nationalgridESO

Guidance Notes for Co-Location of Different Technologies

GB/EU Code Users - Issue 1

September 2021

Foreword

These Guidance Notes have been prepared by the National Grid Electricity System Operator (NGESO) to describe how the Grid Code Compliance Process is intended to work for the various configurations of co-location installations of different technologies on the system. Throughout this document NGESO refers to National Grid ESO and National Grid refers to the Transmission Owner part National Grid Electricity Transmission (NGET) unless explicitly stated otherwise.

These Guidance Notes are prepared, solely, for the assistance of prospective customers planning to co-locate different technologies connected directly to the National Electricity Transmission System. In the event of dispute, the Grid Code and Bilateral Agreement documents will take precedence over these notes.

Small and Medium Embedded installations comprising Type A, Type B, Type C or Type D Electricity Storage Modules of a similar nature should contact the relevant Distribution Network Owner (DNO) for guidance.

These Guidance Notes are based on the Grid Code, Issue 5, Revision 47, effective from the 24th December 2020. They reflect the major changes brought about by Grid Code workgroup modifications GC0096, GC0100, GC0101 and GC0102 as approved by the regulator on 20 May 2020 and 16 May 2018 respectively. These modifications introduced the European Compliance Process (ECP) and European Connection Conditions (ECC). Definitions for the terminology used in this document can be found in the Grid Code.

The Electricity Customer Connections Manager (see contact details below) will be happy to provide clarification and assistance required in relation to these notes and on Grid Code compliance issues.

NGESO welcomes comments including ideas to reduce the compliance effort while maintaining the level of confidence. Feedback should be directed to the NGESO Electricity Connection Compliance team at:

