Grid Code Modification	At what stage is this document in the process?
# GC0096 ## Modification Title: Energy Storage	01 Proposal Form 02 Workgroup Consultation **03 Workgroup Report** 04 Code Administrator Consultation 05 Draft Grid Code Modification Report 06 Final Grid Code Modification Report

Purpose of Modification: This proposal seeks to modify the Grid Code to define the appropriate technical requirements for Storage technologies connecting to the Transmission system and associated changes to the Grid Code requirements for making a connection.

	This document contains the discussion of the Workgroup which formed in January 2017 to develop and assess the proposal, the responses to the Workgroup Consultation which closed on 11 January 2019, the voting of the Workgroup held on DD Month Year and the Workgroup's final conclusions.
	**High Impact**: Developers of new Storage schemes – either standalone or co-located; Transmission System Operator; Distribution Network Operators.
	**Medium Impact** None.
	**Low Impact** None.

Contents

Timetable

The Code Administrator recommends the following timetable:

Initial consideration by Workgroup	January 2017
Workgroup Consultation issued to the Industry	7 December 2018
Workgroup Consultation closes	11 January 2019
Modification concluded by Workgroup	February/March 2019
Workgroup Report presented to Panel	28 March 2019
Code Administration Consultation Report issued to the Industry	8 April 2019
Draft Final Modification Report presented to Panel	30 May 2019
Modification Panel decision	30 May 2019
Final Modification Report issued the Authority	w/c 3 June 2019
Decision implemented in Grid Code	w/c 22 July 2019

Any questions?

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1 About this document

This document is the Workgroup Report that contains the discussion of the Workgroup which formed in Month Year to develop and assess the proposal, the responses to the Workgroup Consultation which closed on DD Month Year, the voting of the Workgroup held on DD Month Year.

GC0096 was proposed by National Grid and was submitted to the Grid Code Review Panel for its consideration on DD Month Year. The Panel decided to send the Proposal to a Workgroup to be developed and assessed against the Grid Code Applicable Objectives.

GC0096 aims to modify the Grid Code to define the appropriate technical requirements for Storage technologies connecting to the Transmission system and associated changes to the Grid Code requirements for making a connection. The Workgroup consulted on this Modification and a total of 8 responses were received. These responses can be views in Section XX of this Report.

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Workgroup Conclusions

At the final Workgroup meeting, Workgroup members voted on the Original proposal and INSERT OUTCOME OF VOTE

The full Terms of Reference can be found in Annex 2.

Table 1: GC0096 Terms of Reference

Specific Area	Location in the report
a) Workgroup meeting one: "Definitions" We will determine which Storage categories shall be the focus of the workgroup; either "Energy Storage" or "Electricity Storage", or both. Once agreed, we will form a high-level working definition (noting the link to the BEIS/Ofgem call for evidence) to set the context for delivering the next workgroup deliverables. We will also consider how this definition links with existing Transmission Generation or Demand users looking to co-locate their Plant with Storage.	Section 3 and 4
b) Workgroup meeting two-to-three – "Technical and Planning Requirements" We will form the minimum Grid Code technical requirements applicable to Storage equipment defined above - either via a stand-alone connection or co-located with an existing user, ensuring consistency and transparency with other classes of Transmission System user.	Section 3 and 4

c) Workgroup meeting four – "Structure" consideration of how (or if), the outcomes from the previous workgroup meetings need to be structured in the Grid Code via legal text changes.	Section 3 and 4
d) Workgroup meeting five – "Next steps" this will be an open attendance meeting allowing a full review of the outputs from the previous workgroups to confirm what will be written up in reports/consultations to progress any Grid Code mod proposals. It will also check the outcomes of GC0096 against the BEIS/Ofgem call for evidence published outcomes (if available). This meeting will also set out what additional arrangements (see 'Out of Scope' below) may need to be considered in other GB frameworks to support Storage, and recommend items for escalation if not currently being considered.	Section 3 and 4

Acronym Table

Acronym	Meaning

2 Original Proposal

Section 2 (Original Proposal) are sourced directly from the Proposer and any statements or assertions have not been altered or substantiated/supported or refuted by the Workgroup. Section 4 of the Workgroup contains the discussion by the Workgroup on the Proposal and the potential solution.

Defect

This Modification was raised by the ESO (formerly part of NGET) in May 2016 to introduce the appropriate Grid Code provisions for Energy Storage[1] devices. This is particularly significant given that technical requirements for Energy Storage devices are not covered under the EU Connection Network Codes.

Energy Storage devices have the capability to act as a source of either export of electricity onto the network (akin to generation) or import of electricity from the network (akin to demand). It is therefore necessary to ensure the existing set of requirements are consistent in terms of Energy Storage devices within the existing industry codes, whilst giving due consideration to compatibility with developments needed in other code areas (for example: the Planning Code and the Data Registration Code) and ensures equitable treatment with other Users.

Given that Energy Storage devices are a growing sector, it was proposed that this paper is also circulated to the Distribution Code Review Panel as similar issues are likely to be faced at a Distribution Code level. This was done, and whilst GC0096 included Distribution Code stakeholders, including DNO representatives, the focus of the Workgroup was on Grid Code changes. Any Distribution Code changes will be consequential from GC0096, using the proposed solution as a basis.

To ensure consistency with their Generation and HVDC Counterparts, it was agreed at the Workgroup meeting held on 15 January 2018, that the proposed definitions and technical requirements for Storage should be applied to the Grid Code text as approved by Ofgem to incorporate RfG and HVDC Codes following consultations GC0100, GC0101 and GC0102. As a consequence, this report and the corresponding legal text, has been updated to address these changes which were implemented into the Grid Code (Issue 5 Revision 22) on 16 May 2018.

What

NGET raised a modification to address this defect in May 2016, and the GC0096 Workgroup was formed in the summer of 2016.

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[1] As set out in Section 3 and the legal text, the proposed definition of which is, in the form of 'Electricity Storage, as: "Is the conversion of electrical energy into a form of energy which can be stored, the storing of that energy, and the subsequent reconversion of that energy back into electrical energy in a controllable manner"

Two workshops with Storage developers and the wider industry were convened in August 2016 by NGET (but not the GC0096 Workgroup) to consider the scope of the modification.

Following these workshops, the primary focus of the GC0096 Workgroup was set to consider how to define 'Storage' unambiguously in the Grid Code; to understand how 'Storage' could be deployed (either on its own or as part of an existing scheme); and to assign proportionate minimum technical requirements for new connections which support the technology's flexibility.

The issue has been complex largely as result of:

i. The large number of different 'Storage' technologies now commercially available;
ii. The variations in which they may be configured either as part of a new development or an existing development; and
iii. The need to ensure equitable treatment with Generation, HVDC and Demand technologies as codified in the EU Connection Network Codes (RfG, HVDC and DCC) which currently exclude storage other than pumped storage.

This report provides the summary, to date, of the GC0096 Workgroup's progress delivering potential solutions to address these objectives.

Why

NGET has received a number of connection applications for transmission connected energy Storage devices which can both import and export electricity to the National Electricity Transmission System for which, in the view of the Proposer and some Workgroup members, there is currently a lack of clear provisions in the Grid Code. Another Workgroup member believed that there are already, in their view, clear provisions in the Grid Code for the treatment of 'Storage' by simple reference to 'Pump Storage' which exhibits all the same characteristics of the proposed GC0096 definition[2]. Applying a harmonised approach should ensure a level playing field is achieved.

Given that National Grid has received a significant degree of interest from further potential connectees, in particular, it is highly likely that additional connection applications will be received in the near future. This modification proposal identifies a need to clearly specify Grid Code requirements for a range of energy Storage

[2] "Is the conversion of electrical energy into a form of energy which can be stored, the storing of that energy, and the subsequent reconversion of that energy back into electrical energy in a controllable manner"

technologies connected in a range of different configurations which could reasonably be considered to fall outside of the existing code provisions.

This modification proposal seeks to assess the appropriate Grid Code provisions for energy Storage devices. This is particularly significant given that energy Storage devices are not covered under EU codes. Furthermore, energy Storage devices have the capability to act as a source of either generation or demand.

In the view of the Proposer, it is therefore necessary to establish a set of requirements which are consistent with existing industry codes, gives due consideration to compatibility with developments needed in other code areas (for example the Planning Code and the Data Registration Code).

In the view of the Proposer, there is currently a lack of bespoke requirements in the Grid Code for a diverse range of energy Storage devices (other than for pumped Storage). Parties who own energy Storage devices and use the National Electricity Transmission System will be expected to meet applicable sections of the Grid Code which are consistent with the existing requirements, including those recent provisions introduced following implementation of Requirements for Generators (RfG) and HVDC European Network Codes and the forthcoming Demand Connection Code (DCC) Network Code. There is a need, therefore, to consider code developments which account for a range of technology solutions and different operational characteristics whilst recognising the capability of the Storage equipment. For example, the technical requirements for an asynchronous battery Storage device connected via DC converter may be most closely aligned to those of an HVDC converter or Power Park Module under the current code, whereas the technical requirements for a synchronous compressed air energy Storage device, may be most closely aligned to the existing treatment of a synchronous generator.

In addition, it is also recognised that certain types of storage technology such as Synchronous Compensators and Synchronous Flywheels are not necessarily controllable and therefore should be treated separately from the general requirements for storage which are being proposed for this modification.

In the view of the Proposer, presently, the application of these requirements is subject to interpretation of the current Grid Code and codified clarity is required. All aspects of energy Storage devices should be considered from the perspective of both bespoke energy Storage installations as well as energy Storage devices which are part of a hybrid power plant with a mix of technology types.

In summary, Connection applications for Storage technologies such as batteries have become increasingly more common on the Transmission and Distribution systems in recent years, particularly since National Grid's Enhanced Frequency Response (EFR) tender in 2016.

Furthermore, BEIS and Ofgem have kicked off reviews of how to encourage greater flexible operation on the GB (whole) electricity system, with a view to maximising

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competition in the provision of services and lowering energy costs for end consumers. This has led the wider industry, including network licensees, to consider what they can do to better support Storage.

~~The view of the Proposer is that regulatory frameworks need to catch-up with this evolution in technology and policy~~. This Modification specifically looks at improving the Grid Code to satisfy these objectives so as to ensure maximum flexibility both for developers and Network Owners/Operators. The view of the proposer is that the Grid Code needs to line up with Ofgem's approach to Storage which treats it in the same way as Generation.

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How

In the view of the Proposer, the Grid Code does not currently consider energy or electricity 'Storage' technologies as a distinct category of User (Pump Storage aside). When Storage developers request Transmission connections, National Grid Electricity Transmission (NGET) have had to deem this equipment as generation, demand, or an interconnector to allow a connection offer to be prepared.

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This workaround has the potential to treat Storage inconsistently. Any adjustments to connection agreements to determine how to connect Storage is set out in Connection Agreements. These are set out in the CUSC (not the Grid Code) as exhibits and are publicly available on the National Grid website[3].

3 Proposer's Solution

High level summary of proposed changes

The Proposer proposes that amendments are made to the Glossary and Definitions of the Grid Code to explicitly set out the requirements on Storage users. These definitions would make it clear what is meant by 'Storage', and how Storage technologies can be deployed in "Connection Schemes"– both as standalone installations or co-located with generation.

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[3] The Connection Application can be found at https://www.nationalgrid.com/sites/default/files/documents/CUSC%20Exh%20B_V1.15_06%20May_16.pdf

The Connection Offer document can be found at: https://www.nationalgrid.com/sites/default/files/documents/CUSC%20Exh%20C_v1.8_06%20May_16.pdf

With those definitions in place, an update of the remaining parts of the Grid Code in particular the European Connection Conditions have been prepared which set out the proposed level of technical requirements which apply to these various Storage configurations. Whilst not all the new definitions have been listed below, the principle ones have been summarised so the reader has a general understanding of how the updates have been made to the remining parts of the code. In summary, however, and as noted earlier, the general approach has been to apply the same principles that already exist to synchronous and non-synchronous generation by changes to these definitions.

New definitions

The new / amended definitions are noted below and are direct extracts from the proposed Glossary and Definitions changes arising from GC0096. In summary, the important definitions are “Electricity Storage”, “Electricity Storage Module”, “Electricity Storage Unit” and “Storage User”.

An Electricity Storage Module could be one or more Synchronous Electricity Storage Unit(s) or a Non-Synchronous Electricity Storage Unit(s) which could also be part of a Power Generating Module. For the avoidance of doubt, Non-Controllable Electricity Storage Equipment would not be considered to be classed as an Electricity Storage Module or as an Electricity Storage Unit.

~~either an Onshore or Offshore Electricity Storage Module made up of one or more Electricity Storage Units.~~

An Electricity Storage Unit could be either a Synchronous Electricity Storage Unit or Non Synchronous Electricity Storage Unit.

The definition~~s~~ of Onshore Generating Unit has been defined as “Unless otherwise provided in the Grid Code, any Apparatus located Onshore which produces electrical energy by converting or re-converting another source of energy, including, an Onshore Synchronous Generating Unit, or, Onshore Non-Synchronous Generating Unit which could also be part of a Power Generating Module or, an Electricity Storage Module”. Similarly the definition of Offshore Generating Unit has been defined as ”Unless otherwise provided in the Grid Code, any Apparatus located Offshore which produces electrical energy by converting or re-converting another source of energy, including, an Offshore Synchronous Generating Unit, or, Offshore Non-Synchronous Generating Unit which could also be part of a Power Generating Module or, Electricity Storage Module”.

