Expert Group „Criteria for significant modernisation (EG CSM)”

Final Report, 2021-09-02

1 Introduction

Commission Regulation (EU) 2016/631 establishing a network code on **Requirements for Grid connection of Generators** (hereafter referred to as 'RfG' or 'NC RfG') entered into force on 17 May 2016.

Commission Regulation (EU) 2016/1388 establishing a network code for **Demand Connection** (hereafter referred to as 'DCC' or 'NC DC') entered into force on 7 September 2016.

Commission Regulation (EU) 2016/1447 establishing a network code on **Requirements for Grid Connection of High Voltage Direct Current Systems and Direct Current-connected Power Park Modules** (hereafter referred to as 'HVDC' or 'NC HVDC') entered into force on 28 September 2016.

The purpose of this document is to summarise agreement between stakeholders in relation to modernisation, modification or equipment replacement for existing facilities which would require a facility to comply in part or fully with the requirements of NC RfG, NC DC and NC HVDC (hereafter these three codes referred to as 'Connection Network Codes, CNC').

This proposal document is produced by the Expert Group "Criteria for significant modernisation" set up under the umbrella of the **European Stakeholder Committee Grid Connection** (ESC GC) following a request of several stakeholders. A wide range of stakeholders was represented in the Expert Group, ranging from System Operators (DSOs, CDSOs as well as TSOs), Regulators, Manufacturers and Generator Operators. References in this document to the Relevant System Operator (hereafter referred to as 'RSO') mean the operator of the system to which the user's facility is connected to, i.e. either TSO or DSO as appropriate.

2 Legal background as laid down in Network Codes

The three European CNC apply to new facilities which will be connected to the Transmission and Distribution Systems on or after each of the respective "Entering into force dates". However, these CNC do not apply to existing facilities of the Transmission and Distribution Systems unless the facility is modified to such an extent that its connection agreement must be substantially revised in accordance with the procedure detailed in the each of the CNC.

NC RfG, Article 4(1) foresees that[1]:

"*1.Existing power-generating modules are not subject to the requirements of this Regulation, except where:*

(a) a type C or type D power-generating module has been modified to such an extent that its connection agreement must be substantially revised in accordance with the following procedure:

(i) power-generating facility owners who intend to undertake the modernisation of a plant or replacement of equipment impacting the technical capabilities of the power-generating 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 such that a new connection agreement is required, the system operator shall notify the relevant regulatory authority or, where applicable, the Member State; and

[1] remember back-up power is formally excluded from the scope of NC RfG by Art. 3.2(b)

(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;";

NC HVDC, Article 4(1)(a) foresees that:

"*1.Except for Articles 26, 31, 33 and 50, existing HVDC systems and existing DC-connected power park modules are not subject to the requirements of this Regulation, unless:*

(a) the HVDC system or DC-connected power park module has been modified to such an extent that its connection agreement must be substantially revised in accordance with the following procedure:

(i) the HVDC system or DC-connected power park module owners who intend to undertake the modernisation of a plant or replacement of equipment impacting the technical capabilities of the HVDC system or DC-connected power park 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 such that a new connection agreement is required, 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;";

NC DC, Article 4(1) foresees that:

"*1.Existing transmission-connected demand facilities, existing transmission-connected distribution facilities, existing distribution systems and existing demand units that are or can be used by a demand facility or a closed distribution system to provide demand response services to a relevant system operator or relevant TSO, are not subject to the requirements of this Regulation, except where:*

(a) an existing transmission-connected demand facility, an existing transmission-connected distribution facility, an existing distribution system, or an existing demand unit within a demand facility at a voltage level above 1 000 V or a closed distribution system connected at a voltage level above 1 000 V, has been modified to such an extent that its connection agreement must be substantially revised in accordance with the following procedure:

(i) demand facility owners, DSOs, or CDSOs who intend to undertake the modernisation of a plant or replacement of equipment impacting the technical capabilities of the transmission-connected demand facility, the transmission-connected distribution facility, the distribution system, or the demand unit 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 such that a new connection agreement is required, 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;";

3 Background and motivation

The Connection Network Codes are not prescriptive in terms of:

- Modification
- Modernisation

- Replacement
- Equipment (Item)
- Substantial Revision (of the Connection Agreement)
- Technical Capability

As such, different stakeholders in different member states **have interpreted** the requirements to apply the Connection Network Codes to existing users **in different ways**; e.g.:

- "Modernisation" in monetary terms, based on a fixed financial amount, or
- "Modernisation" as changes to the characteristics of the generation unit (Technical Capability)

Discussions with stakeholders and stakeholder interventions at the GC ESC have revealed that the existing provision is probably too generic and in its generality leaves room for interpretation and thus leads to ambiguity and legal uncertainty. Therefore a clear and precise description of criteria of modernisation or replacement triggering retrospective compliance due to change of technical capabilities needs to be investigated. The design base of an existing facility has to be respected.

4 Existing practices across member states

The Expert Group collected existing practices across member states both by an inquiry distributed to participating organisations as well as analysing ACER's 2020 Implementation Monitoring Report[2] on the implementation of the RfG. The results can be found in the table of annex 2.

The work of the expert group revealed limited information on the implementation of both NC DC and NC HVDC.

Criteria to define a significant modification of a PGM can be subdivided into qualitative criteria as opposed to quantitative criteria, as ACER has done in its report. According to ACER, only eight NRAs had published quantitative criteria at the time of ACER's request for information. Another eight NRAs are currently in the process of defining quantitative criteria, while nine NRAs will rely on individual decisions or have not provided an answer.

