European Network of
Transmission System Operators
for Electricity

entsoe

Making non-mandatory requirements at European level mandatory at national level

ENTSO-E Guidance document for national implementation for network codes on grid connection

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Description	
Code(s) & Article(s)	All Connection Network Codes (RfG, DCC and HVDC) Articles with requirements, which are not mandatory at pan-European level but entitle the relevant entity to make a decision whether to introduce these requirements either for general application on national level or as a site-specific choice.
Intro-duction	The objective is to give guidance on how to proceed, when deciding if a non-mandatory requirement should be made mandatory in a specific country where the need for this requirement can be demonstrated, and a) Which requirements this choice applies to b) What system characteristics or other factors are relevant to this choice.
NC frame	Key national determining factors for introducing a requirement, which is not mandatory at European level, among others could be: • maintain those requirements, which already exists from previous national regulations and have proven their need and benefit through operational experience in normal and emergency network situations • national generation portfolio characteristics (e.g. level of penetration of renewable energy sources) • national system characteristics (e.g. rural/urban conditions, density of load and generation) A non-mandatory requirement can be made mandatory in a specific country at any point in time after applicability of the relevant CNC. Any detail of the implementation of such a requirement at national level, including approval by the designated entity, will be determined by the respective national implementation process (Article 7 of NC RfG, Article 6 of NC DCC, and Article 5 of NC HVDC). For some requirements the introduction of the capability/functionality as such on national level is a general decision. However, the precise parameters may need to be selected and specified individually for each site, to adequately reflect local conditions. For other requirements the opposite may apply. The decision to have a requirement can be site-specific, but if it is requested a set of definite parameters shall be applied. Non-exhaustive parameters for any requirement may be varied across different types of significant grid users. Similarly non-exhaustive parameter requirements may be applied regionally. In both cases of varying applications, these need to be justified, comply with the network codes and do not lead to rules that would contradict the network codes. In the CNCs, non-mandatory requirements typically use phrases like: • … shall have the right to require … • … may request .. • … can define …, etc.
Further info	Annex I provides an overview on the relationship between mandatory/non-mandatory and

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	exhaustive/non-exhaustive requirements. Annexes II – IV list the non-mandatory requirements of all connection network codes, whose implementation is subject to a decision at the national level.
Interdependencies	
Between the CNCs	Many aspects are shared between the three CNCs RfG, DCC and HVDC, i.e. technical capabilities of the entities addressed by each of these CNCs have the same objective, for example maintaining frequency, voltage and rotor angle stability. Therefore introducing mandatory measures to overcome challenges should be consistent across the three CNCs bearing in mind the different scope of application of these Codes.
With other NCs	There are many links to the implementation of those codes, which shall apply the connection capabilities in both system and market operation (SOC and MC topics), which need to be taken into account during national implementation of the connection codes. In some cases these topics will at national level be contained in combined documents (e.g. broader content Grid Codes). Consistency needs to be maintained in these cases and it may be necessary to coordinate the application of these requirements with system and market operation codes.
System characteristics	System characteristics are expected to change continuously, e.g. from major changes in generation technologies and their electrical characteristics, such as greater proportion delivered via power electronics with consequent implications on system strength. The speed of such change may be different in single countries, e.g. due to differing ambitions of political objectives like levels of penetration of renewable energy sources. Accordingly the need to make requirements mandatory may vary or be phased in differently, in particular if these requirements are relevant for systems with a large penetration of non-synchronous generation. However the need case may not be determined entirely by development in your own country but rather such developments in other countries need to be observed as well. In this context, it is recommended to consider for national implementation the expected changes in network needs over the next 15-20 years, the likely minimum life time of new connections. Implementation of later changes in national requirements affecting the connections already made will be subject to rules for retrospective implementation. The IGD on Guidance on CBA provides general guidance on CBAs including retrospective actions.
Technology characteristics	Technology is constantly changing and hence also characteristics including basic capabilities of users' facilities connected to networks change. When considering the need for non-mandatory requirements, a mutual understanding of technology characteristics is essential. Special care is required to ensure national choices during implementation are realistic and can be made available. Hence, national choices shall not shy away from challenging technical developments on equipment, but needs to respect technical limitations. Care needs to be taken when considering requirements for technical capabilities such that they do not read as one technology is either discriminated against or preferred.
Collaboration	