~~and Offshore Generating Unit which sub-divide into Onshore Synchronous Generating Unit and Onshore Non Synchronous Generating Unit and Offshore Synchronous Generating Unit and Offshore Non-Synchronous Generating Unit which then flow through to Power Park Module and Synchronous Power Generating Module which ultimately form part of a Power Station owned by a Generator of which a Storage User is a subset.~~

The definition of Power Generating Module has also been changed to “Either a Synchronous Power Generating Module, a Synchronous Electricity Storage Module, a Power Park Module or a Non-Synchronous Electricity Storage Module, owned or operated by an EU Generator”.

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Putting this another way, the definition of Generating Unit and Power Generating Module has been updated to include Electricity Storage Units and Electricity Storage Modules such that any obligation that applies to a Generating Unit or Power Generating Module will also include storage. Where there are specific requirements within the main body of the Grid Code which explicitly apply to storage these are explicitly defined for example in ~~ECC.6.3.3 and~~ OC.6.6.6.

In terms of classification, and to ensure consistency with Ofgem's Licensing proposals, storage is being treated in the same way as Generation. It is proposed that these requirements would apply going forward and not retrospectively. Whilst Storage has specifically been excluded from the requirements of the European Connection Network Codes (Requirements for Generators (RfG), HVDC Code and Demand Connection Code (DCC)), the Proposers view and that of Ofgem, agree that any new requirements going forward should be consistent with the European Connection Conditions (ECC's) and not the CC's whilst specifically noting that in doing so, Generators who own and operate Electricity Storage Modules would not be bound by the requirements of the EU Connection Codes as they are not enforceable under EU law. This issue has been addressed through the definition of Storage User and how it sits within the definition of an EU Code User.

It is also worth noting that whilst preparing this modification, the opportunity was taken to amend the definition of Pumped Storage Plant to form Pumped Storage Plant and Existing Pumped Storage Plant. Pumped Storage Plant would apply to any Pumped Storage Plant going forward and hence captured under the ECC whereas an Existing Pumped Storage Plant would revert back to ~~so as to remove the specific reference to the existing Pumped Storage Plants in GB namely~~ the Dinorwig, Ffestiniog, Cruachan and Foyers Power Stations. The advantage of this approach is that if a new pump storage plant were to connect to the GB System in the future, it would be caught by the requirements of the ECC's and hence RfG, whereas there would be no risk of any unintended consequences for existing Pumped Storage Plant. ~~prevent the need for a Grid Code change.~~ To facilitate this change, the definition of "Pump Storage" has been changed to "Pumped Storage" and the definition of Existing Pump Storage Unit has also been added so as not to cause any unintended consequences for existing Pumped Storage Stations.~~.~~

As part of the consultation, a number of parties who provided comments felt that it was appropriate for new Pumped Storage plant to be integrated into the definition of Electricity Storage. The Proposer agrees with this in principle however is concerned that Pumped Storage falls under the auspices of RfG whereas Storage does not. The Proposer has therefore not included pumped storage within the definition of Electricity Storage but has developed the legal text such the requirements upon future Pumped Storage Plant are consistent with those for Electricity Storage Modules.

The main changes to the Glossary and Definitions as a result of these proposals are summarised below in the following table.

~~**Authorised Certifier**~~	~~An entity that issues **Equipment Certificates** and **Power Generating Module Documents** (excluding those in respect of **Electricity Storage Modules**) and whose accreditation is given by the national affiliate of the European cooperation for Accreditation ('EA'), established in accordance with Regulation (EC) No 765/2008 of the European Parliament and of the Council (1).~~
Block Load Capability	The incremental **Active Power** steps, from no load to **Rated MW**, which a **Generating Unit** or **Power Generating Module** (including a ~~**DC Connected Power Park Module** and/or **Electricity Storage Module**~~) or **Power Park Module** or **HVDC System** can instantaneously supply without causing it to trip or go outside the **Frequency** range of 47.5 – 52Hz (or an otherwise agreed **Frequency** range). The time between each incremental step shall also be provided.
Electricity Storage	The conversion of electrical energy into a form of energy which can be stored, the storing of that energy, and the subsequent reconversion of that energy back into electrical energy in a controllable manner.
Electricity Storage Module	Is either one or more **Synchronous Electricity Storage Unit**(s) or a **Non-Synchronous Electricity Storage Unit**(s) which could also be part of a **Power Generating Module**. For the avoidance of doubt, **Non-Controllable Electricity Storage Equipment** would not be considered to be classed as an **Electricity Storage Module** or as an **Electricity Storage Unit**.
Electricity Storage Unit	A **Synchronous Electricity Storage Unit** or **Non Synchronous Electricity Storage Unit**.

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EU Code User	A **User** who is any of the following:- (a) A **Generator** in respect of a **Power Generating Module** (excluding a **DC Connected Power Park Module**) or **OTSDUA** (in respect of an AC **Offshore Transmission System**) whose **Main Plant and Apparatus** is connected to the **System** on or after 27 April 2019 and who concluded **Purchase Contracts** for its **Main Plant and Apparatus** on or after 17 May 2018 (b) A **Generator** in respect of any **Type C** or **Type D Power Generating Module** which is the subject of a **Substantial Modification** which is effective on or after 27 April 2019. (c) A **Generator** in respect of any **DC Connected Power Park Module** whose **Main Plant and Apparatus** is connected to the **System** on or after 8 September 2019 and who had concluded **Purchase Contracts** for its **Main Plant and Apparatus** on or after 28 September 2018. (d) A **Generator** in respect of any **DC Connected Power Park Module** which is the subject of a **Substantial Modification** which is effective on or after 8 September 2019. (e) An **HVDC System Owner** or **OTSDUA** (in respect of a DC **Offshore Transmission System** including a **Transmission DC Converter**) whose **Main Plant and Apparatus** is connected to the **System** on or after 8 September 2019 and who had concluded **Purchase Contracts** for its **Main Plant and Apparatus** on or after 28 September 2018. (f) An **HVDC System Owner** or **OTSDUA** (in respect of a DC **Offshore Transmission System** including a **Transmission DC Converter**) whose **HVDC System** or DC **Offshore Transmission System** including a **Transmission DC Converter**) is the subject of a **Substantial Modification** on or after 8 September 2019. (g) A **User** which the **Authority** has determined should be considered as an **EU Code User**. (h) A **Network Operator** whose entire distribution **System** was first connected to the **National Electricity Transmission System** on or after 18 August 2019 and who had placed **Purchase Contracts** for its **Main Plant** and **Apparatus** in respect of its entire distribution **System** on or after 7 September 2018. For the avoidance of doubt, a **Network Operator** will be an **EU Code User** if its entire distribution **System** is connected to the **National Electricity Transmission System** at **EU Grid Supply Points** only. (i) A **Non Embedded Customer** whose **Main Plant and Apparatus** at each **EU Grid Supply Point** was first connected to the **National Electricity Transmission System** on or after 18 August 2019 and who had placed **Purchase Contracts** for its **Main Plant and Apparatus** at each **EU Grid Supply Point** on or after 7 September 2018 or is the subject of a **Substantial Modification** on or after 18 August 2019. *(j)* A **Storage User** in respect of an **Electricity Storage Module** whose **Main Plant and Apparatus** is connected to the **System** on or after 1 year plus DDMMYY 2019 and who concluded **Purchase Contracts** for its **Main Plant and Apparatus** on or after DDMMYY 2019. *(Note – DDMMYY 2019 is dependent upon Ofgem's Decision Date)*

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Existing Pumped Storage Plant	The Dinorwig, Ffestiniog, Cruachan and Foyers **Power Stations**.
Existing Pumped Storage Unit	A **Generating Unit** within an **Existing Pumped Storage Plant**.
Generator	A person who generates electricity or undertakes **Electricity Storage** under licence or exemption under the **Act** acting in its capacity as a generator in Great Britain or **Offshore**. The term **Generator** includes a **EU Generator** and a **GB Generator**.
~~**Genset**~~	~~A Power Generating Module (including a DC Connected Power Park Module and Electricity Storage Module), Generating Unit, Power Park Module or CCGT Module at a Large Power Station or any Power Generating Module (including a DC Connected Power Park Module and Electricity Storage Module), Generating Unit, Power Park Module or CCGT Module which is directly connected to the National Electricity Transmission System.~~
Intermittent Power Source	The primary source of power for a **Generating Unit** or **Power Generating Module** (~~excluding **Electricity Storage Modules**~~) that can not be considered as controllable, e.g. wind, wave or solar. For the avoidance of doubt, the input to an **Electricity Storage Module** would not be considered to be from an **Intermittent Power Source**.
Main Plant and Apparatus	In respect of a **Power Station** (including **Power Stations** comprising of **DC Connected Power Park Modules** and **Electricity Storage Modules**) is one or more of the principal items of **Plant** or **Apparatus** required to convert or re-convert the primary source of energy into electricity. In respect of **HVDC Systems** or **DC Converters** or **Transmission DC Converters** is one of the principal items of **Plant** or **Apparatus** used to convert high voltage direct current to high voltage alternating current or vice versa. In respect of a **Network Operator's** equipment or a **Non-Embedded Customer's** equipment, is one of the principal items of **Plant** or **Apparatus** required to facilitate the import or export of **Active Power** or **Reactive Power** to or from a **Network Operator's** or **Non Embedded Customer's System**.
Maximum Capacity or P_{max}	The maximum continuous **Active Power** which a **Power Generating Module** can supply to the **Total System**, less any demand associated solely with facilitating the operation of that **Power Generating Module** and not fed into the **System**. In the case of an **Electricity Storage Module** the **Maximum Capacity** is the maximum continuous **Active Power** which an **Electricity Storage Module** can export to the **Total System** less any demand associated with facilitating the operation of that **Electricity Storage Module** when fully charged and operating in a mode analogous to **Generation** or the maximum continuous **Active Power** which an **Electricity Storage Module** can import from the **Total System** less any demand associated with facilitating the operation of that **Electricity Storage Module** when fully discharged and operating in a mode analogous to **Demand**.

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National Demand	The amount of electricity supplied from the **Grid Supply Points** plus:- • that supplied by **Embedded Large Power Stations**, and • **National Electricity Transmission System Losses**, minus:- • the **Demand** taken by **Station Transformers**, **Existing Pumped Storage Units'** and **Pumped Storage Units'** and, for the purposes of this definition, does not include:- any exports from the **National Electricity Transmission System** across **External Interconnections**.
National Electricity Transmission System Demand	The amount of electricity supplied from the **Grid Supply Points** plus:- • that supplied by **Embedded Large Power Stations**, and • exports from the **National Electricity Transmission System** across **External Interconnections**, and • **National Electricity Transmission System Losses**, and, for the purposes of this definition, includes:- the **Demand** taken by **Station Transformers**, **Existing Pumped Storage Units'** and **Pumped Storage Units**.
Non-Controllable Electricity Storage Equipment	An item of ~~**Electricity Storage**~~ storage **Plant**, including but not limited to a **Synchronous Flywheel** or **Synchronous Compensation Equipment** or **Regenerative Braking** whose active output power cannot be independently controlled.
Non-Synchronous Electricity Storage Module	A **Power Park Module** comprising solely of one or more **Non-Synchronous Electricity Storage Units**.
Non-Synchronous Electricity Storage Unit	A **Power Park Unit** which can produce electrical energy by converting or re-converting another source of energy such that the frequency of the generated voltage is not inherently in synchronism with the frequency of the **System**.
Non-Synchronous Generating Unit	An **Onshore Non-Synchronous Generating Unit** ~~or **Onshore Non-Synchronous Electricity Storage Unit**~~ or **Offshore Non-Synchronous Generating Unit** ~~or **Offshore Non-Synchronous Electricity Storage Unit**~~ which could form part of a **Power Generating Module**.
Offshore Generating Unit	Unless otherwise provided in the Grid Code, any **Apparatus** located **Offshore** which produces electrical energy by converting or re-converting another source of energy, including, an **Offshore Synchronous Generating Unit** or **Offshore Non-Synchronous Generating Unit** which could also be part of a **Power Generating Module** or **Electricity Storage Module**.
~~**Offshore Non-Synchronous ElectricityStorage Unit**~~	~~A Non-Synchronous Electricity Storage Unit located Offshore.~~

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Offshore Non-Synchronous Generating Unit	An **Offshore Generating Unit** that is not an **Offshore Synchronous Generating Unit** including for the avoidance of doubt a **Power Park Unit** or **Non-Synchronous Electricity Storage Unit** located **Offshore**.
Offshore Power Park String	A collection of **Offshore Generating Units** or **Power Park Units** or **Non-Synchronous Electricity Storage Units**, joined together by cables forming part of a **User System** with a single point of connection to an **Offshore Transmission System**. The connection to an **Offshore Transmission System** may include a **DC Converter** or **HVDC Converter**.
~~**Offshore Synchronous Electricity Storage Unit**~~	~~A Synchronous Electricity Storage Unit located Offshore.~~
~~**Offshore Synchronous Electricity Storage Module**~~	~~A Synchronous Electricity Storage Module located Offshore.~~
Offshore Synchronous Generating Unit	A **Generating Unit** or **Synchronous Electricity Storage Unit** located **Offshore** which could be part of an **Offshore Synchronous Power Generating Module** in which, under all steady state conditions, the rotor rotates at a mechanical speed equal to the electrical frequency of the **National Electricity Transmission System** divided by the number of pole pairs of the **Generating Unit**.
Offshore Synchronous Power Generating Module	A **Synchronous Power Generating Module** or **Synchronous Electricity Storage Module** located **Offshore**.
Onshore Generating Unit	Unless otherwise provided in the Grid Code, any **Apparatus** located **Onshore** which produces electrical energy by converting or re-converting another source of energy, including, an **Onshore Synchronous Generating Unit** or **Onshore Non-Synchronous Generating Unit** which could also be part of a **Power Generating Module** or an **Electricity Storage Module**.
Onshore Grid Entry Point	A point at which an **Onshore Generating Unit** or a **CCGT Module** or a **CCGT Unit** or an **Onshore Power Generating Module** or a **Onshore DC Converter** or an **Onshore HVDC Converter** or a **Onshore Power Park Module** or an **Onshore Electricity Storage Module** or an **External Interconnection**, as the case may be, which is directly connected to the **Onshore Transmission System** connects to the **Onshore Transmission System**.
Onshore Generating Unit	Unless otherwise provided in the Grid Code, any **Apparatus** located **Onshore** which produces electrical energy by converting or re-converting another source of energy, including, an **Onshore Synchronous Generating Unit** or **Onshore Non-Synchronous Generating Unit** which could also be part of a **Power Generating Module** or an **Electricity Storage Module**.

