Mixed Customer Sites Expert Group:

FINAL REPORT

Purpose: The Mixed Customer Sites group was set up to consider the way in which particular configurations of equipment are dealt with by the Connection Network Codes and, where applicable, to make recommendations on possible improvements to the Codes that could ensure more equitable treatment in these situations to balance the costs to smaller connecting parties and the benefits to system security.

TABLE OF CONTENTS

ABOUT THIS DOCUMENT

This is the final report of the Mixed Customer Sites (MCS) Expert Group, established by the Grid Connection European Stakeholder Committee (GC ESC) in the autumn of 2018 to consider the suitability of the three Connection Network Codes (RfG, DCC and HVDC) to mixed equipment configurations within a single site and to develop and recommend possible future improvements to the Codes to address any issues identified.

DOCUMENT CONTROL

Version	Date	Change Reference
0.1	31 Dec 2018	First draft
0.2	22 Jan 2019	Revised draft following 21 Jan webinar
0.3	21 Feb 2019	Revised draft following 21 Feb webinar
0.4	26 March 2019	Revised draft following 19 March meeting
0.5	5 April 2019	Revisions for discussion at 9 April webinar
0.6	10 April 2019	Comments up to and including 9 April webinar
0.7	3 May 2019	Final comments post-9 April and tidying up
0.8	16 May 2019	Final changes to recommendations section and removal of change marking/comments
Final draft (submitted to the GC ESC)	24 May 2019	Final addition to the recommendations section, reformatted version
Final report (submitted to the GC ESC)	4 September	Including comments from ACER

Any Questions?

Rob Wilson
Expert Group Chair
Robert.wilson2@nationalgrid.com

Ioannis Thomas Theologitis
ENTSO-E
ioannis.theologitis@entsoe.eu

GC-SO ESC/ENTSO-E
GC-SOESC@entsoe.eu

INTRODUCTION

On 11 June 2018, the Grid Connection European Stakeholder Committee (GC ESC) decided to establish three Expert Groups (EG) to consider and clarify the requirements on particular groups of users as applicable under the three European Connection Codes (CNCs); namely, Requirements for Generators[1] (RfG), HVDC[2] and Demand Connection[3] (DCC).

The areas to be considered by the three EGs were:

- Pumped Storage[4] (hydro);
- Storage (non-Pumped Storage); and
- Mixed Customer Sites (MCS), where these could be a combination of generation, demand and/or storage facilities.

The creation of these EGs was proposed by ENTSO-E to elaborate on the three CNCs issues which had been raised by stakeholders during the national implementation of the CNCs; including as a result of a stakeholder survey to identify priority topics for which future revisions to the CNCs could be considered.

The full terms of reference for the EG MCS[5] was approved by the 14 Sept 2018 GC ESC and subsequently with a minor amendment by the 13 Dec 2018 GC ESC.

---

[1] https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=OJ:JOL_2016_112_R_0001

[2] https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:32016R1447

[3] https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=uriserv:OJ.L_.2016.223.01.0010.01.ENG&toc=OJ:L:2016:223:TOC

[4] Defined in RfG Article 2(21).

[5] https://www.entsoe.eu/Documents/Network%20codes%20documents/GC%20ESC/MSC/Annex_EG_MCS_final.pdf

PURPOSE

Objectives

The objectives of the EG MCS, as agreed by the Grid Connection European Stakeholder Committee on 14 September 2018 and extracted from the paper submitted to the GC ESC, are:

- to provide clarification regarding the application of the three Network Codes on Requirements for Generators connection (NC RfG) Demand Connection Code (NC DC) and HVDC connection (NC HVDC) to MCS with generation, demand and storage (to the extent that storage might in future be classed as separate from generation or demand);
- identify differences and similarities of MCS which are Closed Distribution System Operators (CDSOs) and non-CDSOs;
- in the context of MCS:
    - assess types of MCS to be considered;
    - to assess the MCS case against the current definition of system users, found in the Directive 2009/72/EC[6];
    - to review the definitions of Synchronous Power Generating Module (SPGM)/Power Park Module (PPM); and
    - to provide clarification in terms of the Type A-D generator categorisation[7] or applicability of RfG for mixed or novel sites addressing cases such as:
        - mixed generation only sites where a small PGM (e.g. PV) is installed within the connection site of a larger generator;
        - small PGMs connected to a ≥110kV network due to unavailability of lower voltage connection points[8]
        - combined heat and power generating facilities connected at ≥110kV (where Type A-C would be excluded from certain RfG requirements)
        - clarification on arrangements for point of connection to TSO, DSO or CDSO if that will determine the voltage of connection and therefore 'type'

---

[6] https://eur-lex.europa.eu/legal-content/EN/ALL/?uri=celex%3A32009L0072

[7] Further information on the categorisation can be found in NC RfG Article 5. This is also explored further in Section 5 of this report,

[8] Defined in RfG Article 2 (15) as "'connection point' means the interface at which the power-generating module, demand facility, distribution system or HVDC system is connected to a transmission system, offshore network, distribution system, including closed distribution systems, or HVDC system, as identified in the connection agreement;"

(additional point added after initial GC ESC approval on September 14, 2018 and approved by 13 Dec 2018 GC ESC)

As part of their consideration of this final point, the EG also wished to consider clarification regarding reactive power capabilities and where these are assessed. The EG proposes to keep the Connection Point as the location where the Fault Ride Through[9] (FRT) capabilities are assessed.

Finally, it was agreed with the EG on Storage and with the GC ESC that any issues associated with the accommodation of electricity storage technologies at customer sites of any description would be considered by the EG on Storage (rather than within EG MCS).

Task description

Mixed customer sites with generation and demand are subject to the three Connection Network Codes (Requirements for Generators, HVDC and Demand Connection) that determine the technical specification and capability requirements of equipment connected to the system.

Furthermore, as set out by Article 6 of NC RfG and Article 5 of NC DCC, specific provisions apply to industrial sites connected to the electrical system.

Feedback received from stakeholders has highlighted questions relating to this type of site, especially regarding the classification of onsite generation.

The EG MSC is tasked with the following actions:

- compile and categorise questions from stakeholders relating to MCS;
- identify possible solutions to questions regarding the application of the current CNC requirements; and
- investigate potential improvements to the CNC for a better application of the CNCs to the MCS.

To meet these goals, the EG MSC should be guided by the objectives of the 3rd Energy Package and take into account existing national examples and national network code[10] provisions.

As set out in the objectives, the task will include assessments of the connection to the electrical system of plant at higher voltages either where this is more cost-effective due to the unavailability of lower voltage networks, or where the connection is within a mixed customer site; i.e. the differing treatment of connections to a variety of networks or configurations. In all

---

[9] Defined in RfG Article 2 (29) as "'fault-ride-through' means the capability of electrical devices to be able to remain connected to the network and operate through periods of low voltage at the connection point caused by secured faults;"

[10] Often referred to nationally as 'Grid Codes' or 'Connection Rules'

of these cases this may determine the default classification of a generator to ‘Type D’ in RfG on the basis of its connection voltage and independent of its capacity.

Deliverables

The EG MCS is tasked with delivering a report in which stakeholder questions and issues as defined in the group’s objectives are explored, and in which, where possible, solutions to stakeholders’ questions are developed, including proposals of improvements to one or more of the CNC regarding mixed customer sites. Where such recommendations are made these should be quantified in terms of the benefits and any potential risks.

CONNECTION CASES

To help to illustrate the issues that the EG MCS was considering a number of cases were explored as described below and in the accompanying diagrams. These are provided not as an exhaustive view but as illustrations of the scenarios that have been encountered in the implementation of the three Connection Network Codes, and where stakeholder issues with the current application of the CNC have been identified.