One NRA has defined merging or division of metering points as a criterion. However this is not a topic addressed in the NCs, and is not examined here.

All NRAs reporting the use of quantitative criteria have based them on the changes of technical capabilities of power generating modules. Where the criteria are published or drafted, these can be grouped into:

- change of type of classification (B -> C or C -> D) as defined in Article 5(2) of the NC RfG
- change in maximum capacity
- change of (components of a) PGM
- expansion (adding generators or units to a PGM)

2 https://www.acer.europa.eu/Official_documents/Acts_of_the_Agency/Publication/3rd%20edition%20NC%20RfG%20implementation%20monitoring%20report%202020.pdf

- change of voltage level

5 Observations of the Expert Group

5.1 General approach and Principles

The Expert Group intensively examined the wording of the NCs and compared it with the general terminology relating to modification of equipment, particularly drawing on the definitions of EN13306. This provided a clear background in ensuring that no nuance of the wording in the NCs was overlooked.

After deriving a plain text version of the fundamental principles how modifications should be handled. Building on this, the report provides key electrical characteristics by which significant changes should be identified. The Expert Group prepared a proposal for change of the legal text of CNC in chapter 6 to illustrate what would be necessary to reflect the principles derived in legal text.

In terms of retaining the high level principles on which the NCs are drafted, the EG agreed a high level plain text (as opposed to legally drafted) version of the NCs. For the RfG the EG agreed the following description:

> *If a power generating module is modified such that (a) this is a clear investment by the owner in the capabilities of the power generating module and (b) this has a material effect on its electrical and grid-dynamic characteristics, then the investment should include bringing the power generating module up to NC RfG standards.*
>
> *Any new parts or components should, as far as possible, comply with the requirements of the NC RfG even if the module cannot do so, such that if compliance is required in the future, these replacement parts will not be a block on such compliance. This does not apply to recognized spare parts or maintenance activities[3].*

And for the DCC, the slightly more complex formulation was agreed:

> *If:*
>
> *i. a transmission connected demand facility,*
> *ii. a transmission connected distribution facility,*
> *iii. a distribution system (including a closed distribution system),*
> *iv. a demand unit within an installation connected at 1kV or above*
>
> *is modified such that (a) this is a clear investment by the owner in the capabilities of any item (i) to (iv) above and (b) this has a material effect on its electrical and grid-dynamic characteristics, then the investment should include bringing the item up to compliance with the requirements of the DCC.*
>
> *Any new parts or components should, as far as possible, comply with the requirements of the NC DCC even if the whole facility, system or unit cannot do so, such that if compliance is required in the future, these replacement parts will not be a block on such compliance. This does not apply to recognized spare parts or maintenance activities[3].*

For NC HVDC, the same principles apply.

[3] **See** annex 1 for an exact definition of spare part.

5.2 Principles chosen

The EG, in formulating the plain text versions agreed that the principle in determining the need for retrospective compliance is the material change of one or more key electrical characteristics. The following sections explain what the EG believes these characteristics should be for each NC.

5.2.1 RfG

The EG believes that the key electrical characteristics of power generating modules are:

- The maximum capacity of the module,
- Its reactive power capability, if the relevant system operator is formally relying on particular reactive power requirements,
- Its inertia, or other appropriate intrinsic characteristic which affects its stability.

In coming to this view, the EG discussed other characteristics, but concluded that they were either subsets of the above, or not material, particularly when considered against criterion (a) of the plain text principle.

5.2.2 DCC

For the DCC the EG broke the criteria down into those appropriate for each of the separate subject matters of the DCC:

- Transmission Connected Distribution or Demand Facility
    - Significant increase of the main demand equipment capacity connecting the facility to the transmission system
    - The fault level contribution from the facility
    - Increased power factor capability (i.e. an increase in the capacity to generate or absorb reactive power)

  and it has a material effect on its electrical and grid-dynamic characteristics.

  The logic for using main demand equipment capacity is that such changes are material in terms of investment, and main demand equipment capacity is governed by the owner of the Transmission Connected Distribution or Demand Facility (limited to the network components of those).

- Distribution systems, including closed distribution systems, modified beyond a threshold of change defined on national level by the relevant TSO(s).

  Article 12-17 define requirements on

    - general voltage withstand capability
    - general frequency withstand capability
    - maximum short-circuit current
    - reactive power exchange
    - protection
    - Control systems

The first of these is pervasive throughout the subtransmission system; the second throughout the whole distribution system. Distribution systems are passive systems, being insensitive to frequency over a wide range, much wider than the interconnected system. Any required change in voltage operating range could be realised by the adaption of tap changer settings at the T/D interface transformers, making the distribution system compatible to new requirements without more substantial changes.

The remaining requirements primarily relate to characteristics at, or close to, the Transmission Connected Distribution Facility. The Expert Group thus concluded that these should be linked to Transmission Connected Distribution Facilities instead of Distribution Systems.

The Expert Group finds it impossible to conceive any new requirements regarding voltage or frequency triggering the compliance of a whole distribution system. Hence, triggering the compliance of a whole distribution system, given how extensive they are, should not be contemplated except in the most exceptional circumstances. Of course, the obligation that new components of a distribution system should meet the DCC requirement in isolation means that progressively non-compliant parts of distribution systems will be replaced naturally.

- Demand units (i.e. only those supplying demand response services to system operators)
    - A change in their frequency capability
    - A change in capacity
      and it has a material effect on its electrical and grid-dynamic characteristics.

Note: The Expert Group takes the view that requirements on demand units supplying demand response services to system operators should better be laid down in the respective contractual agreements. Imposing additional requirements on these units increases the burden to offer demand response to system operators market, which is detrimental to the functioning of the market.

