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Technical Regulation 3.4.3

TECHNICAL REGULATION 3.4.3 REQUIREMENTS FOR TRANSMISSION-CONNECTED DEMAND FACILITIES, REVISION 1

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TECHNICAL REGULATION 3.4.3

REQUIREMENTS FOR TRANSMISSION-CONNECTED DEMAND FACILITIES

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TECHNICAL REGULATION 3.4.3

REQUIREMENTS FOR TRANSMISSION-CONNECTED DEMAND FACILITIES

Pursuant to section 26(2) and (3), section 31(3) and section 86a of the Danish Electricity Supply Act, cf. Danish Executive Order No. 1248 of 24 October 2023, and pursuant to authorisation in section 7(1)(ii) of Danish Executive Order No. 1358 of 24 November 2023 on transmission system operation and the use of the electricity transmission grid, etc., the following is stipulated:

Part 1

Scope and definitions

1. This regulation sets out requirements for transmission-connected demand facilities that are governed by the requirements under Commission Regulation (EU) 2016/1388 of 17 August 2016 establishing a network code on demand connection as amended ('NC DC') and which are connected after this regulation takes effect.

(2) Transmission-connected demand facilities are found to be existing under this regulation if the demand facility is already connected to the transmission system and has been issued an ION by Energinet at the date on which this regulation takes effect. Existing transmission-connected demand facilities are only subject to the requirements of this regulation under the following circumstances:

- a) For an existing transmission-connected demand facility that is not subject to the requirements of NC DC, and which has been modified to such an extent that the demand facility is fully or partially covered by the new requirements in NC DC pursuant to the procedure in force at any time in NC DC, the entire demand facility will be subject to all requirements in this regulation for the category to which the demand facility will belong after the change.
- b) For an existing transmission-connected demand facility that is subject to the requirements of NC DC, and which has been modified to such an extent that the facility's electrical and dynamic interaction with the transmission system is significantly changed, the entire demand facility will be subject to all requirements in this regulation for the category to which the demand facility will belong after the change.

(3) Appendix 1 lists definitions used in this regulation.

2. The requirements in this regulation apply to transmission-connected demand facilities in categories 3, 4 and 5, which are transmission-connected demand facilities established with a maximum demand capacity of less than 200 MW, and to transmission-connected demand facilities in category 7, which are transmission-connected demand facilities established with or changed to a maximum demand capacity of 200 MW or more.

(2) All requirements apply in the point of connection.

Part 2

Requirements for demand facilities in categories 3, 4, 5, and 7

3. Demand facilities in categories 3, 4, 5, and 7 must comply with the requirements set out in this part.

Active power control

4. The demand facility must have the capability to regulate active power.

(2) The capability to regulate active power must, as a minimum, comply with the following requirements:

- a) Active power must be regulated using a linear function or an approximate linear function actualised as a step function.
- b) The ramp rate for the upward and downward regulation must not exceed:
 - i. 20% of P_n per min. and
 - ii. 60 MW/min.

(3) The ramp rate requirement under subsection 2 above does not apply if other requirements apply to the supply of ancillary services or the activation of a required technical capability of the demand facility.

(4) System users must notify Energinet of the demand facility's minimum demand for active power at stable demand-facility operation and must notify Energinet without undue delay if this changes.

System protection

5. The demand facility must be equipped with system protection.

(2) As a minimum, the system protection must comply with the following requirements:

- a) The system protection must be capable of regulating the demand facility's active power demand according to one of several predefined tapping steps.
- b) It must be possible to configure the demand facility with at least five different configurable tapping steps.
- c) Regulation must commence within one (1) second and must be completed no later than ten (10) seconds after receiving a regulation order.

(3) The tapping steps are stipulated by Energinet according to the facility type and technology used, in coordination with the system user upon or after entering into a grid connection agreement and at the latest upon issue of an ION.