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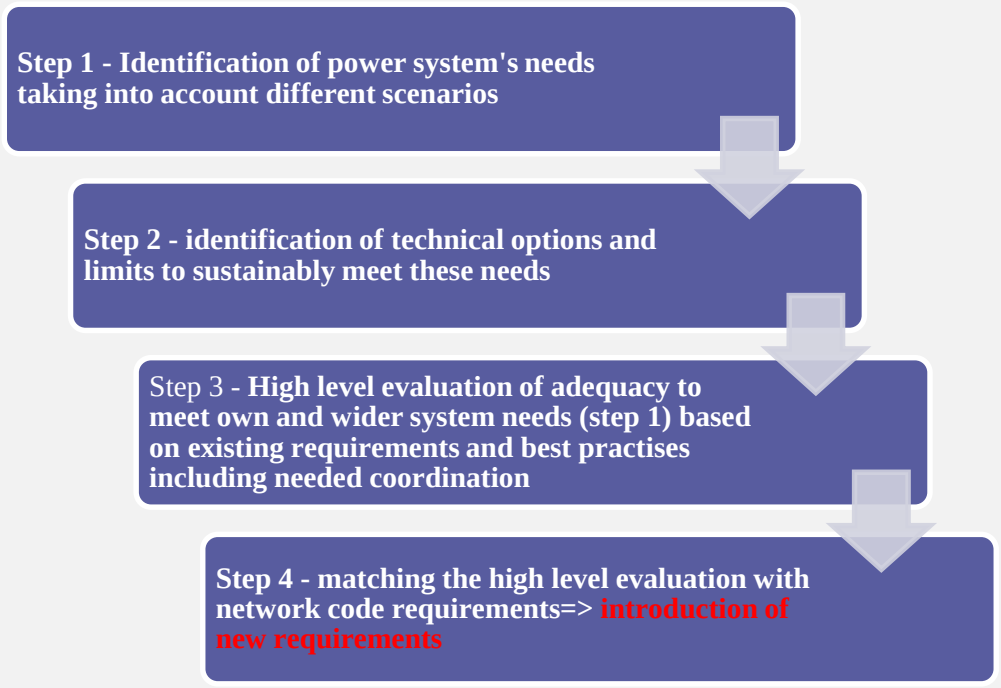
Methodology principles recommended for making non-mandatory requirements mandatory	As the case may be, system studies can help to demonstrate the need of specific requirements and the benefits from its introduction. Such studies shall clearly define the scope of the investigation, the applied methodology, and the underlying assumptions on system conditions and parameters. They are typically governed by the relevant network operator /TSO, often in cooperation with research institutes. Relevant stakeholders (manufacturers, grid users) shall typically provide essential input to such studies, for example technical characteristics and performance parameters of their installations, without which profound results would not be achievable. 
TSO – TSO	When forming the decision on making a non-mandatory requirement mandatory at national level, collaboration with other TSOs may be taken into consideration where it is reasonable. The reasonable extent of such collaboration depends on the physical effects of a specific requirement at stake. For example, frequency-related issues typically should be coordinated at synchronous area level. Collaboration on consistent application of requirements will not necessarily result in equal values and/or parameters to be applied, but may reasonably focus on the use of consistent criteria.
TSO – DSO	Collaboration of connection network codes requirements between TSOs and DSOs, in particular within the TSO's control area is important. However, this is subject to DSO involvement in national implementation as required by Article 7(3)(e) of NC RfG, Article 6(3)(e) of NC DCC, Article 5(3)(e) of NC HVDC. It is recommended to TSOs and DSOs to engage with each other at an early stage of national implementation already to explore interdependencies and possible impacts on transmission and distribution systems.
RSO – Grid User	Collaboration on connection network codes requirements between system operators and grid users is crucial. In context of this IGD, an important aspect is to provide reasoned arguments, why a non-mandatory requirement has been selected for implementation. Such justification shall explain the rationale behind the choice, i.e. the technical background and possible options to solve the issue, in a transparent

