG 2.0, subject to a fast signal response as specified in paragraph 1 for the 50 Hz nominal system.

10. A capability for frequency restoration for an asynchronously connected power park module and an asynchronously connected electricity storage module shall be determined in accordance with Article 15(2)(e) of RfG 2.0. for the 50 Hz nominal system.

11. Where a constant nominal frequency other than 50 Hz, a frequency variable by design or a DC system voltage is used, subject to the agreement of the relevant TSO, the capabilities listed in paragraphs 3 to 10 and the parameters associated with such capabilities shall be specified by the relevant TSO.

Article 40	Editorial typos in the (1)(d) and in the (4)	<p>Article 40(1)(d) for interface points at AC voltages that are not included in the scope of Annex VII, the relevant system operator, in coordination with the relevant TSO shall specify applicable requirements at the connection point;</p> <p>Article 40(4) With respect to reactive power capability for asynchronously connected demand facilities, asynchronously connected power-to-gas demand the actual reactive power range at the interface point shall be specified by the relevant TSO for importing and exporting reactive power prescribed in Article 15(1) of DC 2.0.</p>
Article 40a[NEW]	We would propose editorial changes. Power system should be isolated network.	<p>Article 40a(a) the asynchronously connected power-to-gas demand unit shall, when operating above the minimum operating level, shall be capable of staying connected to the network and continuing to operate stably after the isolated AC network has been disturbed by faults in the isolated AC network according to a voltage-against-time-profile in line with Figure X-d and Tables X.1.1 to X.1.2.</p>

Article 40b[NEW]	<p>ENTSO-E would like to highlight that the reference should be 14.4 and not 14.5</p> <p>ENTSO-E would like propose to make a direct connection to the article 22 of NC RfG 2.0 and how synthetic inertia is specified by Type D PPM. This text on inherent energy is part of Art. Y (7) of NC RfG 2.0 and shall only be referred here. Keeping it, would mean we will have to define it parallel to NC RfG 2.0 in the national implementation.</p>	<p>Article 40b</p> <p>If grid forming capability of an HVDC system as it is set out in Article 14(4) is requested, the asynchronously connected power park modules and the asynchronously connected electricity storage modules shall be capable of providing synthetic inertia within the asynchronously connected power park module's and asynchronously connected electricity storage modules capability, including current limits and inherent energy storage capabilities of each individual unit, if requested by the relevant system operator. 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 affecting the design of the physical components of individual units.</p>
Article 41		
Article 42	Editorial typo in the (a)	Article 42(a) each relevant system operator shall specify and make publicly available the method and the pre-fault and post-fault conditions for the calculation of minimum and maximum short circuit power at the interface point;
Article 43		
Article 44		

Article 45	ENTSO-E considers it important to have in the Art. 45 the inclusion of A-PtG-DU.	<p>Article 45</p> <p>General system management requirements applicable to asynchronously connected power park modules, asynchronously connected electricity storage modules, the asynchronously connected power-to-gas demand unit and asynchronously connected demand facilities</p> <p>With regard to general system management requirements, Articles 14(5), 15(5) and 16(4) of RfG 2.0 shall apply to any asynchronously connected power park module and asynchronously connected electricity storage module. With regard to general system management requirements, Articles 16(1), 17(1) and XX (6) of DC 2.0 shall apply to any asynchronously connected demand facilities and the asynchronously connected power-to-gas demand unit.</p>
Article 46		
		<p>Article 47</p> <p>1. Where a nominal frequency other than 50 Hz, or a frequency variable by design is used in the isolated AC network connecting the asynchronously connected power park modules, asynchronously connected demand facilities, asynchronously connected power-to-gas demand units and asynchronously connected electricity storage modules, subject to relevant TSO agreement, Article 11 shall apply to the remote-end HVDC converter station with the applicable frequency ranges and time periods specified by the relevant TSO, taking into account specificities of the system and the requirements laid down in Annex I.</p> <p>2. With regard to frequency response, the remote-end HVDC converter station owner, the asynchronously</p>

Article 47

ENTSO-E would like to highlight, that ACER should check if legally this accounts for configurations with more than one HVDC systems connected to the isolated AC network. And if so, should the other HVDC stations also contribute to the inertial response or is this allowed but not mandatory. Also, please check the Art. 14 (4), it is wrong reference.

connected power park module owner, the asynchronously connected demand facility owner, the asynchronously connected power-to-gas demand unit owner and the asynchronously connected electricity storage module owner shall agree on the technical modalities of the fast signal communication in accordance with Article 39(1). Where the relevant TSO requires, the HVDC system shall be capable of providing the network frequency at the connection point as a signal to the remote-end HVDC converter station. For an HVDC system connecting an asynchronously connected power park module, an asynchronously connected demand facility, an asynchronously connected power-to-gas demand unit and an asynchronously connected electricity storage module the adjustment of active power frequency response shall be limited by the capability of the asynchronously connected power park modules.