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Onshore Grid Entry Point	A point at which a **Onshore Generating Unit** or a **CCGT Module** or a **CCGT Unit** or an **Onshore Power Generating Module** or a **Onshore DC Converter** or an **Onshore HVDC Converter** or a **Onshore Power Park Module** or an **Onshore Electricity Storage Module** or an **External Interconnection**, as the case may be, which is directly connected to the **Onshore Transmission System** connects to the **Onshore Transmission System**.
Onshore HVDC Converter	Any **User Apparatus** located **Onshore** used to convert alternating current electricity to direct current electricity, or vice versa. An **Onshore HVDC Converter** is a standalone operative configuration at a single site comprising one or more converter bridges, together with one or more converter transformers, converter control equipment, essential protective and switching devices and auxiliaries, if any, used for conversion. In a bipolar arrangement, an **Onshore HVDC Converter** represents the bipolar configuration.
~~**Onshore Non-Synchronous Electricity Storage Unit**~~	~~A Non-Synchronous Electricity Storage Unit located Onshore.~~
Onshore Non-Synchronous Generating Unit	A **Generating Unit** located **Onshore** that is not a **Synchronous Generating Unit** or **Synchronous Electricity Storage Unit** including for the avoidance of doubt a **Power Park Unit** or **Non-Synchronous Electricity Storage Unit** located **Onshore**.
Onshore Power Park Module	A collection of **Non-Synchronous Generating Units** that are powered by an **Intermittent Power Source** or connected through power electronic conversion technology or **Non-Synchronous Electricity Storage Units**, joined together by a **System** (registered as a **Power Park Module** under the PC) with a single electrical point of connection directly to the **Onshore Transmission System** (or **User System** if **Embedded**) with no intermediate **Offshore Transmission System** connections. The connection to the **Onshore Transmission System** (or **User System** if **Embedded**) may include a **DC Converter** or **HVDC Converter**.
~~**Onshore Synchronous Electricity Storage Unit**~~	~~A Synchronous Electricity Storage Unit located Onshore.~~
Onshore Synchronous Generating Unit	An **Onshore Generating Unit** or **Onshore Synchronous Electricity Storage Unit** (which could also be part of an **Onshore Power Generating Module**) including, for the avoidance of doubt, a **CCGT Unit** or **Synchronous Electricity Storage Unit** in which, under all steady state conditions, the rotor rotates at a mechanical speed equal to the electrical frequency of the **National Electricity Transmission System** divided by the number of pole pairs of the **Generating Unit**.
Onshore Synchronous Power Generating Module	A **Synchronous Power Generating Module** or **Synchronous Electricity Storage Module located Onshore**.

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Operational Intertripping	The automatic tripping of circuit-breakers to prevent abnormal system conditions occurring, such as over voltage, overload, **System** instability, etc. after the tripping of other circuit-breakers following power **System** fault(s) which includes **System to Generating Unit**, **System to CCGT Module**, **System to Power Park Module**, S**ystem to Electricity Storage Module**, **System to DC Converter**, **System to Power Generating Module**, **System to HVDC Converter** and **System to Demand** intertripping schemes.
~~**Operational Planning**~~	~~Planning through various timescales the matching of generation output with forecast National Electricity Transmission System Demand together with a reserve of generation to provide a margin, taking into account outages of certain Generating Units or Power Generating Modules or Electricity Storage Modules, of parts of the National Electricity Transmission System and of parts of User Systems to which Power Stations and/or Customers are connected, carried out to achieve, so far as possible, the standards of security set out in The Company's Transmission Licence, each Relevant Transmission Licensee's Transmission Licence or Electricity Distribution Licence, as the case may be.~~
Power Available	A signal prepared in accordance with good industry practice, representing the instantaneous sum of the potential **Active Power** available from each individual **Power Park Unit** within the **Power Park Module** calculated using any applicable combination of , electrical or mechanical or meteorological data (including wind speed) measured at each **Power Park Unit** at a specified time. **Power Available** shall be a value between 0MW and **Registered Capacity** or **Maximum Capacity** which is the sum of the potential **Active Power** available of each **Power Park Unit** within the **Power Park Module.** A unit that is not generating or supplying power will be considered as not available. For the avoidance of doubt, the **Power Available** signal would be the **Active Power** output that a **Power Park Module** could reasonably be expected to export at the **Grid Entry Point** or **User System Entry Point** taking all the above criteria into account including **Power Park Unit** constraints such as optimisation modes but would exclude a reduction in the **Active Power** export of the **Power Park Module** instructed by **The Company** (for example) for the purposes selecting a **Power Park Module** to operate in **Frequency Sensitive Mode** or when an **Emergency Instruction** has been issued.
Power-Generating Module	Either a **Synchronous Power-Generating Module**, a **Synchronous Electricity Storage Module**, ~~or~~ a **Power Park Module** or a **Non-Synchronous Electricity Storage Module** owned or operated by an **EU Generator**.
Power Station	An installation comprising one or more **Generating Units** or **Power Park Modules** or **Power Generating Modules** or **Electricity Storage 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**.

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Pumped Storage	A hydro unit in which water can be raised by means of pumps and stored to be used for the generation of electrical energy;
Pumped Storage Generator	A **Generator** which owns and/or operates any **Pumped Storage Plant** including an **Existing Pumped Storage Plant**.
Pumped Storage Plant	A **Power Station** comprising **Pumped Storage Generating Units** excluding an **Existing Pumped Storage Plant**.
Rated MW	The "rating-plate" MW output of a **Power Generating Module**, **Generating Unit**, **Power Park Module**, **Electricity Storage Module**, **HVDC Converter** or **DC Converter**, being: (a) that output up to which the **Generating Unit** or **Synchronous Electricity Storage Unit** was designed to operate (Calculated as specified in **British Standard BS** EN 60034 – 1: 1995); or (b) the nominal rating for the MW output of a **Power Park Module** ~~or **Synchronous Electricity Storage Module**~~ or **Power Generating Module** being the maximum continuous electric output power which the **Power Park Module** or **Power Generating Module** or **Electricity Storage Module** was designed to achieve under normal operating conditions; or (c) the nominal rating for the MW import capacity and export capacity (if at a **DC Converter Station** or **HVDC Converter Station**) of a **DC Converter** or **HVDC Converter**.
Regenerative Braking	A method of braking in which energy is extracted from the parts braked, to be stored and reused.

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Registered Capacity *(Check def with Legal)*	(a) In the case of a **Generating Unit** ~~or **Synchronous Electricity Storage Unit**~~, other than that forming part of a **CCGT Module** or **Power Park Module** or **Power Generating Module** ~~or **Electricity Storage Module**~~, the normal full load capacity of a **Generating Unit** ~~or **Synchronous Electricity Storage Unit**~~, as declared by the **Generator**, less the MW consumed by the **Generating Unit** ~~or **Synchronous Electricity Storage Unit**~~, through the **Generating Unit's** ~~or **Synchronous Electricity Storage Unit's**~~ **Unit Transformer** when producing the same (the resultant figure being expressed in whole MW, or in MW to one decimal place). (b) In the case of a **CCGT Module** or **Power Park Module** owned or operated by a **GB Generator**, the normal full load capacity of the **CCGT Module** or **Power Park Module** (as the case may be) as declared by the **GB Generator**, being the **Active Power** declared by the **GB Generator** as being deliverable by the **CCGT Module** or **Power Park Module** at the **Grid Entry Point** (or in the case of an **Embedded CCGT Module** or **Power Park Module**, at the **User System Entry Point**), expressed in whole MW, or in MW to one decimal place. For the avoidance of doubt **Maximum Capacity** would apply to **Power Generating Modules** which form part of a **Large**, **Medium** or **Small Power Stations**. (c) In the case of a **Power Station**, the maximum amount of **Active Power** deliverable by the **Power Station** at the **Grid Entry Point** (or in the case of an **Embedded Power Station** at the **User System Entry Point**), as declared by the **Generator**, expressed in whole MW, or in MW to one decimal place. The maximum **Active Power** deliverable is the maximum amount deliverable simultaneously by the **Power Generating Modules** and/or **Generating Units** and/or **CCGT Modules** and/or **Power Park Modules** less the MW consumed by the **Power Generating Modules** and/or **Generating Units** and/or **CCGT Modules** in producing that **Active Power** and forming part of a **Power Station**. (d) In the case of a **DC Converter** at a **DC Converter Station** or **HVDC Converter** at an **HVDC Converter Station**, the normal full load amount of **Active Power** transferable from a **DC Converter** or **HVDC Converter** at the **Onshore Grid Entry Point** (or in the case of an **Embedded DC Converter Station** or an **Embedded HVDC Converter Station** at the **User System Entry Point**), as declared by the **DC Converter Station** owner or **HVDC System Owner**, expressed in whole MW, or in MW to one decimal place. (e) In the case of a **DC Converter Station** or **HVDC Converter Station**, the maximum amount of **Active Power** transferable from a **DC Converter Station** or **HVDC Converter Station** at the **Onshore Grid Entry Point** (or in the case of an **Embedded DC Converter Station** or **Embedded HVDC Converter Station** at the **User System Entry Point**), as declared by the **DC Converter Station** owner or **HVDC System Owner**, expressed in whole MW, or in MW to one decimal place. (f) In the case of an **Electricity Storage Module**, the normal full load amount of **Active Power** transferable (in both an importing and exporting mode of operation) from an **Electricity Storage Module** at the **Grid Entry Point** (or in the case of an **Embedded Electricity Storage Module** at the **User System Entry Point**), as declared by the **Generator**, expressed in whole MW, or in MW to one decimal place.

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~~**Self-Governance Criteria (not sure if we need this as storage is included in generation def but has been added for clarity).**~~	~~A proposed Modification that, if implemented,~~ ~~(a) is unlikely to have a material effect on:~~ ~~(i) existing or future electricity consumers; and~~ ~~(ii) competition in the generation, storage, distribution, or supply of electricity or any commercial activities connected with the generation, storage, distribution or supply of electricity; and~~ ~~(iii) the operation of the National Electricity Transmission System; and~~ ~~(iv) matters relating to sustainable development, safety or security of supply, or the management of market or network emergencies; and~~ ~~(v) the Grid Code's governance procedures or the Grid Code's modification procedures, and~~ ~~(b)~~(a) ~~is unlikely to discriminate between different classes of Users.~~
Storage User	A **Generator** who owns or operates one or more **Electricity Storage Modules**. For the avoidance of doubt, a **Storage User** would not be bound by the requirements **European Regulation** (EU) 2016/631, **European Regulation** 2016/1388 and **European Regulation** 2016/1485. Any derogation in respect of **Electricity Storage Modules** would therefore be against the GB Grid Code as the requirements applicable to **Electricity Storage Modules** are not enforceable by EU Law.
Synchronous Compensation Equipment	**Apparatus** which has the function of providing **Synchronous Compensation**. For the avoidance of doubt, one or more **Synchronous Compensation** units would not constitute an **Electricity Storage Module** unless it could be operated in a controllable manner.
Synchronous Electricity Storage Module	A **Synchronous Power Generating Module** which can convert or re-convert electrical energy from another source of energy such that the frequency of the generated voltage, the rotor speed and the frequency of network voltage are in a constant ratio and thus in synchronism. For the avoidance of doubt a **Synchronous Electricity Storage Module** could comprise of one or more **Synchronous Electricity Storage Units**.
Synchronous Electricity Storage Unit	A **Synchronous Generating Unit** which can supply or absorb electrical energy such that the frequency of the generated voltage, the rotor speed and the frequency of the equipment are in constant ratio and thus in synchronism with the network.
Synchronous Flywheel	An item of synchronously rotating **Plant** for the specific purpose of contributing inertia to the **System**. One or more **Synchronous Flywheels** would not be considered to form an **Electricity Storage Module** unless it could be operated in a controllable manner for its AC input and output power.