5.2.3 HVDC

The EG believes that the key electrical characteristics of HVDC installations are:

- Maximum power transmission capability of HVDC installation
- Increase in converters' maximum current
- Change in overall reactive power capability
- Change of the technological concept (line-commutated converter vs. voltage-sourced converter)

5.3 The Criteria for the Principles

The EG considered whether it was appropriate to determine the criteria for each of the principles stated above. The EG concluded that the thresholds for criteria were probably best set on a national level by either the RSO or TSO as appropriate and, naturally, subject to NRA agreement. From the ACER report it can be seen that some countries have done this already, e.g. the percentage change in maximum power.

The EG did consider whether limits on the criteria could be specified across the EU within which RSOs would be able to determine the appropriate level (in much the same way as Article 5 of the RfG provides bands of capacities for TSOs to set the type boundaries). The EG thinks this is desirable but has not had time to develop the thinking.

5.4 Maintenance and Spare Parts

The EG quickly came to a unanimous view that activities that would generally be classed as maintenance could never trigger retrospective compliance. In coming to this view the EG recognized that some maintenance activities are intrinsically expensive, but nevertheless is only undertaken "to retain or maintain the original required function of the item", to quote from the definition (2.1) of maintenance in EN 13306. Maintenance may have some effect on the electrical characteristics, but never materially so, i.e. it will not go beyond the thresholds to be defined by the relevant system operator.

As part of this discussion it was noted by the EG that many significant electrical assets are supplied with, or have access to, recognized spare parts. The EG believes it does not matter if the spare parts are of the same age as the original asset, or are younger, or even new. If they are a recognized relevant spare part, this would not trigger compliance. Like for like spare parts are not upgrades.

5.5 NC RfG - Discussion of other criteria

The EG believes it is important to retain the principles for retrospective compliance as as possible. To that end the EG has discussed some of the other principles and criteria that have been suggested or are in use in some jurisdictions.

5.5.1 Increase in maximum capacity

Although the EG is proposing this criterion it is worth elaborating on it as many member states have already defined an increase in maximum capacity as being a criterion for judging the significance of modifications. All member states considering this criterion have defined thresholds to define significance.

The Expert Group noted that maximum capacity is set out in the existing connection agreement, valid at the date of entry into force of NC RfG. This should be used as the base for judging the effect of adding to or replacing components or system parts.

Below the national threshold for retrospective compliance, new or modernised components or system parts shall be capable of fulfilling the relevant requirements stemming from the current

version of network codes applicable to them; in accordance with the principles of 5.1. they shall not constitute a bottleneck to fulfilling the CNC requirements in future.[4]

5.5.2 Change of generator significance type classification

The EG does not believe that in itself this is a valid criterion. It would generally be associated with a change in active power output, so should be judged on that criterion alone.

Using the thresholds derived from Article 5 of the RfG risks being inappropriately arbitrary. Consider the case where the power generating module is say 2% under the threshold to the next type. A modification that resulted in only a 2% increase in active power output would trigger not just the compliance requirements of the larger type, but as the PGM is not currently RfG compliant, it would also trigger upgrades to meet all the RfG requirements too. This would not be appropriate for such a small change in this electrical characteristic.

It is also an unwarranted extension of the RfG as the RfG itself contains no such provision for existing installations.

5.5.3 Change of voltage level

A change in voltage level is usually a consequence of a significant increase in output power and should therefore be determined by the active power criterion. However such a change could have a material effect on the reactive capability of the PGM as seen from the (new) connection point. This could well be material to the RSO; however this would depend on what the existing contractual arrangements were for reactive power. If the existing arrangement is for the site to fulfil a narrow range of power factors, then it is unlikely that the change in voltage will affect this, nor will the reactive contribution from the PGM be particularly material at the connexion point. Conversely if the RSO is formally depending on the delivery (or absorption) of reactive power to manage the network voltage profile any disturbance to this would be material and should trigger compliance such that the system's need is met.

It does not matter whether the change is initiated by the PGM owner or the RSO, the compliance requirement applies equally. The question of who bears the cost should already exist in national arrangements (costs-by-cause principle) and has not been considered further by the EG.

5.5.4 Change of generator or parts of it

Several member states have defined a change of the alternator of a synchronous machine (as opposed to a change of generator/inverter of a PPM) as a criterion for significant modification. In some examples a change of a subsystem of the generator system (e.g. alternator, rotor, stator, etc) is sufficient to require (partial) compliance. Such a project would need intensive evaluation and individual planning, and almost certainly material in terms of investment. However, the EG believes that such an investment is likely to trigger one or more of the criteria related to the module as it is hard to imagine that all of active power output, reactive capability and inertia would all remain within tolerance bands defined by the RSO.

[4] As long as a modification is below the threshold laid down on national level: If the owner decides to not apply the CNC for the modernised part, the incapability of the modernised part can never be used as argument for not applying the CNC to any future modernisation (going beyond the threshold) in the same installation.

5.5.5 Change of inverter in “Fully converted PPM or “Double Fed Induction Machines (DFIM)”

In fully-converted PPMs, the inverter of each unit partially or fully defines the electrical capabilities and behaviour. Full-converter systems can be found in PV installations as well as in many modern wind turbines using e.g. permanent-magnet synchronous machines as generator. If an inverter of a unit is exchanged for a more modern one, this unit should be made subject to the full set of requirements of the RfG, in keeping with the principle that new parts should be compliant. The PGM is now composed of a unit or units that can contribute to the overall performance of the PGM against the RfG requirements. The contribution will be pro-rata the rating of the unit compared to the maximum power of the module. Please see annex 3 for more information on the pro-rata principle.

