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Stage 01: Workgroup Report

Grid Code

GC0048: Requirements for Generators – GB Banding Thresholds Workgroup Report

What stage is this document at?

01	Workgroup Report
02	Industry Consultation
03	Report to the Authority

This report summarises the findings of the GC0048 workgroup in assessing viable options for setting banding thresholds in the European Network Code 'Requirements for Generators' as required during the GB implementation, and makes recommendations to the Grid Code and Distribution Code Panels for industry consultation.

This document contains the findings of the Workgroup which formed on January 2014

Published on: **17/03/2016**

The Workgroup recommends:
Industry consultation on the banding options as recommended

High Impact:
All new and existing 1MW+ power generating modules, Transmission System Operators, Distribution Network Operators, Generator Equipment Manufacturers, in the GB synchronous area

Medium Impact:
New 800W-0.999MW power generating modules

Low Impact:
None

Contents

Any Questions?

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About this document

This document is a Workgroup Report which contains the discussions and recommendations of the GC0048 Workgroup in relation to determining the RfG banding levels for Power Generating Modules.

Document Control

Version	Date	Author	Change Reference
0.1	05/11/2015	National Grid	Draft Workgroup Report
0.2	12/12/2015	National Grid	
0.3	09/01/2016	National Grid	
0.4	29/01/2016	National Grid	Revised structure
0.5	26/02/2016	National Grid	Next workgroup draft

1 Executive Summary

The European Network Code 'Requirements for Generators' (RfG) applies technical requirements to new generators of 800 Watts (W) in capacity or greater, who procure their main plant items later than two years after the code enters into force (currently estimated for Q1 2016). In some cases existing power generating modules may be bound by RfG, for example if they undertake significant modernisation which necessitates substantial revisions to their connection agreement.

RfG uses four incremental type bands ('A' to 'D') which set a sliding scale of generator technical capabilities to support System Operators. The Transmission System Operation Guideline (TSOG) also uses the RfG banding thresholds to apply data exchange requirements on new *and* existing power generating modules (other EU codes may also refer to RfG banding too).

Each of the four RfG type bands has an associated connection voltage and installed unit capacity range (MW). For each European synchronous area MW ceiling levels are set out in RfG, and describes the process each Member State needs to follow to set their own levels (whether this be the ceiling level or values below).

It requires any proposals to be justified, consulted on, and finally approved by the appropriate national regulatory authority (NRA). A full cost benefit analysis is not mandated as part of the RfG. In the event that modifications to the levels are required in future, the same process can be rerun no sooner than 3 years later.

The principle of the banding thresholds is to balance a need from System Operators to manage secure and robust systems, against a proportionate and efficient level of support from generators. At the same time the EU codes are interested in facilitating cross border trade, harmonisation and encouraging competition in energy markets.

It is also important to reflect on the extent that it is reasonable for RfG and RfG banding to be used as a remedy for existing issues which TSOs have to manage in the GB synchronous area. Whilst future iterations of RfG banding levels provide an opportunity to revisit the levels of support previously prescribed in Member States, this review shouldn't be at the detriment of a timely and successful formation of the banding levels. Protracted national debates on banding could risk the next phase of implementation, which must legally be completed within two years of RfG's Entry Into Force.

The GC0048 workgroup has been discussing the GB banding levels for over a year. In this time, the group has been trying to understand the needs of the GB System Operator, what generators can inherently do to fulfil these needs, and clarification of any additional costs that could be incurred in doing this.

In January 2016, these discussions culminated with an agreement in principle that the 'maximum' levels as drafted into RfG for the GB synchronous area should be ratified for use in GB, with a three year review written into any resulting legal text (which will follow at a later date).

Overall, it was agreed the high option presented the least risk to GB as a whole. Lowering the level increased the likelihood of onerous costs being incurred by generators (particularly those at Type C providing Frequency Response below the existing 50MW level for PPMs) without the necessary guarantees for remuneration. It also removed the opportunity of harmonising GB to Continental Europe. The workgroup also flagged the risk of banding being used in the TSOG, which could have unforeseen consequences in its application which may exacerbated by a low GB banding level.

The discussions on banding are summarised later in this report which, once agreed by the GC0048 workgroup and the Grid Code and D-Code Review Panels, will form the basis of an industry consultation. This will allow the work of GC0048 to be reviewed by external industry stakeholders and discover any additional perspectives which may be missing to be considered. The outcome of the consultation will ultimately inform a final report justifying the preferred GB banding level, which will be submitted to the national regulatory authority for their decision.

2 Background to the European Network Codes and RfG

This section provides explains the history of RfG and its part of broader work within the EU to harmonise energy markets. It explains who is bound by the requirements, and the process for implementation. It clarifies what the banding does in RfG and how it is applied.

2.1 What is 'Requirements for Generators'?

RfG sets harmonised rules for grid connection across Europe of power generation modules of 800 Watts (W) in capacity or greater. It seeks to provide a clear legal framework for grid connections, facilitate Union-wide trade in electricity, ensure system security, facilitate the integration of renewable electricity sources, increase competition and allow more efficient use of the network and resources.

ENTSO-E web page for RfG, including code text:
http://networkcodes.entsoe.eu/connection-codes/requirements-for-generators/

ENTSO-E overview of the European Network Codes:
https://www.entsoe.eu/major-projects/network-code-development/Pages/default.aspx

2.2 How did it originate?

The European Third Energy Package was adopted in July 2009, and has been law since March 2011. It is a suite of legislation for both Electricity and Gas, and is a key step forward in developing a more harmonised European energy market.

As applied to the electricity supply industry, the Third Energy Package has three key outputs: enhancing sustainability and helping the European Union (EU) meet its decarbonisation obligations; ensuring security of supply in light of a changing generation mix; and creating a single European Market for Electricity.

As is common to all EU law, regulations apply directly to the member states, whereas directives require transcription into national law. In particular, Directive 2009/72/EC (concerning common rules for the internal market in electricity) was transcribed into GB Law via The Electricity and Gas (Internal Markets) Regulations 2011.

The Third Energy Package also delivered the formation of the European Network of Transmission System Operators for Electricity and Gas; ENTSO-E/ENTSO-G. ENTSO-E led the drafting of the RfG before the text was approved by EU Member States in June 2015.

2.3 What was ENTSO-E's objectives when drafting RfG?

ENTSO-E's brief when drafting these codes was to realise the broad objectives of the Third Energy Package. ENTSO-E also considered the challenges additional renewable generation would present to the way Transmission Systems are designed and managed. In a world of increasing wind and solar generation, HVDC interconnection, issues around system voltage, reactive power and increasing frequency sensitivity due to less inertia, become a significant consideration.

From a systems engineering approach, ENTSO-E believe that transmission systems and their users (power generating modules, DSOs and demand facilities) should be considered as 'one system' comprehensively. They should cooperate closely during normal and disturbed operating conditions in order to preserve or restore system security.

In particular, power generating modules are fundamental to the design and operational characteristics of the Transmission system, playing an important role by providing ancillary services for system balancing/frequency control, voltage control, resilience during disturbances and to assist with system restoration after blackouts

RfG therefore specifies power generating module capabilities in this 'system operability' context, and strives to be technology neutral and focuses primarily on capacity and connection.

Timeline

Workgroup Meeting Dates

M1 – 28 January 2014
M2 – 24 March 2014
M3 – 24 September 2014
M4 – 20 October 2014
M5 – 20 November 2014
M6 – 17 December 2014
M7 – 20 January 2015
M8 – 17 February 2015
M9 – 19 March 2015
M10 – 19 May 2015
M11 – 20 July 2015
M12 – 18 August 2015
M13 – 25 September 2015
M14 – 28 October 2015
M15 – 19 November 2015
M16 – 17 December 2015
M17 – 12 January 2016
M18 – 2 March 2016

Article 2 of RfG defines power generating modules and related terms as follows:

'power generating module' means either a synchronous power generating module or a power park module;

'synchronous power generating module' means an indivisible set of installations which can generate electrical energy such that the frequency of the generated voltage, the generator speed and the frequency of network voltage are in a constant ratio and thus in synchronism;

'power park module' or 'PPM' means a unit or ensemble of units generating electricity, which is either non-synchronously connected to the network or connected through power electronics, and that also has a single connection point to a transmission system, distribution system including closed distribution system or HVDC system;

'power generating facility' means a facility that converts primary energy into electrical energy and which consists of one or more power generating modules connected to a network at one or more connection points;

The recitals in RfG state: "*(9) The significance of power generating modules should be based on their size and their effect on the overall system"* – and this is how RfG banding is applied.

