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Engineering Recommendation G99

Issue 1 – Amendment ~~8~~X

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Requirements for the connection of generation equipment in parallel with public distribution networks on or after 27 April 2019

2 Scope and Structure

2.1 This EREC provides the technical requirements for the connection of **Type A**, **Type B**, **Type C** and **Type D Power Generating Module**s to the **Distribution Network**s of licensed **DNO**s in **Great Britain**. For the purposes of this EREC, a **Power Generating Module** is any source of electrical energy, irrespective of the generating technology and **Power Generating Module** type. This EREC applies to all **Power Generating Module**s which are not in the scope of EREC G98, Requirements for the connection of **Fully Type Tested** Micro-generators (up to and including 16 A per phase) in parallel with public **Low Voltage Distribution Network**s on or after 27 April 2019, or are not compliant with EREC G98 requirements.

The requirements set out in this EREC G99 shall not apply to the following **Generator**s who should refer to EREC G59:

(a) **Generator**s whose **Power Generating Module**(s) was already connected to the **DNO**'s **Distribution Network** before 27 April 2019[1] or

(b) **Generator**s who had concluded a final and binding contract for the purchase of main generating plant before 17 May 2018. The **Generator** shall have notified the **DNO** of the conclusion of this final and binding contract by 17 November 2018; or

(c) **Generator**s who have been granted a relevant derogation by the **Authority**.

The requirements set out in this **EREC G99** shall apply to **Generator**s owning any **Power Generating Module** which has been substantially modified on or after 27 April 2019. Such a modification will generally require the **Generator's Connection Agreement** to be substantially revised or replaced for example a change to a technical appendix in a **Connection Agreement**. Section 20.3 contains further details and Annex A.6 provides guidance on what modifications are considered substantial.

2.2 This EREC does not provide advice for the design, specification, protection or operation of **Power Generating Module**s themselves. These matters are for the **Generator** to determine.

2.3 Specific separate requirements apply to **Power Generating Facilities** connected at **LV** comprising **Fully Type Tested, Type A**, **Power Generating Module**s 16 A/phase or less (micro-generators) and these are covered in EREC

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1 **Power Generating Modules** that fully comply with this EREC G99 can be commissioned in advance of 27 April 2019 as they also comply with the pre-existing EREC G59 requirements.

G98. All **Power Generating Module**s 16 A/phase or less connecting to the **DNO**'s **Distribution Network** shall be **Fully Type Tested**.[2]

2.4 The connection of mobile generation operated by the **DNO**, EREC G98 compliant **Power Generating Module**s, Offshore **Power Generating Module**s or offshore **Transmission System**s containing generation are outside the scope of this Engineering Recommendation.

2.5 This document applies to systems where the **Power Generating Module**(s) can be paralleled with a **Distribution Network**. Where the **Power Generating Module**(s) can only be used as an alternative source of energy to supply the same electrical load within the **Customer Installation** the requirements of Section 7.4 of this EREC G99 apply.

2.6 The generic requirements for all types of **Power Generating Facilities** within the scope of this document relate to the connection design requirements, connection application and notification process including confirmation of commissioning. The document does not attempt to describe in detail the overall process of connection from application, through agreement, construction and commissioning. It is recommended that the ENA publication entitled – "*Distributed Generation Connection Guide*" is consulted for more general guidance.

2.7 Any **Power Generating Module** which participates in the balancing mechanism in addition to the general requirements of this EREC will have to comply with the relevant parts of the **Grid Code**. If the aggregated capacity of all the **Power Generating Module**s in the **Power Generating Facility** reaches the threshold for large as defined in the **Grid Code** (ie 10 MW in the north of Scotland; 30 MW in the south of Scotland, 100 MW in England and Wales), then the **Generator** will have to ensure compliance with the relevant parts of the **Grid Code**.

2.8 If the **Registered Capacity** of a **Power Generating Facility** in England and Wales is 50 MW or more, the **Generator** will have to comply with the requirements for an **Embedded Medium Power Station** as detailed in paragraphs 6.4.4 and 13.8.