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Synchronous Power-Generating Module **(Check with Legal – does this work)**	An indivisible set of installations which can ~~generate~~ convert or re-convert electrical energy from another source of energy such that the frequency of the supplied voltage, the rotor speed and the frequency of network voltage are in a constant ratio and thus in synchronism. For the avoidance of doubt, a ~~**Synchronous Electricity Storage Module** is considered to have the same meaning as a~~ **Synchronous Power Generating Module** ~~which~~ could comprise of one or more **Synchronous Generating Units** or one or more **Synchronous Electricity Storage Units**.
Type A Power Generating Module	A **Power-Generating Module** (including an **Electricity Storage Module**) with a **Grid Entry Point** or **User System Entry Point** below 110 kV and a **Maximum Capacity** of 0.8 kW or greater but less than 1MW;
Type B Power Generating Module	A **Power-Generating Module** (including an **Electricity Storage Module**) with a **Grid Entry Point** or **User System Entry Point** below 110 kV and a **Maximum Capacity** of 1MW or greater but less than 10MW;
Type C Power Generating Module	A **Power-Generating Module** (including an **Electricity Storage Module**) with a **Grid Entry Point** or **User System Entry Point** below 110 kV and a **Maximum Capacity** of 10MW or greater but less than 50MW;
Type D Power Generating Module	A **Power-Generating Module** (including an **Electricity Storage Module**): with a **Grid Entry Point** or **User System Entry Point** at, or greater than, 110 kV; or with a **Grid Entry Point** or **User System Entry Point** below 110 kV and with **Maximum Capacity** of 50MW or greater
~~**User System**~~	~~Any system owned or operated by a User comprising:-~~ ~~(a) Power Generating Modules (including Electricity Storage Modules) or Generating Units; and/or~~ ~~(b) Systems consisting (wholly or mainly) of electric lines used for the distribution of electricity from Grid Supply Points or Generating Units or Power Generating Modules (including Electricity Storage Modules) or other entry points to the point of delivery to Customers, or other Users;~~ ~~and Plant and/or Apparatus (including prior to the OTSUA Transfer Time, any OTSUA) connecting:-~~ ~~(c) The system as described above; or~~ ~~(d) Non-Embedded Customers equipment;~~ ~~to the National Electricity Transmission System or to the relevant other User System, as the case may be.~~ ~~The User System includes any Remote Transmission Assets operated by such User or other person and any Plant and/or Apparatus and meters owned or operated by the User or other person in connection with the distribution of electricity but does not include any part of the National Electricity Transmission System.~~

User System Entry Point	A point at which a **Power Generating Module**, **Generating Unit**, a **CCGT Module** or a **CCGT Unit** or a **Power Park Module**, or an **Electricity Storage Module** or a **DC Converter** or an **HVDC Converter**, as the case may be, which is **Embedded** connects to the **User System**.

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Changes to the European Connection Conditions

The legal text provided in Annex 3 sets out the requirements applicable to Electricity Storage Modules which are treated in the same way as Power Generating Modules.

		Electricity Storage Modules			
Grid Code Ref	**Requirement**	**Onshore Synchronous**	**Offshore Synchronous**	**Onshore Non-Synchronous**	**Offshore Non-Synchronous**
ECC.6.1.2	Frequency Range	Y	Y	Y	Y
ECC.6.1.4	Voltage Range	Y	Y	Y	Y
ECC.6.1.5 – ECC.6.1.7	Power Quality – Direct Connections only	Y	Y	Y	Y
ECC.6.2	General Requirements	Y	Y	Y	Y
ECC.6.3.2	Reactive Capability	Y	N[1]	Y	N[1]
ECC.6.3.3	Output Power with falling frequency	Y~~[2]~~	Y~~[2]~~	Y~~[2]~~	Y~~[2]~~
ECC.6.3.4	Reactive Capability for HV System Voltage Changes	Y	Y	Y	Y
ECC.6.3.5	Black Start (Not Mandatory)	Y	Y	Y	Y
ECC.6.3.6	Ability to Modulate Active and Reactive Power in response to frequency and voltage variations	Y	Y	Y	Y
ECC.6.3.7	Frequency Response	Y	Y	Y	Y

ECC.6.3.8	Voltage Control	Y	N	Y	N
ECC.6.3.9	Steady State Load Inaccuracies	Y	Y	Y	Y
ECC.6.3.10	Negative Sequence Loadings	Y	Y	Y	Y
ECC.6.3.11	Neutral Earthing	Y	Y	Y	Y
ECC.6.3.12	Frequency and Voltage Deviations	Y	Y	Y	Y
ECC.6.3.13	Frequency, rate of change of frequency and voltage protection setting arrangements	Y	Y	Y	Y
ECC.6.3.14	Fast Start Capability	Y	Y	Y	Y
ECC.6.3.15	Fault Ride Through	Y	Y	Y	Y
ECC.6.3.16	Fast Fault Current Injection	Y	Y	Y	Y
ECC.6.3.18	System to Generator Operational Intertripping Schemes	Y	Y	Y	Y
OC6.6	Frequency Sensitive Relays and load shedding	Y	Y	Y	Y
ECC.6.5.2	Control Telephony / System Telephony	Y	Y	Y	Y
ECC.6.5.6	Operational Metering	Y	Y	Y	Y
ECC.6.5.8	Electronic Data Communication Facilities	Y	Y	Y	Y
ECC.6.5.9	Fax Machines	Y	Y	Y	Y
ECC.6.5.10	Busbar Voltage – Direct Connections only	Y	Y	Y	Y
ECC.6.6	Monitoring	Y	Y	Y	Y
ECC.7	Site Related Conditions	Y	Y	Y	Y

ECC.8	Ancillary Services	Y	Y	Y	Y
PC	Planning Code Data	Y	Y	Y	Y

[1]Note AC connected Offshore Power Generating Modules have a restricted reactive capability range. Electricity Storage Modules, being a subset of Power Generating Modules will be treated in the same way.

~~[2]Note ECC.6.3.3 A Storage provider would need to meet the Requirements of Figure 3 in ECC 6.3.3 (d) which is the same as an HVDC Converter which requires automatic de-loading for frequencies below 49.5 Hz. In addition, they will also need to meet the requirements of BC.3.7.2 which requires automatic de-loading for frequencies above 50.4 Hz.~~

Does this modification impact a Significant Code Review (SCR) or other significant industry change projects, if so, how?

No.

Consumer Impacts

In the view of the Proposer, this proposal, by facilitating a greater level of connections of Storage to the System should increase the level of competition within ancillary services markets and improve the Transmission System Operator's ability to procure economic options for system balancing. It also provides clarity to the technical requirements expected of Storage providers and ensures consistency with other technologies for which Grid Code requirements already apply. The resulting saving in balancing costs will have a positive impact on end consumer bills. It also has the option to provide greater flexibility to developers in satisfying Grid Code requirements which could be achieved through a mix of conventional technologies and Storage and also provides benefits to the Electricity System Operator and Network Operators in facilitating improved plant performance.

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4 Workgroup Discussions

The Workgroup convened 12 times between January 2017 and March 2019 to discuss the ~~perceived~~ issues, detail the scope of the proposed defect, devise potential solutions and assess the proposal in terms of the Applicable Grid Code Objectives. The Workgroup will in due course conclude these tasks after this consultation (taking account of responses to this consultation).

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The Workgroup discussed a number of the key attributes under GC0096 and these discussions are described below.

At the meeting held on the 15 January 2018, the proposer advised that the treatment of frequency response was different between Synchronous and Non-Synchronous Generation technologies and should this exception also apply to Storage Technologies. In response, a workgroup member suggested that the text proposed for the RfG drafting should be adopted on the basis of equitable treatment between Synchronous and Non-Synchronous Generation Technologies. Other workgroup members agreed with this approach and as such the work was placed on hold until the RfG and HVDC modifications as proposed under consultations GC0100 – GC0102 wereare approved by Ofgem (which would have been required before 17th May 2018) to meet the EU deadline. Whilst one Workgroup member did note that the EU Connection Codes explicitly exclude storage, and questioned if Storage should be applied to the Connection Conditions or European Connection Conditions, the view of the Proposer was that the European Connection Conditions (i.e. the RfG requirements) should apply as a GB modification to ensure consistency with their Generation counterparts. The issue was also raised with Ofgem for determination and is discussed below their response is covered in Section 1 of this report.

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The Proposer presented the defect that they had identified in the Modification proposal. The discussions and views of the Workgroup are outlined below.

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It was also noted in the Workgroup that existing connections who had already applied for a connection would not be affected by these GC0096 proposed changes and that appropriate transitional arrangements would need to be put in place so that existing projects were not affected by the GC0096 changes.

Background

This Modification was raised by the ESO (formerly NGET) in May 2016 to introduce the appropriate Grid Code provisions for Energy Storage[4] devices. This is particularly significant given that technical requirements for Energy Storage devices are not covered under the EU Network Codes.

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Energy Storage devices have the capability to act as a source of either export of electricity onto the network (akin to generation) or import of electricity from the network (akin to demand). It is therefore necessary to ensure the existing set of requirements are consistent in terms of Energy Storage devices within the existing industry codes, whilst giving due consideration to compatibility with developments needed in other code areas (for example: the Planning Code and the Data Registration Code) and ensures equitable treatment with other Users.

Given that Energy Storage devices are a growing sector, it was proposed that this paper is also circulated to the Distribution Code Review Panel as similar issues are likely to be faced at a Distribution Code level. This issue was shared, and whilst GC0096 included

[4] As set out in Section 3 and the legal text, the proposed definition of which is, in the form of 'Electricity Storage, as: "Is the conversion of electrical energy into a form of energy which can be stored, the storing of that energy, and the subsequent reconversion of that energy back into electrical energy in a controllable manner"

Distribution Code stakeholders, including DNO representatives, the focus of the Workgroup was on Grid Code changes. Any Distribution Code changes will be consequential from GC0096, using the proposed solution as a basis.

To ensure consistency with their Generation and HVDC Counterparts, it was agreed at the Workgroup meeting held on 15 January 2018, that the proposed definitions and technical requirements for Storage should be applied to the Grid Code text as approved by Ofgem to incorporate RfG and HVDC Codes following consultations GC0100, GC0101 and GC0102. As a consequence, and following a number of meetings with the Workgroup in the Summer and Autumn of 2018, this report and the corresponding legal text has been updated to address the subsequent Grid Code changes. The proposed legal text to implement the storage related changes into the Grid Code has been prepared onto ~~the latest version of the Grid Code (~~Issue 5 Revision 27~~)~~ of the Grid Code which includes the RfG drafting implemented in May 2018.

Commented [J(A4]: This is nbo longer the latest version so we need to have a chat about this.

In the summer of 2018 following updates to the legal text (which included placing the storage requirements onto the RfG text) one Workgroup member voiced concern that as the EU Connection Codes (RfG, HVDC and DCC) explicitly excluded storage and therefore the proposed legal text drafting related to storage should be integrated into the Connection Conditions (CC's) rather than the European Connection Conditions (ECC's). The Proposer's view is that the ECC's should be used (rather than the CC's) on the basis of the need to ensure consistency between the requirements for generation and storage. Following the same approach is also important for co-located sites where generation and storage will be integrated side by side.

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This issue (of treating generation and storage the same) has been raised with Ofgem and they have advised that they do not consider that inserting the Energy Storage requirements proposed through GC0096 in the European Connection Conditions (ECC's) section of the Grid Code would breach Article 3, paragraph 2 of the Commission Regulation (EU) 2016/631 establishing a Network Code on the Requirements for Grid Connection of Generators ("the RfG").

Ofgem agree that the Connection Conditions (CC's) section of the Grid Code are likely to become obsolete, certainly in respect of new connections, and that once the European Network Codes (ENCs) are in force, all connection requirements for new connections to the system will be found in the ECC's section of the Grid Code. From that perspective, it seems pragmatic that the connection requirements for Energy Storage are to be found in the ECC's section of the Grid Code. The Ofgem view was that should the Workgroup take this view, the legal text will need to be drafted such that it's very clear to Users or classes of Users what types of equipment the ECCs apply to and in doing so that the requirements on Storage are not caught by the requirements of the EU Connection Codes (ie RfG, HVDC and DCC) and that the obligations on Storage are not enforceable under EU law.

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In response, National Grid as proposer of GC0096 supported this view from Ofgem and have amended the draft legal text. In capturing this point, a new term "Storage User" has been created which explicitly excludes such User's from having to satisfy the requirements of the EU Connection Network Codes. In addition, and to explicitly make it clear that the EU Connection Codes do not apply to Storage User's, amendments have been made to section 1.1 of the ECC's and section 1.1 of the ECP's.

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At this point, it is worth noting that the EU Connection Stakeholder Committee have recently established several[5] expert groups of which one is tasked with evaluating the technical requirements for storage. It is unclear at this stage how this may or may not affect the European Network Codes (in particular RfG), however should RfG be updated to include storage in the future, (and notwithstanding wider issues such as Brexit) the approach adopted in GB and the proposed GB Storage modifications should be relatively straight forward to implement should RfG or the European Network Codes be updated at some time in the future.

During the early Workgroup discussions and prior to Ofgem's view of how storage should be treated from a Licensing perspective, the Proposers initial approach was that storage should be treated as a new category of User (namely an Electricity Storage Facility Owner"). On this basis, earlier versions of the Grid Code Legal drafting were prepared which resulted in extensive changes to all sections of the Grid Code.

In parallel with this drafting, Ofgem consulted on a modified generation licence, which clarifies storage as a subset of generation and its treatment in the applicable industry codes for storage. As part of this consultation (earlier in 2018) it was noted that Ofgem will implement changes to the generation licence to include storage via statutory consultation. In addition, The Government will define storage in primary legislation when Parlimentary time allows. At the Workgroup meeting on 24 October 2018 and noting the above issue on licensing, it was noted that the Grid Code legal text could be made significantly simpler if Electricity Storage was rolled into the existing definitions of Generator, Power Station and Power Generating Module. Not least, it was also recognised that consequential changes to other industry codes such as the CUSC and Distribution Code could be made significantly simpler if this approach was adopted.

National Grid was initially concerned that some parties (exempt from owning a Generation Licence such as Network Operators or their affiliates) may have problems with this if they wished to have an installation comprising solely of Electricity Storage Modules. The current licensing arrangements do prevent Licensed Network Operators from owning and operating storage devices, however in the view of the Proposer it would not preclude a company (as part of a separate business) from owning and operating a storage facility providing it could be demonstrated that there was no conflict of interest between the licensed network business and storage business. Other Workgroup members expressed concern around the intrinsic conflict of interest that would arise where an asset owner acts in a system operation role. It is anticipated that this may be resolved with the forthcoming publication of the Clean Energy Package.