2.4 **When does it apply?**

RfG is set to 'Enter Into Force', the formal ratification of the legislation into the Official Journal of the European Union, at the end of Q1 2016. Member States then have two years to implement the code's requirements nationally.

However, there is a point two years after Entry Into Force where new power generating modules will either be bound by existing national requirements, or the new RfG requirements. If a power generating module developer has a legally binding contract to procure their main plant items dated before two years after Entry Into Force, then they are classed as existing and current national requirements will apply. After this date, the user is classed as 'New' and must comply with RfG.

2.5 **What does RfG banding do?**

ENTSO-E provided the following guidance on how the four banding levels evolve power generating module technical capabilities to support the system:

Technical requirements for each RfG banding type:

Type A	Type B	Type C	Type D
• Operation across a range of frequencies • Limits on active power output over frequency range • Rate of change of frequency withstand capability (likely to be at least 1Hz/sec) • Logic interface (input port) to cease active power output within 5 secs	• Type A, plus… • Ability to automatically reduce power on instruction • Control schemes, protection and metering • Fault Ride Through requirements • Ability to reconnect • Reactive capability • Reactive current injection	• Type B, plus… • Active power controllability • Frequency response • Monitoring • Automatic disconnection • Optional Black start • Stable operation anywhere in operating range • Pole slipping protection • Quick resynchronisation capability • Instrumentation and monitoring requirements • Ramp rate limits • Simulation models	• Type C, plus… • Wider Voltage ranges / longer minimum operating times • Synchronisation on instruction • Fault Ride through

2.6 Background on setting the banding levels draft into the code

Originally the maximum banding thresholds in each synchronous area were set in rough proportion to the size of each area embodying the principal that a 10MW power generating module in the Continental Europe (CE) block, for example, would be much less significant than if connected in Ireland.

In the January 2015 draft of RfG, the banding thresholds for the GB synchronous area were instead aligned to the higher CE levels. This was primarily based on GB stakeholder feedback that identical levels across GB and into CE would help manufacturers develop harmonised product standards and allow for future flexibility. If lower thresholds were required for GB, a proposal could be made as long as there was suitable justification.

	Type A	Type B	Type C	Type D
Connection Voltage:	<110kV	<110kV	<110kV	≥110kV
	MW range for Power Generating Modules	**MW range for Power Generating Modules**	**MW range for Power Generating Modules**	**MW range for Power Generating Modules**
Continental Europe	800W-1 MW	1 MW-50MW	50 MW-75 MW	75 MW+
Great Britain	800W-1 MW	1 MW-50MW	50 MW-75 MW	75 MW+
Nordic	800W-1.5 MW	1.5 MW-10MW	10 MW-30 MW	30 MW+
Ireland and Northern Ireland	800W-0.1 MW	0.1 MW-5MW	5 MW-10 MW	10 MW+
Baltic	800W-0.5 MW	0.5 MW-10MW	10 MW-15 MW	15 MW+

[Adapted from RfG Article 5, Clause D, Table 1; June 2015]

Previous versions of the GB synchronous area (RfG definition 2) banding in earlier RfG drafts had the banding thresholds at a lower level, closer aligning England and Wales with the Scottish TSO designation of 'Large' Power Stations:

January 2014 GB Levels	**Type A**	**Type B**	**Type C**	**Type D**
Connection Voltage	<110kV	<110kV	<110kV	≥110kV
MW range for Power Generating Modules	0.8KW-1MW	1MW-10MW	10-30MW	30MW+

2.7 Process for Member States setting their banding level

RfG requires national TSOs to set their levels and ratifiy them via an industry consultation and regulatory authority approval. At the time of writing, it is assumed that National Grid Electricty Transmission will be the national TSO performing this function

This process is further outlined in Article 5(3) of the code:

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.

This is required for implementation, but is also the same process for any subsequent review, as allowed at an interval of no less than three years. Subsequent iterations of the banding can never exceed the levels drafted into the code, which provide a ceiling.

As the requirement to set banding levels lies with Member States, rather than Synchronous Areas as a whole (in the case of the EU synchronous area, there are multiple Member States to one overall Synchronous Area), there is a possibility that a common CE level could be eroded by local TSOs reducing their levels. Therefore whilst it is sensible to consider the positions which neighbouring synchronous areas take (and associated Member States), the initial banding setting should above all reflect the needs of the local network(s).

2.8 **Process in GB for setting our banding level**

The implementation of RfG is being managed through a joint Grid Code and Distribution Code workgroup, GC0048, and their respective code goverance. This approach of using existing national codes for the GB implementation is being taken for all EU codes. At workgroup meetings, stakeholders discussed viable options for the banding, and the pros and cons of setting the levels from various perspectives.

Particular workgroup focus was given to the MW level for the Type B-C boundary (these discussions are outlined in more detail in section 4.2-4.6 later in the report), the point at which the technical requirements evolve from a manufacturer standard and become associated with much more active real-time response capabilities, particularly frequency control and ancilliary service provision.

The workgroup also agreed the rolling three year review allowed the GB NETSO opportunities to verify the banding was still fit for purpose as the system evolved. If it was felt that a change was needed, the GB NETSO could compile their case and submit for industry consultation and then regulartory approval. The process for the three year review of banding is (again) outlined in RfG article 5(3).

3 Background to GB Synchronous Area

The following section provides a background to the key players in the GB energy market and the roles they play. It also explains the profile of the local system, and the trends or future scenarios of generation connecting to the system which need to be considered when setting the banding levels.

3.1 Network Ownership and Operation

The GB Synchronous Area consists of Transmission and Distribution networks each managed by regional owners. There are three Transmission (System) Owners – National Grid for England and Wales; Scottish Power Transmission in the south Scotland region and Scottish Hydro Electricity Transmission (SHET) in the north of Scotland.

National Grid as the National Electricity Transmission System Operator (NETSO) is responsible for operating the transmission system across GB, balancing demand and generation in real-time to manage system frequency and voltage.

The Distribution network is owned by twenty licenced Distribution Network Operator (DNO) companies, and is operated in geographic areas.

Other designated TSOs in GB include Offshore Transmission Owners (OFTOs). Under this regime offshore wind transmission assets are separated from the Generation assets and 'auctioned' to an independent third party operator. The OFTO regime has been in place since 2009.

Interconnector operators are also considered as TOs in GB. Currently there is just over 4GW of installed interconnector capacity between GB and neighbouring synchronous areas, with 8GW of new capacity in development.

All parties above undertake their respective Operator responsibilities under licence issued by the National Regulatory Authority. The following table summarises how these parties will be identified for the remainder of this report.

Roles	Organisation(s)	Referred To As…
GB System Operator	National Grid	GB NETSO
GB Transmission (System) Owner - Onshore	National Grid (England and Wales) Scottish Power Transmission (South Scotland) Scottish Hydro Electric Transmission Plc (North Scotland)	TO
GB Transmission (System) Owner - Offshore	Multiple parties (see below)	OFTOs
GB Distribution Network Operator	Multiple parties (see below)	DNOs
GB Transmission (System) Owner - Interconnector	Multiple parties (see below)	Interconnectors

The full list of licencees is provided on Ofgem's website:
https://www.ofgem.gov.uk/publications-and-updates/list-all-electricity-licensees-registered-or-service-addresses

3.2 Existing regulatory frameworks

Under existing arrangements, connections to the Transmission or Distribution system are governed by the appropriate GB industry codes; connections to the Transmission System are governed by the Connection Use of System Code (CUSC) and the Grid Code. Connections to the Distribution Network are governed by the Distribution Code Use of System Agreement (DCUSA), Distribution Code and its engineering sub-documents.