2.9 This EREC is written principally from the point of view of the requirements in **Great Britain**. There are some differences in the requirements in **Great Britain** and Northern Ireland, which are reflected in the separate **Grid Code**s for **Great Britain** and Northern Ireland, and the separate **Distribution Code** and Engineering Recommendations for Northern Ireland. These documents should be consulted as necessary, noting that the numbering of sections within these documents is not

[2] This EREC G99 contains an **Integrated Micro Generation and Storage** procedure, details of which are given in **Error! Reference source not found.**.

necessarily the same as in the **Distribution Code** for **Great Britain** and the **Grid Code** for **Great Britain**.

2.10 The separate synchronous network operating in the Shetland Isles has specific technical challenges which are different to those of the **Great Britain** synchronous network. This EREC is not in itself sufficient to deal with these issues.

2.11 **Type B, Type C and Type D** pumped-storage **Power Generating Module**s shall fulfil all the relevant requirements of this EREC G99 in both generating and pumping operation mode. Synchronous compensation operation of pumped-storage **Power Generating Module**s shall not be limited in time by the technical design of **Power Generating Module**s. Pumped-storage variable speed **Power Generating Module**s shall fulfil the requirements applicable to **Synchronous Power Generating Module**s as well as those set out in Section 12.3 or Section 13.4.

2.12 Except for **Limited Frequency Sensitive Mode – Overfrequency** and the requirements relating to output power with falling frequency or where otherwise stated, requirements of this EREC G99 relating to the capability to maintain constant **Active Power** output or to modulate **Active Power** output shall not apply to **Power Generating Module**s of facilities for combined heat and power production embedded in the networks of industrial sites, where all of the following criteria are met:

(d) the primary purpose of those facilities is to produce heat for production processes of the industrial site concerned;

(e) heat and power generating is inextricably interlinked, that is to say any change of heat generation results inadvertently in a change of **Active Power** output and vice versa;

Combined heat and power generating facilities shall be assessed on the basis of their electrical **Registered Capacity**.

2.13 **Power Generating Modules** which by agreement between the **Generator** and the **DNO** will have the capability to run in island mode, as described in section 9.6.3 and including **Black Start Station**s, will need to comply with the general requirements of this EREG G99, although the specific technical requirements, particularly in relation to the earthing requirements of Section 8, the design requirements of Section 9 and protection requirements of Section 10 shall be

modified in accordance with any site-specific requirements that are specified in the agreement with the **DNO** and in any contract covering **Black Start** services.

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4 Terms and definitions

4.1 For the purposes of this document, the following terms and definitions apply.

Active Power (P)
The product of voltage and the in-phase component of alternating current measured in units of watts, normally measured in kilowatts (kW) or megawatts (MW).

Active Power Frequency Response
An automatic response of **Active Power** output, from a **Power Generating Module,** to a change in system frequency from the nominal system frequency.

Authority
The Gas and Electricity Markets Authority established under Section 1 of the Utilities Act 2000 The Gas and Electricity Markets Authority established under Section 1 of the Utilities Act 2000.

Automatic Voltage Regulator or AVR
The continuously acting automatic equipment controlling the terminal voltage of a synchronous **Generating Unit** by comparing the actual terminal voltage with a reference value and controlling by appropriate means the output of an **Exciter**, depending on the deviations.

Black Start

The procedure necessary for a recovery from a situation where all electricity supplies have been interrupted and all generation has ceased in that part of the **Distribution Network**. In these cases, there is no immediate prospect of external electricity supply being available to that part of the **Distribution Network** from the **Transmission System** or any other source, and therefore electrical supplies cannot be restored without recourse to the **Black Start Capability** of a **Black Start Station**.

Black Start Capability
An ability in respect of a **Black Start Station**, for at least one of its **Generating Unit**s to ~~Start-Up~~start-up from ~~S~~shutdown and to energise a part of the **Distribution Network** and be synchronised to the **Distribution Network** upon instruction from the **NETSO**, or instruction or signal from the **DNO**, within ~~two hours~~a time period defined in the **Black Start** contract, without an external electrical power supply.