However, if sufficient units are changed so that any of the criteria of active power output, frequency capability, reactive capability or impedance are met, then all the units including commonly used equipment as e.g., a wind farm power controller, will need to be changed to bring the module up to RfG requirements. It is most likely that it would be the active power criterion that triggers compliance.

5.5.6 Expansion/Installation of new units of a PPM

Many member states consider a wind farm’s or PV-installation’s extension by additional units being a significant modification. However, resulting obligations vary depending on member state. Some member states require only partial compliance (i. e. full compliance of the new units on unit level), whereas other member states introduced thresholds from which on full compliance will be required, including commonly used equipment as e.g., a superordinate power controller. The EG believes that these common instances are easily dealt with by the maximum capacity criterion.

5.5.7 Repowering of a PPM

Repowering designates the exchange of single units or even a whole installation against modern generators (based on inverters). As such, repowering can be compared to the installation of new PPM or the change of inverters described in 5.5.5 and 5.5.6 above. If a power generating facility is completely repowered, the new installation needs to become compliant with the NC RfG. If only a part of units in an existing PGM is exchanged, requirements should be applied to the whole PGM on a pro rata basis in the ratio of MW of new units to MW of total units keeping in mind criteria and thresholds described in 5.5.5 and 5.5.6.

5.5.8 Notification procedure

The need of the repetition of the notification procedure has to be organised following the national compliance verification regulations. However, it seems reasonable that the proof of compliance with this Regulation at least has to be revised if a significant modification leads to the necessity of full compliance of the PGM. Nevertheless, as partial compliance for modified PGMs can be discriminatory considering reactive power provision, an example of a proper treatment based on national experiences is added to the annex 3.

6 Recommendations of the Expert Group

Following its discussions, the Expert Group agreed an amendment of Article 4 of the network codes would be advisable to minimize legal uncertainties.

The proposal for a revision of the legal text is as follows:

RfG

Article 4

Application to existing power-generating modules

1. Existing power-generating modules are not subject to the requirements of this Regulation, except where:

   (a) a type C or type D power-generating module has been modified ~~to~~ such an extent that its ~~connection agreement must be revised~~ electrical and grid-dynamic interaction have materially altered. In these cases and prior to carry out a modification ~~in accordance with the following procedure~~ :

      i. power-generating facility owners who intend to undertake the modernisation of a plant or replacement of equipment ~~impacting~~ affecting the electrical characteristics~~technical capabilities~~ of the power-generating 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 material, in respect of any of the criteria in paragraph 1.c below, ~~such that a new connection agreement is required,~~ 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 and if the existing connection agreement needs to be revised or replaced; or

   (b) a regulatory authority or, where applicable, a Member State decides to make an existing power-generating 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.

   (c) For the purposes of this article a material alteration will be defined according to these parameters:

      i. A percentage increase above the existing maximum capacity (P_{max}) of the PGM to be defined by the relevant system operator; or ~~A percentage increase above the existing maximum capacity (Pmax) of the PGM to be defined by the relevant system operator; or~~

      ii. A percentage deviation from the existing required reactive capability of the PGM to be defined by the relevant system operator in coordination with the relevant TSO; or

      ~~iv.~~iii. A change in frequency stability and active power management capabilities to be defined by the relevant TSO.

2. For the purposes of this Regulation, a power-generating module shall be considered existing if:

   (a) it is already connected to the network on the date of entry into force of this Regulation; or

   (b) the power-generating facility owner has concluded a final and binding contract for the purchase of the……

   ……

   ……..

8. Where component parts or units of an existing power generating module are replaced or new parts or units added to an existing power generating module, those new or replacement parts or units should, to the extent applicable:

   (a) Be compliant with the requirements of this Regulation;

   (b) Not be a limitation on the eventual compliance of the power generating module should compliance be required with this Regulation in accordance with this article; and

   (c) Immediately contribute the requirements of this Regulation pro rata compared to the power generating module as appropriate (e.g. reactive power, frequency response etc). to the future compliance of that power generating module for the possibility that compliance with this Regulation is required in the future.

~~8.~~9. Paragraph 8 does not apply to maintenance activities or to recognized spart parts, whether or not those parts are purchased new at the time of their incorporation in the power generating module.

Article 5

Determination of significance

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3. Proposals for maximum capacity thresholds for types B, C and D power-generating modules shall be subject to approval by the relevant regulatory authority or, where applicable, the Member State. In forming proposals the relevant TSO shall coordinate with adjacent TSOs and DSOs and shall conduct a public consultation in accordance with Article 10. A proposal by the relevant TSO to change the thresholds shall not be made sooner than three years after the previous proposal.

4. Power-generating facility owners shall assist this process and provide data as requested by the relevant TSO.

~~4.~~5. Where power generating modules subject to this regulation are modified such that their maximum capacity or the voltage level of their connection point crosses the threshold from which a power generator module is of type B, C and D, those power generating modules

must then comply with the requirements of this Regulation applicable to the type within which the maximum capacity or voltage level of their connection point now lies.

~~5.~~6. If, as a result of modification of the thresholds, a power-generating module qualifies under a different type, the procedure laid down in Article 4(3) concerning existing power-generating modules shall apply before compliance with the requirements for the new type is required.