On this basis and in view of the significant benefits and simplifications to the draft Grid Code changes, following the Workgroup meeting on 24 October 2018, the proposed legal text was updated to incorporate storage within the definition of Generator, Power

[5] Three groups have been set up covering (i) storage (ii) pump storage and (iii) mixed use sites (such as those with generation and storage or demand and storage for example).

Station and Power Generating Module whereas previously separate terms had been used.

What is the defect?

NGET raised a modification to address this defect in May 2016, and the GC0096 Workgroup was formed in the summer of 2016.

Two workshops with Storage developers and the wider industry were convened in August 2016 by NGET (but not the GC0096 Workgroup) to consider the scope of the modification.

Following these workshops, the primary focus of the GC0096 Workgroup was set to consider how to define 'Storage' unambiguously in the Grid Code; to understand how 'Storage' could be deployed (either on its own or as part of an existing scheme); and to assign proportionate minimum technical requirements for new connections which support the technology's flexibility.

The issue has been complex largely as result of:

iv. The large number of different 'Storage' technologies now commercially available;
v. The variations in which they may be configured either as part of a new development or an existing development; and
vi. The need to ensure equitable treatment with Generation, HVDC and Demand technologies as codified in the EU Connection Network Codes (RfG, HVDC and DCC) which currently exclude storage other than pumped storage.

This report provides the summary, to date, of the GC0096 Workgroup's progress delivering potential solutions to address these objectives.

Why change the Grid Code?

NGET has received a number of connection applications for transmission connected energy Storage devices which can both import and export electricity to the National Electricity Transmission System for which, in the view of the Proposer and some Workgroup members, there is currently a lack of clear provisions in the Grid Code. Another Workgroup member believed that there are already, in their view, clear provisions in the Grid Code for the treatment of 'Storage' by simple reference to 'Pump

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Storage' which exhibits all the same characteristics of the proposed GC0096 definition[6] although it was acknowledged by the Proposer that pumped storage as currently codified in the Grid Code applies to synchronous generation and does not recognise other categories of storage technology such as batteries. Applying a harmonised approach should ensure a level playing field is achieved.

Given that National Grid has received a significant degree of interest from further potential connectees, in particular, it is highly likely that additional connection applications will be received in the near future. This modification proposal identifies a need to clearly specify Grid Code requirements for a range of energy Storage technologies connected in a range of different configurations which could reasonably be considered to fall outside of the existing code provisions.

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Attachment 1, which was prepared by the Proposer, identifies a range of energy Storage technologies for consideration and the current interpretation of the Grid Code for the treatment of these varying device types which will be applied in the absence of bespoke definitions and requirements in order to progress pending connection applications. This attachment is for information only and not part of the GC0096 legal text.

Attachment 2, has now been superseded by the proposed legal text (included in Annex 1) as this identifies the additional DRC data which would be required for a Generator intending to connect and Electricity Storage Module to the System. This modification proposal seeks to assess the appropriate Grid Code provisions for energy Storage devices. This is particularly significant given that energy Storage devices are not covered under EU codes. Furthermore, energy Storage devices have the capability to act as a source of either generation or demand.

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In the view of the Proposer, it is therefore necessary to establish a set of requirements which are consistent with existing industry codes and gives due consideration to compatibility with other sections in the Grid Code (in particular the Planning Code, Compliance Processes and the Data Registration Code but also other sections such as the Operating Codes and Balancing Code).

In the view of the Proposer, there is currently a lack of bespoke requirements in the Grid Code for a diverse range of energy Storage devices (other than for pumped Storage). Parties who own energy Storage devices and use the National Electricity Transmission System will be expected to meet applicable sections of the Grid Code which are consistent with the existing requirements, including those recent provisions introduced following implementation of RfG (Requirements for Generators), HVDC European Network Codes and the Demand Connection Code (DCC) Network Code. There is a need, therefore, to consider code developments which account for a range of

[6] "Is the conversion of electrical energy into a form of energy which can be stored, the storing of that energy, and the subsequent reconversion of that energy back into electrical energy"

technology solutions and different operational characteristics whilst recognising the capability of the Storage equipment. For example, the technical requirements for an asynchronous battery Storage device connected via DC converter may be most closely aligned to those of an HVDC converter or Power Park Module under the current code, whereas the technical requirements for a synchronous compressed air energy Storage device, may be most closely aligned to the existing treatment of a synchronous generator.

In addition, it is also recognised that certain types of storage technology such as Synchronous Compensators, ~~and~~ Synchronous Flywheels and Regenerative Braking are not necessarily controllable and therefore should be treated separately from the general requirements for storage which are being proposed for this modification.

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All aspects of energy s~~S~~torage devices should be considered from the perspective of both bespoke energy s~~S~~torage installations as well as energy ~~Storage~~ storage devices which are part of a hybrid power plant with a mix of technology types.

In summary, Connection applications for Storage technologies such as batteries have become increasingly more common on the Transmission and Distribution systems in recent years, particularly since National Grid's Enhanced Frequency Response (EFR) tender in 2016.

Furthermore, BEIS and Ofgem have initiated~~kicked off~~ reviews of how to encourage greater flexible operation on the GB (whole) electricity system, with a view to maximising competition in the provision of services and lowering energy costs for end consumers. This has led the wider industry, including network licensees, to consider what they can do to better support Storage.

The view of the Proposer is that regulatory frameworks need to catch-up with this evolution in technology and policy. This Modification specifically looks at improving the Grid Code to satisfy these objectives so as to ensure maximum flexibility both for developers and Network Owners/Operators. That said however, it is important that if these proposed Grid Code changes are approved, there will need to be consequential updates to other industry codes (eg the CUSC) to ensure the concepts proposed as part of this Grid Code modification are applied and consistent with the other industry codes.

How will the solution address the defect?

In the view of the Proposer, the Grid Code does not currently consider energy or electricity 'Storage' technologies as a distinct category of User (Pump Storage aside). When Storage developers request Transmission connections, the Electricity Transmission System Operator) have had to deem this equipment as generation, demand, or an interconnector to allow a connection offer to be prepared.

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This workaround has the potential to treat Storage inconsistently. Any adjustments to connection agreements to determine how to connect Storage is set out in Connection Agreements. These are set out in the CUSC (not the Grid Code) as exhibits and are publicly available on the National Grid website[7].

Who will be affected by the proposed solution?

According to the Proposer, this Modification should clarify what is currently an ambiguous treatment of Storage for a new developer of new Electricity Storage schemes. This should improve the understanding of developers of the requirements for using the Transmission system, and avoid workarounds by the GBSO when preparing connection offers and agreements. However, according to another Workgroup member, there was already a well established, unambiguous, treatment of Storage (e.g. Pumped Storage) within the Grid Code which did not require the introduction of a potentially discriminatory 'new' approach via GC0096. The Proposer however noted that the current Grid Code provisions for Storage do not reflect the characteristics of non-pumped storage type technologies, such as batteries and that RfG applies to new Pumped Storage Plant but does not apply to Storage.

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Storage when co-located with renewables allows a more flexible operation which should enable greater levels of low-carbon generation to be used on the Transmission System, at points where it is more useful and reduce the need to schedule other forms of generation. It was noted that this already occurred today (in respect of co-located Pumped Storage and run of River Hydro) and was already permitted and addressed in the current Grid Code (and CUSC).

The additional technical capability of Storage when co-located with renewable generation should also aid a User's ability to participate in Ancillary Services with the GBSO or simply to have a more flexible plant which is both of benefit for the developer and National Grid

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An important part of this work is the implication on User's who have already committed to projects but have not yet connected to the System (transmission and distribution connected). In general, the Grid Code applies upon Completion Date (ie the date from when the User first connect their Plant to the System). It is therefore possible that a developer who applied for a connection to the Transmission System would, as a condition of their connection, have to satisfy the requirements of the Bilateral

[7] The Connection Application can be found at https://www.nationalgrid.com/sites/default/files/documents/CUSC%20Exh%20B_V1.15_06%20May_16.pdf

The Connection Offer document can be found at: https://www.nationalgrid.com/sites/default/files/documents/CUSC%20Exh%20C_v1.8_06%20May_16.pdf

Connection Agreement. They therefore place contracts for their equipment on the basis of the requirements in the Bilateral Agreement but it is possible that a Generator could be in the process of building their plant when the Grid Code updates are approved. In order to prevent this situation from arising, it was initiallyis proposed to update the legal text so that the Grid Code requirements become effective from the date of signing their main contract for plant items rather than the Completion Date. A specific consultation question was raised has been asked on this issue and following the consultation it was suggested that the requirements become effective on two criteria, these being i) the date upon which the contract for main contract items being signed (which would be following Ofgem's approval date for the Grid Code Modification and ii) the date upon which the plant first connected to the System (this being 1 year after Ofgem's approval date for the Grid Code Modification). It is believed this approach would be consistent with the same approach used for the other EU Connection Codes and minimises any risk for those projects in the current design and development phase. In addition, it is also important that existing projects which are either connected already or under construction are not affected by the GC0096 proposal.

As part of this work, it is also noted that this GC0096 Workgroup does not include the requirements of the System Operator Guideline GC0106 in respect of data. That said there is a separate Workgroup GC0117 (Improving transparency and consistency of access arrangements across GB by the creation of a pan-GB commonality of PGM requirements). It is expected that storage should not be outside the scope of this work bearing in mind storage will be treated in the same way as generation.

Which?

Wider policy work led by BEIS and Ofgem on improving market access to flexibility sets an important context for this modification. On one of the target areas, an associated call for evidence in December 2016 highlighted the need for better facilitation of new connections for flexible parties.

GC0096 is therefore known to BEIS and Ofgem, and is seen as an enabler to address this point. It is important that any wider changes which may be proposed to the regulatory frameworks or licences in the near future by BEIS/Ofgem in relation to flexibility may require further work.

A Storage working group under National Grid's Power Responsive initiative is investigating how to better support balancing services participation from flexible parties. Further information on National Grid's Power Responsive initiative is available from the following link.

http://powerresponsive.com/

That group is not reviewing transmission connection conditions or supporting technical requirements, so can be viewed as complimentary but separate to the outcomes of GC0096.

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Finally, modifications to the CUSC to better reflect Storage Users are currently being considered though this is expected to be limited now that Storage is being treated as a subset of Generation. Some coordination between Grid Code and CUSC stakeholders have taken place to ensure compatibility for the proposed Grid Code changes. Nevertheless, any decision on potential CUSC mods lies with that Code and is not determined by GC0096, which can continue in isolation.

In addition, current requirements in the Distribution Code place obligations on Licence Exempt Embedded Medium Power Stations (LEEMPS) to meet specific obligations under the Grid Code (PC3.3 and CC.3.3/ECC.3.3). A Licence Exempt Embedded Medium Power Station is defined within the Distribution Code and to ensure the provisions for Storage also apply to Licence Exempt Embedded Medium Power Stations, checks need to be made such that any Electricity Storage Module which forms part of a Licence Exempt Embedded Medium Power Station is included in the Distribution Code Definitions. This specific issue wasis raised as a consultation question.

Definitions

Electricity Storage vs. Energy Storage

The Workgroup considered two possible definitions (for 'Electricity' and 'Energy' Storage). The Workgroup agreed that specific attention should be given to 'Electricity' Storage technologies, rather than to 'Energy' Storage technologies.

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The latter category is widely accepted to be the consumption of power for temporary Storage, to then convert into another form of energy (but not electricity) such as heat. This means any conversion process is 'one way' in respect of electrical flow. It was noted that 'Energy' Storage, in this context, has existed on the GB electricity system for many decades, often in the form of domestic Storage heaters which have often been activated in an aggregate manner (in response to signals sent to individual units) and priced in the market accordingly.

The Workgroup therefore concluded that 'Energy' Storage (that is 'one way' and not 'bi-directional') could reasonably be defined as 'Demand' in the Grid Code. These technologies do not therefore require any specific attention from this GC0096 Modification.

Defining 'Electricity Storage'

The general understanding that the Workgroup took was categorising technologies which import (charge) and export (discharge) power onto the NETS, would be helpful and therefore considered what definitions were already being used by the Storage sector.

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It was noted that the Electricity Storage Network Trade Association as their working definition for Electricity Storage which the GC0096 Workgroup agreed to consider as a starting point:

"Electricity Storage" in the electricity system is the conversion of electrical energy into a form of energy which can be stored, the storing of that energy, and the subsequent reconversion of that energy back into electrical energy".

At the first GC0096 Workgroup, the discussion focused on agreeing a Grid Code definition for Storage. A Workgroup member set out his view that there are already, in his view, clear provisions in the Grid Code for the treatment of transmission connected 'Storage' by simple reference to 'Pump Storage' which exhibits all the same characteristics as the proposed GC0096 definition[8]. Applying a harmonised approach should ensure a level playing field is achieved. However, the Proposer noted that whilst the current Grid Code is clear on its treatment of Pumped Storage, the Proposer noted that this was specific to a small number of stations which utilise Synchronous Generation technology and therefore did not represent the growth in hybrid and battery storage applications which had been witnessed in quite high volumes witnessed over the last few years. The Proposer went on to advise that these specific issues and requirements needed to be reflected in the Grid Code which is what the workgroup is aiming to achieve.

A Workgroup member did conversely note that introducing a 'new' definition of 'Storage' as part of GC0096, would seem to introduce discriminatory treatment – as in treating similar situations differently (as both are transmission connected and both involve the "the conversion of electrical energy into a form of energy which can be stored, the storing of that energy, and the subsequent reconversion of that energy back into electrical energy").