Black Start Station
A **Power Generating Facility** which is registered with the **NETSO** or **DNO**, as having a **Black Start Capability**.

Combined Cycle Gas Turbine Module or CCGT Module
A collection of **Generating Unit**s comprising one or more Gas Turbine Units (or other gas based engine units) and one or more Steam Units where, in normal operation, the waste heat from the Gas Turbines is passed to the water/steam

system of the associated Steam Unit(s) or Steam Units and where the component units within the **CCGT Module** are directly connected by steam or hot gas lines which enable those units to contribute to the efficiency of the combined cycle operation of the **CCGT Module**.

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5 Legal Aspects

5.1 The operation and design of the electricity system in **Great Britain** is defined principally by Directive 2009/72/EC, the **Electricity Act**, the **Electricity Safety Quality and Continuity Regulations (ESQCR)** 2002, as well as general considerations under the Health and Safety at Work Act (HASWA) 1974 and the Electricity at Work Regulations (EaWR) 1989. A brief summary of the main statutory obligations on **DNO**s, **Generator**s and **Customer**s is included as Annex D.4.

5.2 Directive 2009/72/EC gives rise to a number of pieces of other EU law, the most relevant of which is Commission Regulation (EU) 2016/631, the Network Code Requirements for all Generators (RfG). This code supersedes UK law, although it is not a complete set of requirements. This EREC has been written to comply fully with the requirements of the RfG, and to include other requirements required for connection to the **GB** power system.

5.3 Under Section 21 of the **Electricity Act**, **Generator**s may be required to enter into a bespoke **Connection Agreement** with the **DNO**. Such a **Connection Agreement** will specify the terms and conditions including technical, operating, safety and other requirements under which **Power Generating Module**s are entitled to remain connected to the **Distribution Network**. It is usual to include site specific commercial issues, including recovery of costs associated with the connection, GDUoS (Generator Distribution Use of System) charges and the applicable energy loss adjustment factors, in **Connection Agreement**s. It is also common practice by some **DNO**s to collect the technical issues into a subordinate "Technical and Operating Agreement" which is given contractual force by the **Connection Agreement**.

5.4 **DNO**s are required by their licences to have in force and comply with the **Distribution Code**. **Generators** will be bound by their **Connection Agreement**s and licences if applicable, to comply with the **Distribution Code**.

5.5 In accordance with DPC5.4 of the **Distribution Code**, when details of the interface between a **Power Generating Facility** and the **Distribution Network** have been agreed a site responsibility schedule detailing ownership, maintenance, safety and control responsibilities will be drafted. The site responsibility schedule and operation drawing shall be displayed at the point of interconnection between the **DNO**'s **Distribution Network** and **Generator's Installation**, or as otherwise agreed.

5.6 The **DNO**s have statutory and licence obligations within which they have to offer the most economic, technically feasible option for connecting **Power Generating**

Facilities to their **Distribution Network**s. The main general design obligations imposed on the **DNO**s are to:

(a) maintain supplies to their **Customer**s within defined statutory voltage and frequency limits;

~~(b)~~(a) ~~ensure that the **Distribution Network**s at all voltage levels are adequately earthed;~~

~~(c)~~(b) comply with the "Security of Supply" criteria defined in EREC P2;

~~(d)~~(c) meet improving standards of supply in terms of customer minutes lost (CMLs) and the number of customer interruptions (CIs);

(d) ensure that the **Distribution Network**s at all voltage levels are adequately earthed;

(e) facilitate competition in the connection, generation and supply of electricity.

5.7 During **Black Start** it is recognized that **DNOs** may relax some or all of the requirements (a) to (c) of 5.6 for the duration of the **Black Start** event for the purpose of re-establishing a stable network.