DCC

Article 4

Application to existing transmission-connected demand facilities, existing transmission-connected distribution facilities, existing distribution systems and existing demand units used to provide demand response services

1. Existing transmission-connected demand facilities, existing transmission-connected distribution facilities, existing distribution systems and existing demand units that are or can be used by a demand facility or a closed distribution system to provide demand response services to a relevant system operator or relevant TSO, are not subject to the requirements of this Regulation, except where:
    a. an existing transmission-connected demand facility, an existing transmission-connected distribution facility, an existing distribution system, or an existing demand unit within a demand facility at a voltage level above 1 000 V or a closed distribution system connected at a voltage level above 1 000 V, has been modified to such an extent that their electrical and grid-dynamic characteristics have materially altered. In these cases and prior to carry out a modification ~~its connection agreement must be substantially revised in accordance with the following procedure~~:
        i. demand facility owners, DSOs, or CDSOs who intend to undertake the modernisation of a plant or replacement of equipment impacting the technical capabilities of the transmission-connected demand facility, the transmission-connected distribution facility, the distribution system, or the demand unit 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 such that the change is material, in respect of any of the criteria in paragraph 1.c below~~a new connection agreement is required~~, 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 which requirements of this Regulation shall apply and if the existing connection agreement needs to be revised or ~~a new connection agreement is required and which requirements of this Regulation shall apply~~replaced; or
    b. a regulatory authority or, where applicable, a Member State decides to make an existing transmission-connected demand facility, an existing transmission-connected distribution facility, an existing distribution system, or an existing demand unit 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.
    c. For the purpose of this article a material alteration is defined as follows:
        i. in the case of a transmission-connected demand facility and a transmission-connected distribution facility:
            a. a percentage increase, to be defined by the relevant TSO, from the total main demand equipment capacity (in MVA) affording the connexion; or

b. a percentage increase, to be defined by the relevant TSO, in the short-circuit current contribution from the demand facility or distribution facility; or

c. an increase, to be defined by the relevant TSO, in the range of reactive power exchange with the facility.

ii. In the case of a distribution system (including closed distribution systems) the replacement of a percentage of the assets comprising that distribution system, the percentage threshold being defined by the relevant TSO.

iii. In the case of a demand unit that can be used by a demand facility or closed distribution system to provide demand response services:

a. any change in the range of frequencies over which the demand unit can operate;

b. a percentage deviation, to be defined by the relevant system operator in co-ordination with the relevant TSO, from the demand response capacity notified to the relevant system operator.

2. For the purposes of this Regulation, a transmission-connected demand facility, a transmission-connected distribution facility……..

…….

…….

8. Where component parts or units of existing transmission-connected demand facilities, existing transmission-connected distribution facilities, existing distribution systems or existing demand units are replaced or new parts or components added, those new or replacement parts should, to the extent applicable:

a. be compliant with the requirements of this Regulation;

b. not be a limitation on the eventual compliance should compliance be required with this Regulation in accordance with this article; ~~A~~and

c. Immediately ~~C~~contribute to the requirements of this Regulation pro-rata as appropriate for the part or component compared to the whole facility, system or unit as applicable (e.g. reactive power, frequency capability etc).

9. Paragraph 8 does not apply to maintenance activities or to recognized spart parts, whether or not those parts are purchased new at the time of their incorporation into the existing transmission-connected demand facilities, existing transmission-connected distribution facilities, existing distribution systems or existing demand units.

HVDC

Article 4

Application to existing HVDC systems and DC-connected power park modules

1. Except for Articles 26, 31, 33 and 50, existing HVDC systems and existing DC-connected power park modules are not subject to the requirements of this Regulation, unless:
   a. the HVDC system or DC-connected power park module has been modified ~~to~~ that its electrical and grid-dynamic characteristics, relating to paragraph 1.c, have materially altered. In these cases prior to carry out a modification ~~such an extent that its connection agreement must be substantially revised in accordance with the following procedure~~:
      i. the HVDC system or DC-connected power park module owners who intend to undertake the modernisation of a plant or replacement of equipment ~~impacting~~ affecting the ~~technical capabilities~~ electrical characteristics of the HVDC system or DC-connected power park 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 material, in respect of any of the criteria in paragraph 1.c below~~such that a new connection agreement is required~~, 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 and if the existing connection agreement needs to be revised or replaced; or
   b. a regulatory authority or, where applicable, a Member State decides to make an existing HVDC system or existing DC-connected power park 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.
   c. For the purposes of this article a material alteration will be defined according to these parameters:
      i. A percentage increase above the existing maximum power transmission capability ~~capacity~~ of the HVDC installation~~system~~ or DC connected power park module
      ii. A percentage deviation from the HVDC system or DC connected power park module short circuit contribution, to be defined by the relevant system operator in co-ordination with the relevant TSO; or
      iii. A percentage deviation from the existing required reactive power capability triggered by~~of~~ the HVDC system or DC connected power park module. The threshold is to be defined by the relevant system operator in co-ordination with the relevant TSO; or
      ~~iv. A percentage deviation from the existing HVDC system or DC connected power park module inertia, or other appropriate frequency related stability parameter, or set of parameters, to be defined by the relevant TSO~~
      iv. Change of underlying technology, i.e. LCC to VSC
2. For the purposes of this Regulation, an HVDC system or DC-connected power park module shall be considered existing if:

a. it is already connected to the network on the date of entry into …….

……

…….

10. Where component parts or units of an existing HVDC system or DC connected power park module are replaced or new parts or components added, those new or replacement parts should, to the extent applicable:

    (a) be compliant with the requirements of this Regulation;

    (b) not be a limitation on the eventual compliance should compliance be required with this Regulation in accordance with this article; and

    (c) Immediately contribute to the requirements of this Regulation pro-rata as appropriate for the part or component compared to the whole facility, system or unit as applicable (e.g. reactive power, frequency capability etc).

