European Network of
Transmission System Operators
for Electricity

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Connection Network Codes – Introduction to the public consultation of Implementation Guidance Documents

- Introduction -

26 March 2018

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1. Introduction

Overview of connection codes

The European Connection Network Codes - Requirements for Generators (RfG), Demand Connection Codes (DCC) and High Voltage Direct Current Connections (HVDC) – have been developed in accordance with Regulation (EU) 714/2009 and are cornerstones to fulfil the third energy package.

The first connection network code, which entered into force on 17 May 2016, is the Commission Regulation (EU) 2016/631 of 14. April 2016 establishing a network code on requirements for grid connection of generators (RfG). The Commission Regulations on DCC and HVDC followed after that - (EU) 2016/1388 of 17. August 2016 establishing a network code on demand connection (DCC), entering into force on 18 August 2016, and 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 (HVDC), entering into force on 8 September 2016 respectively.

In order to support the implementation of network codes at national level, and as required by the codes, ENTSO-E has produced non-binding guidance on implementation, which are also consulted by the stakeholders. This guidance is provided through so-called Implementation Guidance Documents (IGDs).

Legal background for IGDs

Commission Regulation (EU) 2016/631 of 14 April 2016 establishing a network code on requirements for grid connection of generators (RfG), (Article 58), Commission Regulation (EU) 2016/1388 of 17. August 2016 establishing a network code on demand connection (DCC) (Article 56) and 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 (HVDC) (Article 75) – Non-binding guidance on implementation - stipulate:

1. *No later than six months after the entry into force of this Regulation, the ENTSO for Electricity shall prepare and thereafter every two years provide non-binding written guidance to its members and other system operators concerning the elements of this Regulation requiring national decisions. The ENTSO for Electricity shall publish this guidance on its website.*
2. *ENTSO for Electricity shall consult stakeholders when providing non-binding guidance.*
3. *The non-binding guidance shall explain the technical issues, conditions and interdependencies which need to be considered when complying with the requirements of this Regulation at national level.*

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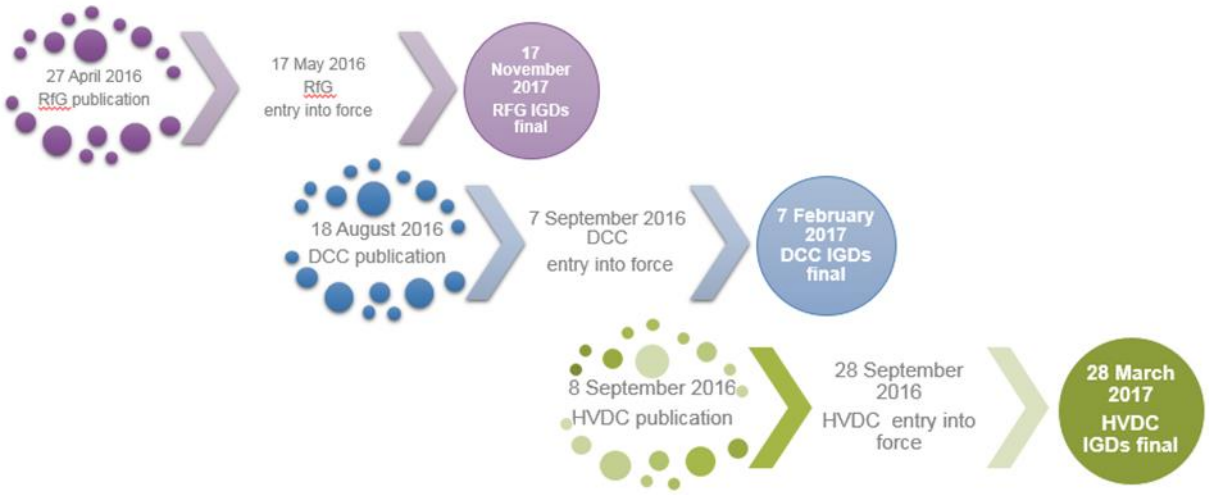

Figure 1: Timeline of adoption of connection network codes and deadlines for publishing different sets of IGDs.

Objectives of IGDs

The main objective of the implementation guidance is to support system operators in the process of determination on national level of non – exhaustive requirements during the national implementation. The objectives of the implementation guidance documents are:

- to facilitate a common understanding of technical issues specified in the connection network codes, in context of new technologies and new requirements (e.g. synthetic inertia)
- to deliver broader explanations and background information and to illustrate interactions between requirements,
- to recommend coordination/collaboration between network operators (TSO) where either explicitly required by the connection codes or reasonably exercised from a system engineering perspective,
- to give guidance to national specifications for non-exhaustive requirements, and
- to express the need of further harmonisation beyond what is requested by the CNCs when reasonable from a system engineering perspective.