3. Where two or more remote-end HVDC converter stations are connected to one or more interface points of the same isolated AC network, the remote-end HVDC converter stations and their respective HVDC systems shall be capable of continuously operating stably over the full operating range between the maximum and the minimum HVDC system active power transmission capacity and contributing to the frequency control of the remote-end HVDC system isolated AC network they are connected to.

Where paragraph 3 applies, the relevant TSO in coordination with adjacent TSOs, shall specify that a study is required, in order to define coordinated frequency droop slope parameters of the remote-end HVDC converter stations including power sharing ratio between the remote-end HVDC stations and their respective HVDC system. This study shall also include

		<p>robustness against control interactions during frequency changes response. The process for the necessary study to be conducted and relevant data to be provided by all grid users involved, as well as mitigating actions identified and implemented, shall be in accordance with the process in Article 29.</p> <p>4. If grid forming capability as set out in Article 14(4) is requested, each remote end HVDC converter station shall be capable of adjusting at its interface point the isolated AC network frequency and voltage phase angle in order to use the synthetic inertia from asynchronously connected power park modules and asynchronously connected electricity storage modules, if it is requested by the relevant TSO.</p>
Article 48		
Article 49		
Article 50		

Please write your amendment proposals, if any, in the table below

	Text amendment proposal (if applicable)
New article	<p>Justification: ENTSO-E would like to propose an overvoltage ride through profile for A-PtG DU. It is for us important that A-PtG-U have a clear requirement.</p> <p>Article 40c Overvoltage ride through capability of power-to-gas demand units</p> <p>The asynchronously connected power to gas demand unit 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 YV at the interface point. The relevant system operator, in coordination with the relevant TSO, may define longer times for operation, if it is required to preserve or to restore system security. The power to gas demand unit owner shall not unreasonably withhold consent to apply longer times for operation, taking account of their economic and technical feasibility.</p> <p>Figure YV The diagram represents the higher limit of a voltage-against-time profile of the voltage at the interface point, expressed as the ratio of its actual value and its reference 1 pu value, before, during and after a fault. Urecf is the maximum voltage as specified by the relevant TSO.</p>

Please upload figures or tables if necessary

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TITLE IV - INFORMATION EXCHANGE AND COORDINATION

Please write your comments on the ACER draft amendments and your alternative text proposals, if any, in the table below

	Comment on the ACER draft amendments	Alternative text amendment proposal (if applicable)
Article 51		<p>Article 51</p> <p>1. With regard to instrumentation for the operation, each HVDC converter unit of an HVDC system shall be equipped with an automatic controller capable of receiving instructions from the relevant system operator and from the relevant TSO. This automatic controller shall be capable of operating the HVDC converter units of the HVDC system in a coordinated way. The relevant system operator shall specify the automatic controller hierarchy per HVDC converter unit.</p> <p>2. The automatic controller of the HVDC system referred to in paragraph 1 shall be capable of sending the following signal types to the relevant system operator:</p> <p>(a) operational signals, providing at least the following:</p> <ul style="list-style-type: none"> (i) start-up signals; (ii) AC and DC voltage measurements; (iii) AC and DC current measurements; (iv) active and reactive power measurements on the AC side; (v) DC power measurements; (vi) HVDC converter unit level operation in a multi-pole type HVDC converter; (vii) elements and topology status; and (viii) FSM, LFSM-O and LFSM-U active power ranges. <p>(b) alarm signals, providing at least the following:</p> <ul style="list-style-type: none"> (i) emergency blocking;