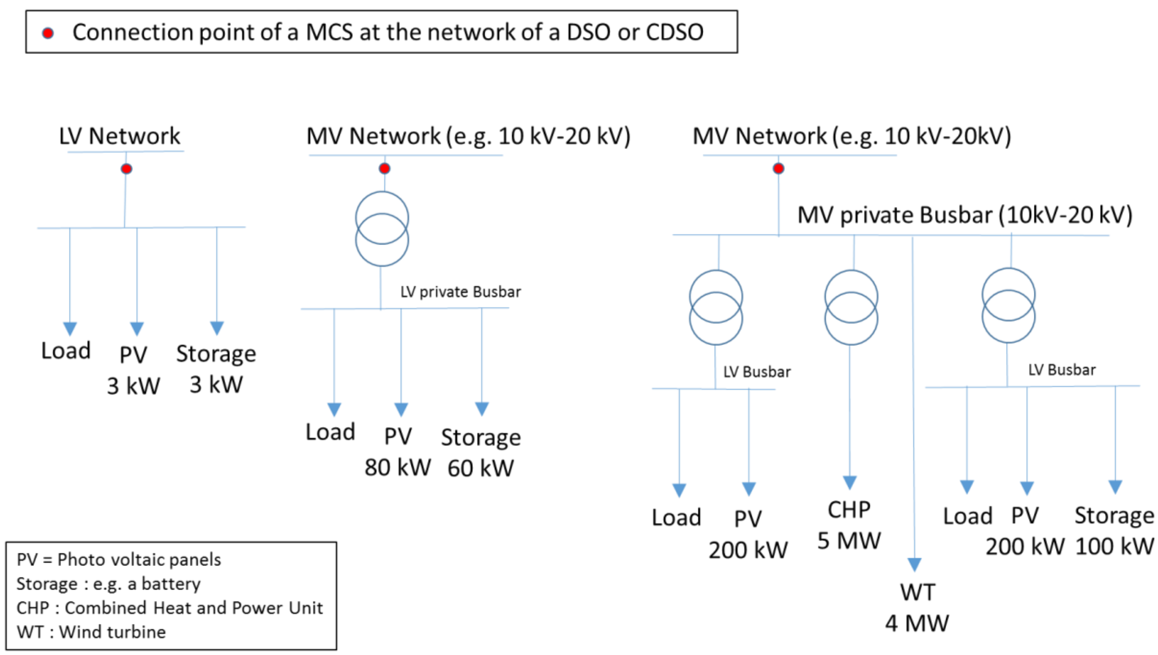
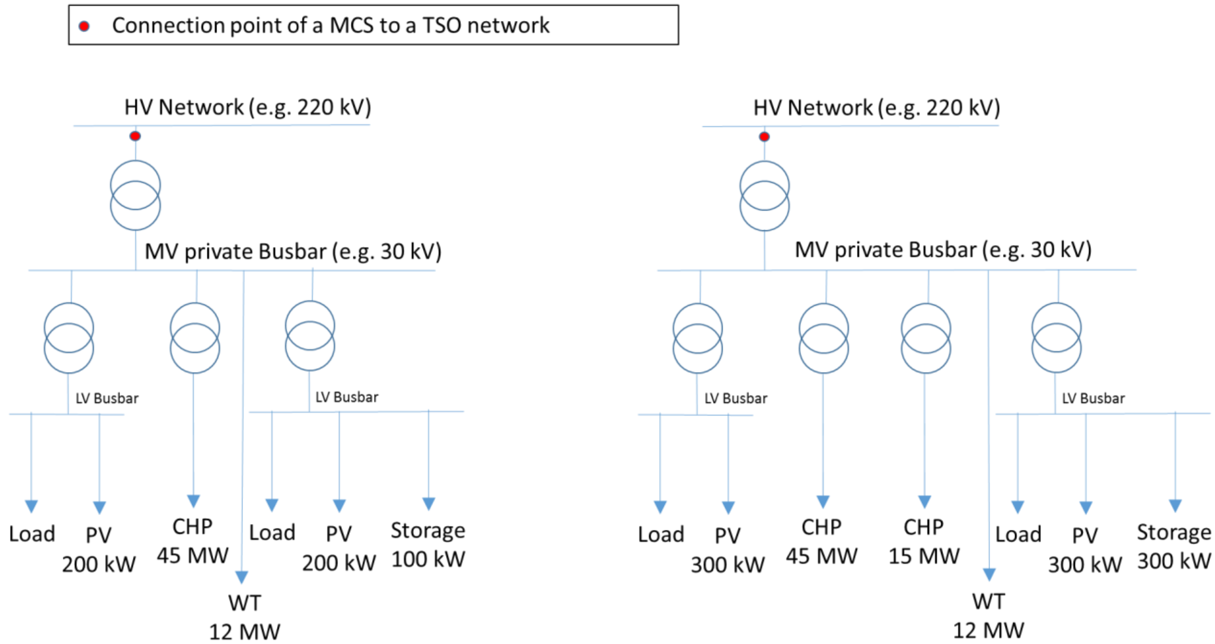


Fig 1(a) & (b) & (c) Mixed site connections to LV and MV networks.[11]

Fig 1 above illustrates connection to the distribution system at Low Voltage (LV) or Medium Voltage (MV) networks which in these scenarios is at a voltage below 110kV. Each of the generators in these examples will be of Type A-D on the sole basis of their MW[12] capacity. (and not their connection voltage).

[11] Voltage values are given here as examples: what constitutes 'Low Voltage' or 'Medium Voltage' or 'High Voltage' may vary by TSO / Member State.

[12] Capacity thresholds vary in different Member States / TSO areas and may be shown as either kW or MW values: MW is shown in this report for simplicity, but should be read as 'MW or kW' as applicable. Further details can be found in Annex 2 which presents the national capacity thresholds.

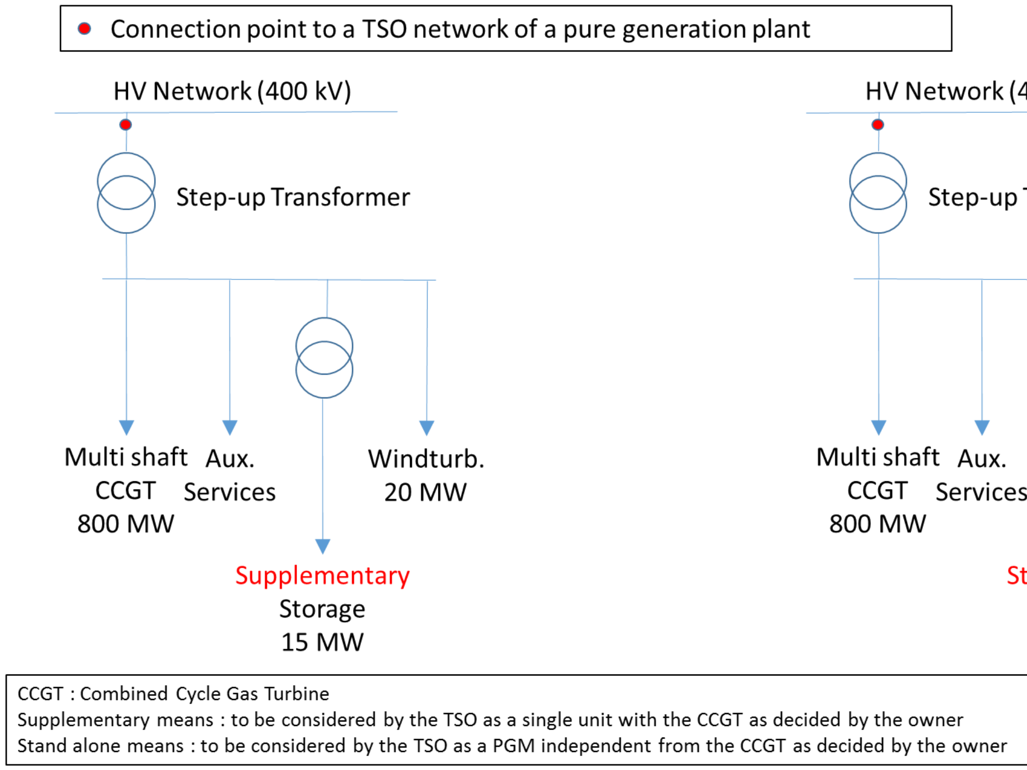


Figs 2 (a) & (b) Mixed sites connecting to HV networks via internal (= private) MV networks

Fig 2 above illustrates potential scenarios to be considered within the remit of mixed sites where connection is to a High Voltage (HV) transmission network, but this is via an internal network at a lower voltage. Each of the generators in these scenarios will at present be classed as Type D due to their connection voltage., at the transmission network, being equal to or greater than 110kV (which is the voltage threshold, set within RfG, in terms of Type D).

Note that for those mixed customer sites that are defined as closed distribution systems, the issues discussed in this document do not apply as the generator 'type' voltage criterion is defined with reference to the voltage level at the connection point with the relevant system operator (RSO), which in this case is the CDSO, and thus the connection voltage of the CDSO to the public (transmission) grid is irrelevant.

This furthers the case for a non-discriminatory treatment of PGMs in CDS versus non-CDS industrial grids.



Figs 3 (a) & (b) Generation sites connecting to HV networks

Finally, in Fig 3 above, the point of these two different treatments of identical configurations is to illustrate two potential scenarios in which storage is collocated with generation: In the first case (Figure 3 (a)) the storage device is defined as supplementary by the common owner of the CCGT and will be treated by the TSO as part of the same connection as the generation modules; in the second case (Figure 3 (b)) it is treated separately by its owner and the TSO will consider it a separate or 'stand alone' PGM.