It was noted by the Proposer that at the two workshops in August 2016, industry developed an initial thought on a definition for Electricity/Energy Storage which can be seen in figure 2 below. Following a Workgroup debate, the Workgroup determined that the correct definition to use was 'Electricity Storage' and that any definition should be technology neutral and setting a minimum standard noting that users can exploit their full operational flexibility through commercial services arrangements/ markets (e.g. Enhanced Frequency Response).

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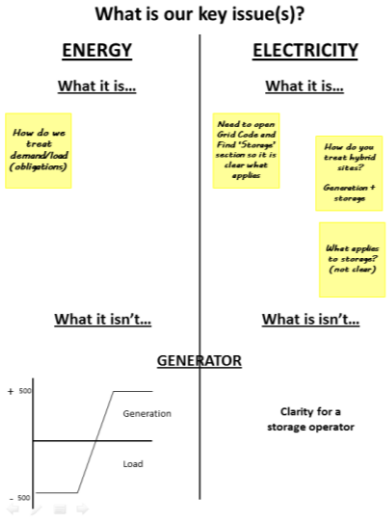
[8] "Is the conversion of electrical energy into a form of energy which can be stored, the storing of that energy, and the subsequent reconversion of that energy back into electrical energy"

Figure 2



At the third Workgroup meeting, a Workgroup member voiced an important clarification. Added to the definition for Electricity Storage was the ability for the Storage Facility Owner to be able to *control* the 'conversion' and 'reconversion' of that electrical energy – an important clarification to ensure a sufficient level of response to system-need for the technologies in question.

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Therefore, the proposed agreed GC0096 definition for Electricity Storage was updated to become:

Electricity Storage *is the conversion of electrical energy into a form of energy which can be stored, the storing of that energy, and the subsequent reconversion of that energy back into electrical energy in a controllable manner.*

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The Workgroup agreed that it was important to include flexibility within any definitions to future proof any innovations for new configurations that may present themselves.

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The addition of "in a controllable manner" was added to exclude certain technologies such as synchronous compensators ~~and~~ Synchronous flywheels and Regenerative Braking Systems which would otherwise struggle to meet the proposed technical requirements. It is also worth noting that storage technologies would only be required to meet the proposed technical requirements when they have sufficient capability – eg a battery is sufficiently charged or other storage device sufficiently fuelled. In other words, if a storage device was completely discharged, there would be no requirement for it to satisfy any of the exporting requirements although the requirements for import would still apply - in just the same way as a generator which had no fuel would have no requirement to satisfy those same exporting requirements.

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In Ofgem's recent consultation on 'Clarifying the regulatory framework for electricity storage: licensing' Ofgem have highlighted their request to maintain the Electricity Storage definition as that originally proposed (ie without reference to "in a controllable manner"). To address this issue, the legal text in the code has been modified to have specific definitions for synchronous compensation equipment and Synchronous flywheels which would fall outside the encompassing definition of Electricity Storage. In addition, and to align with the Storage definition following Ofgem's Storage consultation on Licensing, the term "Electricity Storage" has the term "in a controllable manner" removed and new terms of Non-Controllable Electricity Storage Equipment, which includes equipment such as "Synchronous Flywheels", ~~and~~ "Synchronous Compensation Equipment" and "Regenerative Braking" have been added to address this concern. The aim being that if a Flywheel or Synchronous Compensator (for example) is controllable, it would be treated as contributing to "Electricity Storage" and therefore have to meet the same requirements as an Electricity Storage Module. This change will be necessary to prevent such technologies from having to apply for derogations.

Understanding how Electricity Storage can be configured – Modules and Units

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The primary discussions at the Workgroup focused around how developers could deploy Storage – be that as a new standalone connection, or co-located as part of a new or existing generation/demand scheme.

It became clear that any technical complexity was around co-location, so the focus was how existing Grid Code definitions could be enhanced to incorporate a Storage element. It became clear that definitions for Power Station (from which capacity size determines licence and other compliance obligations), Power Park Module and Power Generating Module were the primary means to do this. Below the Station and modular level, would

be a new definition for a Storage Unit which becomes integrated into the definition of a Generating Unit– permitting developers' flexibility to incorporate Storage in the most efficient means possible. This approach, according to the Proposer, also facilitates co-located sites in the most efficient way. In terms of BMU configuration, (ie where a Generator chooses to select to operate a Power Generating Module with an Electricity Storage Module) the current BSC makes provision as to how the Generator wishes to register its BMU's.

There was some discussion over whether 'Power Station' could be used for standalone configurations as well, and this was the initial default proposal at the Workgroup. However, there was some doubt as to whether this sufficiently distinguishes Storage from Generation, which was one of the objectives of the GC0096 proposal.

There was further consideration outside the Workgroup by the proposer to understand the consequences of using Power Station for standalone Storage connections, particularly in relation to network charging and the CUSC. It was felt, by the Proposer, that using Power Station in this way could cause unnecessary ambiguity and the potential for unforeseen consequences for generation Users in the Grid Code if adjustments were made to the definition of Power Station.

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The initial view was to define stand alone Electricity Storage installations in their own right as an Electricity Storage Facility belonging to an Electricity Storage Facility Owner. The legal drafting was initially prepared on this basis but following the Workgroup meeting on 24 October and in view that Ofgem's minded to position (as noted above) on licensing, treated storage in the same way as Generation, it was agreed by the Proposer that Electricity Storage should be integrated under the envelope of Generation and therefore the use of Generator, Power Station, Power Generating Module and Generating Unit have been amended to include Electricity Storage.

High level proposals for Storage definitions

The following hierarchy of definitions was constructed to explain the relationship and interdependency between the GC0096 new Storage definitions and existing Grid Code definitions to facilitate this.

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Storage as a technology

The Proposer agreed with the Workgroup that a definition to clarify the specific activity for Storage would be useful. The Proposer also agreed with the Workgroup that a definition for 'Energy Storage' – the means of consuming electricity and converting for alternative uses (such as heat) is akin to 'Demand' – is already understood and, therefore, there would be no definition for 'Energy Storage' (as opposed to 'Electricity Storage') taken forward as part of this GC0096 Modification.

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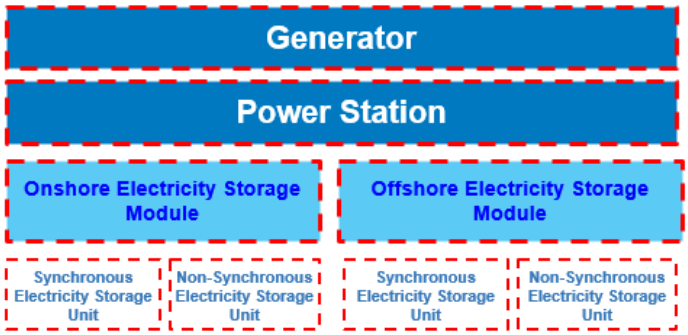
Standalone Electricity Storage Facility



Standalone Storage

The Workgroup considered if using 'Power Station' as a catch-all for both standalone and co-located Storage would be appropriate. This was the ~~the~~ basis of much ~~a lot~~ of the discussions.

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The Proposer sought further guidance outside GC0096 to understand the possible unforeseen consequences of using 'Power Station' in this way, and was made aware of several potential risks – not least network charging (for those also bound by the CUSC) and licencing (where there is no clarity on Storage outside Generation). These CUSC and licencing factors are out of the scope of GC0096 to consider.

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The initial view of the Proposer was to define a collection of standalone Electricity Storage Modules as an Electricity Storage Facility owned by an Electricity Storage Facility Owner.

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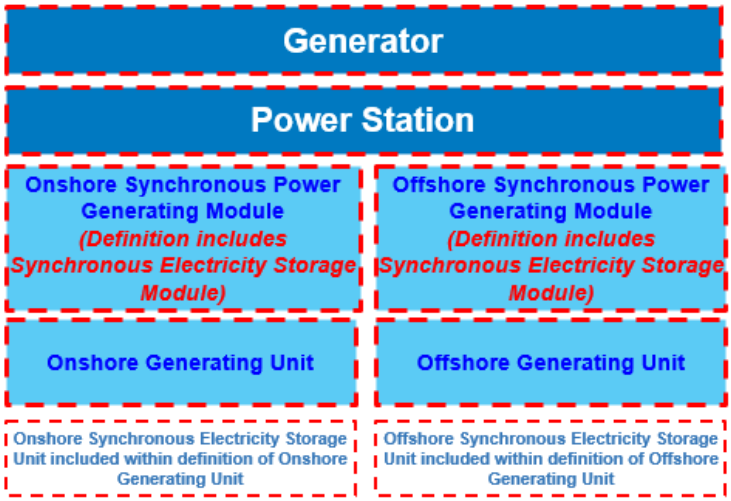
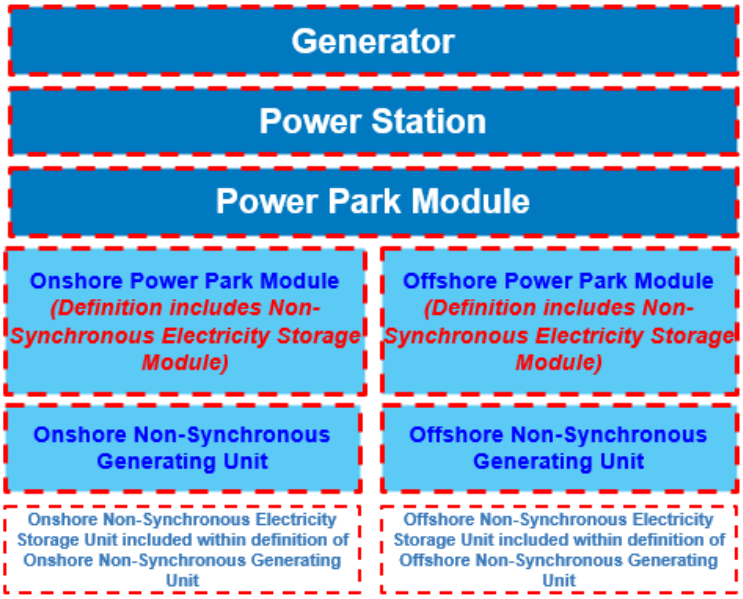
However, as the debate continued and following Ofgem's minded to position on the licensing arrangements for storage, this being that it should be treated in the same way as for generation, it was considered late on as part of the Workgroup discussions that Storage should be treated in the same way as Generation, being part of a Power Station and owned by a Generator. This also has the advantage of significantly simplifying the code and minimises subsequent changes to other industry codes such as the CUSC. ~~:~~

Co-located in a Synchronous Generator



Co-located in a Non-Synchronous Generator



Assigning appropriate technical requirements

The Workgroup reviewed the existing suite of Grid Code Connection Conditions (CCs) and subsequently the European Connection Conditions (ECC's) to determine which would be applicable to Electricity Storage, Modules or Units. The Workgroup's priorities when assigning technical requirements was to ensure consistency and non discriminatory treatment to other Grid Code Users, whilst not limiting the potential capability to do more. In this respect, it is expected that Storage providers will need to satisfy a minimum level of capability to make a connection, and would be encouraged to surpass these through participation in Ancillary Services.

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In the majority of cases, it is expected that Storage would meet the same requirements as Generation and HVDC technologies. The one notable point mentioned was that storage should have a requirement to cater for power output with falling frequency and power output with rising frequency. With storage operating in a mode analogous to Generation, this would be covered through ECC.6.3.3 (Limited Power Output reductions with falling frequency) and ECC.6.3.7.1 (the Limited Frequency Sensitive Mode – Overfrequency (LFSM-O). When the Storage plant is in a mode analogous to demand it should trip off the demand at pre-defined frequency levels in the same way as a pumped storage plant when operating in a pumping mode. The legal text in OC6.6 has been updated to address this issue. However the Proposer notes there are wider issues associated with this issue which are described in the Future Work section below. ~~This issue has been addressed in the revised drafting attached to this report through the diagrams in ECC.6.3.3 and ECC.6.3.7.1.6. It is notable that this issue is equally applicable to HVDC Systems, as codified in Annex II of the EU HVDC Network Code.~~

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So far as the Grid Code is concerned, most of the changes are reflected through the Glossary and Definitions with the rest of the code remining more or less unchanged other than in respect of specific items relating to storage. The key point here is that by amending the definitions such that Electricity Storage is now incorporated into the definition of a Power Generating Module and Generating Unit means that the obligation on Generators will also include storage. In summary, and in view of the intention to align storage to Power Generating Modules (as introduced under RfG)~~.~~ a~~A~~ Generator who owns an E~~e~~lectricity Storage Module would be classified as an EU Code User. ~~Whilst still subject to Workgroup discussion, it is currently proposed that these requirements would apply to any Electricity Storage Facility Owner with a Completion Date on or after 1 January 2019. In addition, further thought will need to be given to the transitional arrangements (ie those developers who have applied for connections ahead of approval of the GC0096 proposals) so as to ensure that in designing to the requirements of the Bilateral Agreement, they are then not caught by the GC0096 requirements which could result in unintended delays and costs.~~

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A full table of the proposed requirements and their applicability to Storage is shown in Section 8 (legal text) of this report.

Onshore and Offshore Considerations

The Workgroup considered whether there were important distinctions to be made between onshore and offshore requirements, particularly in the case of Storage co-located with wind generation. It was then agreed that the modular equivalents – e.g. onshore Generation vs. onshore Storage; offshore generation vs. offshore Storage – should be consistent, given the differing circumstances/topologies between the connecting TOs (OFTOs). The Workgroup agreed that any consideration of Storage being deployed within an OFTO network, owned by an OFTO, was not being considered, as part of GC0096, due to the licence implications.

