

Engineering Recommendation G99

Issue 1 – Amendment 11

TBC 2024

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

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**Amendments since publication**

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| Issue | Date | Amendment |
| G99/1-1 | 23 Jul 2018 | Housekeeping modification   1. To implement the Authority’s decision on DC0079, ie to disallow the use of VS protection and to provide new RoCoF requirements for type tested generation. Changes to clauses 10.6.7.1; A.2-1; A.2-3; A.7.1.2.6; A7.2.2.6; D.2.1. 2. Correction of implementation date to 27 April 2019 throughout. 3. Minor typographical corrections – principally a number of corrected internal paragraph cross references, as well as a small number of spelling mistakes. |
| G99/1-2 | 10 Dec 2018 | Implementation of GC0110 – modification to the compliance assessment for LFSM-O. Changes to the following paragraphs:  11.2.4.1; 12.2.4.1; A.7.2.4; B.5.6.3 – B.5.6.5; B.6.5.4 – B.6.5.6. |
| G99/1-3 | 10 Dec 2018 | Modification to incorporate the Integrated Micro Generation and Storage procedure (otherwise known as the energy storage fast track procedure) into EREC G98 and G99.  A small number of minor typographical corrections throughout. |
| G99/1-4 | 17 Jun 2019 | 1. Various small modifications. 2. Modifications to foreword for the case that a G99 PGM is installed before 27 April 2019. 3. Paragraph 2.16 added in respect of applicable versions of G99 with respect to type testing, Equipment Certificate(s) and Manufactures’ Information. 4. Minimum Generation replaced with Minimum Stable Operating Level. 5. Distribution Licence condition reference number updated from 4 to 12 in paragraph 6.4.5.1. 6. Paragraph 7.1.2 added in respect of regenerative equipment. 7. New paragraph 10.1.4 to clarify type tested interface protection and modification to paragraph 16.3.4. 8. Clarification of automatic reconnection for Generators with a CUSC contract in paragraph 10.3.3. 9. Figures 11.2 and 12.2 modified to show the range of droops that a Generator may choose to implement for LFSM-O. 10. Requirements of paragraph 13.2.6.1 simplified and definition of European Specification removed. 11. Clarification added to paragraph 6.2.4.4, 17.4.3, 18.4.3 and 19.5.7 in respect of Operational Notification. Similar clarification added as applicable to Type A PGMs in paragraph 16.4.3. 12. Paragraph 15.3,3 modified in respect of timing of submission of compliance forms. Paragraph 16.2.4 modification in respect of timing of submission of Type A compliance forms. Section 17.2 and 18.2 Connection process expanded to provide clarity. 13. Amended Product ID to system reference in 16.1.2 and elsewhere, as per updates to ENA Type Test register. 14. Paragraphs 17.2.1 and 18.2.1 modification in respect of connection offer. 15. Paragraph 18.3.4 modification in respect of initial capacity limit on synchronisation for PPMs. 16. Paragraph 19.2.1 modification in respect of timing of Type D PGMD submission. 17. Clarification that a PGMD can be used in paragraph 19.2.4. 18. Paragraph 19.4 Witnessing and Commissioning included 19. Modifications to align the Type Testing for PPMs with the commissioning form. 20. RoCoF withstand test added to Form A2-2, A2-3, B2-1 and C2-1   RoCoF stability test added to Form A2-4, Form B2-2, Form C2-2  Paragraph 15.4.1 revised to align with Forms.   1. Clarification in Form A3-1, B2-1, B3, C2-1 and C3 in respect of phased installations. Requirement for declaration that PGMD is complete removed from Form B3 and C3. 2. Note added to Form A2-2, Voltage fluctuations and flicker that measurements can be recorded as Form A2-1. 3. Logic interface port and wiring check anomalies corrected in Form A2-2 and A2-4. 4. Check for as installed data added to Type A Installation Document. 5. Clarification added to text in Section 21 in respect of Manufacturers Information. 6. Simplification of Type B simulation studies in respect of Reactive Power and Voltage Control studies, LFSM-O studies. 7. Sections B.5.2, B.5.3, B.5.4, B.5.5, B.6.2, B.6.3, B.6.4 and B.6.5 removed. References to these tests removed from the Type B PGMD. Ability for DNO to request these tests included in paragraph 17.2.3. 8. Figure B.5.2 (iii) corrected. 9. Paragraph 13.5.1 modified and paragraph13.5.3 added and Annex C.7.3 revised in respect of Type C reactive capability. 10. Paragraph C.5.3.4 modified to clarify reactive power required envelope of operation for PPMs. 11. Paragraph C.5.7.3 removed. 12. Duplicated words in Annex 6 removed. 13. Reference to Site Responsibility Schedule added to PGMD for Type B and Type C. Power Quality requirements added to the PGMD for Type C PGMs. 14. Annex C.7.3.1 and C.7.3.2 modified to clarify the simulation study voltage requirements for Synchronous PGMs and PPM. 15. Annex C.7.6.6 modified to clarify the frequency simulation study validation requirements. 16. Annex A.4.3 amended in respect of Infrequent Short-Term Parallel Operation. |