GB generation is currently grouped by *Power Station*[1] net capacity, whereas RfG refers to 'power generating module' for determining significance in the Grid Code to apply appropriate technical and commercial obligations. These have three tiers (Small, Medium and Large) and have regional variants depending on the host Transmission area:

Current GB Definitions:			
Power Station size	SHET	SPT	NGET
Small	<10MW	<30MW	<50MW
Medium			50-100MW
Large	>10MW	>30MW	>100MW

The origin of these values stems from the history of how the national codes have evolved over time.
Currently in England and Wales any plant above 100MW, regardless of whether it is embedded or directly connected must be subject to the wholesale electricity market and have a Generation License. Generation below 100MW can opt to be party to the wholesale market or not, unless it is directly connected to the Transmission System, in which case it is a mandatory requirement.

Where generation is connected to the Distribution network, it is referred to as 'Embedded' in the GB codes. These schemes are also categorised in the codes for the purposes of assigning proportionate technical capability.

Embedded Medium Power Stations for example, are still caught by limited requirements of the Grid Code but there is an option of Licence Exemption which means that they do not have to be party to the wholesale electricity market and do not have to be a CUSC signatory (see section 3.2.2).

Small Embedded Power Stations are not bound by default by the requirements of the CUSC and Grid Code, but they can choose to comply if they wish. However any plant which connects to the Distribution Network must satisfy the requirements of the DCUSA and Distribution Code. Larger Embedded Generators, (i.e. those above 10MW, 30MW and 100MW depending on TSO region) will be required to satisfy the requirements of the CUSC, Grid Code, DCUSA and Distribution Code.

Currently in Scotland the terms Large, and Small Power stations are used but these values vary depending upon the Scottish TSO region to which the Generation is connected (see above table). With 132 kV designated Transmission in Scotland, power stations connected to the Transmission Network at 132kV and above are required to comply the CUSC, Grid Code, BSC and be Licenced.

In Scotland a lower set of thresholds is required to deal with localised issues such as voltage control. Later on this report explains how RfG banding is applied, and how it brings consistency to the application of technical requirements on new generators regardless of whether they or north or south of the Scottish border. It is therefore important to consider the application of the banding so that these important requirements continue in a post-RfG implementation world.

Do we use banding to do this, and effectively bring the banding down to a level sufficient to address the most onerous requirement? Or do allow certain local requirements in GB at the moment to persist alongside RfG requirements (where possible) so that the banding can be a little more relaxed?

As well as considering the impact of banding within the existing GB codes, there are other within the regulatory frameworks regime which either impact banding directly, or because they serve as important examples of previous changes which had consequential issues for GB users. The following sections outline two such examples.

[1] **Power Station** An installation comprising one or more **Generating Units** or **Power Park Modules** (even where sited separately) owned and/or controlled by the same **Generator**, which may reasonably be considered as being managed as one **Power Station**. [Grid Code - Issue 5]

3.2.1 **Licence Exemptible Embedded Medium Power Stations (LEEMPS) and stranding of assets**

Embedded Medium generators (between 50-99 MW in England and Wales) are classified as 'LEEMPS' if awarded generation licence exemption. Alternatively these users are classed as a typical 'Medium' Power Station.

LEEMPS do not have to comply with potentially onerous requirements set out in the GB codes (e.g. BSC participation), and avoid Transmission Network Use of System (TNUoS) charging.

A LEEMPS therefore does not have to accede to the BSC or CUSC (and are therefore not a BM party), however this effectively 'strands' the generator from being able to fulfil their mandatory response requirements.

It is therefore important that the banding thresholds are set to consider the scale/nature of the plant in question, particularly for real-time response capabilities set in Type C-D. It is important therefore to apply requirements on users where they are capable of doing so without significant financial investment, or at least with easy route for remuneration of said costs, thus avoiding commercial stranding.

Furthermore, the future of LEEMPS in the context of EU Codes implementation should be considered (outside of this work), as the removal of regional differences through RfG may make this LEEMPS status redundant. Some clarity on this should be sought externally to RfG, but is an important to explain this for new users bound by RfG in this 50-100MW bracket in England and Wales (i.e. does LEEMPS still exist under RfG?).

3.2.2 **Mandatory Frequency Response requirement**

One important consideration for comparing the existing Grid Code and RfG power generating module levels is where the provision of mandatory Frequency Response capability is set.

The Grid Code requirements for Frequency Response, section CC 6.3.7(e), sets this at 50MW for Power Park Modules, or the 'Large' levels for synchronous generating units within Power Stations. Under RfG, the maximum threshold between Type B to Type C set for GB is also 50MW, providing an element of consistency for Power Park Modules under both arrangements (if bandings are not lowered).

Discussions at the GC0048 workgroup on banding considered at length whether it was reasonable to revise (lower) the level for Frequency Response in RfG, under the maximum permitted level of 50MW for Type C

3.3 **The nature of the GB Synchronous Area**

Understanding the nature of connections to GB synchronous area is important when considering RfG banding levels. For example, will existing patterns of installed capacities continue when RfG applies, and are existing levels of response still fit for purpose?

A 'Transmission' connection in GB is defined as 132kV and above in Scotland and Offshore; in England and Wales it is above 132kV. RfG however does not have this distinction. Instead, it refers to connections of greater or less than 110kV. A power generating module directly connecting at greater than 110kV will default to Type D; below, power generating module capacity will determine their band ('A-C').

The GB NETSO performs an annual evaluation of the existing and future connections to the GB energy network based on the best available information in a publication called the Future Energy Scenarios (FES) - http://fes.nationalgrid.com/ which projects a number of possible out-turns in the coming twenty years. This informs an in-depth analysis of system operation provided again by The GB NETSO in the System Operability Framework (SOF) - http://www2.nationalgrid.com/UK/Industry-information/Future-of-Energy/System-Operability-Framework/. The wider industry is consulted with in the formation of both documents.

Changes to the type and scale of generation, or concentrations in particular areas of the network, can add to the operational complexities which the System Operator manages, both in real-time and longer-term timescales. This is explored further in the following sections.

3.4 **GB generation mix**

Commercial and political drivers have encouraged progressive connection of renewable generation sources to the system in recent years. This has, and continues to, displace traditional thermal plant.

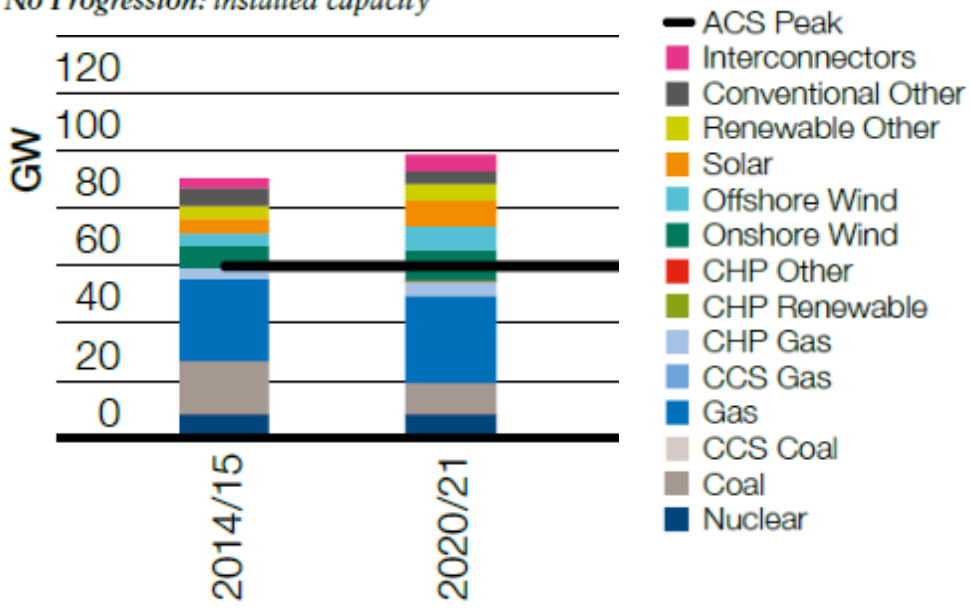
This thermal plant has traditionally provided the majority of support to the GB NETSO for managing all nature of frequency deviations; either through its inherent inertial capability, or being operated in frequency sensitive mode and being available for response dispatch.