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Contents

Foreword 1

Contents 2

Abbreviations 3

Guidance Notes 5

1. Introduction 6

2. Compliance Process 6

Appendix A: Potential Configurations 8

Example 1: Supplementary type generation and storage 8

Compliance Process 8

Example 2: Independently controlled/operated co-located plants 9

Compliance Process 9

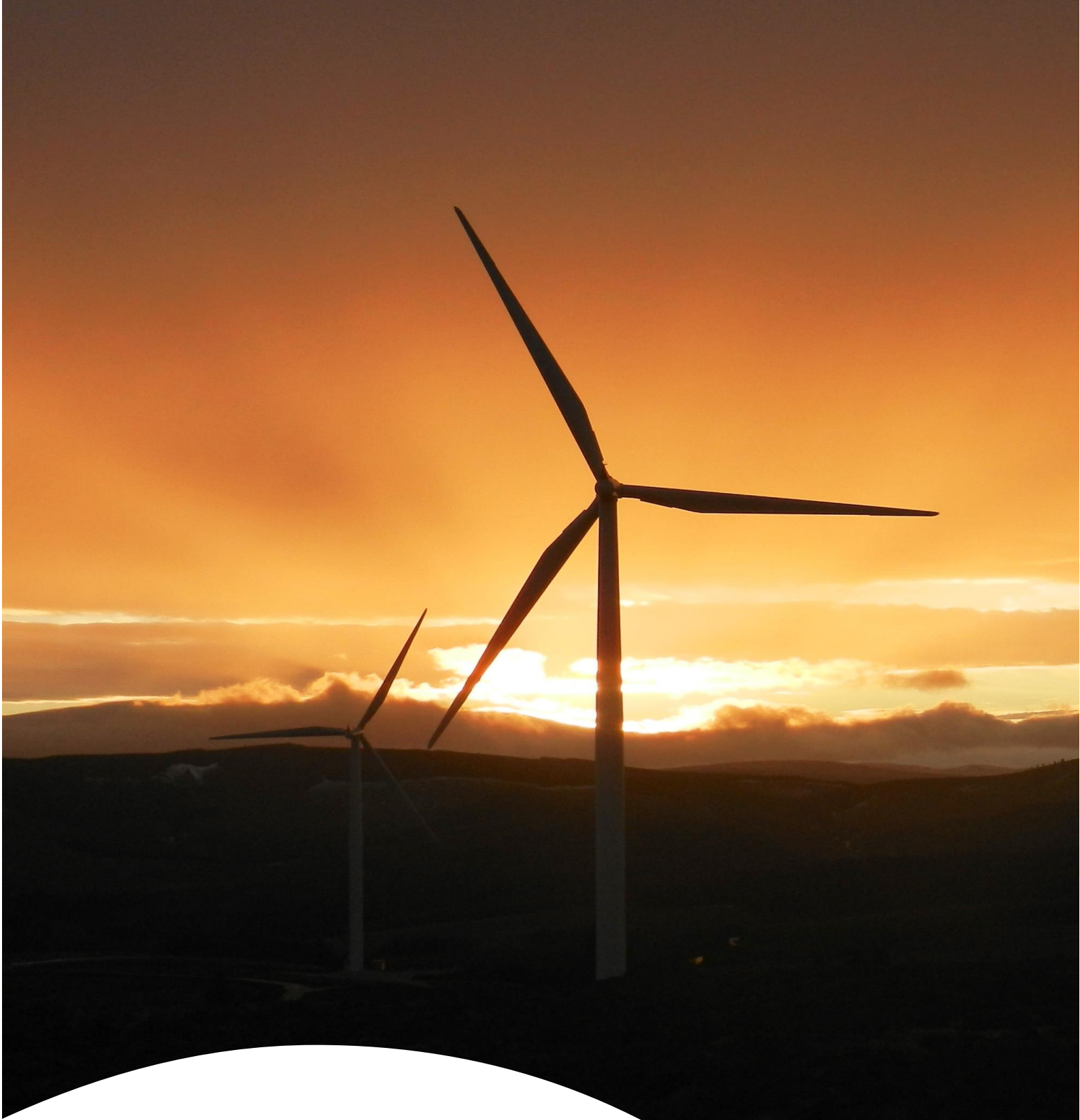
Appendix B: References 11

Abbreviations

This section includes a list of the abbreviations that appear in this document.

Abbreviation	Description
AVC	Automatic Voltage Control (on transformers)
AVR	Automatic Voltage Regulator
BA / BCA	Bilateral Agreement / Bilateral Connection Agreement
BC	Balancing Code
BM / BMU	Balancing Mechanism / Balancing Mechanism Unit
CC / CC.A	Connection Conditions / Connection Conditions Appendix
CCGT	Combined Cycle Gas Turbine
CP	Compliance Processes
CSC	Current Sourced Converter
CUSC	Connection and Use of System Code
DC	Direct Current
DCS	Distributed Control System
DNO	Distribution Network Owner
DPD	Detailed Planning Data
DRC	Data Registration Code
ECC	European Connection Conditions
ECP	European Compliance Processes
EDL/EDT	Electronic Data Logging / Electronic Data Transfer
ELEXON	Balancing and Settlement Code Company
FON	Final Operational Notification
FRT	Fault Ride Through
FSM	Frequency Sensitive Mode
GB	Great Britain
GCRP	Grid Code Review Panel
ION	Interim Operational Notification
LSFM(O)	Limited Frequency Sensitive Mode (Over frequency)
LSFM(U)	Limited Frequency Sensitive Mode (Under frequency)
LON	Limited Operational Notification
MC	Maximum Capacity

MEL	Maximum Export Limit
MG	Minimum Generation
MLP	Machine Load Point
MRL	Minimum Regulating Level
MSOL	Minimum Stable Operating Level
NGESO	National Grid Electricity System Operator
NGET	National Grid Electricity Transmission
OC	Operating Code
OFGEM	Office of Gas and Electricity Markets
PC	Planning Code
PSS	Power System Stabiliser
PSSE	Power System Simulator for Engineering software
RfG	Requirements for Generators (EU legislation)
RISSP	Record of Inter System Safety Precautions
SEL	Stable Export limit
SO	System Operator (NGESO)
SPT	Scottish Power Transmission
SHET	Scottish Hydro Electric Transmission
STC	System Operator Transmission Owner Code
TO	Transmission Owner
TOGA	Transmission Outages, Generation Availability
UDFS	User Data File Structure



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Guidance Notes

1. Introduction

With the advances in technology, increasing number of users are designing and developing installations using either more than one type of plant or technology for connection to the GB electricity system. This recent trend seeks to enhance the technical capability or commercial potential of the overall plant.

A co-located site would be where different technologies, including storage and non-embedded demand, is installed at the same facility behind a single Transmission Entry Point (TIP) or connection point.

There are several ways different co-located technology projects can be developed. For the purpose of providing a broad guidance the technologies can be classed as defined in the Grid Code as follows:

[1.] **Synchronous Generation:** Any Onshore Synchronous Generating Unit or Offshore Synchronous Generating Unit.

[2.] **Non-Synchronous Generation:** An Onshore Non-Synchronous Generating Unit or Offshore Non-Synchronous Generating Unit which could form part of a Power Generating Module.

[3.] **Synchronous Storage:** This would typically be a storage plant where the primary interface between the storage plant and the electricity system is coupled through a Synchronous Generating Unit for example a compressed air energy storage system. A Synchronous Generating Unit is one 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.