Mixed Customer Sites not exporting or with limited export of active power to the Network

During the discussions of the group it was noted that in some scenarios a demand site could have a negative export of active power to the Network. This can happen in industrial and Combined Heat and Power (CHP or Cogeneration) plants where the generated power is completely or nearly completely consumed by the loads of the production facility.

When it is expected that no power is exported to the network then the DCC code should be applicable at the Connection Point, but for the generating unit embedded in the plant it is expected that the RfG code requirements apply in terms of the technical capabilities of the generating plant, where this is based on the Power Generating Module capacity and voltage.

Frequently in national code there are thresholds defined in terms of the maximum exported active power compared to the maximum capacity of the generating plant that determines if the site or plant is basically designed as generating plant with a main focus on exporting electrical power to the network, or its design is based on the industrial process needs.

For industrial sites, according to art 6.3 of RfG, conditions of disconnection from the network can be agreed among parties (plant owners and Relevant System Operators) to maintain where possible the industrial process.

For CHPs art 6.4 in RfG defining active power controllability requirements is also to be taken in consideration. CHPs are classed based on their electrical maximum capacity.

VOLTAGE CRITERIA OPTIONS

RfG 'type' designation criteria

In the Requirements for Generators code, the 'Type' classification by which generators are designated to a level of technical capability within four categories A-D is on the basis of their MW capacity but also the voltage of their connection point (the test being whether the connection point to the RSO is located at either less than 110kV or equal to/greater than 110kV).

The MW capacity thresholds were set for each Member State within the maximums given in Table 1 in Article 5 of RfG (which is reproduced below) per synchronous area as part of the national implementation of RfG; however, if the voltage of their connection point was greater than or equal to 110kV such a power generating module would default to being classified as Type D regardless of MW capacity. The values set for these thresholds through national implementation are included in Annex 2.

Requirements for Generators network code: Article 5 - Determination of significance

2. Power generating modules within the following categories shall be considered as significant:

- *(a) connection point below 110 kV and maximum capacity of 0.8 kW or more (type A);*
- *(b) connection point below 110 kV and maximum capacity at or above a threshold proposed by each relevant TSO in accordance with the procedure laid out in paragraph 3 (type B). This threshold shall not be above the limits for type B power generating modules contained in Table 1;*
- *(c) connection point below 110 kV and maximum capacity at or above a threshold specified by each relevant TSO in accordance with paragraph 3 (type C). This threshold shall not be above the limits for type C power generating modules contained in Table 1; or*
- *(d) connection point at 110 kV or above (type D). A power generating module is also of type D if its connection point is below 110 kV and its maximum capacity is at or above a threshold specified in accordance with paragraph 3. This threshold shall not be above the limit for type D power generating modules contained in Table 1*

Synchronous areas	Limit for maximum capacity threshold from which a power generating module is of type B	Limit for maximum capacity threshold from which a power generating module is of type C	Limit for maximum capacity threshold from which a power generating module is of type D
Continental Europe	1 MW	50 MW	75 MW
Great Britain	1 MW	50 MW	75 MW
Nordic	1.5 MW	10 MW	30 MW
Ireland and Northern Ireland	0.1 MW	5 MW	10 MW
Baltic	0.5 MW	10 MW	15 MW

Table 1: Limits for thresholds for type B, C and D power generating modules

The way in which these requirements were drafted respected the provisions outlined in the 'whereas' Recitals included within RfG as follows:

(9) *"The significance of power generating modules should be based on their size and their effect on the overall system. Synchronous machines should be classed on the machine size and include all the components of a generating facility that normally run indivisibly"*

But it also considered the ACER Grid Connection Framework Guidelines[13] (FWGL) which noted that: (on page 8)

> *"The minimum standards and requirements shall be defined for each type of significant grid user and shall take into account the voltage level at the grid user's connection point."*

The default voltage criteria for Type D was, according to ENTSO-E, introduced to respect the requirement set out in the ACER FWGL and to incentivise economical connection decisions being taken regarding the size and connection voltage of equipment, acknowledging that connection at a higher voltage will impact the transmission system more directly so a lack of machine performance will be more likely to lead to socialisation of increased operational costs. Given that it is generally the case that economics dictates that larger machines connect at higher voltages the voltage criteria is – for straightforward connections - usually academic. On this basis it can also be argued that the existing size thresholds implicitly already recognise the technical issues arising from the voltage of connection and the explicit inclusion of an actual voltage threshold into the RfG code should in the view of some parties not have been necessary.

However:

[13] https://www.acer.europa.eu/Official_documents/Acts_of_the_Agency/Framework_Guidelines/Framework%20Guidelines/FG%20on%20Electricity%20Grid%20Connections.pdf

- In mixed site connections (eg a PV installation in association with a larger generator or small CHP within a large industrial complex) this can lead to a disproportionate level of technical requirements falling on small plant where this becomes classed as Type D due to the voltage at the site connection point
  [note that in the case of a Closed Distribution System, the CDSO is the Relevant System Operator in terms of any connections made within the CDS grid and hence the Connection Point and voltage will be within the CDS rather than to the transmission or distribution system to which the CDS is itself connected]
- Some geographical issues are not accounted for – so where a lower voltage connection is simply not possible or economic (e.g. hydro in remote mountainous locations)
- Given that machines over a certain MW size connect at a higher voltage and therefore default to Type D, some TSOs used this to determine Type D rather than seeking to lower the Type D MW capacity threshold which has led to a potential mismatch between classification by MW size and voltage criteria.
- While derogations were suggested as a possible way of resolving certain issues, it was noted that the design of a set of criteria where from the outset it could be foreseen that derogations could be commonly required would appear not to have taken all circumstances into account during the drafting and would not be looked upon favourably by all NRAs. Moreover, derogations would have to be applied for in each member state, and if a class derogation was not available in each case, leading to a substantial additional workload for all parties without any additional benefit when compared to establishing a solution in the code. It is also common for derogations to be time-limited or tied to a condition that will achieve their resolution which again would be an unsatisfactory outcome.

National experiences of voltage criteria

(please also see Annex 1 for a fuller explanation of the different national approaches to implementation of the Connection Network Codes).

The EG MCS considered the situation in a number of Member States and the different approaches to national implementation that had been taken.

It was noted that experiences for example in GB where the normal distribution voltage levels are 132kV and then 33kV (with limited instances of 66kV) are that with some geographic exceptions plant above approximately 30MW in size will normally connect to 132kV for economic and engineering reasons. Given that in GB Type B has been set at 1-10MW and

Type C at 10-50MW the voltage criteria will only be active for straightforward connections in the range 30-50MW that will default from Type C (on MW capacity) to Type D (on voltage). This is similar in the Netherlands and so for these Member States given that the requirements for Types C/D are in any case seen as being fairly close (while those in Types A/B are significantly different), the voltage criteria is less material for straightforward connections. The key issue remains where Types A/B generators by MW capacity are connected at a higher voltage due to being part of a mixed site and are therefore classed as Type D.

A further point for consideration is that in Belgium, France and Germany (amongst others) a large number of (non-CDSO, Cf. previous comments) industrial sites are connected at transmission voltages (so >110kV). As an example, a specific issue with this in terms of a Type D classification for smaller generators is that certain CHP units cannot withstand a fault having a U_{ret} of 0V (as defined in RfG for Type D to comply with) due to low inertia while being capable of compliance with the Type B requirement for Fault Ride Through which allows a U_{ret} of 5%-30%; so to avoid either precluding use of this plant or requiring derogations this would need to be addressed.

A further point noted was that it is likely that in France and Belgium a RfG class derogation[14] is going to be progressed to exclude Type A and B generators (on MW capacity) from the voltage criteria. This does not resolve the issue for Type C generators connected in industrial (non-CDSO) sites above 110kV, which would be treated differently from similar (Type C) generators connected at lower voltage levels (either on public networks or within CDS sites) and also as derogations against RfG are not a desired way forward in most member Member States or with Regulators.

Bearing these points in mind, the EG MCS therefore focused on the application of the voltage criteria and how this could be adapted to consider the issues that had been identified in its application.

Voltage criteria options

The EG MCS discussed a number of options for the revision of the voltage criteria as follows:

- Use of an 'interface point' to determine all connection requirements (see Figure 4 below); or
- Use of an interface point just to determine the connection voltage and therefore Type (other requirements, including reactive capability, would still apply at the Connection Point); or

---

[14] See Title 5, Articles 60-65, of RfG for further information on derogations.