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	manner. This is subject to grid users' involvement, typically through respective associations in national implementation procedures. It is recommended to system operators to engage with grid users at an early stage of national implementation already to raise awareness on system engineering aspects and inform about system challenges. Early involvement supports transparency of the implementation processes and helps to mitigate concerns about discretionary decisions during implementation. It enables stakeholders to contribute actively to solutions and to make use of their expertise, e.g. manufacturers' knowledge about technical capabilities and constraints of certain technologies. Factual discussions on technical / procedural challenges based on expertise and best practice are thus facilitated.

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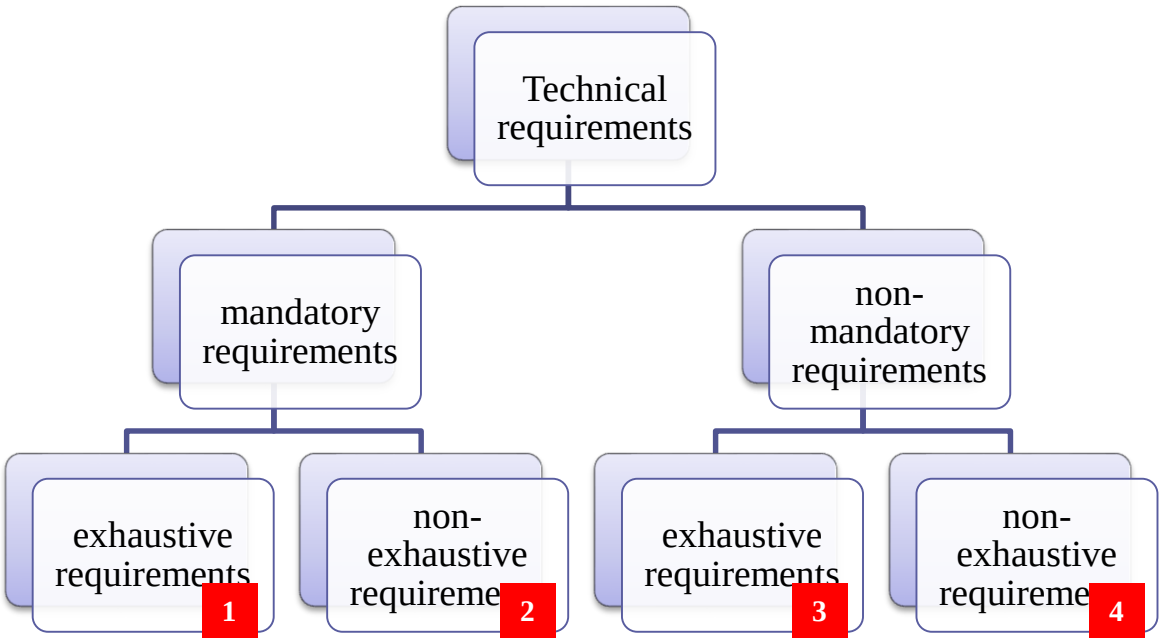
Annex I: Relationship between mandatory/non-mandatory and exhaustive/non-exhaustive requirements



Definitions:

Mandatory requirement: Requirement shall be applied in all EU Members States and other countries, which implement connection network codes

Non-mandatory requirement: Each EU Member States and other country, which implements connection network codes can make a decision whether to introduce such a requirement either in general on national level or as a site-specific choice

Exhaustive requirement: Requirement needs no further national specifications (e.g. parameters) for its entire application

Non-exhaustive requirement: Requirement needs further national specifications (e.g. parameters) for its entire application in general on national level or as a site-specific choice

Examples from NC RfG

Mandatory + exhaustive requirement:

Article 16 (2) (a) (i): Voltage Ranges[1]

Type D power-generating modules shall fulfil the following requirements relating to voltage stability:

[1] except for those voltage ranges where TSOs shall still specify the time period for operation

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With regard to voltage ranges:

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

Mandatory + non-exhaustive requirement:

Article 14 (3) (a): Fault-ride-through capability

Type B power generating modules shall fulfil the following requirements in relation to robustness:

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

(i) each TSO shall specify a voltage-against-time-profile in line with Figure 3 at the connection point for fault conditions, which describes the conditions in which the power generating module is capable of staying connected to the network and continuing to operate stably after the power system has been disturbed by secured faults on the transmission system;

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

(iii) the lower limit referred to in point (ii) shall be specified by the relevant TSO using the parameters set out in Figure 3, and within the ranges set out in Tables 3.1 and 3.2;

(iv) each TSO shall specify and make publicly available the pre-fault and post-fault conditions for the fault-ride-through capability in terms of:

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

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

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

(v) at the request of a power generating facility owner, the relevant system operator shall provide the pre-fault and post-fault conditions to be considered for fault-ride-through capability as an outcome of the calculations at the connection point as specified in point (iv) regarding:

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

pre-fault operating point of the power generating module expressed in active power output and reactive power output at the connection point and voltage at the connection point; and

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

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

…

Non-mandatory + exhaustive requirement:

Article 16 (2) (a) (iii): Voltage Ranges in Spain

notwithstanding the provisions of point (i), the relevant TSO in Spain may require power generating modules be capable of remaining connected to the network in the voltage range between 1.05 pu and 1.0875 pu for an unlimited period

Non-mandatory + non-exhaustive requirement:

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Article 13 (1) (a) (ii): wider frequency ranges

the relevant system operator, in coordination with the relevant TSO, and the power generating facility owner may agree on wider frequency ranges, longer minimum times for operation or specific requirements for combined frequency and voltage deviations to ensure the best use of the technical capabilities of a power generating module, if it is required to preserve or to restore system security

Annex II: RfG non-mandatory requirements

The classification of requirements and parameters as general (G) or site specific (S) as suggested in this annex is indicative for the sole purpose of proving non-binding guidance for implementation, without prejudice to the classification to be made at the national level.

Reference Article	Requirement	General (G) or site specific (S) decision on introduction at national level	
		Requirement as such	Parameters
6 (3)	Industrial site - conditions for disconnection of generating modules with critical loads	S	S
13 (1) (a) (ii)	wider frequency ranges	S	S
13 (2) (b)	disconnection at randomized frequencies	G	S
13 (2) (f)	minimum regulation level of LFSM-O	S	-
13 (6)	remote control of active power output	S	-
14 (2) (b)	remote control of active power output	S	-
15 (2) (d) (iv)	shorter initial FSM response delay for PGMs without inertia	G	S
15 (5) (a) (ii)	quotation for providing black-start capability[2]	S	G/S
15 (5) (b)	capability of island operation	S	G/S
15 (6) (b) (i)	definition of quality of supply parameters	S	G/S
15 (6) (c) (i)	provision of simulation models	G	S
15 (6) (c) (iv)	recordings of PGM performance	S	G/S

[2] black start capability is not mandatory without prejudice to the Member State's rights to introduce obligatory rules in order to ensure system security

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15 (6) (d)	additional devices for secure system operation	S	S
16 (2) (a) (ii)	shorter times of operation for simultaneous low voltage and high frequency	G	S
16 (2) (a) (iii)	voltage ranges in Spain	G	G
16 (2) (a) (v)	voltage ranges in Baltic states	G	G
16 (2) (b)	wider voltage ranges and longer minimum times of operation	S	S
16 (2) (c)	voltage thresholds for automatic disconnection	S	S
17 (2) (a)	reactive power capability for synchronous PGMs	G	S
18 (2) (a)	supplementary reactive power compensation for HV connecting line of synchronous PGMs	G	S
20 (2) (a)	reactive power capability of PPMs	G	S
20 (2) (b)	fast fault current injection by PPMs	G	S
20 (2) (c)	asymmetrical fault current injection by PPMs	G	S
21 (2)	synthetic inertia capability of PPMs	G	S
21 (3) (a)	supplementary reactive power compensation for HV connecting line of PPMs	G	S
21 (3) (f)	power oscillations damping by the power park module	G	S
25 (2)	offshore voltage ranges in Spain	G	G
25 (3)	offshore voltage ranges in Baltic states	G	G

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Annex III: DCC non-mandatory requirements

The classification of requirements and parameters as general (G) or site specific (S) as suggested in this annex is indicative for the sole purpose of proving non-binding guidance for implementation, without prejudice to the classification to be made at the national level.

