ENTSO-E Connection Codes Implementation Guidance Documents_Frequency Stability Parameters

Overview

Europe currently has three connection network codes: Requirements for generators (RfG), Demand Connection (DCC) and High Voltage Direct Current (HVDC). RfG has entered into force on 17 May 2016, the DCC on 18 August 2016 and the HVDC on 8 September 2016.

The Member States have the obligation to implement these codes no later than three years after their entry into force. Within this timeframe the Member states have 2 years to define the national specifications for the so-called non-exhaustive requirements.

In order to support the implementation at national level and also in line with the legal requirements of these network codes ENTSO-E has drafted and when necessary improved non-binding implementation guidance documents (IGDs), eight of which we currently put forward for consultation.

These guidance documents are primarily addressed to the transmission system operators and other system operators concerning the elements of the codes requiring national decisions. They shall explain the technical issues, conditions and interdependencies which need to be considered when complying with the requirements of these Regulations at national level.

The current IGDs consultation is scheduled as follows:

20 November 2017 – 21 December 2017 – ENTSO-E publishes **eight (8) draft IGDs** for consultation – **six (6) new** and **two (2) updates** (please see the list below). The comments received will support the finalisation of the IGDs.

The IGDs have been developed after extensive internal coordination with regional groups and system operation expertise.

In additional a public survey to manufacturers and other stakeholders was conducted as well as three public workshops:

- **1st Public Workshop**: **Workshop on the connection codes frequency parameters** *<https://www.entsoe.eu/news-events/events/Pages/Events/2017-03-09-cnc-freq.aspx?EventWorkshopId=283>*

- **2nd Public Workshop: 2nd Workshop on the connection codes frequency parameters** *<https://www.entsoe.eu/news-events/events/Pages/Events/2017-07-20-cnc-freq.aspx?EventWorkshopId=317>*
- **3rd Public Workshop: 3rd Workshop on the connection codes frequency parameters** *<https://www.entsoe.eu/news-events/events/Pages/Events/%E2%80%8B%E2%80%8B%E2%80%8B%E2%80%8B3rd-Workshop-on-the-connection-codes-frequency-parameters.aspx?EventWorkshopId=332>*

All the above have been in respect to the **Roadmap** *<user_uploads/roadmap-to-complete-the-igds-on-frequency-stability-requirements.pdf>* that ENTSO-E prepared in March 2017.

More information can be read **here** *<user_uploads/171120_cnc_igds_introduction-document.pdf>* .

A preview of all the questions in this consultation can be accessed here.

The IGDs under consultation are listed below and can be downloaded from the following **link** *<user_uploads/igds-freq.stab.parameters.zip>* .

1. **Frequency Sensitive Mode**
2. **Limited Frequency Sensitive Mode**
3. **Demand Response - System Frequency Control**
4. **Frequency Ranges**
5. **Maximum Admissible Active Power Reduction at Low Frequencies**
6. **Automatic (re-)connection and Rate of Change of Active Power**
7. **Rate of Change of Frequency Withstand Capability (RoCoF)**
8. **Need for Synthetic Inertia for Frequency Regulation**

Why we are consulting

ENTSO-E is consulting the IGDs for three main reasons:

1. Although the main addressees of the IGDs are the system operators, the connection codes have a significant impact on manufacturers, power generating module operators, demand facilities and distribution networks.
2. The IGDs are drafted as supporting material for the connection codes implementation at the member state level and shall aim to give guidance for national specifications for non-exhaustive requirements.
3. The IGDs are legally requested to be consulted with stakeholders before their release within the six month of the entry into force of the Regulations.

Introduction

1 What is your name?

Name

2 What is your email address?

If you enter your email address then you will automatically receive an acknowledgement email when you submit your response.

Email

3 What is your organisation?

Organisation

Frequency Sensitive Mode IGD

Frequency Sensitive Mode (or 'FSM') means the operating mode of a power-generating module or HVDC system in which the active power output changes in response to a change in system frequency, in such a way that it assists with the recovery to target frequency.

The objective of this guidance document is to help to determine the main criteria/motivation for the specifications of the FSM capabilities of power generating modules at national level.

For adequate specifications of the relevant parameters it is essential to be aware of the objective of the FSM functions and to understand how it interacts with other frequency stability requirements.

For each synchronous area, proposals for national choices for the non-exhaustive FSM parameters are provided through this IGD.

The IGD can be found **here** <*user_uploads/1---igd-on-fsm.pdf*> .

1 Do you consider this IGD helpful to reasonably support the national implementation process? (Please select only one item)

Please select all that apply

☐ yes ☐ no

2 Does the content of the IGD cover the technical issues of this topic appropriately? (Please select only one item)

Please select all that apply

☐ yes ☐ no

3 Comments on the technical information within this IGD

4 General (other) comments

Limited Frequency Sensitive Mode

The objective of this guidance document is to help to determine the main criteria/motivation for the specifications of the limited frequency sensitive mode capabilities of power generating modules at national level.

Limited frequency sensitive mode at overfrequency (LFSM-O) is to be activated, when the system is in an emergency state of overfrequency and all frequency containment reserves (FCR) in negative direction have already been deployed.