Many Transmission-connected Large Power Stations with compliant capability have not been scheduled to provide frequency support services during their operating life. However the GB NETSO procurement process for these services is constantly under review to improve efficiency and promote participation to all parties, not least those with existing compliant capability. This will need to be addressed to take account of the differing nature of Type C generators for dispatch (for example, are Type C compelled to be full BM parties and submit parameters to the NETSO?)

Increasing proliferation of intermittent (variable output) [2] energy sources, which are also non-synchronously connected to the GB network, has increased the regularity and complexity of actions the GB NETSO has had to take in recent years. A primary concern is the visibility (i.e. output forecasting/metering) of such plant to the GB NETSO, and the limited inclination of capable plant to contract directly to provide ancillary services.

Selected charts showing associated GB installed generation capacity trends from the 2015 FES are shown below, highlighting the change to the profile of generation on the system in future years and therefore the potential for increasing system management issues for the GB NETSO:

Figure 60
No Progression: installed capacity



[2] Variable output for the purposes of this report are intermittent generation sources – either renewable technologies 'Offshore Wind', 'Onshore Wind', 'Solar', 'Renewable Other', or 'Interconnectors', as referenced in the FES charts

Figure 64
Solar PV: installed capacity

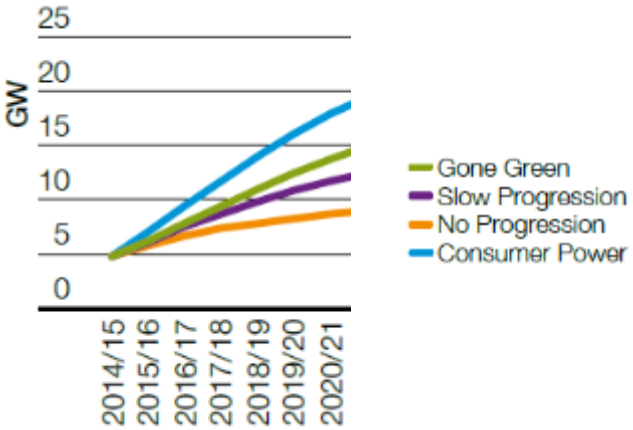


Figure 65
Wind: onshore and offshore installed capacity

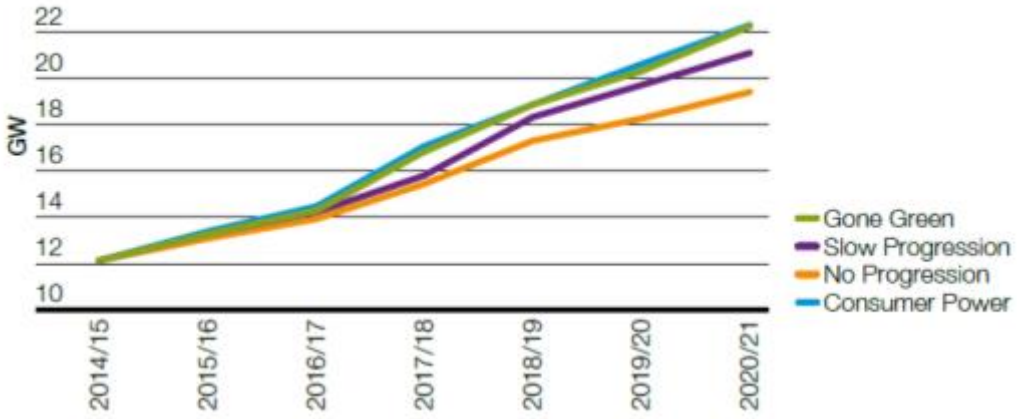
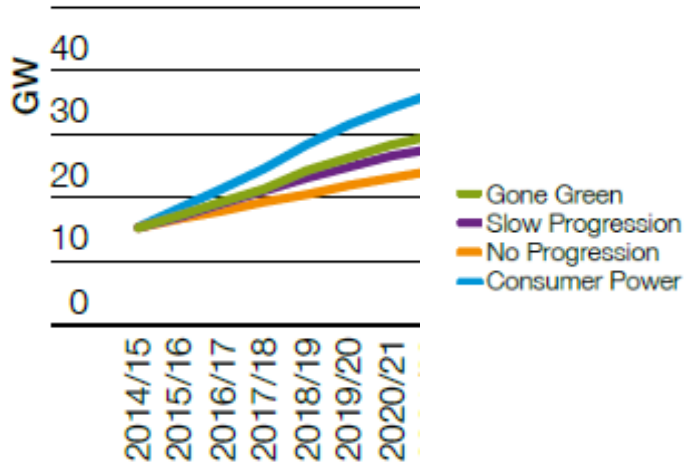


Figure 68
Distributed and micro-generation: installed capacity



Source: [Future Energy Scenarios (FES) 2015]

The primary concern from these charts for the GB NETSO, even in the slowest views of change (e.g. the 'No Progression' scenario), is the significant connection of additional distribution-connected generation, as well as rapid increases in variable load renewable technologies. These require active management, not least in demand forecasting (the majority of this generation will be 'invisible' to the GB NETSO) but also issues with voltage caused by demand reduction, reduced inertia and consequently increased Rate of Change of Frequency ('RoCoF').

It was noted by the workgroup that the FES 2015 assessment of existing and new solar was potentially inaccurate, not least from recent Energy Policy changes. The timing of FES 2016 (July 2016 ETA) may be important XYZ, though its trends are likely to evolve within the range of possible outcomes raised in the FES 2015. Therefore workgroup are generally satisfied that our assessment is as future proofed as it can be.

Additional generation of this type can exacerbate the underlying issues experienced already, along with the increase of interconnector capacity; as well as the steady decrease of large thermal plant which traditionally has supported the GB NETSO in managing the system.

A question for the banding setting process is whether the decision can help address the above issues, affecting as it does only new generation (2019+ connections). As RfG does not by default apply to existing plant (although retrospective application is allowed where this can be justified), there is a debate for relevant System Operators whether some operational issues need to be dealt with outside RfG and banding (for example in the TSOG implementation).

3.5 **Role of interconnectors**

With 4.154GW of installed interconnector capacity installed and 8.7GW in development, the role of interconnectors in the GB system is also another important consideration (alongside RfG). The GB NETSO through the SOF has determined that interconnectors cannot be guaranteed to provide support through controlling flow of MWs at times of system constraint. This is due to the commercial nature of the flow (i.e. flow generally matches favourable prevailing power prices), as well as the possibility of comparable constraint existing each side of an interconnector.

However, in consideration of setting the RfG banding, one should not completely disregard interconnectors. It would be inefficient to use RfG banding to mandate response capability to make GB entirely self-sufficient for response from generation, when there are GWs of theoretical interconnector capacity (as well as other ancillary services options). Interconnector capacity could also participate in ancillary service markets if conditions were favourable.

The role of interconnectors on the GB system, particularly their capability or not to provide response, should be considered outside of RfG, in case the assumption on self-sufficiency from generator response needs to change.

3.6 **Emergency Instructions**

Emergency Instructions are defined in the Balancing Code section of the Grid Code under BC2.9 'Emergency Circumstances' and criteria for their use are also set out.

The GB NETSO is given provision in the Grid Code to use emergency instructions generally when all normal balancing actions have been exhausted and to resolve conditions including:
(a) Events on the National Electricity Transmission System or the System of another User; or
(b) the need to maintain adequate System and Localised NRAPM (Negative Reserve Active Power Margin); or
(c) the need to maintain adequate frequency sensitive Gensets in accordance with BC2.9.5; or
(d) the need to implement Demand Control in accordance with OC6; or
(e) (i) the need to invoke the Black Start process or the Re-Synchronisation of De-Synchronised Island process in accordance with OC9; or
(ii) the need to request provision of a Maximum Generation Service; or
(iii) the need to issue an Emergency Deenergisation Instruction in circumstances where the condition or manner of operation of any Transmission Plant and/or Apparatus is such that it may cause damage or injury to any person or to the National Electricity Transmission System.

Emergency instructions can be made to parties with whom the GB NETSO has a contractual relationship and who are therefore bound by the Grid Code. Therefore they can be made to a directly connected generator, or BM party, or to a DNO where they can be used to request the disconnection of embedded generation.