Voltage variations at energisation and connection

6. Upon energising and connecting a demand facility, the facility must have sufficient capability to limit voltage variations between the voltages before and after connection so that:

- a) voltage variations are limited compared with normal operating voltage
- b) voltage changes do not exceed the outer limits of the system operating voltage, continuous voltage, or temporary voltage.

(2) Demand facilities must limit the maximum static voltage jumps so that each time the facility components of the demand facility are energised, the change in static voltage levels is limited within the following intervals:

- a) normal operation +/- 3% of the previous operating voltage before connection
- b) special events +/- 4% of the previous operating voltage before connection. The scope of special events is assessed by Energinet in connection with an ION and included as part of the grid connection agreement before an FON is issued.

(3) During sequential energisation of multiple facility components, the requirement for static voltage jumps, cf. subsection 2, must be complied with for the change in operating voltage from before the first connection until after the last connection.

(4) Demand facilities must limit the maximum dynamic voltage dips so that each time the facility components of the demand facility are energised, the transient state is limited pursuant to the following requirement:

- a) The maximum dynamic voltage dips must, as a minimum, remain within the intervals indicated in Table 1 and shown in Figure 1.

Period [s]	Maximum permissible dynamic voltage dip [%]
0-0.1	-8
0.1-1	-6
1-∞	-4

Table 1. Maximum permissible dynamic voltage dip
(minimum requirement).

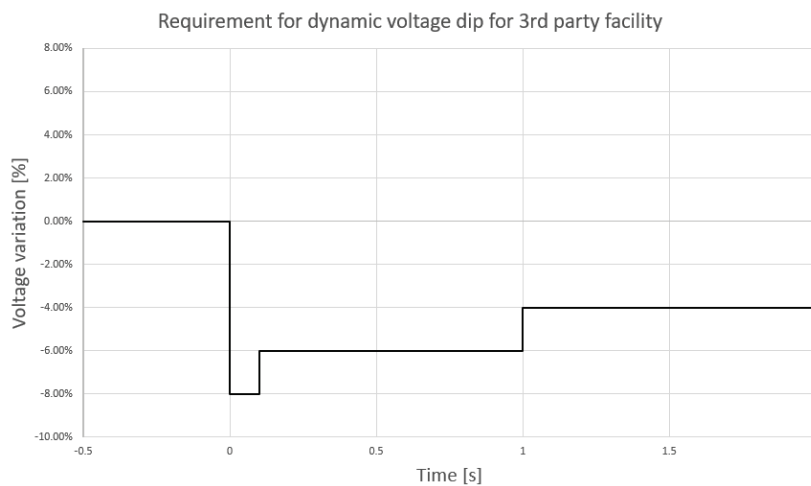


Figure 1. Maximum permissible dynamic voltage dip
(minimum requirement).

- b) Specifically, Energinet may set more stringent requirements than the minimum requirements for the maximum dynamic voltage dips specified in subsection 4(a), taking account of the specific circumstances at the point of connection
- c) Voltage must be measured in RMS, and it must be measured over an entire period and updated every half period as described in IEC 61000-4-30
- d) Compliance with the requirement must be evaluated on the basis of the phase-to-phase voltage or phase-to-earth voltage at which the greatest voltage change occurs
- e) Energinet stipulates the minimum short-circuit level at which the requirement must be complied with.

(5) In connection with energisation and connection, the demand facility must limit the interchange of reactive power wherever possible and transition as soon as possible to normal operation for reactive power regulation.

Zero-miss

7. To prevent the introduction of the zero-miss phenomenon into Energinet's circuit breakers, the system user, whose demand facility comprises equipment that must be energised through Energinet's circuit breakers, must document that the demand facility cannot introduce the zero-miss phenomenon into Energinet's circuit breakers. The documentation must include

electro-technological arguments showing why zero-miss cannot or will not occur in Energinet's circuit breakers. The documentation must be submitted to and approved by Energinet before an EON can be issued to the demand facility.