	<p>Regarding the (3), ENTSO-E would like to highlight, that this need to be checked on project level and it may not be applicable. By adding the term if applicable, we can avoid derogations. As a proposal we have added if specified by the relevant TSO.</p> <p>Regarding the (3)(b)ENTSO-E would like to highlight, that this need to be checked on project level and it may not be applicable. By adding the term if applicable, we can avoid derogations.</p>	<ul style="list-style-type: none"> (ii) ramp blocking; (iii) fast active power reversal. <p>3. If specified by the relevant TSO, the automatic controller referred to in paragraph 1 shall be capable of receiving the following signal types from the relevant system operator:</p> <ul style="list-style-type: none"> (a) operational signals, receiving at least the following: <ul style="list-style-type: none"> (i) start-up command; (ii) active power setpoints; (iii) frequency sensitive mode settings; (iv) reactive power, voltage or similar setpoints; (v) reactive power control modes; (vi) power oscillation damping control; and (vii) synthetic inertia. (b) alarm signals, receiving at least the following, if applicable: <ul style="list-style-type: none"> (i) emergency blocking command; (ii) ramp blocking command; (iii) active power flow direction; and (iv) fast active power reversal command. <p>4. With regards to each signal, the relevant system operator may specify the quality of the supplied signal.</p>
Article 52	ENTSO-E would like to highlight that the term fast frequency control is not defined in the NC HVDC 1.0. Therefore, we propose to have Article 14b with name fast frequency control.	Article 52(b) fast frequency control, if applicable as referred to in Article 14 b and Article 35;
Article 53		
		Article 54(2)(d) be open source generic model for RMS simulations delivered for cross-border network stability studies additionally to encrypted models if

ENTSO-E would like to make a proposal in the (2) (d) for clarity and avoidance of doubt.

Regarding the (3)(c), ENTSO-E would like to add DC network disturbance into the requirement 3(c). The reason is that future HVDC systems with more than two HVDC stations, hence multi-terminal, would need to show by simulations response to DC network disturbance and how DC faults protection selectivity functions. See also relevant section in compliance.

Regarding the (3)(e), need to cover all subsystems so that no components are lost. Please mind the plural at the end.

Regarding the (3)(g), ENTSO-E believes that here we need to add the term DC side. This is important for the case of multi-terminal HVDC systems and for ensuring that the EMT model is capable to simulate

applicable;

Article 54(3)(c) be able to reproduce the detailed transient response of the HVDC system and its control and protection blocks (including synchronisation) during balanced and unbalanced AC network and DC network disturbances in the valid frequency range;

Article 54(3)(e) represent at least transformers models (including saturation), resistors, filters, breakers, AC and DC arresters in the valid frequency range;

Article 54(3)(f) include all the control and protection models as agreed between the relevant TSO and the HVDC system owner (e.g., under /overvoltage, overcurrent, chopper and frequency sensitive control functions);

Article 54(3)(g) be capable to be used for the numerical calculation of the frequency dependent impedance of the HVDC converter station (impedance magnitude and impedance phase angle) from AC and DC side in the frequency range that the model is valid;

Article 54(4)
4. For the purpose of the risk assessment of the

Article 54

DC faults as well as protection operation, for example DC protection relays and algorithms, ensuring proper encryption.

Regarding the (4), ENTSO-E believes that here we need to add the term DC side. This is important for the case of multi-terminal HVDC systems and for ensuring that the EMT model is capable to simulate DC faults as well as protection operation, for example DC protection relays and algorithms, ensuring proper encryption.

ENTSO-E would like to propose that this requirement applies also to A-PPM; A-ESM and A-DF. Ideally, it should be written also in Article 15(4) (c) of the NC RfG 2.0 and referred by NC HVDC in the Article 38.

ENTSO-E proposal is to add new sentence in paragraph 5. The need of obtaining harmonic emissions data has been specified in Expert Group Interaction Studies and Simulation Models (EG ISSM) FINAL REPORT 01.10.2021, however only in the section regarding PPMs (page 34). It is commonly known that HVDC converter stations as Power Electronic Devices (PED) can distort the line voltage by injecting additional harmonic voltages /currents into the grid (see e.g. CIGRE TB 754 AC side harmonics and appropriate harmonic limits for VSC HVDC). Therefore, TSO should have the right to request from the HVDC system owner the model of harmonic component emissions (Norton currents or Thevenin voltages).

resonance stability of the HVDC convert station, the TSO shall have the right to request from the HVDC system owner the frequency dependent impedance model of the HVDC converter station at the AC and the DC side. Without prejudice to the Member State's rights to introduce additional requirements, the following requirements shall apply:

- (a) the impedance model of the HVDC converter station shall be requested in the frequency range 5 Hz till 2500 Hz; the TSO has the right to extend the required applicability of the model up to 9000 Hz;
- (b) the relevant TSO together with the HVDC owner shall agree if the calculation of the impedance model of the HVDC converter station will be either numerically (using the EMT model) or analytically (using transfer function) or both. In the case of numerical calculation, the TSO shall specify the frequency steps where the impedance is provided. The number of different frequency steps shall be reasonably limited to provide acceptable results and at the same time limit the simulation effort and data storage to an acceptable amount;
- (c) the relevant TSO shall have the right to request the impedance model of the HVDC station through the specified operating range and all control modes of operation;
- (d) the impedance model of the HVDC converter station shall be provided for both the positive and for the negative phase sequence;
- (e) the HVDC system owner shall take into account the influence of the whole HVDC unit control and measurement system as well as other parts of the HVDC unit which influences the output

impedance in the specified frequency range; if coupling between different frequencies exists in a given frequency range, this should be sufficiently represented;

(f) the HVDC system owner shall specify and justify simplifications made in the calculation of the impedance model.