Where the GB NETSO issues an Emergency Instruction to a BM Participant the Emergency Instruction shall be treated as a Bid-Offer Acceptance, meaning that generators will be compensated. For non-BM parties no compensation arrangements are set out.

If it is assumed that the B/C threshold implicitly determines the level at which generators are members of the BM, meaning that embedded generators below 50MW will not be compensated for Emergency Instructions.

To date Emergency Instructions have been used rarely and only to resolve specific local issues, usually to do with the thermal capacity of a local group to manage exports. It is possible that in the future their use may increase as a greater proportion of generation is not contracted with the GB NETSO and is therefore uncontrollable by other means. Setting the B/C threshold lower would mitigate this risk; however, generators affected by this decision can voluntarily decide to become BM participants.

4 GC0048 workgroup discussions on banding

This section explains the discussions had at the RfG workgroup GC0048 to assess what the banding level for GB should be. This involved understanding the requirement firstly as set out in RfG, as well as the process for applying and changing, and then summarising the perspectives of the various workgroup stakeholders on the pros and cons of potential banding levels. The GC0048 workgroup web page includes an archive of materials presented at the workgroup:
http://www2.nationalgrid.com/UK/Industry-information/Electricity-codes/Grid-code/Modifications/GC0048/

4.1 Understanding what the banding does

GC0048 began discussing the RfG banding thresholds in relative detail from November 2014. At that point, the expectation was that the next version of RfG draft would raise the GB levels from their original state to the higher Continental European levels, so these became the focus. This adjustment to GB levels was confirmed in January 2015.

The discussion therefore focused on the consequences of that change and latterly focused on the Type B-C boundary, and whether it was reasonable to lower it closer to the initial draft RfG. This was due to the transition from B to C being identified as embodying the largest shift in power generating module requirements and potentially cost. From a GB NETSO perspective, Type C is where the real-time response capabilities it needs stem from.

	Type A	Type B	Type C	Type D
Connection Voltage:	<110kV	<110kV	<110kV	≥110kV
	MW range for Power Generating Modules	**MW range for Power Generating Modules**	**MW range for Power Generating Modules**	**MW range for Power Generating Modules**
Continental Europe	800W-1 MW	1 MW-50MW	50 MW-75 MW	75 MW+
Great Britain	800W-1 MW	1 MW-50MW	50 MW-75 MW	75 MW+
Nordic	800W-1.5 MW	1.5 MW-10MW	10 MW-30 MW	30 MW+
Ireland and Northern Ireland	800W-0.1 MW	0.1 MW-5MW	5 MW-10 MW	10 MW+
Baltic	800W-0.5 MW	0.5 MW-10MW	10 MW-15 MW	15 MW+

4.2 Understanding banding compliance costs

The workgroup began to try and find the cross point where generator costs of compliance and GB NETSO costs in managing the system are equal. To achieve this, the GB NETSO sought to understand the incremental generator costs for the compliance obligations in Type C, in comparison to being Type B. This included:

- CAPEX costs for generator equipment needing to provide more complex, real-time requirements (such as Frequency Response, or active power deviation)
    - The group also sought to understand the inherent capability of manufacturer equipment in case no incremental cost was required
- CAPEX and OPEX costs for procuring real-time 24/7 monitoring capability and response dispatch (including systems, premises and personnel)
- Costs for market participation/facilitation of the above capabilities, e.g. Balancing & Settlement Code participation

On the GB NETSO side, the workgroup sought to clarify:

- Costs for managing the system
    - Procurement of additional reserve in the absence of providers in RfG should the banding remain at the CE levels.
- What the GB NETSO was doing to make the market facilitation for response capabilities more straight forward and potentially less cost intensive to new participants
- What the GB NETSO actually requires for Frequency Response, to drive the requirement for any lowering of the B-C boundary
- What the current availability and utilisation of frequency response services is

During the GC0048 workgroups in 2015, various representatives exchanged presentations trying to substantiate the points above. Whilst this was a sensible methodology, which would have led to a Cost Benefit Analysis for the GB banding, these discussions became difficult to progress as whilst costs could be understood and accepted, benefits were difficult to quantify, leading to a one sided position.

The GB NETSO challenged the workgroup on whether generator equipment had the inherent technical capability to comply with additional technical requirements already. This would make lowering the banding level more straight forward as there would be little to no incremental costs.

However, workgroup members focused on whether the GB NETSO could present a definitive need for more capability first. The workgroup also challenged the GB NETSO on the current levels of Frequency Response capability, the majority of which is not utilised. Whilst the GB NETSO explained that this was often due to lack of operational availability (e.g. wind load) or commercially viable pricing, there was a concern that new 'smaller' users would have to procure capability without a route to be remunerated for its provision..

It became clear that technical capability (which RfG sets) and market facilitation (which RfG is silent on), could not easily be separated by the workgroup in the context of banding. There was also concern from developers and manufacturers at divulging commercially sensitive information to answer the GB NETSO questions on capability, particularly on any incremental costs.

The workgroup agreed that some form of CBA should provide the justification for setting the banding, but the lack of acceptable data (including withheld commercial data) respectively undermined this approach. It was also clear that having a blank canvas in which to form a banding level, without a fixed time horizon into the future for them to apply to, would make the task extremely difficult. The workgroup therefore agreed to define a five year horizon for system needs and future generation volumes, and agreed to form a range of banding options to provide some context to the debate and hopefully promote consideration of costs.

4.3 **Forming banding options**

In October 2015, the GC0048 workgroup agreed three banding options to take forward to analyse in more detail for possible use in GB. It was felt that a high, medium and low level would provide a comprehensive assessment to find a 'best fit' level (or levels) to consult on with industry.

In its discussions, the workgroup had partially considered the MW values for the GB synchronous area written in the RfG Article 5(3) set a default or 'do nothing' position, if preferred. However RfG is clear that member states formally justify and ratify their banding levels *whatever* they may be, including the 'ceiling' levels provided in the RfG text. This meant due consideration of these ceiling levels was needed during the workgroups assessment of viable options, including the case to lower.

Therefore three tiered options were formed to allow more coherent assessment of the GB banding levels:

'High' option:

	Type A	**Type B**	**Type C**	**Type D**
Connection Voltage:	<110kV	<110kV	<110kV	≥110kV
Option 1 MW	800W - 1MW	1MW-50MW	50MW-75MW	75MW+

The majority of the workgroup advocated these MW levels be assessed given they are (a) quoted in the final version of RfG and (b) National Grid's proposal for lower banding levels, particularly for Type C, was not substantiated sufficiently to satisfy the generator community. Finally, these levels are at present consistent with those of the neighbouring CE synchronous area.

'Medium' option:

	Type A	Type B	Type C	Type D
Connection Voltage:	<110kV	<110kV	<110kV	≥110kV
Option 2 MW	800W - 1MW	1MW-30MW	30MW-50MW	50MW+

Again, a sizeable proportion of the workgroup recommended taking forward a mid-level for consideration. The levels above were a proposal for consideration by the RfG workgroup from National Grid in late 2014.

'Low' option:

	Type A	Type B	Type C	Type D
Connection Voltage:	<110kV	<110kV	<110kV	≥110kV
Option 3 MW	800W - 1MW	1MW-5MW	5-10MW	10MW+

There was moderate support within the workgroup that a spectrum of options should be analysed to ensure the right option is chosen. At the October workgroup meeting the levels for a low option were considered, culminating in the formation of the values quoted above. These levels are comparable with the Type B-D maximum levels for the Irish synchronous area, so were proposed a counter balance to considering consistency to CE as in the 'high' option. Type A is consistent with the GB levels drafted into the code.

The following sections present stakeholder feedback from a workgroup survey assessing the three options. The full responses from the workgroup are summarised in appendix 1.