[4.] **Non-Synchronous Storage:** This would typically be a storage plant where the primary interface between the storage plant and the electricity system is coupled through a non-synchronous generating unit or power electronic converter for example a battery system. The technical requirements would in this instance would be similar to those of a Power Park Module. A Non-Synchronous Electricity Storage Module is a Power Park Module comprising solely of one or more Non-Synchronous Electricity Storage Units. A Non-Synchronous Electricity Storage Unit is 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.

[5.] **HVDC Systems:** An electrical power system which transfers energy in the form of high voltage direct current between two or more alternating current (AC) buses and comprises at least two HVDC Converter Stations with DC Transmission lines or cables between the HVDC Converter Stations.

[6.] **Non-Embedded Demand:** a demand directly connected to an onshore or offshore transmission system.

This document is intending to guide prospective developers through the compliance process. More detailed guidance documents are available for generating and storage technologies connected on their own. This guidance document should be used alongside the relevant guidance notes for technologies that are published.

2. Compliance Process

The objective of the compliance process remains the same regardless of different combination and co-locations. The compliance process aims to ensure that by specifying minimum technical, design and operational criteria the basic rules for connection to the National Electricity Transmission System and to a User's System are similar for all EU/GB Code Users of an equivalent category and will enable NGESO to comply with its statutory and Transmission Licence obligations.
In 2020 Ofgem approved Grid Code modification GC0096 [2] which treats storage in the same way

as Generation and having to meet similar requirements to those of Generators, who are obliged to meet the European Connection Conditions (ECC) of the Grid Code. GC0096 modification also includes requirements for Compliance as detailed in the European Compliance Processes (ECP's) which also makes for the provision of co-located sites.

As most of these developments are emerging and new to the GB electricity industry. The Grid Code compliance process does not necessarily explicitly cover all co-location combinations. There are however few references to co-located sites with synchronous or non-synchronous generators (ECP.A.5 when a battery is alongside synchronous generator and ECP.A.6 when battery is alongside a PPM).

For the purpose of demonstrating technical compliance, the co-located sites can be divided into two categories, these being:

- **Supplementary Component** – A Generating Unit or a Demand Unit is linked to the operation of the generating unit/demand unit of different technology and both modules cannot be independently controlled.

  For example, the use of the Storage device is used by the developer to comply with RfG requirements (e.g. FSM) when modernizing an existing generating unit or a new unit is constructed. In that case, when the main component is off, the storage device should also be off.

  Note: this supplementary component could be shared between different generating modules or demand facilities at the same installation or between different demand units in the same facility.

- **Independently Controlled/Operated Component** - A facility where there is a generating unit/demand unit and a different technology type generating unit/demand unit, but where the operation of both units is independent from each other. In this case for example, it is possible to have the storage device running when the other component(s) of the facility is (are) switched off.

For supplementary type co-location, the compliance will be assessed with the main plant. For example, if a storage device is installed to enhance frequency response, the main plant's frequency response capability will be assessed while the assistance is provided by the storage device. If the installation is completed after EU code implementation cut off times, the whole plant will be accessed against EU code requirements. This assumes that the new installation significantly influences the overall plant's performance.

For independently controlled/operated co-located plants, the compliance will be assessed individually as appropriate. In addition to the different co-locating technologies, there is a possibility for GB Code User's and EU Code Users choosing to co locate. With the assumption that the components are sufficiently independent code requirements will be followed as applicable.

Some installations might be in both categories depend on the mode of operation. For example, a storage device could be partly used to support a generating unit or demand unit, and partly to provide services; or a storage device could be used to support such a unit when this unit is running and could be used independently when the unit is not running. In this case the storage device would have to comply with the requirements for independently controlled devices.

Some potential examples are given in appendix A of this document. However, Users are encouraged to engage with NGESO in the early stages in the design development to understand the compliance requirements and the expected process. This is to recognise that the combinations explained in this document are not exhaustive and each user would like to develop their projects in unique way to suit their business case.

Appendix A: Potential Configurations

Example 1: Supplementary type generation and storage

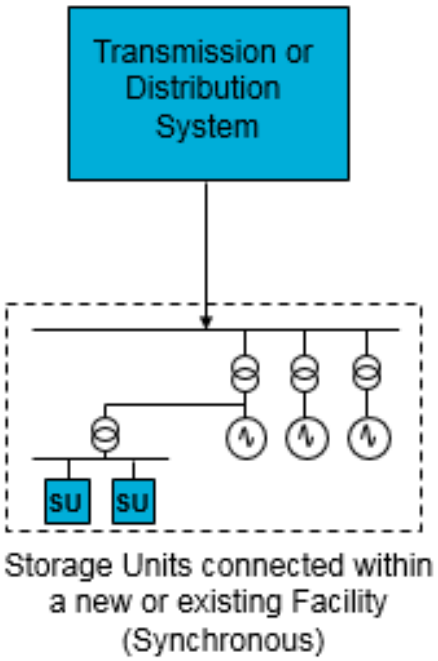

Figure 1: A possible supplementary type configuration [1]