Article 54(5)

For the purpose of harmonic and inter harmonic network studies, the TSO shall have the right to request from the HVDC system owner the frequency dependent equivalent model (Thevenin or Norton circuit) of the HVDC converter station at the AC side. The requirements corresponding to those set out in paragraph (4) shall apply.

Please write your amendment proposals, if any, in the table below

	Text amendment proposal (if applicable)
New article	

Please upload figures or tables if necessary

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TITLE V - OPERATIONAL NOTIFICATION PROCEDURE FOR
CONNECTION

Please write your comments on the ACER draft amendments and your alternative text proposals, if any, in the table below

	Comment on the ACER draft amendments	Alternative text amendment proposal (if applicable)
Article 55		
Article 56		
Article 57		
Article 58		
Article 59		
Article 60		
Article 61		
Article 62		
Article 63		
Article 64		
Article 65		
Article 66		

Please write your amendment proposals, if any, in the table below

	Text amendment proposal (if applicable)
New article	

Please upload figures or tables if necessary
The maximum file size is 1 MB

TITLE VI - COMPLIANCE

Please write your comments on the ACER draft amendments and your alternative text proposals, if any, in the table below

	Comment on the ACER draft amendments	Alternative text amendment proposal (if applicable)
Article 67		
Article 68		
Article 69		
Article 70		
Article 71		

Article 72	ENTSO-E would like to propose the inclusion of a test for A-PtG DU. This is in line with NC RfG 2.0 requirements.	<p>Article 72(15) With regard to LFSM-UC of A-PtG-DU the asynchronously connected power to gas demand unit owner shall demonstrate its technical capability to provide LFSM-UC according to the conditions of Article 39. (8); The following requirements with regard to the test shall apply:</p> <ul style="list-style-type: none"> a. the A-PtG-DU 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: <ul style="list-style-type: none"> i. the test results, for both dynamic and static parameters, meet the requirements set out in Article 39 (8) and ii. undamped oscillations do not occur after the step change response.
		<p>Article 73</p> <ol style="list-style-type: none"> 1. Equipment certificates may be used instead

of part of the simulations below, on the condition that they are provided to the relevant system operator.

2. With regard to the fast fault current injection simulation:

- (a) the HVDC converter unit owner or the HVDC converter station owner shall simulate fast fault current injection in the conditions set forth in Article 19;
- (b) the simulation is deemed passed, provided that compliance with the requirements specified in accordance with Article 19 is demonstrated.

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

- (a) the HVDC system owner shall simulate the capability for fault-ride-through in the conditions set forth in Article 25; and
- (b) the simulation is deemed passed, provided that compliance with the requirements specified in accordance with Article 25 is demonstrated.

4. With regard to the post fault active power recovery simulation:

- (a) the HVDC system owner shall simulate the capability for post fault active power recovery in the conditions set forth in Article 26;
- (b) the simulation is deemed passed, provided that compliance with the requirements specified in accordance with Article 26 is demonstrated.

5. With regard to the reactive power capability simulation:

- (a) the HVDC converter unit owner or the HVDC converter station owner shall simulate the capability for leading and lagging reactive power capability in the conditions referred to in Article 20

(2) to (4);

(b) the simulation shall be deemed passed, provided that the following conditions are cumulatively fulfilled:

(i) the simulation model of the HVDC converter unit or the HVDC converter station is validated against the compliance tests for reactive power capability as referred to in Article 71;

(ii) compliance with the requirements as referred to in Article 20(2) to (4) is demonstrated.

6. With regard to the power oscillations damping control simulation:

(a) the HVDC system owner shall demonstrate the performance of its control system (POD function) to damp power oscillations in the conditions set forth in Article 30;

(b) the tuning shall result in improved damping of corresponding active power response of the HVDC system in combination with the POD function compared to the active power response of the HVDC system without POD;

(c) the simulation shall be deemed passed, provided that the following conditions are cumulatively fulfilled:

(i) the POD function damps the existing power oscillations of the HVDC system within a frequency range specified by the relevant TSO. This frequency range shall include the local mode frequency of the HVDC system and the expected network oscillations; and

(ii) a change of active power transfer of the HVDC system as specified by the relevant TSO does not lead to undamped oscillations in active or reactive power of the HVDC system.