- Increase of voltage criteria to be >220kV; or
- Removal of Type A from the voltage criteria (i.e. Type A only decided by MW capacity); or
- Removal of Types A&B from the voltage criteria; or
- Removal of Type A plus some requirements of Type B (e.g. perhaps FRT or reactive range) from the voltage criteria; or
- Removal of voltage criteria completely for non Type D (so determining all of Types A-B-C based on MW capacity only, not their connecting voltage)

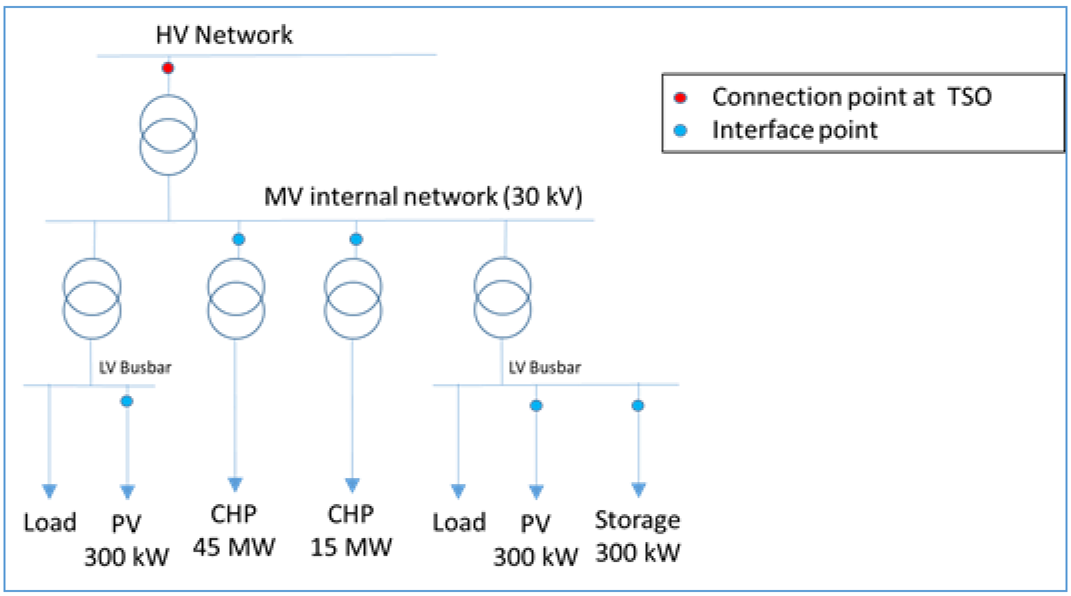


Fig 4 (a) & (b) Interface point vs Connection point

Fig 4 above shows the concept of an additional 'interface point'; the Connection Point here is to the DSO/TSO network, so meaning that where this Connection Point is >110kV then any of the generators within the network shown will be treated as Type D. The application of any technical requirements including those in RfG will also usually be through the connection agreement that will apply to the point of connection and will apply requirements measurable at this point

By adding an 'interface point' then the voltage determining the generator 'Type' will be at this lower voltage level, so making assessment of Type based on MW capacity more likely. Technical requirements will also apply at the 'interface point' rather than the point of connection to the DSO/TSO network. An exception to this is for Fault Ride Through requirements, where since the requirement is to ride through faults on the transmission system then this should continue to be defined at the Connection Point.

Points that were included in the EG MCS's discussions were:

- Should PGMs connected to internal, public and closed distribution system (CDS) networks be treated differently, even if the underlying technical connection is identical?

  The intent of the CNC was not to differentiate between plant connected within industrial sites or to (public and non-public) networks but to place requirements on generators generally in proportion to their capabilities and size to ensure a stable and robust transmission network with the participation of all users, noting also that certain provisions for industrial sites are made in RfG article 6.

- If the 'Type' thresholds are relaxed by revising the voltage criteria, would further operational costs need to be socialised?

- How will an 'interface point' be defined and what would the legal status of this be? What visibility will the TSO/DSO have of performance within a connection site? Could compliance be established at an 'interface point' and what is the treatment for any cable connecting the generator terminals to a busbar[15]?

- The fact that the majority of Type A & B PGMs are likely to be mass-market products and with compliance established through the use of equipment certificates Equipment Certificates[16] derived from the CENELEC standard associated with RfG and with characteristics therefore defined independently from their Connection Point

- What technical issues could arise from determining requirements at an 'interface point'? (or in the variation to this option where the 'interface point' is only used to define the voltage, can this resolve issues with reactive capability?)

- Will the solution work in all cases?

---

[15] Note CENELEC standards 50549-1 and 50549-2 which are generally aimed at type A and B, mass-market applications; these also facilitate an easier use of equipment certificates in compliance. Reference to standard 50549-2 may be important here: '*Generating plants shall be able to operate with reactive power provision as defined by the DSO and the responsible party. The default reactive power requirement Q is up to 33 % of PD over-excited and under-excited when active power is above 20 % PD. When operating at active power below 20 % PD reactive power shall be provided according to Figure 12 to a minimum active factor of 0,52. The stringent reactive power requirement Q is up to 48,4 % of PD over-excited and under-excited when active power is above 20 % PD. When operating at active power below 20 % PD reactive power shall be provided according to Figure 12 to a minimum active factor of 0,38. The reactive power capability shall be evaluated at the terminals of the/each generating unit or at the POC. The reactive power of generating plants with Smax above a power threshold to be defined by the DSO and responsible party shall be evaluated at POC.*'

[16] Defined in RfG Article 2(47).

Voltage criteria options for Mixed Customer Sites-pros and cons

The following summary table was developed by the EG MCS; a scored version of this was also developed and both are presented here.

Voltage Criteria Solution	Pro	Con
Use 'interface point' for all	• Treats public/private networks identically • For generators (although not Network Operators), solves issues with supply of onerous reactive power requirements at smaller MW capacities across Connection Point	• Lack of visibility of performance within a network to TSO/DSO • For Network Operators, difficult to establish reactive power requirements or compliance where this is within a network leading to operational difficulties and possibly costs. • Possible legal issues in establishing an additional boundary • Doesn't solve geographic availability of LV/MV issue • It would completely reverse the disposals for the connection stated in the EU law (the CNC) and in the technical requirements approved by NRA. The connection requirements are defined with reference to the Connection Point not with reference to the 'interface point' • Creates incentives/distortion for PGM/PPM connection at lower voltage levels also through the splitting of large PGM/PPMs into artificially smaller modules • Socializing of costs for reactive power compensation
Use 'interface point' - for Type selection only	• Maintains visibility of performance to TSO/DSO • By generally leading to reclassification, reduces technical requirements for smaller generators	• Possible legal issues in establishing an additional boundary • Doesn't solve geographic availability of LV/MV issue • Similar in outcome to removing the voltage criteria • It would completely reverse the disposals for the connection stated in the EU law (the CNC) and in the technical requirements approved by NRA. The connection requirements are defined with reference to the Connection Point not with reference to the 'interface point' • Creates incentive/distortion for the PGM/PPM connection at lower voltage level also through the splitting of large PGM/PPM in different small PGMS/PPMs • Discrimination of types that are not considered • Socializing of costs for reactive power compensation
Change the default criteria to >220kV	• Simple – minimum change to RfG	• Doesn't resolve issues with transmission connections constrained for geographic reasons

		• Doesn't solve case where a major industrial site is connected at 220kV+. Examples of this exist in Germany and in Belgium
Removal of Type A from the voltage criteria (i.e. Type A only decided by MW capacity)	• Resolves all Type A issues highlighted by EG MCS • Solves obligations in the SOGL imposed for Type A PGMs connected at >110 kV	• Could this incentivise connections to keep within MW capacity for Type A? • Discrimination against types B-C
Removal of Types A&B from the voltage criteria (i.e. types A&B only decided by MW capacity	• Resolves all Type A/B issues highlighted by EG MCS	• Could this incentivise connections to keep within capacity for Types A and B? • Discrimination against type C
Removal of voltage criteria completely (so determining all of Types A-B-C based on MW capacity only)	• Simple in principle • Resolves all cases • Costs for grid connection (transformer, substations, etc.) will prevent smaller generators to connect at EHV • No discrimination towards any generators of type A-C issues highlighted by EG MCS	• Simple but may be viewed as significant change to RfG. • Possible socialisation of additional operational costs although this is difficult to quantify • In some cases this would need TSOs to revise the MW 'capacity' thresholds applicable to each Member State, since in their selection an assessment was made of the volumes of generation in each 'Type' including those defaulting to Type D due to connection voltage
Removal of Type A plus some requirements of Type B (e.g. perhaps FRT or reactive range) from the voltage criteria;	• Retains voltage criteria for Type C and elements of Type B • Resolves need otherwise for RfG derogations against specific technical requirements	• Complex and feels similar in principle to a RfG derogation