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This principle was accepted by the Workgroup and was factored into the determination of technical requirements accordingly meaning that onshore Storage technologies will be treated in the same way as onshore Power Generating Modules and Offshore Generation should be treated in the same way as Offshore Power Generating Modules. It was however noted that in GB, there is an Offshore Transmission Regime which results in slightly different requirements between Offshore Generation and Onshore Generation.

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Wider requirements

As highlighted above, the view of the Proposer was to initially include a standalone Storage definition which approximates to 'Power Station', namely an Electricity Storage Facility being owned by an Electricity Storage Facility Owner. Although an earlier version of the legal drafting was prepared to explicitly define an Electricity Storage Facility owned by an Electricity Storage Facility Owner, this was subsequently dropped following a Workgroup discussion on 24 October 2018 on the basis of simplifying the code and to ensure consistency with Ofgem's licensing arrangements in which storage should be treated in the same way as generation. The decision was taken at that meeting to simplify the legal drafting such that the definition of Electricity Storage was contained within the definition of Generatorion, Power Station and Power Generating Module. Whilst it is acknowledged that the code is not as clear as explicitly defining storage on a case by case basis, it does have the advantage that it significantly reduces the amount of Grid Code changes and the subsequent changes to other related Industry Codes.

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For the purposes of this Workgroup, the main focus has concentrated on the Glossary and Definitions, European Connection Conditions and European Compliance Processes, with additional consequential amendments being made to the remaining sections of the code as the need arises.

Future Work

In the view of the Proposer, these elements represent the minimum set of definitions and requirements needed to facilitate parties who own Storage to connect to the transmission network in so far that they reflect equivalent definitions used for synchronous and non-synchronous generation technologies or demand where necessary.

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In general, the updates to remining parts of the code are simply consequential changes as a result of changes to the Glossary and Definitions. In summary, the approach adopted is similar to that of Pumped Storage in which a Pumped Storage Generator has to meet all the specific requirements of a Generating Unit with specific requirements specified in respect of Pumped Storage where they are necessary.

In respect of Compliance, a Workgroup Member did raise the point as to how compliance would be demonstrated where you have a 'co-located' site (with, for example, both generation and storage or demand and storage at one site) and the Grid Code requirements were satisfied by a combination of the storage and generation. This issue has been addressed in the ECP's by specifically stating that compliance can be demonstrated through the combined capability of the storage and generating plant though demonstration on an individual basis (through their own capabilities) would be required where either the storage plant or generating plant was out of service if the party so wished to operate the co-located plant in that mode of operation. In addition, following the consultation, a question was raised with regard to the treatment of a pumped storage unit where the pumping function is completely independent of the generating function. Under the revised legal drafting the European Compliance Processes have been updated to address this issue where the pumps will be treated as demand and the generation treated as generation.

In addition, one workgroup member noted that in a co-located site there were many permutations and combinations which could affect compliance., For example, ~~in particular~~ where you ~~may~~ have an existing Generator which had a Power Station comprising Generating Units or Power Park Modules which are~~were~~ caught by the requirements of the CC's and CP's and that Generator then wishes to connect ~~how~~ a new Electricity Storage Module within that Power Station. In this case the Electricity Storage Module would be ~~(being~~ caught by the requirements of the ECC's and ECP's ~~would be assessed from a~~and compliance would have to assessed from this perspective. As a general point, National Grid would not wish to see new requirements applied to existing plant where there is no change to their plant and apparatus.

An example of these permutations and combinations are shown below in the following table.

ESS co-location cases	Requirement to meet ECC and ECP	Requirement to meet CC and CP
New Power Generating module and New ESS Module connected in a parallel connection	Both PGM and ESS have to demonstrate compliance cumulatively and individually if the plants are expected to operate independently	Not applicable
New Power Generating module and New ESS Module connected in a consolidated connection	Both PGM and ESS have to demonstrate compliance cumulatively and individually if the plants are expected to operate independently	Not applicable
Existing Power Generating	Only new ESS based on its MW	Existing Power Generating

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Module with ION/FON and New ESS Module in a parallel connection[9]	output (Type A, Type B, Type C or Type D) to demonstrate compliance individually	Module
Existing Power Generating Module with ION/FON and New ESS Module in a consolidated connection[10]	Only new ESS based on its MW output (Type A, Type B, Type C or Type D) to demonstrate compliance individually	Existing Power Generating Module

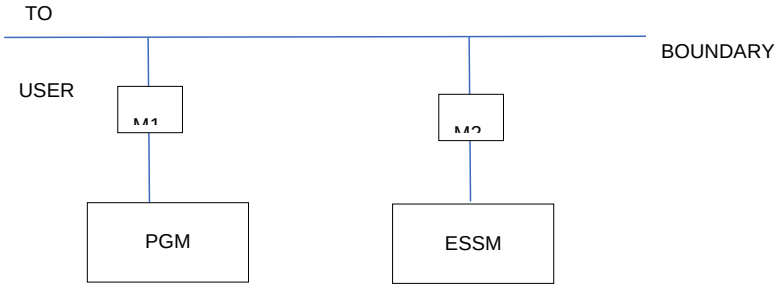

Figure 2. Parallel connection

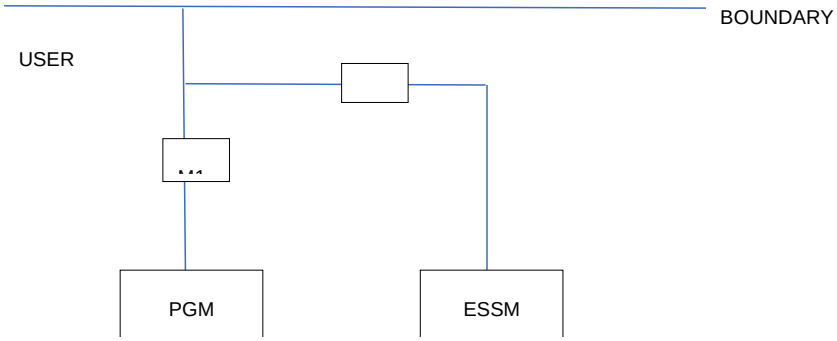

Figure 1. Consolidated connection

As part of the Workgroup discussions, one workgroup member noted that storage should have a requirement to cater for limiting power input with falling frequency and limiting power output with rising frequency and proposed the use of the following graph.

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[9] Demonstration of cumulative compliance is dependent on market participation of ESSM e.g. capacity market or Firm Frequency Response

[10] Demonstration of cumulative compliance is dependent on market participation of ESSM e.g. capacity market or Firm Frequency Response

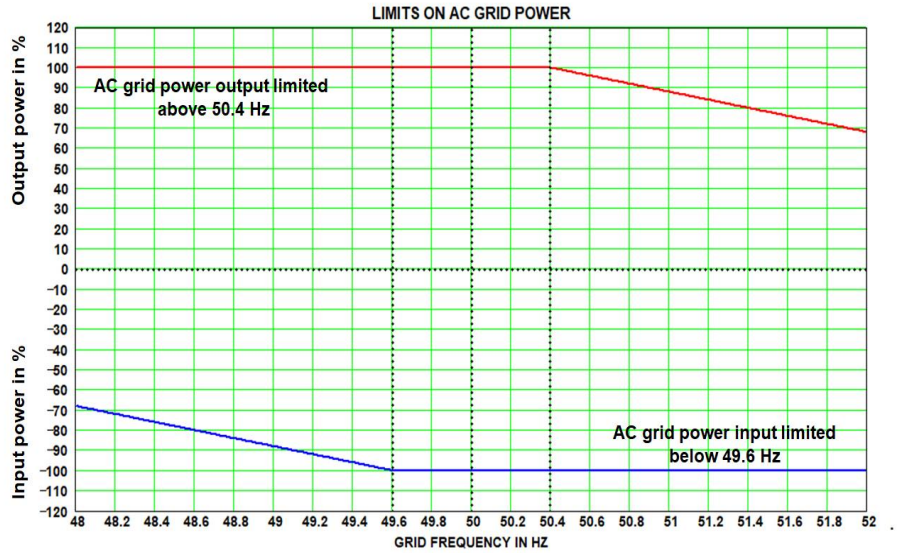

Figure 2.0

In addition, a Workgroup Member noted that as part of a future co-located site that it was entirely likely that an energy storage technology could be integrated as part of a solar park, wind farm or synchronous plant. Figure 3.0(a) and Figure 3.0(b) below (which have been re-produced in this report with the kind permission of Enstore) illustrate this example for a wind farm or solar park.

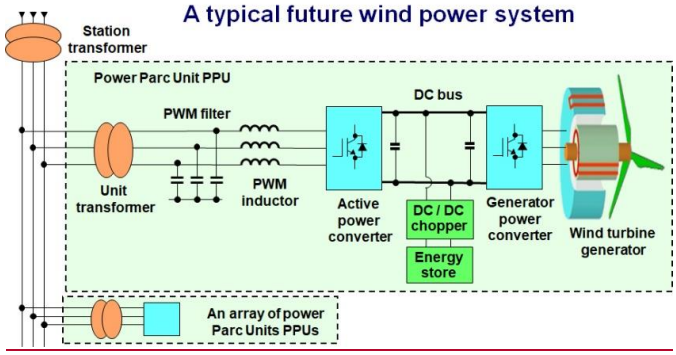

Figure 3.0 (a)

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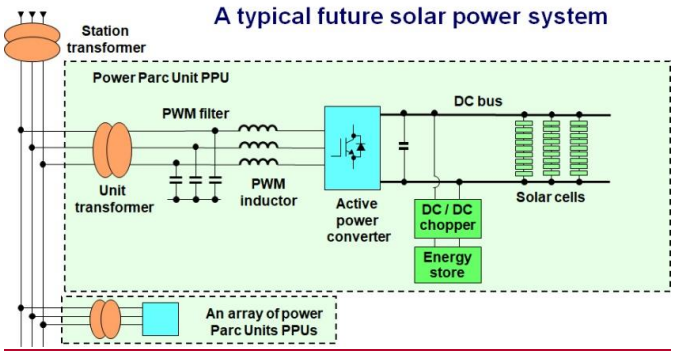

Figure 3.0 (b)

One workgroup member noted that for wind farms and solar parks, the storage elements are not directly connected to the AC Grid and raised concern that they would not be required to satisfy the requirements of the GC0096 proposals. It was also noted that for rotating synchronous generators this is not so much of an issue.

In response, the Proposer would note that where you have a Power Station comprising of Power Park Modules and/or Electricity Storage Modules, the Grid Code applies to the Power Park Modules and Electricity Storage Modules within that Power Station.

In addition, the Proposer would note that as part of the GC0096 proposals, that when a storage element is operating in a condition analogous to demand, then there is a requirement for this demand to be reduced as frequency falls as defined under OC6.6, in just the same way as pump tripping as part of a pumped storage plant.

The Proposer would however note that the characteristic shown in Figure 2.0 may be more appropriate however as also pointed out by a workgroup member this requirement applies to generation equally as it applies to Storage. As such, and as the aim of the workgroup is to ensure consistent treatment between different classes of User's, this is an issue that should be highlighted as a future area of work as the implications of a change to generation affects a much greater audience.

As noted above, the EU Network Codes (RfG, HVDC and DCC) specifically exclude storage, however it is unclear if Storage may be introduced as part of a future update to the suite of European Codes. Whilst the issues of Brexit may have an issue here, The Proposer is actively engaged with an Expert Group within ENTSO-E and advising them of the approach to storage adopted in GB. It is hoped this approach will reduce any European changes that may arise in the future.

Furthermore, data exchange requirements for Storage may need to be reviewed in order to consider changes needed to implement the System Operation Guideline (SOGL) the details of which are being addressed in a separate Grid Code modification proposal (GC0106[11]). At this point, it is worth noting that as part of the EU ~~Stakeholder~~

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[11] https://www.nationalgrid.com/uk/electricity/codes/grid-code/modifications/data-exchange-requirements-accordance-regulation-eu-0

~~Committee for Connections~~ Storage Connection E~~e~~xpert G~~g~~roup, the issues of SOGL are also outside the scope of thi~~s~~ ~~European~~ group and would need be picked up at some future date.

Workgroup Consultation Question Review:

The Workgroup met to review the responses from the Workgroup Consultation. Below are the discussions that took place in relation to each question. A summary of the consultation responses can be found at the following link

INSERT LINK

The full consultation responses can be found at Annex x.

Q1 – Do you believe that GC0096 Original proposal or any potential alternative that you may wish to suggest better facilitates the Grid Code Objectives?

SSE's response stated that if the definitions are changed then the legal text could be simplified and therefore much of the additional draft legal text changes would be unnecessary. The Proposer highlighted that the definitions have been changed and potentially a mis-understanding has been made about the version used to provide the consultation response or the intention of what the draft legal text is looking to achieve. It was confirmed that there has not been a mis-understanding and the response provided is correct. What is important is to ensure that there is a level playing field and no discrimination between industry participants.

The Workgroup noted that the Authority had previously stated that Storage should be treated in the same way as Generation.

A Workgroup member highlighted that there are three conventional differences between storage and electrical generation. A different Workgroup member stated that Pump Storage is already in use today, so the technologies captured by GC0096 should be treated in the same as Pump Storage is currently treated in the Grid Code.

The Proposer stated that the Grid Code as currently written, meant that some elements of Pump Storage would not apply to Electricity Storage. Given this, simply including Electricity Storage within the definition of Pump Storage would not be appropriate.

The Workgroup noted the responses and highlighted that The Proposer needs to make changes to the definitions to be clearer, and provide more transparency.

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Q2 - Do you support the proposed implementation approach?