Point on wave

8. If Energinet assesses that there is a risk of the demand facility's transformers generating temporary overvoltages due to interaction with the transmission system which could damage Energinet's equipment, Energinet may demand controlled circuit breaker switching during the energisation of a transformer by equipping the demand facility's transformers with circuit breaker synchronisation (point on wave) for controlled connection. The controlled connection must be configured to minimise inrush current. The system user must inform Energinet about the size and type of the transformers without undue delay after becoming aware of this to allow Energinet to make the assessment.

Phase jumps

9. The demand facility must have robustness properties in the event of phase jumps in the point of connection.

(2) The robustness properties during phase jumps in the point of connection must as a minimum ensure that the demand facility remains connected to the transmission system in the event of immediate phase jumps in the system voltage of at least 20 degrees measured in the point of connection.

Part 3

Requirements for demand facilities in category 7

10. Demand facilities in category 7 must comply with the requirements set out in this part.

Undervoltage fault ride-through (UV-FRT)

11. The demand facility must be able to withstand a voltage dip (UV-FRT properties) without disconnecting from the connected transmission system.

(2) In the point of connection, the demand facility's UV-FRT properties must, as a minimum, meet the requirements specified in Table 2 and Figure 2 where current blocking under UV-FRT is allowed:

Voltage (pu)		Time (s)	
U_{ret}	0	t_{clear}	0.15
U_{clear}	0.35	t_{rec1}	0.15
U_{rec1}	0.35	t_{rec2}	0.55
U_{rec2}	0.90	t_{rec3}	1.5

Table 2 UV-FRT requirements.

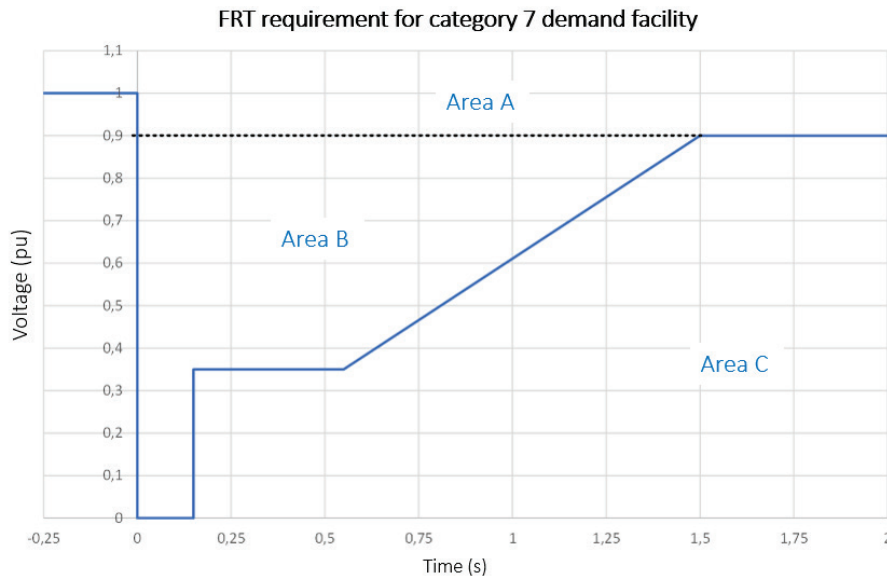


Figure 2 UV-FRT requirements. Area A is the normal operating range. Area B is where the demand facility must remain connected and where current blocking is permitted. Area C is where the demand facility may disconnect.

Post fault active power recovery (PFAPR)

12. The demand facility must be capable of automatically resuming operation after an incident in the connected electricity system and after normal operating conditions in the point of connection have been restored (PFAPR properties).