Article 73

ENTSO-E would like to highlight that there is no grid forming simulation requirement for the PPMs, in RfG 2.0 on the compliance part. We believe that this should be in the simulations section and is an important article.

ENTSO-E would like to highlight that there is a need for compliance article for Art. 14b (fast frequency control).

ENTSO-E would like to highlight that there is a need for compliance article for Art. 12.

ENTSO-E believes that the current regulation is applicable to HVDC systems with more than two HVDC converter stations (multiterminal). Therefore, for future applicability ENTSO-E would need to require compliance by simulations from fast recovery after DC faults.

ENTSO-E would like to highlight that there is a need for compliance article for Art. 12b.

7. With regard to the simulation of active power modification in case of disturbance:

(a) the HVDC system owner shall simulate the capability to quickly modify active power according to Article 13(1)(b); and

(b) the simulation shall be deemed passed, provided that the following conditions are cumulatively fulfilled:

(i) the HVDC system has demonstrated stable operation when following the pre-specified sequence of active power variation;

(ii) the initial delay of the adjustment of the active power is shorter than the value specified in Article 13(1)(b) or reasonably justified if greater.

8. With regard to the fast active power reversal simulation, as applicable:

(a) the HVDC system owner shall simulate the capability to quickly reverse active power according to Article 13(1)(c);

(b) the simulation shall be deemed passed, provided that the following conditions are cumulatively fulfilled:

(i) the HVDC system has demonstrated stable operation;

(ii) the time of adjustment of the active power is shorter than the value specified in Article 13(1)(c) or reasonably justified if greater.

9. With regard to the grid forming simulations:

(a) the HVDC system owner shall simulate its technical capability to provide grid forming capability according to Article 14, if applicable.

(b) In case that Article 47 (5) is applicable, the remote End HVDC converter station owner shall simulate its capability to modulate the isolated AC

network frequency and voltage phase angle.

(c) the simulation is deemed passed, provided that compliance with the requirements specified in accordance with Article 14 is demonstrated.

10. With regard to the fast frequency control capability simulations:

(a) the HVDC system shall demonstrate its technical capability to provide fast frequency control according to Article 14b.

(b) the simulation is deemed passed, provided that compliance with the requirements specified in accordance with Article 14b is demonstrated.

11. With regard to the RoCoF simulations:

(c) the HVDC system shall demonstrate its technical capability to provide RoCoF immunity according to Article 12.

(d) the simulation is deemed passed, provided that compliance with the requirements specified in accordance with Article 12 is demonstrated.

12. With regard to the fast recover from DC faults:

(a) the HVDC system owner shall simulate the capability of the HVDC system to fast recover from disturbances in the DC system (DC network) according to Article 27.

(b) the simulation is deemed passed, provided that compliance with the requirements specified in accordance with Article 12 is demonstrated.

13. With regard to the voltage phase angle jump simulations:

(e) the HVDC system shall demonstrate its technical capability to provide voltage phase angle jump immunity according to Article 12b.

(f) the simulation is deemed passed, provided

		that compliance with the requirements specified in accordance with Article 12b is demonstrated.
		<p>Article 74</p> <p>Compliance simulations for asynchronously connected power park modules, asynchronously connected electricity storage modules, asynchronously connected power to gas demand unit and remote-end HVDC converter units</p> <p>1. Asynchronously connected power park modules and asynchronously connected electricity storage modules are subject to the compliance simulations detailed in this Article. Equipment certificates may be used instead of part of the simulations described below, on the condition that they are provided to the relevant system operator.</p> <p>2. With regard to the fast fault current injection simulation:</p> <p>(a) the asynchronously connected power park module owner and the asynchronously connected electricity storage module owner shall simulate the capability for fast fault current injection in the conditions set forth in Article 20(2)(b) of RfG 2.0; and</p> <p>(b) the simulation shall be deemed passed, provided that compliance with the requirement according to Article 20(2)(b) of RfG 2.0 is demonstrated.</p> <p>3. With regard to the post fault active power recovery simulation of A-PPM and A-ESM:</p> <p>(a) the asynchronously connected power park module owner and the asynchronously connected electricity storage module owner shall simulate the capability for post fault active power recovery in the</p>

conditions set forth in Article 20(3)(a) of RfG 2.0;
and

(b) the simulation shall be deemed passed, provided that compliance with the requirement according to Article 20(3)(a) of RfG 2.0 is demonstrated.

4. With regard to the post fault active power recovery simulation of A-PtG-DU:

(a) The asynchronously connected power to gas demand unit owner shall simulate the capability for post fault active power recovery in the conditions set forth in Article 40(a).(c).