Voltage criteria conclusions

A scoring matrix was produced by the EG MCS as an aid to assessing each of the options against the multiple criteria suggested by the members of the group, and stemming from the development of the 'pros and cons', as shown above for each of the options, as follows:

Acceptability					Simple solution (in terms of the code text)	Simple solution (in terms of ease of implementation)	Does it work in all cases?	Additional costs for			Treats connection to all networks equitably	Visibility of performance within a network	Establishes another legal boundary	Solves issues to do with reactive power supply	Solves issues to do with FRT	Solves issues to do with geographic non-availability of LV connections	Solves issues with large industrial sites connected at <220kV	Solves issues with large industrial sites connected at 220kV or above	Will not encourage 'gaming' of connection configurations
TSOs	DSOs	Generators	Manufacturers	Industrial sites				System operators	Generators	Industrial sites									

While examples of this being filled in by each of the main groupings of stakeholders (transmission and distribution network operators, generators, manufacturers and industrial/commercial customers) represented within the EG MCS were developed, it was difficult to make this objective or comparable, since not all criteria could effectively be scored by all those groupings. However, it was used to develop the table below which gives an 'order of preference' of the options for each of the main groupings of stakeholders involved (noting that this was the opinion of the representative members of the Expert Group only rather than a full survey). It also helped EG MCS to facilitate a discussion of the criteria that needed to be part of the assessment, and from which the EG were able to develop conclusions.

The full scoring by category is given in Annex 3.

	Order of Preference					Summary of Comments
	TSOs*	DSOs	Generators	Manufacturers	Industrial consumers	
Use interface point for all	5	6	2	2	2	Concerned about establishing another legal boundary
Use interface point – for type selection only	6	5	5	4	3	Doesn't solve reactive issues
Change the default criteria to 220kV	4	3	6	6	4	Doesn't work for some >220kV industrial sites
Removal of type A from the voltage criteria (ie type A only decided by capacity)	3	4	4	4	6	Type A is not really an operating standard so far away from type D; doesn't solve types B&C
Removal of types A&B from the voltage criteria	2	2	3	3	5	This could work; A/B are massmarket product standards really so should be treated differently. Doesn't solve type C but this is more similar to D anyway
Remove type D voltage criteria completely (so from all of types A-B-C)	1	1	1	1	1	Likely that some TSOs would need to reassess capacity thresholds - and some disagreement on this basis

**Note that the TSO category does not reflect the views of all TSOs. For those member states where this solution would result in the need for a reassessment of the capacity thresholds this is heavily caveated.*

The conclusions of this work were therefore that there was a strong preference for the removal of the voltage criteria. This was viewed as a simple solution in principle, although it was noted that for some Member States where such a decision would impact a large volume of generators due to the initial setting of their capacity thresholds it would be necessary to in conjunction reassess these thresholds to maintain the correct balance between generator requirements and system security. It was also highlighted that it might similarly be necessary to compensate for the loss of fault ride through capability by establishing as part of the 'type B' requirements two alternative fault ride through voltage profiles to cover performance expected for a connection at either above or below 110kV.

The use of an 'interface point' was unpopular with network operators who saw this as presenting significant legal and operational challenges. Other stakeholders felt it could work and, if the removal of the voltage criteria were not to be progressed, could be a viable alternative. It was noted that a similar concept had been used in Italy previously to apply requirements at the terminals of a machine; and that in Belgium (and France and Germany) the interface point would be likely to also be the location of any metering. However, other members of the group felt that being able to define an interface point in a legally unambiguous way which would work without exception would be extremely challenging. This challenge was felt by those members to significantly outweigh the potential benefits of the option. Potentially associated with this option, the loading conditions and topology of the internal grid of a mixed customer site considered when verifying the compliance of the connectee, as well as the use of shared equipment from the mixed customer site to meet the connectee's obligations, were not considered in the scope of the group.

Most parties agreed that removing the voltage criteria just from Types A&B would also be a workable solution and would reflect that Type A&B requirements in RfG are closer to product standards while those in Types C&D establish more of an operational interface. This would not work for some larger CHP installations, however, and could be seen to increase the discrimination against such plant in Type C. Again, it is possible that this could be resolved by moving the B/C capacity threshold, and if the number of instances were limited would make seeking derogations in these exceptional cases more of a viable option. However, in the case that there were a higher number of instances, this would lead to a heavy additional workload for all parties and potentially different (non-harmonised) treatment of similar situations across different Member States.

Definitions

To make the 'interface point' option work would need a definition to be added to the code. No changes to definitions were identified as being required as part of either the complete removal of the voltage criteria or its removal from Types A&B.

A definition of 'mixed customer sites' has not been included, since this was felt to be open to debate and difficult to make future proof. If it is not necessary to be able to codify a solution, then the group felt that it was better not to attempt to do this.

Independent Controllability

The group highlighted an existing issue in the application of RfG regarding multiple machines marshalled together through a single connection point. Whilst it is generally accepted that such a configuration for renewable generators (solar, wind) is treated as a single power park module due to elements of the installation not being independent and often the marshalling being through a single converter station, this maxim did not apply equally to multiple synchronous machines. In these cases the key factor to consider was whether the machines were independently controllable, although it was noted that this could act as a perverse incentive to achieve a lower 'Type' classification. It was also acknowledged that this issue had been addressed in the 'whereas' recitals of RfG[17] and, while noting the issue, that this was not within the scope of the EG to further progress. In careful drafting of any legal text for changes to the code it will however need to be taken into consideration.

[17] RfG 'whereas' recital (9); *"The significance of power generating modules should be based on their size and their effect on the overall system. Synchronous machines should be classed on the machine size and include all the components of a generating facility that normally run indivisibly, such as separate alternators driven by the separate gas and steam turbines of a single combined cycle gas turbine installation. For a facility including several such combined cycle gas turbine installations, each should be assessed on its size, and not on the whole capacity of the facility. Non-synchronously connected power generating units, where they are collected together to form an economic unit and where they have a single connection point should be assessed on their aggregated capacity."*

Status Quo

In any assessment of possible changes a further option that remains is to do nothing, or maintain the status quo. The group concluded that this was inconsistent with the issues identified in the application of RfG to mixed customer sites. In the event that no changes were made to RfG, this would continue to compel member states to progress derogations to their national implementation of RfG. The NRAs of a number of member states have expressed that relying on derogations is not preferred since it indicates that the solution was either incomplete or incorrect. While class derogations for type A and B generators are being considered in Belgium and France, the derogation route is also generally not optimal for stakeholders requiring compliance questions to be resolved as part of a future business case since it gives insufficient commercial certainty. And as derogations may be time limited or tied to conditions any resultant issues could continue to resurface indefinitely.

The principle of a level playing field was discussed by the group and again points to the need for a complete solution without the need for derogations. It was noted though that the voltage criteria as it stands is mandatory rather than non-exhaustive and that any instances of discrimination enshrined within the statute of RfG are permissible since they are part of the law.

Agency Comments

The Agency commented on the removal of the voltage criteria as being a simplistic proposal because of the likely reassessment of the capacity thresholds (i.e. the values in MW), or other reassessment of technical requirements, that some TSOs would need to carry out due to the reduced volume of generators required to comply with a higher 'Type' technical specification, and therefore the reduction in support from low capacity PGMs which are determined as Type D, in order to guarantee and maintain secure and correct system performance.

The Agency also drew the attention of the group to the requirement in the ACER Framework Guidelines to include voltage criteria in any considerations, as noted elsewhere in this report, and particularly pointed out the context for this in that the classification of certain low-capacity PGMs as Type D (with the consequent application of more technically demanding requirements) should be seen more as a partial side effect of the correct application of voltage criteria when determining the significance of a PGM. Again, quoting from the Framework Guidelines *"The criteria and methodology for the definition of significant grid users [...] shall be based on a predefined set of parameters which measure the degree of their impact on cross-*

border system performance via influence on control area`s security of supply, including provision of ancillary services ("significance test").”

The inclusion of voltage criteria is clearly in line with the Framework Guidelines but moreover, the identified issues arise more from the definition of the physical connection point rather than necessarily the voltage levels. The correct definition of the physical connection point was again required by the Framework Guidelines to be formulated when developing the network codes(s) since *“The network code(s) shall define the physical connection point between the significant grid user’s equipment and the network to which they apply”* [page 8 (paragraph 6) of the FG EGC]

Hence, the Agency recognises the aim of the MCS EG to find an effective and practical solution to the identified issues.