| G99/1-5 | 14 November 2019 | Modifications to 12.6 and 13.6 to clarify the fast fault current injection requirements for Types B, C and D. |
| G99/1-6 | 02 March 2020 | 1. Addition of BS EN 50549 as a standard in Section 3.3. 2. Definition of NETSO modified to reflect the separation of the TO and SO in Section 4.1. 3. Definition of Registered Capacity revised, para 11.1.6 clarified and new para 12.5.3 added in respect of agreement of control and power factor requirements. Table 9.1, a summary of voltage control and reactive power added. 4. Clarity about simulation models and validation, new para 6.3.9.1 added. Clarity around the description of simulation models added in paragraphs 17.4.1, 18.4.1 and 19.5.3. 5. Inclusion of requirement previously only in the commissioning forms about monitoring tripping and auxiliary protection supplies as new para 10.3.8. 6. Clarity in respect of FSM operation new para 13.2.6.1. 7. Modification to para 16.1.6 in respect of UK and EU directives. 8. Clarification added to paragraph 2.1, new paragraph 20.3.4 and 20.3,5 and Annex 6 table in respect of modifications and compliance with appropriate EREC. 9. Addition of LFSM-O tests for slow acting micro hydro in A.7.2.4. 10. Clarity added to form A1-1 to ensure the SAF can be used instead of form A1-1 where appropriate. 11. Removal of phrase about transformer ratings and power quality from forms A2-1 and A2-3 (already adequately covered in Section 9.4.3.2). The use of \* to indicate items that could be tested on site has been removed in the Type Testing forms. Clarity added to forms A2-1 and A2-2 in terms of Type Testing Interface Protection devices only. 12. Tolerances for Droop measurement added to Annex A.7.1.3 13. Modification made to tests in Appendix A.7 in respect of incorrect reference to Controller. 14. Clarification made in A.7.2.4 that the LFSM-O tests are also suitable for > 50 kW PGMs. 15. References in PGMD in respect of frequency compliance revised. 16. Guidance about exciter transient voltage control added as Tables C.4.1 and C.4.2. 17. Text modified in respect of power quality monitoring requirements in C.6.1. Additional text added to post event recording specification C.6.2.5.1.2 and C.6.2.5.1.5. |
| G99/1-7 | 01 August 2021 | 1. Modifications to storage exclusions: paragraph 1.2, paragraph 5.20, paragraph 6.2.2.4, paragraph 11.1.1, paragraph 12.1.1 and paragraph 13.1.1. 2. Clarifications to the foreword. 3. Addition of new section 2.2 defining the implementation date for Electricity Storage. 4. Revision of definition of Generating Unit. 5. New definition of Vehicle to Grid Electric Vehicle. 6. Revision of the definition of Synchronous Power Generating Module. 7. New paragraphs 7.1.3, 11.2.3.3, 12.2.3.3, 13.2.3.2, 15.1.3 and 16.5, A.7.1.7, A.7.2.3.2, B.5.4, B.6.3, C.8.8, C.9.6. 8. Revision of Figure 4.6, Table 6.1 and Figure 6.7. Revision of figures 6.8 and 6.9, new figures 6.10, 6.11 and 6.11. 9. Inclusion of storage frequency tests Annex A.7.1.7, A.7.2.3.2, B.5.4, B.6.3, C.8.8 and C.9.6.   13.Revision of Annex A.4.2 to clarify exclusions against the implementation date. |
| G99/1-8 | 01 Sept 2021 | Minor technical modifications:   1. Removal of sentence in Foreword that is out of date. 2. Updates to the titles of EREC G5 and EREC P28 in the references and clarification that BS EN 50549 is a suite of documents. 3. New references to cyber security guidance documents, a requirement to comply with these in a new clause 9.1.9, new footnote 12 in 14.1.4(f), additional check on compliance in forms A2-1, A2-2, A2-3 and the PGMDs, confirmation in respect of installation compliance in commissioning forms, Form A3, Form B3 and Form C3. 4. Amendments to the definitions of Connection Agreement, Droop. MSOL, MRL and Fully Type Tested (see also item 12). 5. Clarification on providing validated models, with amendments to 6.3.7, 6.3.8.4(b) and 6.3.8.5. 6. A new clause 9.6.2 on customer’s installation island, with an introduction in 9.6.1. 7. Modification to 10.2.2, 10.3.8 and Forms A3, B3 and C3 to clarify that the Generating Unit may be tripped, rather than the whole Power Generating Module. 8. Relaxation on the output power with falling frequency requirement for CCGT, which aligns with the equivalent Grid Code requirement, in 11.2.3.1(b), 12.2.3.1(b) and 13.2.3.1(b) (and updated Figures). 9. Clarification that reactive capability is on the basis of nominal voltage in 12.5.1. 10. Review of the use of the terms Minimum Operating Level and Minimum Stable Operating Level, with amendments to 13.2.6.4(b), A.7.2.4.1, B.5.2.5, B.6.2.6, C.8.6.3, C.8.6.5, C.9.5.4 and C.9.5.6. 