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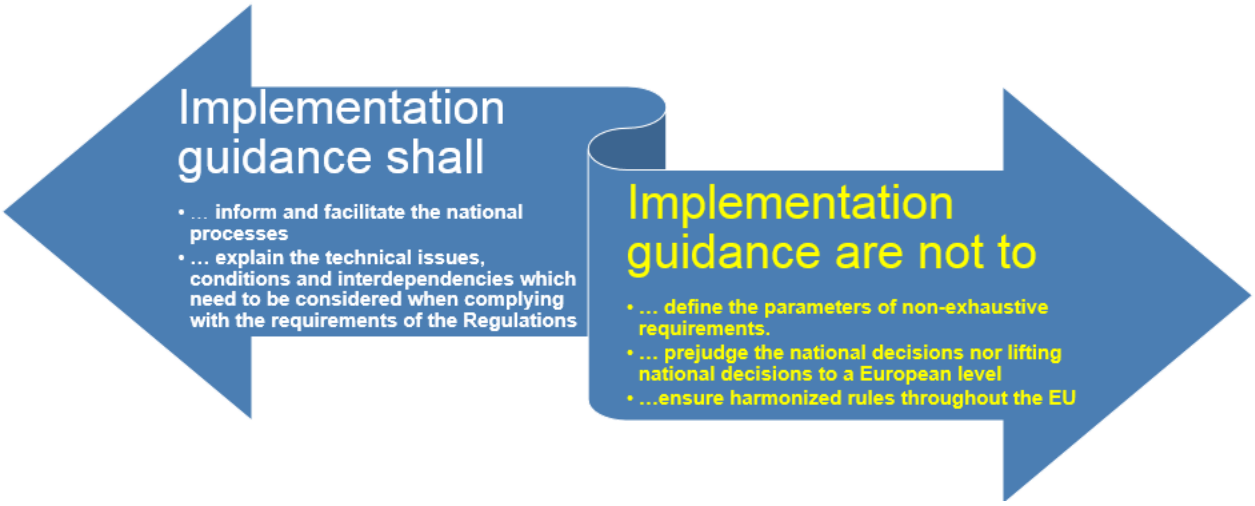

Figure 2: Scope of IGDs

Target audiences

IGDs are written for TSO staff who works and applies different connection codes.

How have IGDs been drafted?

The IGDs were drafted by ENTSO-E experts taking account of the input received from stakeholders during the process as follows:

- 23 September 2015 workshop - stakeholders were informed of the intent to draft IGDs and gave their initial views on how they saw this being accomplished. They wished to be strongly involved in the process. Consequently ENTSO-E organised ahead of the entry into force of the codes:
- A survey on Stakeholders' priority issues for IGDs. This survey took place between 25 December 2015 and 22 January 2016. As a result ENTSO-E has taken on board further topics for IGDs. The outcomes of the survey were presented in the workshop on 29 February 2016.
- A public stakeholder workshop on 29 February 2016 with the objective of defining the content of IGDs to address each of the priority issues previously identified. The outcomes can be accessed on the event site.
- 1 July – 15 August 2016 – ENTSO-E publishes draft IGDs for consultation from the RfG perspective. The comments received supported the update of the IGDs which ENTSO-E published on 17 November 2016 according to the RfG regulation.
- A public stakeholder workshop on 13 September 2016 aimed at checking the ENTSO-Es understanding of the stakeholders' consultation comments and to gather additional feasible suggestions.
- 8 December 2016 – 16 January 2017 - consultation of the updated IGDs from the DCC and HVDC perspective. The outcomes of this second consultation further enhanced the IGDs and ENTSO-E published these new/updated IGDs on March 8.

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- Regular input and updates from stakeholders on their expectations for the IGDs and regular updates on the next steps within the European Connection codes Stakeholder committee.

The IGDs were drafted from a topic perspective and therefore most of them cover more than one connection code simultaneously.

ENTSO-E experts have committed to proceed to the drafting of new IGDs or to improve the current ones in order to support the process of implementation of all the NCs.

Similar process regarding stakeholder involvement and consultations is followed for any new or updated IGDs that is produced beyond the legally required period of 6 months.

ENTSO-E has already conducted a public consultation for a set of four IGDs (one new and three updates) in April 2017 and recently again on 5 new and 3 updated IGDs on frequency related parameters - February 2018.

2. Implementation Guidance Documents on HVDC related topics

ENTSO-E has prepared the consultation in a transparent and open manner.

The current IGD consultation is scheduled as follows:

26 March 2018 – 4 May 2018 – ENTSO-E publishes three (3) draft IGDs for consultation. The comments received will support the finalization of the IGDs.

If applicable, please use the line numbering to indicate the specific passage of the IGD while introducing the comments.

3. List of Implementation Guidance Documents on HVDC related topics

Style of IGDs

The IGDs were developed in an easy to read and short format and focus on the most relevant information. The IGDs include information on the legal framework (Codes & Articles), objectives of the IGDs, interdependencies between/in the codes, system and technology characteristics, further information, and recommendations on collaboration between the system operators at different levels and between them and grid users.