RECOMMENDATIONS

The recommendations of the EG MCS based on the considerations of the group are that the following options for development of the generator 'Type' criteria as set out within RfG have merit. In determining a short list of potential solutions from an assessment of all of the options available it is apparent however that there is not a single obvious solution that works unambiguously in all cases and that is free from consequences:

- **(either) Remove the voltage criteria completely, so making the assessment of Type purely on the basis of machine/module MW capacity size.**

This is in keeping with the basic ethos of RfG in linking the level of technical requirement to MW size but moves away from the ACER framework guideline requirement to include voltage in the assessment. The EG MCS agreed that this was potentially the simplest solution but noted that it will cause some TSOs to reassess their thresholds where the removal of the voltage criteria results in a significant reduction in network support by reducing the volume of generators required to comply with a higher 'Type' technical specification. It could also be necessary for the same reason to consider amending the fault ride through voltage profile requirements in type B to give two profile options for connection at above and below 110kV.

- **(or) Remove the voltage criteria from Type A and B generators (ie Type C by MW capacity, where connected at >110kV, would still default to Type D.**

Types A & B are similar to product standards while Types C & D are fairly similar; this option is therefore not unduly discriminatory against Type C generators but for many Member States it is also not greatly different to removing the voltage criteria completely. If applying this option, consideration should also be given to extending the specific exclusions noted in RfG Article 6(4) for CHP Types A-C to Type D; this may be reasonable on the basis of MW capacity but is arbitrary if on the basis of voltage.

- **(or) Introduce the concept of 'interface points' for the application of all technical requirements other than Fault Ride Through, and for use in the voltage criteria assessment.**

While the principle of this option is straightforward, it was seen by network operators represented on EG MCS as a significant legal and operational challenge; and also to introduce complexities in having to assess compliance within an embedded network with limited visibility

– and possibly needing further support at the Connection Point to the system, the cost for which would be socialised rather than being borne by the connectee.

Other options that were considered by EG MCS and discarded were to:

- Increase the voltage criteria to 220kV – which would not be a solution for the connection of generation at major>220kV industrial sites.
- Remove the voltage criteria from Type A generators – which would be discriminatory against Type B & C generation in not solving their issues. Type B in particular is as with Type A more similar to a product standard so should be treated consistently.
- Remove the voltage criteria from Type A and selected elements of Type B generators – which was felt to be similar to but more complex than RfG derogation approach.
- Apply the 'interface point' concept just to the determination of the connection voltage – which did not resolve the requirement for a smaller generator to provide technical requirements such as reactive range at the Connection Point to the system.

Further changes to the definitions in RfG were not concluded by the EG MCS, to be necessary although it was noted that work on definitions would also be ongoing as part of the Storage EG.

Finally, the EG MCS concluded that any of the changes to the RfG 'Type' settings made as above should be made considering how to treat projects caught by RfG but which had not yet been connected. One way to do this would be to make the changes retrospective by not specifying a date from which they applied, so overwriting the earlier requirement. However, this would need to take account of the national implementation processes and, where TSOs have also indicated that as part of any proposed change they would need to reassess their Type MW capacity thresholds, this would also need to be considered. As in some cases TSOs have indicated that the removal of the voltage criteria and reassessment of thresholds could only be acceptable where undertaken in conjunction; a more workable solution would be to apply the changes from a date to be determined but to make clear that this date, and the application of the revised requirements, also applied to any generator connections that had either been completed or were in progress and to which RfG had already been applied.

Where these changes lead a TSO to reconsider their capacity thresholds, a possible simplification of this would be to specify in the code that this should be through an assessment reporting to the NRA of that Member State to determine the size at which pure generator connections (as seeking to establish this with a MCS scenario would not give an accurate answer – for example, a 50MW demand site with 45MW of on-site generation could potentially sustain a connection at 33kV) would normally be made at 110kV or above. This level could then be used to set either the B/C or C/D thresholds so limiting the impact of the removal of the voltage criteria. During their national implementation a similar approach to this was taken both in the UK and Germany where the typical capacity for connection at a voltage over 110kV and the capacity thresholds were broadly aligned; in both Member States this has led to a very limited use of ‘Type C’ classification as higher voltage connections at which ‘Type D’ applies by default through the voltage criteria achieve a very similar categorisation to the C/D capacity threshold.

ANNEX 1: NATIONAL IMPLEMENTATION APPROACHES

Great Britain

In GB the three Connection Network Codes were implemented through a series of modifications to the GB national network codes (namely the Grid Code and Distribution Code) and their accompanying documents. The ethos that was followed was to make sure that GB stakeholders did not need in the future to read both the GB and European Codes but could be confident that in following the requirements set out in the national network codes they would also be compliant with their CNC obligations.

The modifications made to the GB codes were as follows:

- Grid Code modification GC0100[18]- which set the 'type thresholds from RfG and also determined the Fault Ride Through parameters for RfG and HVDC
- Grid Code modification GC0101[19]- which set voltage and reactive requirements for RfG and HVDC
- Grid Code modification GC0102[20]- which set compliance and general system management requirements for RfG and HVDC

Decisions approving each of these modifications were made by NRA (Ofgem) on 15 May 2018 and they were implemented into the Grid Code on the 17 May 2018.

NRA approval of Grid Code modification GC0104 which set requirements for the Demand Connection Code followed in September 2018.

In each case the Grid Code modification, which applies to any generator connected to the GB transmission system (predominantly 275/400kV in England and Wales, 132/275/400kV in Scotland), was accompanied by a modification to the Distribution Code. The accompanying Distribution Code documents G59 and G83 which set out requirements and guidance for smaller distribution connected generators were also updated via two new documents: G98 and G99.

RfG Type	GB thresholds - approved	Possible maximums	Connection Voltage
A	800W-1MW	800W-1MW	<110kV
B	1-10MW	1-50MW	<110kV
C	10-50MW	50-75MW	<110kV
D	>50MW	>75MW	>110kV

[18] https://www.nationalgrideso.com/codes/grid-code/modifications/gc0100-eu-connection-codes-gb-implementation-mod-1

[19] https://www.nationalgrideso.com/codes/grid-code/modifications/gc0101-eu-connection-codes-gb-implementation-mod-2

[20] https://www.nationalgrideso.com/codes/grid-code/modifications/gc0102-eu-connection-codes-gb-implementation-mod-3

The thresholds set in GB were on the basis of finding a balance between the costs that would be incurred by a generator and the benefit to system operation as would be seen in reduced costs to the end consumer. For standard connections, the voltage criteria was not considered to be particularly material as in most cases capacity would determine the Type with the exception of some generators in the 30-50MW range defaulting to Type D due to connection at 132kV.

Germany

In Germany, VDE|FNN defines in the Technical Connection Rules requirements for connection and parallel operation with the grid, that fulfil both the EU specifications and the specifics for the German electric power system. Users that comply with these codes of practice will also adhere to the European Network Codes. The following technical rules are applicable for mixed customer sites as a part of the National Standardisation Document Set[21]:

- VDE-AR-N 4100 and, VDE-AR-N 4105 (LV means $U_{CGP} \leq 1$ kV)
- VDE-AR- N 4110 (MV means 1 kV < U_{GCP} < 60 kV)
- VDE-AR-N 4120 (HV means 60 kV ≤ U_{GCP} < 150 kV)
- VDE-AR-N 4130 (eHV means $U_{GCP} \geq 150$ kV) - available also in English.

The German Technical Connection Rules are set up for the different voltage levels since the requirements for grid connection depend on them. Additionally, the requirements distinguish between the different Types A to D, which are defined with[22]

- Type B: P ≥ 135 kW (equals S ≥ 150 kVA)
- Type C: P ≥ 36 MW (equals S ≥ 40 MVA)
- Type D: P ≥ 45 MW (equals S ≥ 50 MVA)

Article 5 (2d) of NC RfG is met because of all generators connected to 110kV or higher are automatically Type D.

Mixed customer sites are explicitly included in the scope of these technical rules. Moreover, they have separate paragraphs with specific requirements. In the case that the installed generation MW capacity within a mixed customer site connected directly to 110kV or higher is less than 50% of the agreed active power for consumption of this customer, simplified requirements for reactive power can be negotiated with the consent of the connected system operator.

[21] https://www.vde.com/en/fnn/topics/european-network-codes/rfg

[22] https://www.vde.com/de/fnn/themen/europaeische-network-codes/leistungsklassen

Often small generation units in mixed customer facilities are connected to DSOs or a CDSO. In the case of a CDSO connection Paragraph 110 of the national network code (Energiewirtschaftsgesetz – EnWG) applies which transposes Article 30 of Directive 2009/72/EC into national law. For discussion conducted in Chapter 5 and the application of the NC RfG and the Technical Connection Rules, in the case of a closed distribution network the point of connection of the downstream network user to the closed distribution system is relevant.