Reference Article	Requirement	General (G) or site specific (S) decision on introduction at national level	
		Requirement as such	Parameters
12 (2)	wider frequency ranges	S	S
13 (4)	voltage ranges in Spain	G	G
13 (5)	voltage ranges in Baltic states	G	G
13 (6)	voltage thresholds for automatic disconnection	S	S
15 (1) d)	use of other metrics than power factor to set out reactive power capability ranges	G	G
15 (2)	Prohibition to export reactive power at an active power flow of less than 25% of the maximum import capability	G	S
15 (3)	active control of TSO-DSO reactive power exchange by the DSO	G	S
15 (4)	consideration of distribution system for TSO reactive power management	S	S
19 (1) (a)	contribution of transmission-connected demand facilities to low frequency demand disconnection	G	S
19 (1) (a)	use of combination of frequency and RoCoF thresholds for low frequency demand disconnection	G	G
19 (2) (a)	low voltage demand disconnection of transmission-connected distribution facilities	S	S
19 (2) (b)	low voltage demand disconnection of transmission-connected demand facilities	S	S
19 (2) (c) and (d); **19 (3)**	on-load tap changer blocking	G	S

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19 (4) (c)	remote disconnection of transmission-connected demand facilities or transmission-connected distribution facilities	G	G
21 (2)	provision of simulation models	G	S

Annex IV: HVDC non-mandatory requirements

The classification of requirements and parameters as general (G) or site specific (S) as suggested in this annex is indicative for the sole purpose of proving non-binding guidance for implementation, without prejudice to the classification to be made at the national level.

Reference Article	**Requirement**	**General (G) or site specific (S) decision on introduction at national level**	
		Requirement as such	**Parameters**
11 (2)	wider frequency ranges	S	S
11 (4)	maximum active power reduction at low frequencies	G	G
13 (1) (a) (i)	transmitted active power adjustment step size	G	S
13 (1) (a) (ii)	minimum active power transmission capacity	G	S
13 (1) (c)	fast active power reversal	G	G
13 (3)	automatic remedial actions	S	S
14	synthetic inertia	G	S
16 (1)	frequency control	S	S
18 (2)	wider voltage ranges and longer minimum times of operation	S	S
18 (5)	voltage ranges in Baltic states	G	G
19 (1)	fast fault current injection in case of symmetrical faults	G	S
19 (3)	fast fault current injection in case of asymmetrical faults	G	S
25 (4)	active and reactive power blocking	S	S

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25 (5)	narrower settings of undervoltage protection	S	S
29 (1)	requesting studies on HVDC systems interaction	S	S
29 (7)	transient performance levels in case of events with interaction/impact on other equipment	S	S
37 (1)	black start capability	S	S
38	Articles 13 - 22 of RfG as far as applicable to offshore PPMs according to Chapter 4 of RfG	as of RfG	as of RfG
39 (2) (b)	wider frequency ranges or longer minimum times of operation of DC-connected PPMs	S	G
39 (c)	automatic disconnection at specified frequencies	G	S
40 (1) (b)	wider voltage ranges or longer minimum times of operation of DC-connected PPMs	S	S
40 (1) (c)	voltage thresholds for automatic disconnection of DC-connected PPMs	S	S
40 (2) (b) (ii)	supplementary reactive power compensation for HV connecting line of PPMs	S	S
47 (2)	Provision of network frequency signal at the remote-end HVDC converter	S	S
48 (1) (b)	wider voltage ranges or longer minimum times of operation at the remote-end HVDC converter	P	S
51 (4)	quality of information exchange signals	G	S
53 (2)	definition of quality of supply parameters	G	G/S
54 (1)	provision of simulation models	G	S
54 (4)	recordings of HVDC system performance	S	G/S
54 (5)	provision of HVDC system control system models	G	S

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