List of IGDs

No	Title of IGD	Status	Short description
1	Embedded HVDC systems – frequency schemes in case of system split	New	NC HVDC Article 15 requires that the HVDC systems shall be capable of regulating by means of automatic control their active power as a function of the deviation of frequency from its nominal value measured at its connection point when operating in Frequency Sensitive Mode (FSM), Limited Frequency Sensitive Mode-Underfrequency (LFSM-U) or Limited Frequency Sensitive Mode-Overfrequency (LFSM-O). These requirements were designed consistently to the corresponding requirements for power generating modules by

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			NC RfG with the aim of achieving similar response from power generating modules and HVDC systems in case of system frequency deviations, as well as the same mechanism for reserves sharing. The interpretation of the FSM, LFSM-O and LFSM-U requirement is obvious for power generating modules that have only one connection point to which the active power frequency response in case of a frequency deviation shall apply. However, in case of HVDC systems the interpretation may not be so clear: the capability to provide active power frequency response is a relevant feature for HVDC systems connecting different synchronous areas, which are not connected to each other by AC lines, and therefore do not share the same frequency. In this situation, the HVDC system can provide support to one synchronous area, which suffers a frequency deviation, by increasing/decreasing the active power infeed/offtake. This active power regulation of the HVDC system providing support to one synchronous area has an immediate impact on the frequency of the other synchronous area, which then needs to be compensated by active power frequency response of generators in that area. This capability of HVDC systems was therefore conceived to be a mean to share frequency reserves across synchronous areas. However, if an HVDC system is located within a single synchronous area, i.e. the HVDC system is embedded in one control zone or area according to Article 3.1 c) and d) of Regulation (UE) 2016/1447, the FSM and LFSM-O/-U features are not needed in normal operation, without prejudice that these control functions may be useful in case of system splits after which each HVDC terminal resides in a different frequency zone of the split synchronous area. This IGD aims at clarifying the possible settings of the frequency control functionality for HVDC systems embedded in a synchronous area and recommending its configuration. In addition, the IGD addresses the need for coordination of the frequency control function with additional control functions which aim at guaranteeing the robustness of the control functions and contributing to system security.
2	HVDC systems default parameters	New	This document addresses the need from TSOs in countries that are mandated to implement the EU regulation for HVDC systems, but do not intend to establish an HVDC system in the short and mid-term planning period. It provides a list of the minimum set of requirements for an HVDC system and a guidance with the recommended default parameters for the non-exhaustive requirements to be applied when implementing the EU regulation.

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			The document includes a list of recommended parameter values and selection ranges for the minimum set of parameters to be specified based on current European practice with HVDC systems.
3	Interactions between HVDC systems and other connections	New	This document addresses the increasing concern regarding potential interactions associated with HVDC systems. In addition, the document provides guidance on the analysis needed to be undertaken in order to identify possible interactions between HVDC systems and other grid connected equipment. The main areas to be analysed in details are namely: • harmonic interactions between the network and the HVDC systems; • resonances between other HVDC systems or synchronous generators and equipment (e.g., Closed-Cycle Gas Turbine, series compensation and wind turbine); and sub synchronous oscillation or sub-synchronous torsional interactions between HVDC systems and generator shafts nearby as well as control interactions between different converter based modules. It is very important to keep in mind that the interaction between a HVDC system with the grid, should be analysed not only for the existing grid elements and planned projects, but also taking into account the long term plans that will take place in the life-time of the HVDC system [7]. The TSO has the task to specify the set of relevant studies required in Art. 29 (interactions between HVDC converter stations, or HVDC converter stations and other plants and equipment) and Art. 31 (sub-synchronous torsional interactions) of NC HVDC [2], relevant for the studies related to the equipment and relevant system conditions in the network system and securing exchange of all related information according to Art 51 (Information exchange and coordination). The studies according to Art. 29 and 31 shall be provided by the HVDC system owner, unless Member States provide that the responsibility for the studies lies with the TSOs. In any case, the TSO shall assess the result of the studies based on their scope and extent, and may request additional studies if necessary. The TSOs may also review and replicate some part or all of the studies. In this case the HVDC system owner shall provide to the relevant TSO all necessary models and data that are adequate to perform the predefined studies. The study required by Art. 29 of NC HVDC shall identify the conditions, if any, where potential adverse interactions exists

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			and propose possible necessary mitigation actions. Mitigating actions shall be reviewed by the TSO. It is understood that the TSO's review should cover completeness, robustness and adequacy of the mitigation action(s). Finally, it is of high importance that the relevant TSO shall continuously monitor the performance of the HVDC system (Art. 53). This is vital to identify the upcoming interactions due to grid development and to reduce the risks of uncertainties.

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