Compliance Process

In this case, it is assumed that compliance would be with respect to the main plant (which could be generation or storage). Thus, for a Power Generating Module, it would take into account the capacity of the complete module. For example, in the case of a co-located installation comprising a generator and storage module and the storage module cannot be independently controlled from the Power Generating Module, (i.e. the storage module is used to improve the performance of the generating plant - e.g. providing enhanced FSM capability or reactive power capability,) compliance would be assessed on the total Maximum Capacity of the installation (e.g. if the Maximum Capacity of the Power Generating Module is 100MW and the Maximum Capacity of the Storage Module is 20MW, then compliance would be assessed on a total Maximum Capacity declared by the Generator which would be 120MW). On the other hand, it is likely that the Generator as plant owner may wish to declare the maximum capacity of the installation (Storage and Power Generating Module) to be 100MW in which case compliance would be assessed on a maximum capacity of 100MW.

Example 2: Independently controlled/operated co-located plants

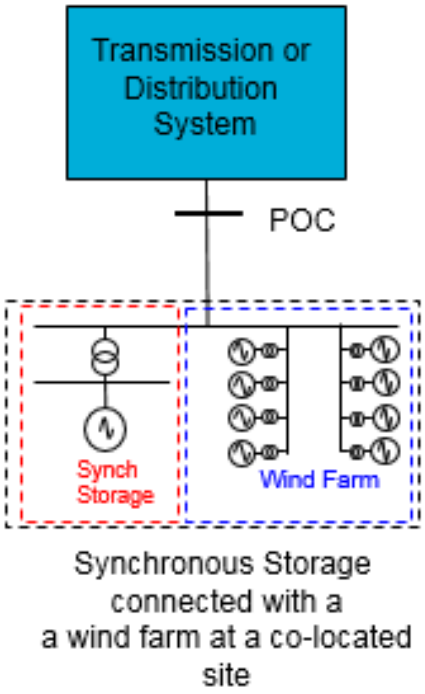

Figure 2: A possible independently controllable configuration [1]

Compliance Process

This is an example where synchronous storage units are added to a main offshore wind plant. In this case, it is assumed that stand-alone energy storage systems should be treated as any other technology that offer services to the electricity system [1].

The challenging part is determining what compliance process is applied to the additional storage units. Assume in this case the storage unit is connected to offshore network but located onshore. There are no clear rules in current Grid Code how this storage unit should be treated for compliance purposes i.e. should this be an onshore or offshore synchronous unit.

This is a known gap in the current CC and ECC codes. There is a work in progress in the offshore coordination space which potentially could clear some ambiguities[1].

In the meantime, the compliance process should take more pragmatic approach in collaboration with the developer.

Users/developers are encouraged to discuss potential compliance categorisation, process and agree the way forward. Let's assume in this case the storage unit is agreed to be treated as onshore synchronous unit. Based on this, the overall compliance process is summarised below.

[1] The ESO Offshore Coordination project forms part of the Department of Business, Energy and Industrial Strategy (BEIS) Offshore Transmission Network Review (OTNR) to address increasingly ambitious targets for offshore wind. The project published its phase 1 report in December 2020 where it is accepted that a review of Grid Code is necessary to address technical and commercial challenges for a future meshed offshore connection. The Phase 2 work in underway and further details can be found in the link below.
https://www.nationalgrideso.com/future-energy/projects/offshore-coordination-project

Compliance	Non-Synchronous Generation	Synchronous Storage	Combined
Voltage control	Note 1	Note 5	Note 9
Reactive capability	Note 2	Note 6	Note 10
Frequency response	Note 3	Note 7	
Fault ride through	Note 4	Note 8	

Note 1 to Note 4: The non-synchronous generation element should follow the compliance process as applicable to its type as defined in the Grid Code. Please refer to the relevant sections of Grid code and guidance notes.

Note 5 to Note 8: The synchronous storage should follow the compliance process as applicable (or as agreed with the user) to its type as defined in the Grid Code. Please refer to the relevant of Grid code and guidance notes.

Note 9 and Notes 10: Combined voltage control and reactive capability at the Connection Point should be verified to confirm that there is no interaction between both units adversely affecting each other.

Appendix B: References

[1.] Storage Expert Group: Final report 5th June 2019

The report and supporting documents available in the link below
https://www.entsoe.eu/network_codes/cnc/expert-groups/

[2.] GC0096: Energy Storage

The proposal and supporting documents are available in the link below

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

[3.] Offshore Coordination Project

https://www.nationalgrideso.com/future-energy/projects/offshore-coordination-project

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