(2) The PFAPR properties must, as a minimum, comply with the following requirements:

- a) No later than five (5) seconds after normal operating conditions are restored in the point of connection, the demand facility must consume active power equating to at least 80% of the level immediately before the incident. However, a difference in the consumption of active power, before and after the incident, equating to 2% of the rated power of the demand facility, is allowed.
- b) No later than twenty (20) seconds after normal operating conditions are restored in the point of connection, the demand facility must consume active power equating to at least 90% of the level immediately before the incident. However, a difference in the consumption of active power, before and after the incident, equating to 2% of the rated power of the demand facility, is allowed.
- c) No later than thirty (30) seconds after normal operating conditions are restored in the point of connection, the demand facility must consume active power equating to at least 95% of the level immediately before the incident. However, a difference in the consumption of active power, before and after the incident, equating to 2% of the rated power of the demand facility, is allowed.
- d) During the transient start-up period, unintentional overshoot of the consumption of active power compared to before the incident must be limited so that the consumption of active power does not exceed the level before the incident by more than:
 - i. 10% of the rated power of the demand facility within the first five (5) seconds after the incident.
 - ii. 5% of the rated power of the demand facility within the first five (5) seconds after the incident and onwards.

- iii. If the rotating consumption is directly connected and caused by an inertia response, Energinet can allow an unintentional overshoot that exceeds Energinet's detailed specifications hereof.
- e) During the transient start-up period, regulation must lie above the lower curve defined by the points (T_1, P_1) , (T_2, P_2) , (T_3, P_3) and (T_4, P_4) , where the bottom curve is defined by line sections between these points. The points are:
 - i. $T_1 = 1$ second
 - ii. $T_2 = 5$ seconds
 - iii. $T_3 = 20$ seconds
 - iv. $T_4 = 30$ seconds
 - v. $P_1 = 0$
 - vi. $P_2 = 80\%$ of the pre-incident level
 - vii. $P_3 = 90\%$ of the pre-incident level
 - viii. $P_4 = 95\%$ of the pre-incident level.
- f) When evaluating demand after the incident, power limitations and voltage dependency in the demand facility can be taken into account. If the voltage returns to a level that is different from before the incident, a corresponding change in demand is accepted.
- g) Energinet may permit the initiation of PFAPR before the operating conditions are restored to continuous operation provided that the system user has demonstrated – by means of simulation using the instructions and in cooperation with Energinet – that this does not adversely affect voltage restoration in the point of connection following the fault.
- h)

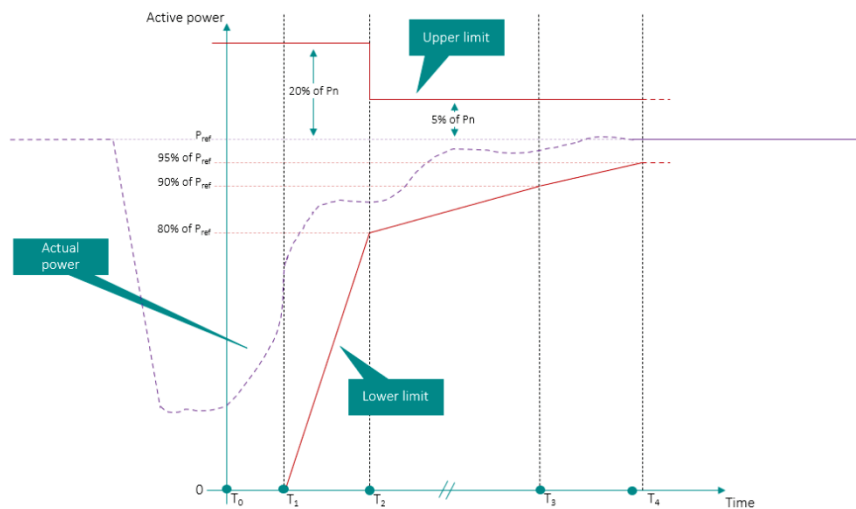


Figure 3 PFAPR requirements. T_0 is the time at which operating conditions in the point of connection have returned to the continuous operating range. T_1 is 1 second after T_0 . T_2 is 5 seconds after T_0 . T_3 is 20 seconds after T_0 . T_4 is 30 seconds after T_0 .