Limited frequency sensitive mode at underfrequency (LFSM-U) is to be activated, when the system is in an emergency state after of underfrequency and all frequency containment reserves (FCR) in positive direction have already been deployed.

For adequate specifications of the relevant parameters it is essential to be aware of the objective of the LFSM-O/-U functions and to understand how it interacts with other frequency stability requirements and assumptions for a system defence plan.

In order to implement comprehensively the LFSM-O/-U capabilities this implementation guidance may go beyond the explicit requests of NC RfG and will also make recommendations on further parameters, which are not addressed in this network code, but are nonetheless relevant to ensure an adequate performance of these features.

For each synchronous area, proposals for national choices for the non-exhaustive LFSM-O/- U parameters are provided through this IGD.

The IGD can be found **here** *<user_uploads/2---igd-on-lfsm.pdf>*

1 Do you consider this IGD helpful to reasonably support the national implementation process? (Please select only one item)

Please select all that apply

☐ yes ☐ no

2 Does the content of the IGD cover the technical issues of this topic appropriately? (Please select only one item)

Please select all that apply

☐ yes ☐ no

3 Comments on the technical information within this IGD

4 General (other) comments

Demand Response – System Frequency Control

Demand response is an important instrument for increasing the flexibility of the internal energy market and for enabling optimal use of networks. It should be based on customers' actions or on their agreement for a third party to take action on their behalf. A demand facility owner or a closed distribution system operator (‘CDSO’) may offer demand response services to the market as well as to system operators for grid security. In the latter case, the demand facility owner or the closed distribution system operator should ensure that new demand units used to provide such services fulfil the requirements set out in this Regulation, either individually or commonly as part of demand aggregation through a third party. In this regard, third parties have a key role in bringing together demand response capacities and can have the responsibility and obligation to ensure the reliability of those services, where those responsibilities are delegated by the demand facility owner and the closed distribution system operator.

The objective of this guidance document is to help to determine the main criteria/motivation for the recommended settings and applications of the DR SFC capabilities of demand units at a synchronous system and national level.

For adequate specifications of the relevant parameters it is essential to be aware of the objective of DR SFC, the deployment strategies that can be applied, and to understand how it interacts with other frequency stability requirements and assumptions for a system defence plan.

In order to implement comprehensively the DR SFC capabilities, this implementation guidance will look beyond only DR SFC in the NC DCC, considering the proposed settings for LFSM outlined in other guidance documents.

For each synchronous area, proposals for national choices for the non-exhaustive DR SFC parameters are provided in this IGD.

The IGD can be found **here** <*user_uploads/3---igd-on-dr-sfc.pdf*> .

1 Do you consider this IGD helpful to reasonably support the national implementation process? (Please select only one item)

Please select all that apply

☐ yes ☐ no

2 Does the content of the IGD cover the technical issues of this topic appropriately? (Please select only one item)

Please select all that apply

☐ yes ☐ no

3 Comments on the technical information within this IGD

4 General (other) comments

Frequency Ranges

This document addresses the frequency ranges required for the AC transmission and distribution lines including HVDC systems on the AC lines, the power generation and demand facilities.

The general principle for the frequency range and time duration requirements are follows:

- Frequency ranges for transmission and distribution network lines, including HVDC systems on the AC lines, to stay connected to the system shall be wider than for power generating and demand facilities
- Frequency ranges for power generating facilities to stay connected to the system shall be wider than for demand facilities
- Frequency ranges for demand facilities to stay connected to the system shall be narrower than for power generating facilities

The IGD can be found **here** *<user_uploads/4---igd-on-f-ranges.pdf>*

1 Do you consider this IGD helpful to reasonably support the national implementation process? (Please select only one item)

Please select all that apply

☐ yes ☐ no

2 Does the content of the IGD cover the technical issues of this topic appropriately? (Please select only one item)

Please select all that apply

☐ yes ☐ no

3 Comments on the technical information within this IGD

4 General (other) comments

Maximum Admissible active power reduction at low frequencies

The objective of this guidance document is to help determining the main criteria for the specifications/motivation, at national level, of the capability not to reduce active power output more than an admissible value due to frequency decrease.

For adequate specifications of the relevant parameters it is essential to be aware of the objective of the requirement and to understand how it interacts with other frequency stability requirements and external factors such as power plant technology and ambient conditions.

For each synchronous area, proposals for national choices for the non-exhaustive requirement on admissible active power reduction at low frequencies are provided through this IGD.

The IGD can be found **here** *<user_uploads/7---igd-on-p-at-low-f.pdf>*

1 Do you consider this IGD helpful to reasonably support the national implementation process? (Please select only one item)

Please select all that apply

☐ yes ☐ no

2 Does the content of the IGD cover the technical issues of this topic appropriately? (Please select only one item)

Please select all that apply

☐ yes ☐ no

3 Comments on the technical information within this IGD

4 General (other) comments

Automatic connection/reconnection and admissible rate of change of active power

This document addresses the issue of automatic connection/reconnection of power generating modules of type A, B and C. Automatic connection/reconnection is not allowed for type D power generating modules.