11. A new clause on rapid re-synchronisation requirement, as per RfG Article 15 5 (c), in 13.7.2. 12. Modifications for power quality assessment (EREC G5 and P28) and type testing (including removing the word “partial” in the context of type tested), including amendments to 15.3, 22.1 (including table), Forms A2-1, A2-2 and A2-3 and C.9.1.5. 13. Allowing for a family approach to type testing in new clauses from 15.6. 14. A new clause 15.7 summarising compliance demonstration required for Power Generating Modules in infrequent short-term parallel operating mode. 15. Clarification in 20.3.3 that a new EREC G99 application is required where a modification results in an increase in installed capacity over 16 Amps per phase. 16. Inclusion of an energy source / energy conversion technologies table at the end of applications forms (A1-1, A1-2), and request for technology type code to be included in application form. 17. A request in the notes to include electricity storage capacity (kWh) in the application form, where Electricity Storage devices are part of the installation. 18. Modifications to recognise the limitations of small rotating machines to operate stably at low output, including changes to Form A2-1 (new footnotes) and additional guidance in A.7.2.2.4 and A.7.2.5.1. 19. Modifications to the forms in Annex A (A2-1, A2-2, A2-3), including:     1. Clarifications and additional guidance in the type test compliance verification forms;     2. New operating range tests (Test 5 continuous operation) and Test 6 RoCoF withstand in Form A2-1;     3. Additional columns in the harmonics test sheet for measurements from all three-phases to be recorded;     4. Moved fields for test dates and location to top of voltage fluctuations and flicker test sheet; and     5. New requirement to provide a high- level description of the logic interface. 20. Modifications to Annex A Form A2-4, including:     1. Clarification in the notes at the front of the form that details for other onsite tests should be provided at the end of the form;     2. Clarification in the stability tests that confirmation is sought of no trip of the interface protection (similarly in B2-2 and C2-2); and     3. Clarification in the test schedule that a trip of the interface protection should trip the appropriate circuit breaker (similarly for B2-2 and C2-2). 21. Modifications to the PGMDs, including:     1. Clarification that where multiple types of evidence are indicated as being acceptable for demonstrating compliance, the Generator and/or Manufacturer can determine the most appropriate format;     2. The addition of “E” for exempt in the key to compliance;     3. The addition of space in the PGMD for DNO review date and comment;     4. Change the type of evidence requested for Power Quality (voltage fluctuations and flicker and harmonics) from TV (Type Test report) to T (tests) in accordance with modification item 12, and expanded the submission stage to include FONS.     5. Removal of the requirement in Form C2-1 Part 1 to undertake simulation studies for synchronous generators in accordance with annex C.7.4;     6. The addition of rows to C2-1 Parts 1 and 2 for a number of requirements including C.10 minimum frequency response, 13.7.2 rapid re-synchronisation and C.6 dynamic system monitoring; and     7. Removal of a row in C2-1 Part 2 asking for compliance demonstration with 12.2.1 operating range and removal of a duplicate row (13.3). 22. Clarification on the provision of modelling equivalents for Customer’s Installations and associated equipment in a new clause B.4.1.3. 23. Clarification and drafting improvements to B.4.2.1 (similarly for C.7.3.1). 24. Guidance on the minimum fault level that can be assumed in simulation studies in B.4.4.3 (similarly for C.7.5.3). 25. Correction of internal cross reference in B.4.5.2 (ii). 26. Clarification in C.5.6.1 and C.5.7.1 that the scope is limited to PGMs that are required to comply with relevant parts of the Grid Code. 27. Modifications to Annex C.6, including new clauses C.6.2.4 on instrument transformers, C.6.2.5 on overall accuracy, C.6.2.6 on time keeping and the addition of negative and zero sequence parameters in C.6.2.2.2, Table C.6.7 and Table C.6.8 for fault recording. 28. Drafting revisions to C.7.3 simulation studies of reactive capability, including new clauses C.7.3.2 and C.7.3.3, to improve clarity. 29. Clarification in C.7.5.5 on Grid Code compliant PGMs. 30. Clarification in C.7.6.5 and C.7.6.6. 31. Clarification in C.8.6.6 and C.9.5.7. 32. Corrections to internal cross references in C.9.1.2 and C.9.5.3. 33. A small number of minor typographical corrections throughout. |