(b) the simulation shall be deemed passed, provided that compliance with the requirement according to Article 40 (a).(c) is demonstrated.

5. With regard to the reactive power capability simulation of asynchronously connected power park modules and asynchronously connected electricity storage modules:

(a) the asynchronously connected power park module owner and the asynchronously connected electricity storage module owner shall simulate the capability for leading and lagging reactive power capability in the conditions referred to in Article 40 (2); and

(b) the simulation shall be deemed passed, provided that the following conditions are cumulatively fulfilled:

(i) the simulation model of the asynchronously connected power park module and the asynchronously connected electricity storage module is validated against the compliance tests for reactive power capability as referred to in Article 72 (2);

Editorial changes proposals.

ENTSO-E would like to propose a legal text to ensure the simulation of the post fault active power recovery of the A-PtG-DU.

ENTSO-E proposal for FRT of PtG DU.

ENTSO-E would like to highlight that there is no requirement in NC HVDC on compliance. EG CROS did not touch neither discuss this. Therefore, we propose a legal text to simulate the prove the capability.

(ii) compliance with the requirements as referred to in Article 40(2) is demonstrated.

6. With regard to the reactive power capability simulation of remote-end HVDC converter units:

(a) the remote-end HVDC converter unit owner or the remote-end HVDC converter station owner shall simulate the capability for leading and lagging reactive power capability in the conditions referred to in Article 48(2); and

(b) the simulation shall be deemed passed, provided that the following conditions are cumulatively fulfilled:

(i) the simulation model of the remote-end HVDC converter unit or the remote-end HVDC converter station is validated against the compliance tests for reactive power capability at the as referred to in Article 72(3);

(ii) compliance with the requirements as referred to in Article 48(2) is demonstrated.

7. With regard to the power oscillations damping control simulation:

(a) the asynchronously connected power park module owner and the asynchronously connected electricity storage module owner shall simulate the capability for power oscillations damping under the conditions as referred to in Article 21(2)(f) of RfG 2.0; and

(b) the simulation shall be deemed passed, provided that the model demonstrates compliance with the conditions of Article 21(2)(f) of RfG 2.0.

8. With regard to fault-ride-through capability simulation of A-PPM and A-ESM:

(a) the asynchronously connected power park module owner and the asynchronously connected

		<p>electricity storage module owner shall simulate the capability for fault-ride-through under the conditions as referred to in Article 16(3)(a) of RfG 2.0;</p> <p>(b) the simulation shall be deemed passed, provided that the model demonstrates compliance with the conditions of Article 16(3)(a) of RfG 2.0.</p> <p>9. With regard to fault-ride-through capability simulation of A-PtG-DU :</p> <p>(a) The asynchronously connected power to gas demand unit owner shall simulate the capability for fault-ride-through under the conditions as referred to in Article 40 (a).</p> <p>(b) the simulation shall be deemed passed, provided that compliance with the requirement according to Article 40 (a) is demonstrated.</p> <p>10. With regard to Grid forming capability of A-PPM and A-ESM:</p> <p>(a) the asynchronously connected power park module and the asynchronously connected electricity storage module shall simulate its technical capability to provide grid forming control according to the conditions of NC RfG 2.0, Article 22 and if applicable NC HVDC 2.0 article 40b;</p> <p>(b) the simulation shall be deemed passed, provided that compliance with the requirement according to Article 22 of NC RfG 2.0 and if applicable Article 40 (b) is demonstrated.</p>
Article 75		
		<p>Article 76</p> <p>1. ACER shall monitor the implementation of this Regulation in accordance with Article 32(1) of Regulation (EU) 2019/943. Monitoring shall cover in particular the following matters:</p>

Article 76

It is not clear for ENTSO-E what is the purpose of the article related to the GC ESC and how the GC ESC is engaged in this scope of monitoring. We would like to kindly ask for clarification.

ENTSO-E would like to highlight that DSOs are not responsible for HVDC systems and connection to isolated AC systems. We recommend to remove the related sentence.

- (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 HVDC systems, asynchronously connected power park modules, asynchronously connected demand facilities, asynchronously connected power-to-gas demand units and asynchronously connected electricity storage modules under this Regulation continues to be valid.

2. ACER, in cooperation with ENTSO for Electricity, shall maintain a list of the relevant information to be communicated by ENTSO for Electricity to ACER in accordance with Articles 30(5) and 32(1) of Regulation (EU) 2019/943. 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.

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.

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 authorities, ACER or the ENTSO for Electricity 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.