Belgium

It is the intention of the Belgian TSO to ask for an RfG class derogation[23] for a limited period of 5 years to remove the voltage criteria for PGMs in Types A and B. This option has the advantage of solving many of the issues encountered in the current version of the code but still has the following disadvantages:

- It does not solve the issue of PGMs of Type C connected at 110 kV or above
- The duration of the RfG class derogation is limited in time. So a renewal procedure will be required to keep the class derogation active and with attendant uncertainty for investors with future project portfolios
- The NRA has to approve the RfG class derogation

Netherlands

The Connection Network Codes are implemented by changing the national network codes. A group with members from the Dutch TSO and DSOs created a draft text. This was consulted with stakeholders and proposed to the NRA. The changes are now approved by the NRA.

Not many cases of a mixed customer site are expected in the Netherlands. Therefore, a RfG derogation[24] per individual request of a customer will be supported by the TSO first on a case by case basis. At the moment it is not expected that the TSO will ask for a general applicable derogation[25].

---

[23] As per Article 63 of RfG.

[24] As per Article 62 of RfG.

[25] As per Article 63 of RfG

ANNEX 2: CAPACITY THRESHOLDS SET DURING NATIONAL IMPLEMENTATION

Correct at March 2019 - Values published on Active Library site: https://docs.entsoe.eu/cnc-al/

Member State	Type Threshold Proposals		
	A/B	B/C	C/D
AL	No limits defined	No limits defined	The minimum power threshold for a generating module to be connected to the transmission system network will be 15 MW for voltage level 110 kV at the connection point and 50 MW for voltage level 220 kV at the connection point
AT	250 kW	35 MW	50 MW
BA			
BE	1MW	25 MW	75 MW (25 MW if>110 kV)
BG	1 MW	5 MW	20 MW
CH	200-300 KW	36 MW	45 MW
CY			
CZ	A1: 11 KW A2: 100 KW	B1: 1 MW B2: 30 MW	75 MW
DE	135 KW	36 MW	45 MW
DK	125 KW	3 MW	25 MW
EE	0.5 MW	5 MW	15 MW
ES	100 KW	5 MW	50 MW
FI	1 MW	10 MW	30 MW
FR	1 MW	18 MW	75 MW
GB	1 MW	10 MW	50 MW
GR	1 MW	15 MW	75 MW
HR	500 kW	5 MW	10 MW
HU	200 KW	5 MW	25 MW
IE	100kW	5MW	10MW
IS			
IT	11,08 kW	6 MW	10MW
LT	250 kW	5 MW	15 MW
LU	135 KW	36 MW	45 MW
LV	0,5 MW	5 MW	15 MW
ME			
MK			
NL	1 MW	50 MW	60 MW
NO	1,5 MW	10 MW	30 MW
PL	200kW	10MW	75MW
PT	1 MW	10 MW	45 MW
RO	1 MW	5 MW	20 MW
RS	1 MW	50 MW	75 MW
SE	1,5 MW	10 MW	30 MW
SI	10 kW	5 MW	20 MW
SK	100 KW	5 MW	20 MW

ANNEX 3: SCORING OF OPTIONS FOR VOLTAGE CRITERIA

The full scoring of the voltage criteria options as provided by representatives of each category within the workgroup was as follows:

TSOs

(Robert Wilson)

	Acceptability								Additional costs for												
	TSOs	DSOs	Generators	Manufacturers	Industrial sites	Simple solution (in terms of the code text)	Simple solution (in terms of ease of implementation)	Does it work in all cases?	System operators	Generators	Industrial sites	Treats connection to all networks equitably	Visibility of performance within a network	Establishes another legal boundary	Solves issues to do with reactive power supply	Solves issues to do with FRT	Solves issues to do with geographic non-availability of LV connections	Solves issues with large industrial sites connected at <220kV	Solves issues with large industrial sites connected at 220kV or above	Will not encourage 'gaming' of connection configurations	**Totals**	Comments (particularly on acceptability)
Use interface point for all	2	2	3		3	2	2	4	3	3	4	4	1	1	4	4	1	4	4	4	**55**	Concerned about establishing another legal boundary
Use interface point – for type selection only	3	3	3		3	2	2	4	3	3	2	3	3	1	2	2	1	4	3	4	**51**	Doesn't solve reactive issues
Change the default criteria to 220kV	3	3	1		2	4	4	1	3	3	2	3	3	5	3	3	4	5	1	3	**56**	Doesn't work for some >220kV industrial sites
Carve out of type A from the voltage criteria (ie type A only decided by capacity)	3	3	3		3	3	4	2	4	4	3	3	3	5	3	3	2	3	3	2	**59**	Type A is not really an operating standard
Carve out of types A&B from the voltage criteria	3	3	4		4	3	4	4	3	4	4	3	3	5	4	4	3	4	4	2	**68**	This could work; A/B are massmarket product standards really
Remove type D voltage criteria completely (identical to a carve out of types A-B-C)	1	2	5		5	4	4	4	1	5	5	3	3	5	4	4	5	5	5	4	**74**	Is this necessary? - type C/D requirements are not that different. Likely that some TSOs would want to reassess capacity thresholds

DSOs

(Paul de Wit)

	Acceptability							Additional costs for													
	TSOs	DSOs	Generators	Industrial sites	Simple solution (in terms of the code text)	Simple solution (in terms of ease of	Does it work in all cases?	System operators DSOs	Generators	Industrial sites	Treats connection to all networks equitably	Visibility of performance within a network	Establishes another legal boundary	Solves issues to do with reactive power supply	Solves issues to do with FRT	Solves issues to do with geographic non-	Solves issues with large industrial sites	Solves issues with large industrial sites	Will not encourage 'gaming' of connection	Totals	nments (particularly on acceptabil
Use interface point for all		1			1	1	3	2			4	1	1	2	2	1			2	**21**	Concerned about establishing another legal boundary
Use interface point – for type selection only		2			2	2	3	2			3	1	1	2	2	1			2	**23**	Doesn't solve reactive issues
Change the default criteria to 220kV		3			4	4	1	4			3	3	5	3	3	4			3	**40**	Doesn't work for some >220kV industrial sites
Carve out of type A from the voltage criteria (ie type A only decided by capacity)		3			3	4	2	3			3	3	5	3	3	2			2	**36**	Type A is not really an operating standard
Carve out of types A&B from the voltage criteria		3			3	4	4	3			3	3	5	4	4	3			2	**41**	This could work; A/B are massmarket product standards really
Remove type D voltage criteria completely (identical to a carve out of types A-B-C)		5			5	5	5	3			3	3	5	4	4	5			4	**51**	Is this necessary? - type C/D requirements are not that different. Likely that some TSOs would want to reassess capacity thresholds

DSOs

(Mike Kay)

	Acceptability							Additional costs for													
	TSOs	DSOs	Generators	Industrial sites	Simple solution (in terms of the code text)	Simple solution (in terms of ease of implementation)	Does it work in all cases?	System operators	Generators	Industrial sites	Treats connection to all networks equitably	Visibility of performance within a network	Establishes another legal boundary	Solves issues to do with reactive power supply	Solves issues to do with FRT	Solves issues to do with geographic non-availability of LV connections	Solves issues with large industrial sites connected at <220kV	Solves issues with large industrial sites connected at 220kV or above	Will not encourage 'gaming' of connection configurations	Totals	Comments (particularly on acceptability)
Use interface point for all		2	3		2	2	3	2	4		4	1	1	3	3	3	4	4	2	**43**	Concerned about establishing another legal boundary
Use interface point – for type selection only		3	3		2	2	3	2	4		3	1	1	2	3	3	4	3	2	**41**	Doesn't solve reactive issues
Change the default criteria to 220kV		2	4		5	5	1	3	3		3	3	5	3	3	4	5	1	2	**52**	Doesn't work for some >220kV industrial sites
Carve out of type A from the voltage criteria (ie type A only decided by capacity)		3	5		4	5	5	2	5		5	1	5	2	3	5	5	5	2	**62**	Type A is not really an operating standard
Carve out of types A&B from the voltage criteria		4	4		4	4	5	4	5		5	1	5	3	5	2	3	3	2	**59**	This could work; A/B are massmarket product standards really
Remove type D voltage criteria completely (identical to a carve out of types A-B-C)		4	4		5	5	5	3	5		5	1	5	3	4	3	4	4	2	**62**	Is this necessary? - type C/D requirements are not that different. Likely that some TSOs would want to reassess capacity thresholds