| G99/1-9 | 03 Oct 2022 | Introduction of Small Generation Installation procedures.  Addition of new definitions of   * Intrinsic Design Capacity * Small Generation Installation   Slight modification to the definition of Registered Capacity.  New Section 6.2.2  Minor consequential changes to Forms A1-1, A1-2 and A3-2.  New form A3-3 added.  Replace "Integrated Micro Generation and Storage” with “Small Generation Installation” throughout.  Modifications to The Distribution Code and Associated Documents to reflect the terms of the UK’s departure from the EU.   * Addition of new definitions: Retained EU Law and IP Completion Day, * Amendment to existing definition: Manufacturers Information * Section 3.2 Removal of EU regulation and directive references   Amendment to existing sections of text in paragraphs 5.1, 5.2. 16.1.6 and 19.7.2 (c) |
| G99/1-10 | 4 March 2024 | Substitution of Anchor Plant replacing Black start:   * Additional paragraph 2.14 to Scope and Structure * Terms and definitions modified to include Anchor Plant Capability, Anchor Power Station and System Restoration * Additional paragraph 5.7 * Additional paragraph 9.1.8 * Additional paragraph 9.6.3.1 * Additional paragraph 10.1.8 |
| G99/1-11 | Xx xx 2024 | 1. Modification of 6.3.7 to include more detail on the models being referred to. 2. Modification to G99 Form C3 Part 2 to include checks to confirm that the Dynamic System Monitoring & Fault Recording and Power Quality Monitoring equipment has been commissioned. 3. Modification to Forms A 1-2 and A 3-3 to remove thermal storage items. 4. Clarifications in C.7.6 on studies required in island mode operation and in non-island mode operation. 5. Modifications to 2.17 to provide clarity on the validity of type tests needed. 6. Insertion of new section 20.3.6 to provide clarity on compliance of existing generators involved in private wire schemes. 7. Modification to sections 11.2.4.1 (c) and (d) to provide references to Figures A.7.10 and A.7.9 respectively. 8. Modification to sections 2.1 and 2.4 to include Power Generating Modules which are not amenable to type testing. 9. Modifications to Forms A1-1 and A1-2 to provide clarity on manufacturer’s reference number. 10. Revision of the definition of Intrinsic Design Capacity and amendment to forms A2-1, A2-2 and A2-3. 11. Modification to 13.2.6.4 to clarify that Figure 13.6 is a minimum response. 12. Modification to Figures C.5.2 and C.5.3. 13. Modification to section 6.2.2.3 and 6.2.2.4 to include “fully type tested” to G100 references. 14. Addition of sections 17.3.6 and 18.3.6 to include the use of Ions for Type C PPMs. 15. Modification to section 5.19 and addition of sections 6.1.6.3, 6.1.6.4, 17.1.1, 18.1.1 and 19.1.2 to include amendments related to BEGAs. 16. Addition of example 13a to A.6 to provide clarity for the case where one inverter from many forming a pre-G99 PPM is replaced. 17. Replacement of 11.2.3.3, 12.2.3.3, C.8.8 and C9.6, removal of , 13.2.3.2, and insertion of 13.2.5.2, C.7.6.7 and C7.7.3 related to requirements for Electricity Storage Power Generating Modules when operating in an importing mode of operation. 18. Addition of 15.9 on Compliance Monitoring. 19. Introduction of section 7.8, Forms A1-3 and A3-4, and section A.8 related to Power Generating Module Sharing Systems. 20. Various modifications related to Customer Island Operation. 21. Note about the accommodation of cyber security in C.6.2.9 22. Addition of "IS" (ie initial submission) to the C.6 requirements in for C2 (the PGMD for type C and D PGMs). 23. Addition of “installed at the Connection Point” in the scope of C.6.   Minor modifications:   1. Modification of C.6.3 reference from ENA ER G5/4 to ENA ER G5. 2. Correction of references to Annexes in 21.4. 3. Correction of placement of Figures 12.8. 4. Modification to use of technology wording in Forms A1-1, A1-3, A3-1, A3-2, B2-1, B3, C2-1 and C3 5. Insertion of a note in Annex A.6 to indicate that the table applies to Types B, C and D as well. 6. Deletion of wording related to storage from A.7.2.1. 7. Correction reference to export capacity in A.7.2.6.1. 8. Correction of paragraph references in A.7.1.3 and A.7.2.5.1. 9. Modification of the Vehicle to Grid Electric Vehicle definition. 10. Correction of paragraph reference in C.9.6.4. 11. Correction of Figure 13.7 numbering. 12. Correction of paragraph reference in C.9.5.2. 13. Correction of paragraph reference in C.9.3.2. 14. Correction of reference to figures in 12.3.1.1. 15. Correction of paragraph reference in A.7.1.3. 16. Correction of Figure 16.1 numbering. 17. Addition to section 16.4.2 to include the requirement of a photograph with online connection applications   Increase in the maximum allowable phase imbalance in 7.5.3 and consequential amendments to A1-1, A1-3, A3-1, A3-2, A3-3 and A5. |