4. Where ENTSO for Electricity or ACER identify areas in 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 60(2) of Regulation (EU) 2019 /943.

Please write your amendment proposals, if any, in the table below

	Text amendment proposal (if applicable)
New article	

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TITLE VII - DEROGATIONS

Please write your comments on the ACER draft amendments and your alternative text proposals, if any, in the table below

	Comment on the ACER draft amendments	Alternative text amendment proposal (if applicable)
Article 77	ENTSO-E believes it is important to add all relevant grid users here for case of derogations.	Article 77(1) Regulatory authorities may, at the request of a HVDC system owner, an asynchronously connected power park module owner, an asynchronously connected demand facility owner, an asynchronously connected power-to-gas demand unit owner or an asynchronously connected electricity storage module owner, or their prospective owner, relevant system operator or relevant TSO, grant HVDC system owners, asynchronously connected power park module owners, asynchronously connected demand facility owners, asynchronously connected power-to-gas demand unit owner or asynchronously connected electricity storage module owners, or their prospective owner, relevant system operators or relevant TSOs derogations from one or more provisions of this Regulation for new and existing HVDC system and/or asynchronously connected power park modules, asynchronously connected demand facilities, the asynchronously connected power-to-gas demand unit owner and/or asynchronously connected electricity storage modules in accordance with Article 78, Article 79, Article 80, Article 81 and Article 82.
Article 78		
Article 79		
Article 80		
Article 81		
Article 82		

Article 83		
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Please write your amendment proposals, if any, in the table below

	Text amendment proposal (if applicable)
New article	

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TITLE VIII - FINAL PROVISIONS

Please write your comments on the ACER draft amendments and your alternative text proposals, if any, in the table below

	Comment on the ACER draft amendments	Alternative text amendment proposal (if applicable)
Article 84	It is not clear to ENTSO-E what is meant by national agreements. Please clarify.	
Article 85		
Article 85a[NEW]		
Article 86		

Please write your amendment proposals, if any, in the table below

	Text amendment proposal (if applicable)
New article	

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Annex I - Frequency ranges referred to in Article 11

Please write your comments on the ACER draft amendments and your alternative text proposals, if any, in the table below

	Comment on the ACER draft amendments	Alternative text amendment proposal (if applicable)
Annex I	Please check the references to the Regulation in Table 1.	

Please upload figures or tables if necessary

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Annex II - Requirements applying to frequency sensitive mode, limited frequency sensitive mode overfrequency and limited frequency sensitive mode underfrequency

Please write your comments on the ACER draft amendments and your alternative text proposals, if any, in the table below

	Comment on the ACER draft amendments	Alternative text amendment proposal (if applicable)
Annex II	<p>Regarding Figure 1, ENTSO-E believes that the caption of Figure 1 uses incorrect terminology. dP1 is labelled “power change”, whereas dP and dP2 are labelled “power exchange”, which has a different (and incorrect) meaning. Consistently use “change” instead of “exchange”.</p> <p>Regarding Table 2, ENTSO-E believes the values of $\Delta f_1/f_n$, $\Delta f_2/f_n$ and $\Delta f_{db}/f_n$ given in table 2 are not plausible. The percent-symbol seems to be not needed here. We propose to remove, it is a mistake.</p>	<p>Figure 1: Active power frequency response capability of an HVDC system in FSM illustrating the case with deadband and insensitivity. In this figure, ΔP is the active power change by an HVDC system with the network at its connection point based on its actual operating point, P_{max} is maximum transmission capacity of the HVDC system, f_n is the target frequency in the AC network where the FSM service is provided, Δf is the frequency deviation in the AC network where the FSM service is provided, ΔP_1 is the agreed power change for the FSM at reaching the frequency threshold value Δf_1, ΔP_2 is the agreed power change at reaching the frequency threshold value Δf_2, Δf_{db} is the deadband of the power frequency response, $\Delta f_{insensitivity}$ is the frequency response insensitivity (or else the permissible tolerance allowed), s_1 is the droop value for the given ΔP_1 and s_2 is the droop for the given ΔP_2.</p> <p>Regarding Table 2, please refer to the attached files.</p>

Please upload figures or tables if necessary

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Annex III - Voltage ranges referred to in Article 18

Please write your comments on the ACER draft amendments and your alternative text proposals, if any, in the table below

	Comment on the ACER draft amendments	Alternative text amendment proposal (if applicable)
Annex III		

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Annex IV - Requirements for U-Q/Pmax-profile referred to in Article 20

Please write your comments on the ACER draft amendments and your alternative text proposals, if any, in the table below

	Comment on the ACER draft amendments	Alternative text amendment proposal (if applicable)
Annex IV		