11. Paragraph 8 does not apply to maintenance activities or to recognized spart parts, whether or not those parts are purchased new at the time of their incorporation into the existing transmission-connected demand facilities, existing transmission-connected distribution facilities, existing distribution systems or existing demand units.

Annex 1 "Definitions"
Expert Group „Criteria for significant modernisation (EG CSM)" Report

Date 17th May 2021, proposal to the subgroup by Yacine HASSAINE, Heinz BERGER, Patryk Mazek

Disclaimer

The appendix provides an overview of some existing definitions and their suitability for better understanding of modification procedures established in CNCs that could help in determining the criteria for significant modification

The definitions set out in this Annex may support the assessment of a significant modernisation but are not binding.

1 Explanation of the terms need to be defined

The Connection Network Codes are not prescriptive in terms of:

- Modification
- Modernisation (Modernization)
- Replacement
- Equipment (Item)
- Substantial Revision (of the Connection Agreement)
- Technical Capability

As such, different stakeholders in different member states **have interpreted** the requirements to apply the Connection Network Codes to existing users **in different ways**. E.g.:

- "Modernisation" in monetary terms, based on a fixed financial amount, or
- "Modernisation" as changes to the characteristics of the generation unit (Technical Capability)

During the discussion the EG found, that maintenance is also worth to be defined. By researching EG found the **EN 13306:2017 Standard Maintenance – Maintenance terminology; Trilingual version.** The definitions the EG was looking for (terms above) were also defined in this standard.

We see at least two advantages:

1. The EN Standard 13306 is well accepted in the industry and therefore easy implementable and enforceable.
2. This standard is valid over the whole lifecycle of the subjects of the CNCs (i.e. Power Generating Modules, transmission connected demand facilities, transmission connected distribution facilities, distribution systems, demand units and HVDC systems).

The below definitions with using the EN standard 13306 are useful but a lot of discussions were devoted and the terms still raise doubts in the context of their application to modernization procedures set out in CNCs. All below terms are not of binding character but show the clues to approach of classification different activities related to changes of existing facilities.

2 Definitions

Item (equipment) *EN 13306 (3.1)*

Part, component, device, subsystem, functional unit, ***equipment*** *or system that can be individually described and considered.*

Note of the EG: The term **equipment** is clearly defined.

2.1 Modification *EN 13306 (7.7)*

Combination of all technical, administrative and managerial actions intended ***to change one or more functions*** *of an item.*

NOTE 1 to entry: Modification is not a maintenance action, but has to do with changing the required function of an item to a new required function. ***The changes may have an influence on the dependability characteristics.***

[Note 2 to entry: Modification may involve the maintenance organization.]

NOTE 3 to entry: The change of an item where a different version is ***replacing the original*** *item without changing the function or ameliorating the dependability of the item* ***is called a replacement*** *and* ***is not a modernisation****.*

Examples of modification (non-exhaustive) by the EG:

- Repowering a wind farm by replacing the existing wind turbines by modern types
- …

Modernisation/Modernization *EN 13306 (7.8)*

Modification or improvement of the item, taking into account technological advances, to meet new or changed requirements.

Comment: Requirements of the owner or operator concerning maintenance (e.g. expected technical lifetime).

Note 1 of the EG: Requirements in this context do not mean the CNC requirements themselves. It is possible that the items original requirements do not match the CNC requirements.

Note 2 of the EG: If a range of modernization is not related to the scope of CNCs requirements then the modernisation might not be a subject of art. 4.1 a) CNCs

Examples of modernisation (non-exhaustive) by the EG:

- replacement of an obsolete analog controller by a digital one
- implementation of operating experience
- enhancement of plant safety (e.g. fail safe and redundancy) by new protection systems (process and electrical)
- Adding new turbines, PV panels, etc. which increase the maximum capacity

Improvement *EN 13306 (7.6)*

Combination of all technical, administrative and managerial actions, intended to ameliorate the intrinsic reliability and/or maintainability and/or safety of an item, ***without changing the original function.***

NOTE 1 to entry*: An improvement may also be introduced to prevent misuse in operation and to avoid failures.*

Note 1 of the EG: Improvement is used here with regard to maintenance.

Note 2 of the EG: Improvement might be used, refer to art. 4.1.a) CNCs, in cases when technical capabilities will meet with the scope of CNC requirements. This is a wider interpretation of the EN Standards definition.

Examples of improvement (non-exhaustive) by the EG:

- improved design and materials for mechanical parts (blades, shape of blades, higher temperature, better materials for retaining rings, better material for wind turbine blades/propellers)
- improved hydraulics and thermodynamics
- Improved equipment within the frequency ranges and time periods
- Improved equipment within the voltage ranges and time periods
-

Maintenance *EN 13306 (2.1)*

*Combination of all technical, administrative and managerial actions during the life cycle of an item intended to retain it in, or restore it to, a state in which it can **perform the required function**.*

***NOTE 1 to entry:** Technical maintenance actions include observation and analyses of the item state (e.g. inspection, monitoring, testing, diagnosis, prognosis, etc.) and active maintenance actions (e.g. repair, **refurbishment**).*

***NOTE 2 to entry**: See also the definitions of improvement and modification.*

Examples of maintenance (non-exhaustive) by the EG:

- Replacing a rotor after short circuit of rotor windings
- Replacing stator winding

Spare Part *EN 13306 (3.5)*

Item intended to replace a corresponding item in order to retain or maintain the original required function of the item.