4.4 GC0048 workgroup assessment of high option

	Type A	Type B	Type C	Type D
Connection Voltage:	<110kV	<110kV	<110kV	≥110kV
High option MW range	800W - 1MW	1MW-50MW	50MW-75MW	75MW+

Positives

- A higher option for mandating requirements on new power generating modules to begin with avoids:
    - Stranded assets
    - Significant incremental costs for power generating modules/manufacturers
    - Inconsistent requirements compared to existing users, and future users if the levels were to be raised
- Provides consistency with existing GB technical requirements for mandatory Frequency Response capability at 50MW
- Alignment with existing code levels in England & Wales for Medium generators as well as Licence Exemption across GB, minimising potentially different new power generating module capacity configurations
- Consistency with CE draft banding levels (NB Prior to national implementation in member states)
- Harmonises regional differences currently in place in Scotland and England & Wales
- Minimises the risk of negative impacts on cross border trade or conditions for connection in GB being incrementally more difficult than other EU member states
- Requires member states to ratify these levels and not lower them
- These levels represent the least onerous position for new power generating modules and simplifies requirements for smaller generators
- Still a sizeable proportion of new generation capacity falling into Types C and D and therefore have Frequency Response capability by default to replace older Transmission-connected power stations being retired
- Protracted RfG banding setting is a risk to the overall RfG implementation programme. These levels present the least risky position to the majority of GB users, and so ratifying these would be quicker and more straightforward than the lower levels

Negatives

- Consistency with CE, as long as other Member States maintain their levels as per code draft
- Type C set above 30MW/10MW erodes some existing technical requirements (e.g. Frequency Response) for Large synchronous generators connecting to the Transmission system in Scotland. (Can these be considered as local requirements?)
- A broad 1-50MW Type B range, groups generation units of 1MW and 50MW in the same band despite their very different impact on the system and inherent technical, and potentially commercial, capabilities
- A higher banding also encourages developers to build new schemes with capacities which are just below more onerous levels – repeating existing patterns of behaviour (e.g. 49.9MW power generating stations in England & Wales)
- The majority of new Type A-B generation will be non-synchronous and embedded. This will exacerbate the issues the GB NETSO has in managing the system, but these generators will only be required to support a passive response capability. Is it fair to rely on existing larger generators and new Type C-D generation to fix address this disparity?
- Burden largely sits with GB NETSO to mitigate system security issues in absence of capable generation in a context of rapid proliferation of variable load renewable technology Type A-B. This inevitably leads to higher system balancing costs which are eventually borne by end consumers via BSUoS
- Fairly likely therefore that the GB NETSO would consider code modifications to address deficiencies caused by high banding
- GB NETSO more likely to review banding levels after the permitted three year period

4.5 **Assessment of mid option**

	Type A	**Type B**	**Type C**	**Type D**
Connection Voltage:	<110kV	<110kV	<110kV	≥110kV
Mid option MW range	800W - 1MW	1MW-30MW	30MW-50MW	50MW+

Positives

- From the perspective of the GB NETSO and Scottish TSOs, this level most equitably assigns responsibility between generators and System Operators for managing system issues while considering existing GB code requirements
- The GB NETSO feels adopting the 'mid' option is the most equitable means to do this which lessens the need for future banding level changes or code working groups investigating other methods of managing the system
- Reduces 1MW-50MW range for Type B which is too broad given the differing nature of assets at each end of the scale.
    - It apportions a response requirement from what the GB NETSO considers to be inherently capable units of 30MW or greater
- Given that RfG supersedes regional differences in England, Wales and Scotland for Large, Medium and Small Power Stations accommodated currently in the Grid Code, the lower band in this option for Type C gives closer alignment to the Scottish Power Transmission area for managing voltage and reactive issues (see section 4.8.2)
- From an electrical engineering viewpoint this provides the TSO/DSO with a better route to control concerns regarding stability and security of a supply network if FES/SOF assessments of future years, regarding dominance of distributed generation occur

Negatives

- However, the existing 50MW level for Power Park Modules to provide mandatory Frequency Response under the Grid Code is lowered in this option to 30MW, and therefore extended to new generators in England and Wales connecting below 132kV. Or in other words, an incremental requirement for new generators in England and Wales compared to existing obligations in the Grid Code today.
- Codified obligation on potentially capable generation circumvented (support to GB NETSO bound by commercial inclination)
-
- As for GB NETSO costs for the mid option, the increased level of generator support facilitated by lowering Type C. outweighs any additional resource or cost for the GB NETSO facilitating generator participation in balancing services (i.e. implementation of

systems such as EDL), and verifying the capability of generators to fulfill their capability through on-site testing

- Licence, connection contract and market procurement changes might be required to allow >30 MW Power Stations/power generating modules to participate in the Frequency Response market.
- Furthermore, while excess mandatory frequency response availability may be superficially attractive to the GB NETSO (as excess supply would depress the market price), it is likely to be an uneconomic allocation of resources to smaller generators not currently obligated for this requirement which will ultimately increase costs for consumers as generators seek to recover their costs by increasing their prices.
- And finally, future projections show very little generation in the range 30-50MW and also connecting at less than 132kV so making the choice of this mid-range option immaterial. It is acknowledged though that setting the thresholds may affect the capacities of future projects.

4.6 **Assessment of low option**

	Type A	**Type B**	**Type C**	**Type D**
Connection Voltage:	<110kV	<110kV	<110kV	≥110kV
Low option MW range	800W - 1MW	1MW-5MW	5-10MW	10MW+

Positives:

- Highest possible availability of generator response to assist System Operators, leading to lots of competition in response markets driving down balancing costs
- There is consistency with GB Grid Code levels in north Scotland (SHET region) for 'Large' Power Stations, though it is difficult to justify aligning the entire GB network to the lowest levels in Scotland.
- This option is not without merit for assessing potential banding levels more broadly by identifying trends which may emerge from analysis of the different banding level options. The ceiling banding levels were draft into the code considering the nature of the energy networks in the respective synchronous areas. The level for GB initially corresponded more closely with the Irish level (similar to this low option), rather than CE.
    - The question is whether, in terms of consistency, aligning to CE is a better fit than Ireland. Advocating the high option solely because of this alignment to CE ignores the intention behind the banding.

Negatives:

- High level of generator cost for compliance - too onerous a manufacturing standard for smaller generation
- The cost of compliance leads to GB generation costing more than generation in wider Europe where banding levels are higher. Currently, only Ireland would have lower thresholds than this proposal
- GB NETSO market facilitation mechanisms not currently fit for purpose for contracting directly with large numbers of Type C generation starting at 5MW
    - GB NETSO resource/cost issues for facilitating compliance testing, installing operational communications systems etc., which at these levels basically erode any benefit of having significant volumes able to support.
- Only the most pessimistic views of FES/SOF would come close to providing justification from GB NETSO for banding this low
- Huge volumes of responsive plant could lead to over-supply of mandatory frequency response capability could depress the market value of frequency response services and result in inefficient investment in mandatory frequency response capabilities.
- The alignment to Ireland and Northern Ireland is an inaccurate comparison to GB. They already have 20% renewable electrical energy penetration and are pressing forward towards 40% (requiring up to 75% non-synchronous generator penetration as a percentage of instantaneous demand) with frequency response capability mandated for generators >=5MW. They do not presently propose to reduce this threshold and it is not clear that GB is facing more pressing challenges which would justify an even lower B/C threshold
- Generators also cite issues with cross border trade, given the significant deviation to the neighbouring CE synchronous area. A level which deviates from the majority of the EU synchronous areas will cause manufacturers to have to develop extra designs and carry extra inventory to allow fair competition.

4.7 Conclusions from 'three option' approach

In conclusion, none of the three sets of levels were entirely perfect; though it was clear the high option presented least risk. There were significant reservations about the potential costs involved with the 'low' option, for both generators procuring the capabilities needed for compliance, and for GB NETSO dealing with plant of a much lower unit capacity scale.

The workgroup continued to press towards a quantifiable assessment of the banding, but remained unable to present and agree suitable evidence. The group therefore moved the discussion onto understanding the consequences of going with the high option, as a justification for a lower set of GB banding appeared unlikely to be agreed. There was also a growing expectation that RfG banding could only do so much, and actually a lot of the GB NETSO concern directed towards the banding level could be dealt with elsewhere.

Section 4.8 summarises the key points the workgroup discussed in this regard.

4.8 Issues which changing the banding levels will not address

4.8.1 Power Generating Modules connecting at 110kV or greater are Type D by default

This concept was established early in the drafting of the code and was unchanged throughout Comitology. Any user connecting above 110kV (so typically 132kV in GB) would be Type D **regardless of their installed capacity**. This potentially means a proportion of generation of a Type B-C capacity would have to provide full RfG requirements by virtue of their connection voltage.