Generators

(Eric Dekinderen/Garth Graham)

	Acceptability							Additional costs for													
	TSOs	DSOs	Generators	Industrial sites	Simple solution (in terms of the code text)	Simple solution (in terms of ease of implementation)	Does it work in all cases?	System operators	Generators	Industrial sites	Treats connection to all networks equitably	Visibility of performance within a network	Establishes another legal boundary	Solves issues to do with reactive power supply	Solves issues to do with FRT	Solves issues to do with geographic non-availability of LV connections	Solves issues with large industrial sites connected at <220kV	Solves issues with large industrial sites connected at 220kV or above	Will not encourage 'gaming' of connection configurations	**Totals**	Comments (particularly on acceptability)
Use interface point for all			4		2	2	5	4	4	3	5	3	3	5	5	1	4	4	4	**58**	
Use interface point – for type selection only			1		2	2	2	3	4	3	1	3	1	2	3	1	3	3	4	**38**	
Change the default criteria to 220kV			1		5	4	1	3	4	1	1	3	3	2	3	1	4	1	3	**40**	
Carve out of type A from the voltage criteria (ie type A only decided by capacity)			2		5	4	1	5	4	3	3	3	3	3	3	1	1	1	2	**44**	
Carve out of types A&B from the voltage criteria			2		5	4	1	5	4	3	3	3	3	3	3	4	1	1	2	**47**	
Remove type D voltage criteria completely (identical to a carve out of types A-B-C)			5		5	5	5	5	5	5	5	3	5	3	3	5	5	5	5	**74**	

Manufacturers

(Luca Guenzi)

	Acceptability							Additional costs for															
	TSOs	DSOs	Generators	Industrial sites	Simple solution (in terms of the code text)	Simple solution (in terms of ease of implementation)	Does it work in all cases?	System operators	Generators	Industrial sites	Treats connection to all networks equitably	Visibility of performance within a network	Establishes another legal boundary	Solves issues to do with reactive power supply	Solves issues to do with FRT (1)	Solves issues to do with FRT (2)	Solves issues to do with geographic non-availability of LV connections	Solves issues with large industrial sites connected at <220kV	Solves issues with large industrial sites connected at 220kV or above	Will not encourage 'gaming' of connection configurations	Totals (1)	Totals (2)	Comments (particularly on acceptability)
Use interface point for all			4	4	2	4	4		4	4	4	3	1	4	4	1	4	4	4	4	**58**	**55**	Interface point permit the exact definition of the requirements to be met by generators. It simplifies the way industrial sites have to define the requirements internally (it works with product standard). However the criteria used in defining the requirements shall most probably be recosnidered and values to be redefined (?). In case FRT requirements is considered for the single units, for type D units 0%Un would not be acceptable since a faulty unit should remain connected (therefore the requirements either should remain at the POC or to be reconsidered as many others). -> it oncreases the work of TSOs which should be knowledgeable in defining the requirements at the interface point function of their expectation for the system. Concerned to state a new legal boundary.
Use interface point – for type selection only			3	4	2	3	4		4	3	3	3	1	3	3	3	4	3	3	3	**49**	**49**	The effect is much similar to the last solution, but it eventually requires much more modification to the code. Concerned to state a new legal boundary.
Change the default criteria to 220kV			1	1	5	3	1		3	3	3	3	5	2	3	3	2	3	2	4	**44**	**44**	The overall effect is like the last option. It works only if there is no exception (or motivated exception).
Carve out of type A from the voltage criteria (ie type A only decided by capacity)			3	3	3	3	3		4	4	3	3	5	3	3	3	2	2	2	3	**49**	**49**	it does not address type B and C, which, especially Type B can be considered mass market generation.
Carve out of types A&B from the voltage criteria			4	4	3	3	3		4	4	3	3	5	3	3	3	3	3	3	3	**54**	**54**	A/B are massmarket product standards which mens that it will apply for the majority (in term of number) of the units, but plants/generators type C (relevant, looking at some threshold considered by System Operator and Regulator) are excluded.
Remove type D voltage criteria completely (identical to a carve out of types A-B-C)			5	5	5	4	4		4	4	4	3	5	3	3	3	4	4	4	4	**65**	**65**	The more simple solution. It does not provide the advantage of the 1st solution, but it is simple and the modification to the RfG are minimal.

Industrial Consumers & CDSOs

(Michaël Van Bossuyt)

	Acceptability				Simple solution (in terms of the code text)	Simple solution (in terms of ease of implementation)	Does it work in all cases?	Additional costs for			Treats connection to all networks equitably	Visibility of performance within a network	Establishes another legal boundary	Solves issues to do with reactive power supply	Solves issues to do with FRT	Solves issues to do with geographic non-availability of LV connections	Solves issues with large industrial sites connected at <220kV	Solves issues with large industrial sites connected at 220kV or above	Will not encourage 'gaming' of connection configurations	Totals	Comments (particularly on acceptability)
	TSOs	DSOs	Generators	Industrial sites				System operators	Generators	Industrial sites											
Use interface point for all				2	2	2	2	3	3	3	3		5	2		NA	3	3	4	**37**	Concerned about establishing another legal boundary
Use interface point – for type selection only				2	2	2	2	3	3	3	3		5	2		NA	3	3	4	**37**	Doesn't solve reactive issues
Change the default criteria to 220kV				1	4	2	1	3	3	3	1		5	3		NA	4	1		**31**	Doesn't work for some >220kV industrial sites
Carve out of type A from the voltage criteria (ie type A only decided by capacity)				1	3	3	1	3	3	3	1		5	3		NA	1	1		**28**	Does not solve the problem for type B and C
Carve out of types A&B from the voltage criteria				1	3	3	1	3	3	3	1		5	4		NA	1	1		**29**	Does not solve the problem for type C
Remove type D voltage criteria completely (identical to a carve out of types A-B-C)				5	5	5	5	5	5	5	5		5	4		NA	5	5	5	**64**	Type C/D requirements in the exhaustive and non-exhaustive (national) obligations can be significantly different

For industrial consumers, it is unambiguously clear that only the removal of the type D voltage criterion will solve all open issues discussed in this framework of (non-CDS) Mixed Customer Sites. A carve-out of type A or A and B will only partially solve the problem, while shifting the threshold to 220kV will retain the current issue for a number of industrial sites (non-CDS). The use of an interface point, whether for all requirements or only for type selection purposes, will mimic the situation that currently already exists for Closed Distribution Systems, but will require an in-depth discussion on the introduction of a new concept with potential secondary effects and will open, as opposed to CDSs where the CDSO is the RSO for many requirements, an extensive discussion on responsibilities for qualification and validation of generation facilities.

LIST OF PARTICIPANTS

Name	Organisation	Representation at GC ESC
Robert Wilson	National Grid	ENTSO-E
Pietro Meloni	Terna	ENTSO-E
Karel Mägi	ELERING	ENTSO-E
Ioannis Theologitis	ENTSO-E	ENTSO-E
Eric Dekinderen	VGB	VGB
Jean-Noël Marquet	EDF	VGB
Manuel Weindorf	GE	EASE
Fernando Morales	Highview Power	EASE
Brittney Elzarei	EASE	EASE
Michael Van Bossuyt	IFIEC	IFIEC
Maxime Buquet	GE	EUTURBINES
Luca Guenzi	SOLARTURBINES	EUTURBINES
Magdalena Kurz	EUTURBINES	EUTURBINES
Alberto Bridi	EDYNA	CEDEC
Paul de Wit	Alliander	CEDEC
Marc Malbrancke	CEDEC	CEDEC
Gaetan Claeys	EUGINE	EUGINE
Frederik Kalverkamp	FGH	EFAC
Garth Graham	SEE	EURELECTRIC
Mike Kay	ENA	GEODE
Karol O'Kane	ESB	EURELECTRIC
Pat Dowling	ESB	EURELECTRIC
Benjamin Düvel	BDEW	EURELECTRIC
Nelida Santos	Iberdrola	EDSO for Smart Grids
Manuel Jaekel	Innogy	EDSO for Smart Grids
Juan Marco	EDSO for Smart Grids	EDSO for Smart Grids
Andrés Pinto-Bello Gomez	smartEn	smartEn
Marcus Müller	Tesla	smartEn
Katrin Schweren	Tiko	smartEn
Raffaele Rossi	SolarPower Europe	SolarPower Europe
Vasiliki Klonari	WindEurope	WindEurope
Gunnar Kaestle	B.KWK	COGEN Europe
Alexandra Tudoroiu	COGEN Europe	COGEN Europe
Vincenzo Trovato	ACER	ACER
Nikolas Schmitz	BNetzA	BNetzA