*NOTE 2 of EN 13306: In English, any item that is dedicated and/or exchangeable for a specific item is often referred to as **replacement item**.*

*NOTE 3 (7.7) of EN 13306: The change of an item where a different version is replacing the original item without changing the function or ameliorating the dependability of the item **is called a replacement** and **is not a modification.***

Note 1 of the EG: Replacement of equipment can take part due to preventive and corrective maintenance (spare parts). Spare parts which retain or maintain the original required function of the item without meeting new or changed requirements are part of maintenance action.

Note 2 of the EG: EN 13306 does not define “replacement of equipment” but “spare part”.

Examples of replacement of equipment (non-exhaustive) by the EG:

- Like for like replacement of all rotating parts under maintenance condition if new or *changed requirements cannot be met*
- Like for like replacement of all non-rotating parts under maintenance condition if new or *changed requirements cannot be met*
- Replacement of obsolete instrumentation and control systems under maintenance condition if new or *changed requirements cannot be met*
- Replacement of obsolete protection systems (process and electrical) under maintenance condition if new or *changed requirements cannot be met*

On the other hand replacement of equipment due to economic reasons (reducing losses, reducing operation costs, etc.) is not maintenance related.

Annex 2 “Examples of criteria from Member States”

	General	Change of generator type (B->C; C->D)	Exemption	Maximum capacity	Generator	Inverter	Expansion	
Austria	None			> 15%	exchange of synchronous generator and excitation	exchange against one with extended capabilities	Adding a generator/unit to an existing PPM/PGM	change of voltage level by customer
Belgium (proposal Elia, not yet accepted)		complete compliance	Increase of budget >10% for complete compliance: compliance is postponed to the next modification	> 50%: complete compliance 20%<X<50% Capacity: partial compliance	replacement of stator and rotor of a SPGM	replacement of the converter of a PPM	< 50%: new installation to comply completely (eg. wind turbine, PV-inverter) > 50%: complete installation to comply	change of voltage level by customer: partial compliance w.r.t. voltage range, reactive power, trafo impedance and FRT
Bulgaria (no data)								
Czech	individual decision by NRA							
Germany	Replacing components or system parts >= 50 % of total connected active power			Every change subject of evaluation			modifications of electrical infrastructure (trafo etc.)	

	Change of protection; deterioration of system perturbations			
Denmark (not yet finalised)	Depending on affected share of power			
Estonia	individual decision by NRA			
Spain	Replacing components or system parts >= 70 % of total connected active power		> 20%: complete compliance	
Finland	RSO and PGF owner to agree on amendments, otherwise NRA to decide			
France	Applies to type A+B as well; Several modifications will be summed up to identify total share	complete compliance	synchronous:>20% hydraulic>30% non-synchronous:>10%	replacement of stator and rotor of a SPGM;
Great Britain	Impacting technical capabilities			
Greece (no data)				

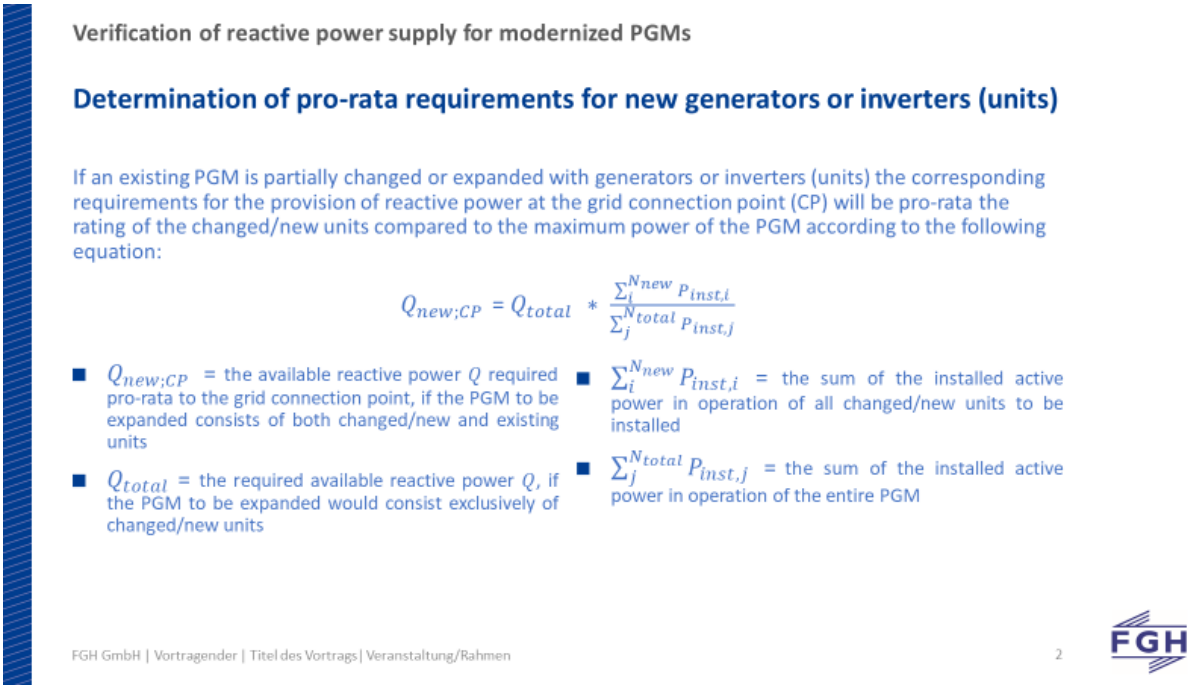
Croatia (Proposal)	Merging or division of metering points, change of technical design of connection		Increase: revision of connection agreement	replacement of generator or exciter	exchange	connection of additional unit at same PCC
Hungary	individual decision by NRA					
Ireland	Complete repowering: full compliance			New governor: frequency response		Only new part to fulfill RfG

Italy	Only full compliance considered		a. for synchronous generators: (i) the replacement of the alternator, (ii) the renewal of voltage and/or frequency regulation systems, (iii) the renewal of the control and protection systems of the power plant, (iv) modification/replacement of components related to the thermal or hydraulic cycle (e.g. burners, boiler parts, hydraulic lines, turbine, etc.);	(i) the replacement of a number of wind turbines or inverters with a power of at least 10% of the efficient power, (ii) the renewal of power plant control systems.