This means that the GB NETSO does get access to additional capability without adjusting the banding level, though the nature of ownership boundaries, particularly in Scotland, may affect the extent to which this principle actually applies.

4.8.2 Ancillary Service markets do not need compulsory participation

Non-mandatory response markets, including Demand Side Response, Firm Frequency Response, Fast Frequency Response, Black Start, Enhanced Reactive Capability, provide another means for the GB NETSO to manage system constraints as opposed to Emergency Instructions (see section 3.6).

Also an increasing trend of embedded generation changing its commercial arrangements to participate in markets indicates that a mandatory/codified route for obtaining additional response from smaller generators might not be required.

4.8.3 The GB NETSO should look into market facilitation/ participation (regardless of RfG banding)

Generators throughout the GC0048 workgroup asserted that the GB NETSO has an 'overabundance' of compliant Transmission-Connected frequency response capacity already, which is not utilised. However the issue raised by the GB NETSO is the lack of operational and commercial availability of this plant, typically from variable load renewable technology. However the GB NETSO acknowledges that 'market facilitation' is an additional consideration for generators' costs if they are required to provide additional mandatory response requirements to existing GB arrangements.

The GB NETSO have established methodologies for generation to be dispatched to provide mandatory Frequency Response. However these processes and systems are evolved year on year, and in the long term delivering this requirement will be made easier, providing additional opportunities for generators.

Does BSC participation need to be mandated for new users bound by RfG at Type C or Type D?. This should be addressed during implementation to provide clarity where there may be doubt in existing arrangements.

High participation prices in these markets also present a commercial availability issue for the GB NETSO, particularly for variable load renewable technologies in receipt of a subsidy. This is certainly not an issue RfG or the GB NETSO can resolve, but is an important context in the procurement of balancing services.

4.8.4 **Local requirements should continue where they do not contradict RfG or have no effect on EU-cross border trade**

The technical capabilities of generators play an important part in maintaining the integrity of Transmission and Distribution networks, including maintaining Transmission system voltage profiles and supporting transient recovery from disturbances or faults. To achieve this it is necessary that generators in different parts of the network contribute appropriately in steady state and dynamic conditions.

Instead of pushing for a much lower banding level, to align GB with the most stringent support requirements in specific areas of the GB synchronous area, it is much more efficient to accommodate requirements as a local requirement (e.g. reactive range and fast acting automatically voltage control in Scotland).

4.8.5 **The interaction with the Transmission System Operation Guideline (TSOG)**

It is of note that the TSOG makes use of the RfG bandings in that it sets out in its scope (Art 2.1.a) that it 'applies to *existing* and new power generating modules of type B, C and D in accordance with Article 5 of Commission Regulation No [000/2015 RfG]'.

The intention of the TSOG is that where requirements are placed on power generating modules that these are non-technical in nature and instead for the exchange of operational capability and availability information (up to and including real time). Technical requirements are set out appropriately in the EU Connection Codes (i.e. RfG).

At present the drafting in this respect needs to be improved and there are also legitimate concerns over whether the extent of the proposed information exchange requirements under TSOG are achievable at the lower end of the scale (given that band B will start at 1MW or potentially lower) or would be fully utilised.

Given that RfG sets technical requirements for power generating modules, while the TSOG is concerned with operating the system, other than the use of the banding there is no other obvious interaction which should delay implementation of RfG in GB synchronous area. The banding concerns under TSOG are shared with other member states and are an issue that needs to be addressed under the TSOG.

If there is any risk of generators being bound by onerous requirements or incurring additional compliance costs via TSOG, where the banding is used to apply such conditions, clearly the high option for the RfG level minimises any negative consequential impacts.

5 Workgroup conclusions on banding

At the January 2016 workgroup meeting, GC0048 concluded the following on setting RfG banding thresholds.

5.1 Banding setting should not be used to fix all the issues of the GB synchronous area at implementation

The GC0048 workgroup agreed that there are issues for the GB NETSO to manage on the NETS, as evidenced through the FES and SOF. However, it felt that it was disproportionate and potentially risky to mitigate this through using the implementation set of RfG banding thresholds.

5.2 Visibility of generation connecting to the system is almost as important as its capability to provide response

As mentioned previously, the lack of visibility of distribution-connected generator which impacts the system is a key concern for the GB NETSO. However rather than use RfG banding to add real-time monitoring to smaller power generating modules (i.e. lowering Type C), the GB NETSO has access to Data Exchange requirements through the TSOG. These apply to both new and existing users, potentially as low as 1MW.

5.3 Consistency to existing GB requirements and potentially EU continental synchronous area is a benefit

In line with the point raised above around using the banding to address the issues of the GB synchronous area, it is also important to recognise that new generation is not yet part of this problem. Therefore to apply more onerous requirements to make up for a deficiency in existing arrangements is unfair to new-connecting power generating modules.

5.4 The GB NETSO benefits from additional technical capability compared to existing codes through RfG (and TSOG), regardless of banding

The following generator requirements are a non-exhaustive list giving examples of new requirements which apply to new users and which are beneficial to the GB NETSO in managing the system:

- Input port to cease active power in 5 seconds (Type A)
- Fault Ride Through (Type B+)
- Data exchange requirements (Type B+/TSOG)

5.5 Three year review and implementation process

RfG permits Relevant Transmission System Operators to revisit the banding levels every three years after the code enters into force and after a previous setting of the levels. Based on applying the ‘high’ options and trying to arrange implementation in the most efficient manner possible, the GB NETSO is likely to utilise this review opportunity in due course.

5.6 Management of local requirements

The technical capabilities of generators play an important part in maintaining the integrity of Transmission and Distribution networks. To achieve this, it is necessary that generators in different parts of the network contribute appropriately in steady state and dynamic conditions.

Where RfG is ‘silent’ on a technical capability which is important for this local system management, and/or there is no negative impact on EU cross-border trade, existing national requirements to support this can be carried forward post-RfG go-live. This should be considered in the drafting of the new RfG requirements within the Grid Code and Distribution Code.

6 Workgroup Recommendations

Following the lengthy discussions of the GC0048 workgroup, broad consensus was reached in January 2016 that the banding as written into the final version of RfG should be applied for national GB implementation. The GB NETSO would review this at three years after Entry Into Force, and as required every three years subsequent to that to confirm that the levels remain compatible for the needs of the GB synchronous area.

	Type A	Type B	Type C	Type D
Connection Voltage:	≤110kV	≤110kV	≤110kV	>110kV
Unit MW	800W - 1MW	1MW-50MW	50MW-75MW	75MW+

In adopting this higher level, it is acknowledged that some additional measures may be required at a GB level to manage the volumes of Embedded Generation to ensure visibility to the System Operator and ensure all generation is treated in a fair and economic manner. These could be pursued assuming there is no conflict with RfG itself, and there is no negative impact on EU cross-border trade.

7 Impact & Assessment

7.1 Impact on the Grid Code

The legal text for applying the agreed banding level needs to be considered in conjunction with the existing levels of Large/Medium/Small (see proposals in section 9) and potentially within the overall approach for the EU Connection Codes in general.

7.2 Impact on National Electricity Transmission System (NETS)

Implementation of RfG will support the GB NETSO through additional technical capabilities on new generators to assist system operators, as well as opportunities for improved data provision in conjunction with the Transmission System Operation Guideline.

Removing regional differences for new users should also improve consistency of approach across the country for connecting generation, It should also encourage consideration externally to RfG to ensure the commercial and licencing processes required for some new generators are reconsidered.

The importance of local requirements needs to be stressed however. It is important that where specific requirements for new connections arise, due to the nature of some local systems, that these continue where there is no conflict to RfG and where there is no impact on cross border trade.

The three year review of the GB banding level permits any adverse impacts not identified in the banding setting for implementation to be addressed, as long as suitable justification is presented and approved via industry consultation and then regulatory approval.