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Annex V - Voltage-against-time-profile referred to in Article 25

Please write your comments on the ACER draft amendments and your alternative text proposals, if any, in the table below

	Comment on the ACER draft amendments	Alternative text amendment proposal (if applicable)
Annex V	Regarding Table 7.2, ENTSO-E proposes a change for Trec1.	Regarding Table 7.2, please refer to the attached files (proposed Trec1: 1,5-3,0)

Please upload figures or tables if necessary

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Annex VI - Frequency ranges and time periods referred to in Article 39(2)

(a)

Please write your comments on the ACER draft amendments and your alternative text proposals, if any, in the table below

	Comment on the ACER draft amendments	Alternative text amendment proposal (if applicable)
Annex VI	<p>Regarding Table 8, ENTSO-E would like to propose to increase the duration up to 60s. This should be the same as Annex I. There was a mistake in NC HVDC 1.0. The remote End Station requirement should be the same with the A-PPM, A-ESM; A-DF and A-PtG -DU. 60s is the right value.</p> <p>Please pay attention to the scope extension in the Table 8 label.</p>	<p>Please refer to the attached files</p> <p>Table 8 caption: Minimum time periods for the 50 Hz nominal system for which a A-PPM, A-ESM, A-PtG DU shall be capable of operating for different frequencies deviating from a nominal value without disconnecting from the network.</p>

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Annex VII - Voltage ranges and time periods referred to in Article 40

Please write your comments on the ACER draft amendments and your alternative text proposals, if any, in the table below

	Comment on the ACER draft amendments	Alternative text amendment proposal (if applicable)
Annex VII	<p>ENTSO-E has discussed the change in the voltage ranges for A-PPM, A-ESM, A-DF and A-PtG DU. We recommend the following proposal, as in the table.</p> <p>Justification: In the NC HVDC 1.0, the voltage ranges were coupled to the same ranges as in NC RfG. In future, isolated AC networks would need to have more flexibility in order to optimise costs while preserve as much as possible a harmonisation needed.</p> <p>Regarding Table 10, Rated Voltage 400 kV, 1,05 pu-1,15 pu , in NC RfG 2.0, it is 1.1 p.u. Here, we proposed to add the sentence, Various sub-ranges of voltage withstand capability may be specified by the relevant TSO. This gives the option to have a subrange, 1,05-1,1 and 1,1-1,15 (with the even zero seconds duration)</p> <p>Regarding Figure 7, ENTSO-E would like to highlight a mistake that needs to be corrected. Proposed change: The position, size and shape of the inner envelope are indicative and other than rectangular may be used within the outer envelope.</p>	<p>Figure 7: U-Q/Pmax-profile of an asynchronously connected power park module and asynchronously connected electricity storage module at the connection point. The diagram represents boundaries of a U-Q/Pmax-profile of the voltage at the connection point[s], expressed by the ratio of its actual value to its reference 1 pu value in per unit, against the ratio of the reactive power (Q) to the maximum capacity (Pmax). The position, size and shape of the inner envelope are indicative and other than rectangular may be used within the fixed outer envelope. For profile shapes other than rectangular, the voltage range represents the highest and lowest voltage points. Such a profile would not give rise to the full reactive power range being available across the range of steady-state voltages.</p> <p>Regarding Table 9 and Table 10, please refer to the attached files.</p>

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Annex VIII - Reactive power and voltage requirements referred to in Article 48

Please write your comments on the ACER draft amendments and your alternative text proposals, if any, in the table below

	Comment on the ACER draft amendments	Alternative text amendment proposal (if applicable)
Annex VIII	<p>ENTSO-E would like to propose changes in the table 12 in order to fix issues with material standards, especially of 132 kV.</p> <p>Regarding Table 12, Rated Voltage 132 kV, 0,9 pu - 1,0 pu, ENTSO-E would like to highlight that 1,0 pu should be corrected to 1.098pu. This is also a comment in the EG CROS that has not been implemented.</p>	Regarding Table 12 and Table 13, please refer to the attached files

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Other additional provisions

Please write your amendment proposals, if any, in the table below

	Text amendment proposal (if applicable)
Other new provisions	

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Useful links

[more info on ACERs HVDC public consultation \(https://www.acer.europa.eu/documents/public-consultations/pc2024e05-public-consultation-amendments-electricity-grid-connection-network-code\)](https://www.acer.europa.eu/documents/public-consultations/pc2024e05-public-consultation-amendments-electricity-grid-connection-network-code)

Background Documents

[ACER_draft_amendment_proposal_NC_HVDC_for_PC_2024_E_05.docx](#)

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