Lithuania	Only full compliance considered			AVR, governor system, boiler regulating system	
Luxemburg	individual decision by NRA				
Latvia	individual decision by NRA				
Netherlands	Based on technical and economic assessment; RSO and PGF owner to agree on amendments				
Poland	Only available in Polish				
Portugal	Only available in Portuguese				
Romania		Full compliance	>10% for type C; >5% for type D	AVR, speed governor, PSS etc.: partial compliance	Exchange of inverter: full compliance
Sweden	individual decision by NRA				
Slovenia	Established in grid code; impacting operational limits				

	and technical characteristics	
Slovakia	Transmission: individual decision Distribution: Increase in active power	Change in voltage level-> change of generator type

Annex 3 “Partial compliance of reactive power supply for modified PGMs”



For verification purposes, the entire PGM with all existing and changed/new units must be completely modeled. The verification has to be provided at least during the operation of the PGM at U_c at the CP.

The calculation basis is formed by the specific requirements for the provision of reactive power of the existing units and the changed/new units of the PGM (according to the current version of the grid code).

If there are no specific requirements set by the system operator for the reactive power supply of the existing part of the PGM, its real PQ-behaviour must be taken as a basis for the requirement.

The following slides illustrate the methodology:

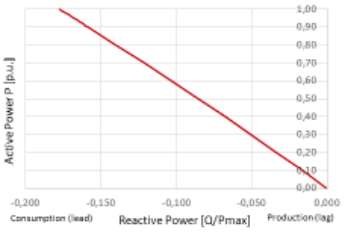
Verification of reactive power supply for modernized PGMs

1) Determination of the requirement for the existing PGM (without changed/new units)

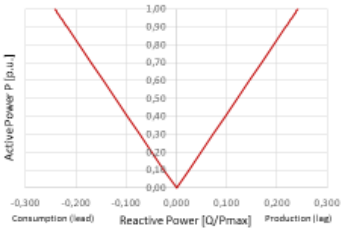
2) Determination of the pro-rata reactive power demand according to the equation for the changed/new units (without existing units, cf. equation on slide 2)

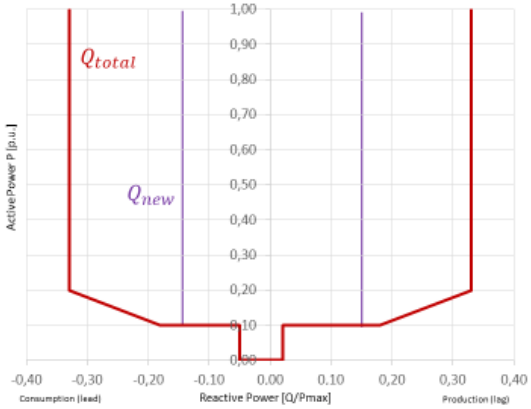
No reactive power requirement available for existing PGM

(reactive power behaviour with cos(phi)=1 at the unit)



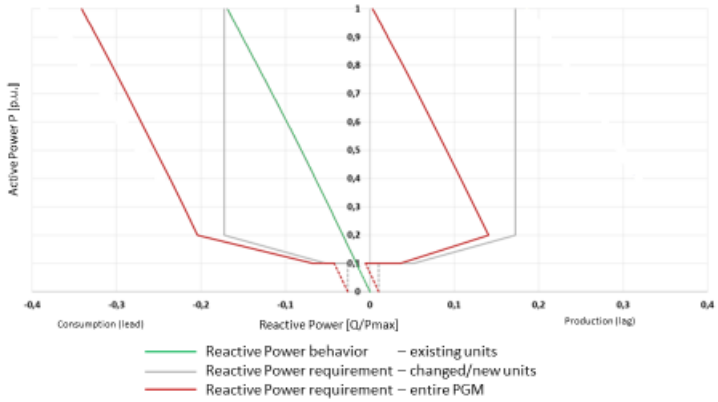
Reactive power requirement available for existing PGM





Verification of reactive power supply for modernized PGMs

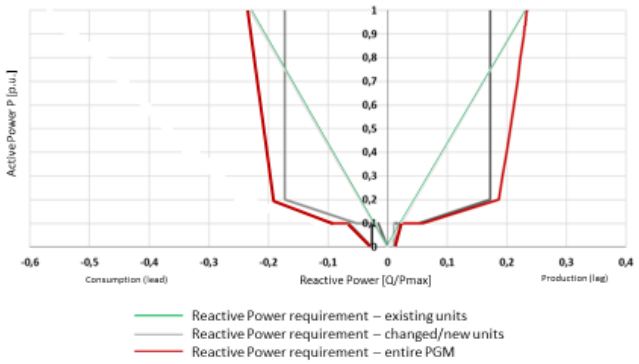
3) Determination of the reactive power requirement for the entire PGM (existing and changed/new units) by adding the requirements from 1) and 2) point by point



No reactive power requirement available for existing PGM

Verification of reactive power supply for modernized PGMs

3) Determination of the reactive power requirement for the entire PGM by adding the requirements from 1) and 2) point by point



Reactive power requirement available for existing PGM