The motivation for allowing automatic reconnection after an incidental disconnection or during system restoration is that neither the relevant TSO nor the relevant DSO can manage to respond to all individual start-up requests of power generating modules. In addition communication with type A power generating modules for connection/reconnection is not required. Hence they need to act autonomously according to a configured schedule in such cases.

Automatic reconnection of power generating units after an incidental disconnection includes, but is not limited to, the following fundamental conditions:

- Specifications of the voltage range, for which reconnection is allowed
- Specifications of the frequency range, for which reconnection is allowed
- Specification of a minimum observation time of voltage and frequency conditions
- Specification of a maximum gradient of active power increase after reconnection

Uncoordinated/uncontrolled reconnection of a large amount of distributed generation after system disturbance could result in system stability problems and cause system split or islanding. Therefore some basic rules/conditions for reconnection shall be specified.

In addition, coordination between frequency ranges for reconnection of power generating modules and disconnection/reconnection of demand facilities shall also be taken into account where relevant.

The document provides guidance on implementing the capability of power generating modules related to voltage and frequency ranges, observation time and gradient of active power increase for connection or reconnection.

Recommendation on the preferred values of voltage and frequency intervals for automatic reconnection as well as a minimum observation time and maximum gradient of active power increase after reconnection is given in the methodology section of this document and is based on current practice and for Continental Europe (CE) on the ENTSO-E report on Dispersed generation impact on CE region security.

The IGD can be found **here** <*user_uploads/8---igd-on-autoconnect.pdf*>

1 Do you consider this IGD helpful to reasonably support the national implementation process? (Please select only one item)

Please select all that apply

☐ yes ☐ no

2 Does the content of the IGD cover the technical issues of this topic appropriately? (Please select only one item)

Please select all that apply

☐ yes ☐ no

3 Comments on the technical information within this IGD

4 General (other) comments

Rate-of-change-of-frequency withstand capability (RoCoF)

The requirement aims at ensuring that power generating modules (NC RfG), demand units offering Demand Response (DR) services (DCC), HVDC systems and DCconnected power park modules shall not disconnect from the network up to a maximum rate of change of frequency (df/dt). A large rate of change of frequency (RoCoF) may occur after a severe system incident (e.g. system split or loss of large generator in a smaller system). The facilities shall remain connected to contribute to stabilize and restore the network to normal operating states.

The resulting RoCoF withstand capability will be an important input to calculate the essential minimum inertia (provided by the synchronous PGM with inherent inertia and by PPMs with synthetic inertia) for system stability in case of outage or system split, incl. asynchronous operation of control block. Therefore there is a direct link between RoCoF and inertia related requirements.

Please note that this IGD would be updated in respect to frequency measurement criteria once the outcome of task force on this topic is finalized and published.

The IGD can be found **here** *<user_uploads/5---igd-on-rocof.pdf>*

1 Do you consider this IGD helpful to reasonably support the national implementation process? (Please select only one item)

Please select all that apply

☐ yes ☐ no

2 Does the content of the IGD cover the technical issues of this topic appropriately? (Please select only one item)

Please select all that apply

☐ yes ☐ no

3 Comments on the technical information within this IGD

4 General (other) comments

Need for synthetic inertia for frequency regulation

System inertia is an essential parameter for frequency stability of the electrical power system. It determines the initial rate of change of frequency in case of a sudden imbalance between supply and demand (e.g. trip of a large MW source or demand). A slower rate of change of frequency provides margins for activating automated active power reserves, predominantly via Frequency Sensitive Mode (FSM) (normal state) or Limited Frequency Sensitive Mode (LFSM) (emergency state).

Replacement of conventional synchronous power generating modules, whose rotating masses inherently contribute to system inertia, by power park modules largely connected through power electronics results in a decrease in the Total System Inertia (TSI). Increased application of power electronic drives at the demand side also contributes to a decrease in inertia. This decrease in TSI combined with a higher frequency volatility, particularly if no countermeasures are taken, may become an essential aspect in context of frequency stability.

The objective of this IGD is to provide guidance on Synthetic Inertia (SI) aspects to be considered when choosing relevant national parameters and opting in or out of nonmandatory requirements. It should be noted that the need for SI is less when the relevant TSO is experiencing or foreseeing modest penetration of RES. The challenge of maintaining frequency stability increases dramatically when total system inertia decreases at synchronous area (SA) level. Exceptionally, during rare system splits, some TSOs normally relying upon adequate inertia from elsewhere in the SA, could experience a lack of inertia for a short critical time. If insufficient inertia is available after a system split, this could result in a major challenge to prevent an immediate system collapse.

The IGD can be found **here** *<user_uploads/6---igd-on-si.pdf>*

1 Do you consider this IGD helpful to reasonably support the national implementation process? (Please select only one item)

Please select all that apply

☐ yes ☐ no

2 Does the content of the IGD cover the technical issues of this topic appropriately? (Please select only one item)

Please select all that apply

☐ yes ☐ no

3 Comments on the technical information within this IGD

4 General (other) comments