Where justified, requirements under RfG, and including those associated with future adjustments to the banding thresholds, can also be applied retrospectively through a defined process of cost benefit analysis, consultation and approval by regulatory authority. This also permits due consideration to making changes post-RfG implementation to rectify deficiencies or inequities in the application of banding (and potentially other requirements if there is no impact on cross border trade).

7.3 Impact on Grid Code and Distribution Code Users

The proposed banding level will make arrangements as coherent as possible for new users connecting to the GB energy system. It prevents a disproportionate application of requirements on existing vs new users, and should best facilitate cross-border trade through the establishment of product standards with Continental Europe and within GB.

7.4 **Impact on Distribution Code Users**

Banding will affect all generators connected to distribution networks in terms of technical requirements of generators' equipment and in terms of the data and coordination required in the future. The thresholds for banding will influence how the Distribution Code and associated documents will be redrafted in accommodating the EU Network Codes.

7.5 **Impact on Greenhouse Gas emissions**

RfG at its core is set up to support the connection of renewable generation, and encourage its participation in response services with System Operators. The application of the banding level does not directly impact this objective.

7.6 **Assessment against Grid Code Objectives**

The Workgroup considers that the recommended application of a 'high' banding level in GB addresses the Grid Code objectives as follows:

i. to permit the development, maintenance and operation of an efficient, coordinated and economical system for the transmission of electricity;

A high RfG banding level has a neutral impact on this objective

ii. to facilitate competition in the generation and supply of electricity (and without limiting the foregoing, to facilitate the national electricity transmission system being made available to persons authorised to supply or generate electricity on terms which neither prevent nor restrict competition in the supply or generation of electricity);

A high banding level sets consistent requirements on generators connecting anywhere in GB, and extends similar levels for generators in Continental Europe. This promotes harmonisation between GB and EU generation and provides opportunities for manufacturers to establish product standards which will lower costs for developers.

iii. subject to sub-paragraphs (i) and (ii), to promote the security and efficiency of the electricity generation, transmission and distribution systems in the national electricity transmission system operator area taken as a whole; and

A high RfG banding level has a neutral impact on this objective

iv. to efficiently discharge the obligations imposed upon the licensee by this license and to comply with the Electricity Regulation and any relevant legally binding decisions of the European Commission and/or the Agency.

As the ratification of banding levels in RfG is required by European Law and progresses the implementation of this European Network Code, the very nature of this activity ensures GB's compliance with European Commission legislation

7.7 **Assessment against Distribution Code Objectives**

The Distribution Code objectives are largely consistent with the Grid Code objectives. They are provided here for information, but align with i, ii and iv above:

(a) Permit the development, maintenance, and operation of an efficient, co-ordinated, and economical system for the distribution of electricity; and

(b) Facilitate competition in the generation and supply of electricity; and

(c) Efficiently discharge the obligations imposed upon distribution licensees by the distribution licences and comply with the Regulation and any relevant legally binding decision of the European Commission and/or the Agency for the Co-operation of Energy Regulators

7.8 Impact on core industry documents

The proposed modification needs to be applied to the Grid Code and Distribution Codes in the most efficient and accessible means possible. Draft legal text has been provided to assist understanding how banding may be added to the GB Grid Code.

7.8.1 CUSC/BSC

The level set for Type C may implicitly set the level for balancing market participation, given it sets the requirement for mandatory Frequency Response.

It is sensible to consider how the commercial requirements on power generating modules is set once RfG is applied, to provide clarity for new schemes if it becomes ambiguous.

Requirements on commercial participation are set in the CUSC and BSC. The workgroup recommend consideration of the above, but this is not mandatory in implementing the RfG banding level within the GB Codes.

7.9 Impact on other industry documents

The proposed modification may impact connection agreements for existing and new development schemes who have not/will not procure main plant items by two years after RfG entering into force.

With the banding set to the maximum permissible values under EU law, some change may be required to the industry framework and market to manage the higher volumes of distribution-connected generation either in parallel or post-RfG implementation.

7.10 Implementation

The Workgroup proposes that, should the proposals be taken forward, that the banding levels are ratified, but formal legal text changes are considered within the wider implementation of RfG, HVDC and DCC European Network Codes in GB during 2016-2017, subject to Authority decision.

8 Proposed Legal Text

The following legal text has been proposed by National Grid to support understanding of the application of banding. It is therefore illustrative currently, and is largely a lift and shift from articles and sections of RfG summarising banding and outlining the difference between the four types. The MW ranges for the high options have been inserted, so yet again this is for demonstration purposes:

The European Network Code on requirements for the grid connection of generators (RfG) sets out such requirements under four Types A-D which are described as follows:

- *The requirements applicable to Type A power generating modules should be set at the basic level necessary to ensure capabilities of generation with limited automated response and minimal system operator control. They should ensure that there is no large-scale loss of generation over system operational ranges, thereby minimising critical events, and include requirements necessary for widespread intervention during system-critical events.*
- *The requirements applicable to Type B power generating modules should provide for a wider range of automated dynamic response with greater resilience to operational events, in order to ensure the use of this dynamic response, and a higher level of system operator control and information to utilise those capabilities. They ensure an automated response to mitigate the impact of, and maximise dynamic generation response to, system events.*
- *The requirements applicable to Type C power generating modules should provide for a refined, stable and highly controllable real-time dynamic response aiming to provide principle ancillary services to ensure security of supply. Those requirements should cover all system states with consequential detailed specification of interactions of requirements, functions, control and information to utilise those capabilities and ensure the real time system response necessary to avoid, manage and respond to system events. Those requirements should also provide for sufficient capability of generating modules to respond to both intact and system disturbed situations, and should provide the information and control necessary to utilise generation in different situations.*
- *The requirements applicable to Type D power generating modules should be specific to higher voltage connected generation with an impact on control and operation of the entire system. They should ensure stable operation of the interconnected system, allowing the use of ancillary services from generation Europe-wide.*

The thresholds for these types are as follows for the GB synchronous area:

i. connection point below 110 kV and maximum capacity of 0.8 kW or more (Type A);

ii. connection point below 110 kV and maximum capacity at or above 1MW (Type B);

iii. connection point below 110 kV and maximum capacity at or above 50MW (Type C); and

iv. 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 75MW

These values were set for GB on [Insert Date]. A proposal by NGET to change the thresholds can be made no sooner than three years after the previous proposal and shall be subject to approval by the relevant regulatory authority.

In forming such a proposal NGET shall coordinate with adjacent TSOs and DSOs and shall conduct a public consultation. Power generating facility owners shall assist this process and provide data as requested.

9 Proposed Industry Consultation Questions

Despite advocating the 'high' banding level, the GC0048 workgroup believe it is important that industry parties get an opportunity to consider the same three options as discussed at their meetings.

Therefore the consultation will allow responses advocating any one of the three, but seek that any selection is verified through comprehensive justification, including provision of any costs, cost-savings, and benefits. The consultation will also require industry parties to consider the impact on Grid Code or Distribution Code objectives of their preferred banding option.

The following questions are recommended by GC0048, but are included for illustrative purposes for now:

i. *From your perspective, which of the banding options presented in this report ('high', 'medium', and 'low' [please see section 4.3]) is most suitable to apply in the GB synchronous area for the next three-five years?*

ii. *In respect of your preferred banding option stated in question (i), please can you provide a supporting justification, particularly focusing on quantifying any costs/savings/benefits when it is compared to the other two options presented in this report.*

    [NB that confidential submissions can be made – see note below] to support the banding option you believe is most suitable. A non-exhaustive costs template is attached to support this cost/benefit analysis – please use this when submitting your information].

iii. *How do you believe your preferred banding level facilitates the Grid Code/Distribution Code objectives?*

iv. *Does your preferred banding level adequately protect the interests of all Transmission System and Distribution System Users? If not, why does it fail to do so?*

v. *Do the proposed banding levels strike an appropriate balance between the needs of the System Operator, Network Operators, Generators and other interested parties? If not, why do they fail to do so?*

vi. *Are there additional considerations for the banding level which the Workgroup has so far not taken account of in this report?*

vii. *Please provide any other comments you feel are relevant to the proposed change.*

Appendix 1 – Banding option pro-forma responses

GC0048 Banding Options Pro-forma_R

Appendix 2 – Generator Costs Template

GC0048 Generator Costs - Control Setup