5.8 Failure to meet any of the above obligations will incur legal or regulatory penalties. The first two criteria, amongst others, define the actions needed to allow islanded operation of the **Power Generating Facility** or to ensure that the **Power Generating Facility** is rapidly disconnected from the **Distribution Network** under islanded conditions. The next two criteria influence the type of connection that may be offered without jeopardising regulated standards.

5.~~8~~9 General conditions of supply to **Customer**s are also covered by Regulation 23 of the **ESQCR** 2002. Under Regulation 26 of the **ESQCR** 2002 no **DNO** is compelled to commence or continue a supply if the **Customer's Installation** may be dangerous or cause undue interference with the **Distribution Network** or the supply to other **Customer**s. The same regulation empowers the **DNO** to disconnect any part of the **Customer's Installation** which does not comply with the requirements of Regulation 26. It should also be noted that each installation has to satisfy the requirements of the HASWA 1974 and the EaWR 1989.

5.~~9~~10 The **DNO** shall refuse to allow the connection of a **Power Generating Module** which does not comply with the requirements and connection process set out in this EREC G99 and which is not covered by a derogation granted by the **Authority** or a **LON** as described in Section 19.6.

5.1~~0~~1 Regulations 21 and 22 of the **ESQCR** 2002 require installations that have alternative sources of energy to satisfy Regulation 21 in relation to switched

alternative supplies, and Regulation 22 in the case of sources of energy running in parallel with the **Distribution Network**.

5.11~~2~~ Under Regulation 22 of the **ESQCR** 2002, no person may operate **Power Generating Module**s in parallel with a public **Distribution Network** without the agreement of the **DNO**.

5.12~~3~~ All **Generator**s have to comply with the appropriate parts of the **ESQCR**.

5.13~~4~~ Any collection of **Power Generating Module**s under the control of one **Generator** in one installation is classed in the industry codes as a **Power Generating Facility**.

5.14~~5~~ **Power Generating Facilities** that are to be connected to a **Distribution Network** and contain **Power Generating Module**s that trade in the wholesale market as Balancing Mechanism Units or have for other reasons become a party to the Balancing and Settlement Code and/or National Grid's Connection and Use of System Code, will then have to comply with the applicable **Grid Code** requirements for **Power Generating Module**s.

5.15~~6~~ Information, which should assist **Generator**s wishing to connect to the **Distribution Network** at **High Voltage** (**HV**), will be published by the **DNO** in accordance with condition 25 of the Distribution Licence. This is known as the **Long Term Development Statement (LTDS)**. The general form and content of this statement is specified by Ofgem and covers the existing **Distribution Network** as well as authorised changes in future years on a rolling basis.

5.16~~7~~ Under the terms of the **Electricity Act**, generation of electricity is a licensed activity, although the Secretary of State, may by order[3] grant exemptions. Broadly, generating stations of less than 50 MW are automatically exempt from the need to hold a licence, and those between 50 MW and 100 MW may apply to the Department for Business, Energy and Industrial Strategy for an exemption if they wish.

5.17~~8~~ **Generator**s will need appropriate contracts in place for the purchase of any energy that is exported from the **Generator**s' **Power Generating Facilities**, and for any energy imported. For this purpose the **Generator** will need contracts with one or more **Supplier**s, and where the **Supplier** does not provide it, a meter operator agreement with the appropriate provider.

5.18~~9~~ **Generator**s wishing to trade ancillary services for National Grid purposes will need appropriate contracts in place with National Grid in its role as Great Britain System Operator.

5.20~~19~~ In **GB** law, **Electricity Storage** is treated just as generation. Accordingly, this EREC G99 includes **Electricity Storage** in the definition of a **Generating Unit**

[3] see http://www.opsi.gov.uk/si/si2001/20013270.htm

and Annex A.4 details certain requirements which do not apply to **Electricity Storage** devices.

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9 Network Connection Design and Operation

9.1 General Criteria

9.1.1 As outlined in Section 5, **DNO**s have to meet certain statutory and **Distribution Licence** obligations when designing and operating their **Distribution Network**s. These obligations will influence the options for connecting **Power Generating Module**s.