The Workgroup noted the consultation responses received in relation to how the proposed modification should be implemented. A Workgroup member raised that there needed to be a transitional period for the implementation of GC0096 given that this modification would affect projects that are currently live. The Proposer stated that the proposed implementation date was suggested earlier in the process and now it is clear this is unrealistic. A Workgroup member stated that they feel the Grid Code implementation date should be 10 working days after a decision is received from the Authority.

The Workgroup then discussed how GC0096 could be implemented practically. The Workgroup agreed that any party connecting to the transmission network should have a period in which to sign any main plant contracts, followed by a defined period to notify NGESO in order to be considered to have the existing Grid Code requirements apply to their site. The example used in the Workgroup was 10 Working days from the Ofgem decision to sign any main plant contracts, followed by 20 working days to notify NGESO.

The Workgroup discussed having a period of 1 year from the Authority decision date (ie the date upon which contracts for main plant are signed and 1 year later when that plant connects to the System). This will allow ~~on GC0096 for the affected~~ parties to connect to the transmission network ~~for the existing Grid Code requirements to apply~~ with little impact on existing or current projects.~~.~~

It was proposed that industry parties that do not sign their main plant contract or notify NGESO within the time period or connect to the network with the defined period would be caught by the new requirements set out in GC0096.

A Workgroup member highlighted that a separate Workgroup is currently working on Fast Fault Current Injection (Grid Code modification GC0111). This Workgroup is looking to provide updated legal text to the European Connection Conditions~~de~~. It was observed that a Battery provider may struggle to comply with the Fast Fault Current Injection requirements but it was noted that this modification ~~this will~~ applies~~y~~ to parties affected by the new GC0096 requirements~~.~~ Since the GC0096 Consultation was held, there have been substantial updates to the GC0111 proposed text so there is not envisaged to be a conflict between the requirements on battery storage providers and the revised GC0111 requirements.

Q3 - Do you have any other comments?

The Workgroup reviewed the consultation responses. In particular, in relation to Drax's consultation response, the Proposer highlighted that with Storage there is finite capability.

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It was highlighted by a Workgroup member that there may be an opportunity for industry participants to avoid GC0096 requirements depending upon the location of the storage on the site. The Workgroup member emphasised the importance that all storage is treated equally, regardless of how the site is configured.

The Workgroup discussed the definition of Intermittent Power Source and the Proposer agreed that clarification is required on the definition. The legal text has been updated to address this issue.

It was highlighted by a Workgroup member that there are concerns over the practicality of the draft solution and the participation from Ttransmission Ssystem users. They queried how will GC0096 deal with mixed sites? It was agreed that the Proposer will clarify this and report back to the Workgroup which has been addressed for example through the treatment of pumped storage plant where the pumping elements are separate from the generating elements. -

Q4 - Do you wish to raise a Workgroup Consultation Alternative request for the Workgroup to consider?

The Workgroup noted that there were no responses that stated they wished to raise a Workgroup Alternative Grid Code Modification.

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Q5 – Do you agree with the proposed 'Electricity Storage' definitions? Please provide your reasoning for your answer to this question. If you answered no, what would you include / amend / remove?

A Workgroup member noted that there have been amendments to the definition of Electricity Storage, including pump storage. It was agreed that for avoidance of doubt, Electricity Storage would have to comply with all other relevant aspects of the Grid Code.

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It was noted by the Workgroup that there was a minor error in relation to the use of 'in a controllable manner'. The Proposer agreed to amend the draft legal text.

The Workgroup discussed amending the Offshore and Onshore Generating Unit definitions. The reason this change was suggested relates to the fact that under the current draft definition, suppliers may not be caught in all circumstances by the definition. However, the Workgroup suggested a change that will ensure –all suppliers are caught as intended by GC0096.

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Q6 – Do you agree with the decision to not define 'Energy Storage'? Please provide your reasoning for your answer to this question.

The Workgroup noted the consultation responses and agreed with the respondents that Energy Storage should not be defined.

Q7 – Do the proposed changes provide suitable flexibility for viable 'Electricity Storage' technologies and topologies? Or, do you feel these proposed changes limit the development of 'Electricity Storage' in any way or present barriers to entry (please provide supporting justification / evidence)?

The Workgroup noted the responses received and in particular in relation to ensuring that a level playing field is created.

Q8 - Do you believe new Pump Storage schemes should be incorporated into the proposed approach on 'Electricity Storage'? Please provide your reasoning for your answer to this question.

A Workgroup member highlighted that Pump Storage is included in the RfG and stated that any changes proposed through GC0096 need to ensure no further requirements are added in addition to the European Connection Codes. The Proposer agreed with this suggestion.

Q9 – Do you believe existing Pump Storage schemes should be incorporated into the proposed approach on 'Electricity Storage'. Please provide your reasoning for your answer to this question.

The Workgroup noted the consultation responses. The Workgroup agreed that existing plant should not be caught by the new proposals. The Proposer explained that if the proposal was applied to existing plant it was felt that this may be disadvantageous to the existing plant owners as they may suddenly have additional requirements to meet in order to be compliant. Therefore, GC0096 will not be retrospectively applied.

Q10 – Do you believe if the definition of Pumped Storage should be included within the definition of Electricity Storage. Please provide your reasoning for your answer to this question.

The Workgroup noted the consultation responses received which overall supported having Pumped Storage included within the definition of Electricity Storage. The Proposer agreed to update the draft legal text to reflect this, however as noted in the report, Pumped Storage is caught by the requirements of RfG whereas Electricity Storage is not. As a result, Pumped Storage has not been included in the definition of Electricity Storage but the legal drafting has been clarified to ensure the requirements for pumped storage are equitable to Electricity Storage.

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Q11 – Do you believe there are any unintended consequences behind these proposed changes, either within the Grid Code/D-Code, CUSC, BSC or elsewhere? Please provide your reasoning for your answer to this question.

The Workgroup noted that it was felt that there was a need for a Distribution Code change to be made in consequence of GC0096. A Workgroup member highlighted that the ENA have already created a Workgroup to address the required Distribution Code change.

A Workgroup member highlighted Northern Powergrid's response, which highlights an inconsistency between the Grid Code and Distribution Code. The Proposer stated that they believed the wording between the two codes is similar. It was agreed that the Proposer will contact Northern Powergrid to discuss this further.

Q12 – Do you believe that it is appropriate to apply the same approach to Storage Providers as adopted for Power Generating Modules? Please provide your reasoning for your answer to this question, in particular, if you answered no, please state why and what different approach should be adopted.

The Workgroup noted the consultation responses, which stated unanimously that they supported applying the same approach to Storage Providers as adopted for Power Generating Modules.

Q13 – Do you agree that it is appropriate to include Electricity Storage within the definition of Generation and its related terms. Please provide your reasoning for your answer to this question, in particular, if you answered no, please state why and what different approach should be explored.

The Workgroup noted the consultation responses, which unanimously agreed that Electricity Storage should be included within the definition of Generation and its related terms.

Q14 – Do you believe there are any other unintended consequences behind these proposed changes? Please provide your reasoning for your answer to this question.

The Workgroup noted the consultation responses, which stated that there were no unintended consequences behind the changes beyond the already highlighted Distribution Code change in question 11.

Q15 – Do you believe that it is appropriate to classify storage as an EU Code User with the premise that Generators who own or operate Electricity Storage Modules

are explicitly excluded from satisfying the requirements of the EU Connection Codes and that they would not be enforceable under EU law. Please provide your reasoning for your answer to this question. Do you believe that this exclusion is adequately defined in the proposed draft changes to the Grid Code legal text?

The Workgroup noted the responses and discussed this question. The Proposer agreed to confirm the position with the National Grid legal team and respond back to the Workgroup.

Q16 – Do you agree that it is appropriate to specify that these requirements are applicable from the date on which main plant items are procured rather than the Completion Date. Please provide your reasoning for your answer to this question, in particular, if you answered no, please state why you feel this is the case and if you believe there is a more appropriate solution.

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The Workgroup noted the consultation responses, which stated that it is appropriate to specify that requirements are applicable from the date of which main plant items are procured and the date upon which the storage plant connects to the System. The Workgroup discussed when the requirements would be applicable during question 2, implementation and these comments have been reflected in the revised Legal drafting.

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Q17 – The current legal drafting is based on the proposed requirements being applicable based on a Storage User who had concluded Purchase Contracts for its Main Plant and Apparatus on or after 1 January 2019. This assumes implementation is based on the date main plant items are procured as noted in question 16, but do you have any preference for an implementation date. Bearing in mind the proposed changes are unlikely to be approved until mid 2019, a more appropriate date may be 1 January 2020. Do you support this implementation date? If not please state why and what alternative you believe would be more appropriate.

The Workgroup noted the consultation responses and referred back to the discussion in relation to question 2, implementation. An Authority decision for GC0096 would be anticipated in mid-2019.

Q18 – Do you believe that Electricity Storage Modules which form part of a License Exempt Embedded Medium Power Station (LEEMPS) are adequately catered for in these provisions and it is clear that a License Exempt Embedded Medium Power Station comprising of storage would be caught by the requirements in the Grid Code from the obligations in the Distribution Code.

The Workgroup has noted the consultation responses and believed this would not cause a major issue.

Q19 – Do you believe that the list of storage technologies shown in Annex 3 is sufficient or should some technologies be added or subtracted? Please provide your reasons for your answer to this question.

One Workgroup member highlighted they didn't find the list of storage options provided as part of the consultation was clear that it will be included in the Grid Code. The Proposer confirmed they would ensure it is clear that the list of storage options will be included into the Grid Code as part of GC0096 which has been included in the latest legal text based on the list provided by EASE (European Association for Storage of Energy).

The Proposer confirmed GC0096 is looking at active and reactive equipment, so in response to SSE's suggestion for StatCom and Static Synchronous Series Compensators to be included, the Proposer and Workgroup confirmed this shouldn't be included.

Legal Text Comments:

The Workgroup noted that a number of stakeholders included suggestions for amending the legal text. The Workgroup reviewed these suggested amendments. The Proposer agreed to contact each stakeholder to discuss the outcome of this review. The Proposer confirmed he will then update the legal text for the Workgroup to review incorporating all of the changes that had been discussed.

5 Workgroup Consultation

The GC0096 Workgroup sought the views of Grid Code Parties and other interested parties in relation to the issues noted in this document and specifically in response to the questions highlighted in the report and summarised below:

The GC0096 Workgroup Consultation was issued on 07 December 2018 for 23 Working Days, with a close date of 11 January 2019. 19 additional questions to the standard Workgroup consultation questions were asked, these can be found in Section 4.

8 responses were received to the Workgroup Consultation which can be found in Annex 4.

6 Relevant Objectives

Below sets out the Proposer's view in relation to how the proposed modification impacts on the Applicable Grid Code Objectives:

Impact of the modification on the Applicable Grid Code Objectives:

Relevant Objective	Identified impact
(a) To permit the development, maintenance and operation of an efficient, coordinated and economical system for the transmission of electricity	Positive
(b) Facilitating effective 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);	Positive
(c) 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;	Positive
(d) 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; and	Neutral
(e) To promote efficiency in the implementation and administration of the Grid Code arrangements	Neutral

7 Implementation

The Workgroup then discussed how GC0096 could be implemented practically. The Workgroup agreed that any party connecting to the transmission network should have a period in which to sign any main plant contracts, followed by a defined period to notify NGESO in order to be considered to have the existing Grid Code requirements apply to their site. The example used in the Workgroup was 10 Working days from the Ofgem

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decision to sign any main plant contracts, followed by 20 working days to notify NGESO.

The Workgroup discussed having a period of 1 year from the Authority decision date on GC0096 for the affected parties to connect to the transmission network for the existing Grid Code requirements to apply.

It was proposed that industry parties that do not sign their main plant contract or notify NGESO within the time period or connect to the network with the defined period would be caught by the new requirements set out in GC0096.

8 Legal Text

The proposed legal text weblink can be found in Annex 1 below.

Annex 1 - Legal Text

The legal text can be found at the following link:

https://www.nationalgrideso.com/codes/grid-code/modifications/gc0096-energy-storage

Annex 2 – Terms of Reference

Annex 3 – List of Storage Technologies

- Chemical
  - Ammonia
  - Hydrogen
  - Synthetic Fuels
  - Drop-in Fuels
  - Methanol
  - Synthetic Natural Gas
- Electrical
  - Supercapacitors
  - Superconducting Magnetic ES (SMES)
  - Mechanical
    - Adiabatic Compressed Air
    - Diabatic Compressed Air
    - Liquid Air Energy Storage
    - Pumped Hydro
    - Flywheels
  - Thermal
    - Latent Heat Storage
    - Thermochemical Storage
    - Sensible Heat Storage
  - Electrochemical
    - Classic Batteries
      - Lead Acid
      - Lithum Polymer (Li-Polymer)
      - Metal Air
      - Nickle Cadmium (Ni-Cd)
      - Sodium Nickle Chloride (Na-$NiCl_2$)
      - Lithum Ion (Li–ion)
      - Sodium Ion (Na–ion)
      - Lithum Sulphur (Li-S)
      - Sodium Sulphur (Na-S
      - Nickle – Metal Hydride (Ni-MH)

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Flow Batteries

Vanadium Red- Oxide

Zinc – Iron (Zn – Fe)

Zinc – Bromine (Zn – Br)

Other

~~Batteries~~

~~Types – e.g. Lithium Ion, Sodium Sulphur, Sodium – Nickel Chloride, Lead Acid, Vanadium redox -flow etc;~~

~~Flywheels;~~

~~Liquid Air Energy Storage;~~

~~Compressed Air Energy Storage;~~

~~Hydro Pumped Storage~~

~~Supercapacitors; or~~

~~Other~~

Annex 4 – Workgroup Consultation Responses