(3) If PFAPR is not technically achievable for process-related reasons, Energinet may permit, subject to Energinet's specifications of this, the installation of an additional load system in the demand facility that can be temporarily loaded until the demand facility is once again capable of using electricity.

Limited frequency sensitive mode – underfrequency (LFSM-U)

13. The demand facility must have the capability to decrease active power at a specified activation frequency, i.e. an autonomous LFSM-U response.

(2) The LFSM-U response must, as a minimum, comply with the following requirements:

- a) It must be possible to set the activation frequency within the range from 49.5 Hz up to and including 49.8 Hz.
- b) The LFSM-U response must be activated as soon as possible, without undue delay and no more than two (2) seconds after initiation.
- c) The decrease of active power must be 20% of the existing active power consumption, with a linear tolerance of +/- 10%.
- d) Reconnection of the consumption disconnected must take place three hundred (300) seconds after system frequency has been restored within the normal operating range.
- e) Frequency must be measured at a minimum accuracy of +/- 50 mHz.

Part 4

Exemptions

14. An existing or future system user may apply to Energinet for an exemption from parts or all of the requirements in this regulation.

(2) All of the following conditions must be met for an exemption to be granted:

- a) There must be special circumstances, or the system user must have entered into a final and binding agreement to purchase the main demand equipment.
- b) There must be a significant technical and/or socio-economic consideration.
- c) The exemption must not cause a significant deterioration in the technical quality or balance of the public electricity supply system – neither locally nor more broadly.
- d) The exemption must not lead to greater burdens on other companies.
- e) Any deviation must not be inexpedient from an economic viewpoint.

(3) Applications for exemption must be sent to myndighed@energinet.dk and must include a description of what is covered by the exemption and the reason(s) for applying, cf. subsection 2, a-e.

Part 5

Enforcement and sanctions

15. Energinet can issue an order to comply with this regulation to a participant that blatantly or repeatedly disregards its obligations under this regulation. In the event of failure to comply with an order, Energinet can decide to impose fines, or that the participant will be fully or partially excluded from using Energinet's services.

Part 6

Complaints, etc.

16. Complaints about the content of this regulation may be brought before the Danish Utility Regulator.

(2) Orders under section 11 may be appealed to the Danish Utility Regulator.

(3) Complaints about decisions made by Energinet pursuant to this regulation may be brought before the Danish Utility Regulator, cf. section 7(4) of the Executive Order on transmission system operation and the use of the electricity transmission grid, etc.

Part 7

Effective date

17. This regulation enters into force on 1 November 2024.

Appendix 1 – Terminology and definitions

The following definitions apply to this regulation:

- 1) 'EON' (energisation operational notification): an authorisation issued by the relevant transmission system operator (TSO) to the system user, the owner of a demand facility, a distribution-system operator or the owner of an HVDC system, authorising such user, operator or owner to energise a generation facility, a demand facility, a distribution system or an HVDC system, as the case may be, using the grid connection.
- 2) 'ION' (interim operational notification): an authorisation issued by the relevant transmission system operator (TSO) to the system user, the owner of a demand facility, a distribution-system operator or the owner of an HVDC system, authorising such user, operator or owner to operate a generation facility, a demand facility, a distribution system or an HVDC system, as the case may be, using the grid connection for a limited period of time and to initiate compliance tests to ensure that the relevant specifications and requirements are met.
- 3) 'system user': a natural or legal person that supplies electricity or is supplied with electricity from a transmission system.
- 4) 'point of connection' (POC): the point in the public electricity supply system to which the demand facility is or can be connected, determined by the relevant TSO.
- 5) ' U_{rec} ' and ' T_{rec} ': the lower limits for restoration of voltage after rectification of a fault.
- 6) ' U_{ret} ': the remaining voltage in the point of connection during a fault.
- 7) ' T_{clear} ': the moment at which the fault has been rectified.