9.1.2 The technical and design criteria to be applied in the design of the **Distribution Network** and **Power Generating Module** connection are detailed in this document and DPC 4 of the **Distribution Code**. The criteria are based upon the performance requirements of the **Distribution Network** necessary to meet the above obligations.

9.1.3 The **Distribution Network**, and any **Power Generating Module** connection to that network, shall be designed:

(a) to comply with the obligations (to include security, frequency and voltage; voltage disturbances and harmonic distortion; auto reclosing and single phase protection operation).

(b) according to design principles in relation to **Distribution Network**'s plant and equipment, earthing, voltage regulation and control, and protection as outlined in DPC4, subject to any **Modification** to which the **DNO** may reasonably consent.

9.1.4 **Power Generating Module**s should meet a set of technical requirements in relation to its performance with respect to frequency and voltage, control capabilities, protection coordination requirements, **Phase (Voltage) Unbalance** requirements, neutral earthing provisions, islanding and **Black Start Capability** as applicable. The technical connection requirements in this chapter are common to all **Power Generating Module**s.

9.1.5 In addition requirements for **Type A Power Generating Module**s are detailed in Section 11. Requirements for **Type B Power Generating Module**s are detailed in Section 12. Requirements for **Type C and Type D Power Generating Module**s are detailed in Section 13.

9.1.6 The **Reactive Power** and voltage control requirements are given in Section 11, Section 12 and Section 13 for **Type A Power Generating Module**s, **Type B Power Generating Module**s, and **Type C** and **Type D Power Generating Module**s respectively. They are summarised in Table D.4 for information.

9.1.7 Every **Power Generating Module** and any associated equipment must be designed and operated appropriately to comply with cyber security requirements. As a minimum the recommendations in "ENA and Department for Business, Energy and

Industrial Strategy (BEIS) Distributed Energy Resources (DER) – Cyber Security Connection Guidance" (where applicable) and the relevant principles for cybersecurity from PAS 1879 "Energy smart appliances – Demand side response operation – Code of practice" should be implemented.

~~9.1.7~~9.1.8 As explained in 2.13 **DNOs** may relax certain aspects of section 9 for island operation, and section 5.7 during **Black Start**.

~~9.1.8~~ …

9.6 Island Mode

9.6.1 There are two specific instances of island mode to be considered:

(a) where the **Generator** wishes to deliberately move from the long-term parallel mode of operation to the situation where the **Generator**'s **Power Generating Module**(s) is arranged to supply just the load presented by the **Customer's Installation**, with the **Customer's Installation** disconnected from the **DNO**'s **Distribution Network**; or

(b) where one or more **Power Generating Module**s, belonging to one or more **Generator**s, support an isolated part of the **DNO**'s **Distribution Network**, maintaining supplies to other **Customer**s of the **DNO**.

9.6.2 Customer's Installation Island

9.6.2.1 Wherever a **Generator**'s **Power Generating Module** runs in parallel with the **DNO**'s **Distribution Network** for more than 5 minutes per month, the design of the **Power Generating Module** and the **Customer's Installation** must meet the requirements for long-term parallel operation and comply with all the appropriate requirements of this EREC G99.

9.6.2.2 Where a **Generator** intends to operate the **Power Generating Module** so that it supplies just the **Customer's Installation**, it is the **Generator**'s responsibility to ensure the safety of the **Customer's Installation** in respect of electrical and general safety.

9.6.2.3 The arrangements of Figures 8.6 (HV) and 8.9 (LV) will generally be appropriate for earthing and switching arrangements. Exact designs of **Customer's Installation**s will vary, but the functional requirements of these figures should be implemented.

9.6.2.4 It is the **Generator**'s responsibility to ensure appropriate and safe synchronisation to, and disconnection from, the **DNO**'s **Distribution Network**, respecting the requirements of EREC P28 on voltage disturbances on the **DNO**'s **Distribution Network**.

9.6.3 DNO Distribution Network Island

9.6.3.1 The provisions of this section 9.6.3 apply to situations where island mode operation is envisaged both for the mutual benefit of **DNOs** and relevant **Generators**. For **Black Start Stations**, additional or conflicting technical requirements may be imposed, again by mutual agreement, and recorded in the **Black Start** services contract.

~~9.6.3.1~~9.6.3.2 A fault or planned outage, which results in the disconnection of a **Power Generating Module**, together with an associated section of **Distribution Network**, from the remainder of the **Total System**, creates the potential for island mode operation. It will

be necessary for the **DNO** to decide, dependent on local network conditions, if it is desirable for the **Generator**s to continue to generate onto the islanded **DNO**'s **Distribution Network**. The key potential advantage of operating in island mode is to maintain continuity of supply to the portion of the **Distribution Network** containing the **Power Generating Module**. The principles discussed in this section generally also apply where **Power Generating Module**s on a **Generator**'s site is designed to maintain supplies to that site in the event of a failure of the **DNO** supply.

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10 Protection

10.1 General

10.1.1 The main function of the protection systems and settings described in this document is to prevent the **Power Generating Module** supporting an islanded section of the **Distribution Network** when it would or could pose a hazard to the **Distribution Network** or **Customer**s connected to it. The settings recognize the need to avoid nuisance tripping and therefore require a two stage approach where practicable, ie to have a long time delay for smaller excursions that may be experienced during normal **Distribution Network** operation, to avoid nuisance tripping, but with a faster trip, where possible, for greater excursions.

10.1.2 In accordance with established practice it is for the **Generator** to install, own and maintain this protection. The **Generator** can therefore determine the approach, ie per **Power Generating Module** or per installation, and where in the installation the protection is sited.

10.1.3 Where a common protection system is used to provide the protection function for multiple **Power Generating Module**s the complete installation cannot be considered to comprise **Fully Type Tested Power Generating Module**s if the protection and connections are made up on site and so cannot be factory tested or **Type Tested**. If the units or **Power Generating Module**s are specifically designed to be interconnected on site via plugs and sockets, then provided the assembly passes the function tests required in Form A2-4 (Annex A.2), the **Power Generating Module**s can retain **Type Tested** status.

10.1.4 **Type Tested Interface Protection** shall have protection settings set during manufacture. An **Interface Protection** device or relay can only be considered **Type Tested** if:

(a) The frequency and LoM protection settings are factory set in firmware by the **Manufacturer** to those in Table 10.1 and cannot be changed outside the factory (except as provided by (e) below).

(b) The voltage protection settings are factory set to those in Table 10.1 and can be changed by agreement with the **DNO** and by personnel specifically instructed by the **Generator** to make this change.

(c) The access by the personnel specifically instructed shall be controlled by a password, pin or a physical switch that has the facility to be sealed.

(d) Any **Interface Protection** device functionality other than the voltage protection settings (eg such as any auto reclosing functionality) can only be changed by personnel specifically empowered to do so by the **Generator**.

(e) Any changes to device firmware etc, where **Type Tested** status is to be retained, outside of the original factory environment shall be undertaken by personnel specifically empowered and equipped for that task by the **Manufacturer**.

10.1.5 Once the **Power Generating Module**s has been installed and commissioned the protection settings shall only be altered following written agreement between the **DNO** and the **Generator**. Paragraphs 10.6.14 and 10.6.15 detail the protection setting calculation for non-standard **LV** connections and the display requirements respectively.

10.1.6 In exceptional circumstances additional protection may be required by the **DNO** to protect the **Distribution Network** and its **Customer**s from the **Power Generating Module**.

10.1.7 Note that where the **Generator** installs an export limitation scheme in accordance with EREC G100 the installation will also need to comply with the requirements of that EREC.

10.1.8 Where a **Generator** has entered into an agreement with the DNO for island mode operation or has entered into a **Black Start** services contract, the **DNO** and the **Generator** shall agree variations to the standard arrangements described in this Section 10 to the extent necessary to facilitate the island mode and/or **Black Start** services.