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Foreword

This Engineering Recommendation (EREC) is published by the Energy Networks Association (ENA) and comes into effect on 27 April 2019 for **Power Generating Modules** first installed on or after that date. It has been prepared and approved for publication under the authority of the **Great Britain Distribution Code** Review Panel. The approved abbreviated title of this engineering document is “EREC G99”.

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**sin **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 which would be in the scope of EREC G98 but are not suitable for type testing or which are designed to work in island mode.

The definition of **Power Generating Modules** within this document includes **Electricity Storage** and hence this document also applies to **Electricity Storage** devices when operating in export mode and includes **Vehicle to Grid Electric Vehicle**s[[1]](#footnote-2). The applicability of the requirements in this document to **Electricity Storage** depends on the date on which the **Electricity Storage** devices are commissioned as detailed in paragraph 2.2.

# Purpose

* 1. The purpose of this Engineering Recommendation (EREC) is to provide requirements for the connection of **Power Generating Facilities** to the **Distribution Network**s of licensed **Distribution Network Operator**s **(DNO**s**)**. It is intended to address all aspects of the connection process from standards of functionality to site commissioning, such that **Customer**s**, Manufacturer**s and **Generator**s are aware of the requirements that will be made by the local **DNO** before the **Power Generating Facility** will be accepted for connection to the **Distribution Network**.
  2. The requirements set out in this EREC are designed to facilitate the connection of **Power Generating Module**(s) whilst maintaining the integrity of the **Distribution Network**, both in terms of safety and supply quality. It applies to all **Power Generating Module**(s) within the scope of Section 2, irrespective of the type of electrical machine and equipment used to convert any primary energy source into electrical energy. The time based exclusions for **Electricity Storage** and other exceptions are noted in Annex A.4. The rest of this document applies to **Electricity Storage** in full.

# Scope and Structure

* 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**sin **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 which would be in the scope of EREC G98 but are either not suitable for type testing or which are designed to work in island mode.

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

1. **Generator**s whose **Power Generating Module**(s) was already connected to the **DNO**’s **Distribution Network** before 27 April 2019[[2]](#footnote-3) or
2. **Generator**s who had concluded a final and binding contract for the purchase of main generating plantbefore 17 May 2018. The **Generator** shall have notified the **DNO** of the conclusion of this final and binding contract by 17 November 2018; or
3. **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.

* 1. **Power Generating Modules** comprising **Electricity Storage** devices commissioned before 01 September 2022 are exempt from a small number of requirements. These specific exclusions for **Electricity Storage** are listed in Annex A4. **Power Generating Modules** comprising **Electricity Storage** devices commissioned on or after 01 September 2022 shall comply with EREC G99 in full.
  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.
  3. Specific separate requirements apply to **Power Generating Facilities** comprising **Fully** **Type Tested**, **Type A**, **Power Generating Module**s 16 A/phase or less (micro-generators) and these are covered in EREC G98. All **Power Generating Module**s 16 A/phase or less connecting to the **DNO**’s **Distribution Network** shall be **Fully** **Type Tested** unless the **DNO** agrees that it is impractical in those cases where a **Power Generating Module** is being designed specifically for that location, such as is sometimes appropriate for micro hydro installations, etc.
  4. For **Electricity Storage Power Generating Module**s when operating in an importing mode of operation, relevant requirements are laid out in section 11.2.3.3, 12.2.3.3, and 13.2.5.2. These requirements apply to all **Electricity Storage Power Generating Module**s which were first connected to the **DNO**’s **Distribution Network** on or after [01 January 2026].
  5. The connection of mobile generation operated by the **DNO**, EREC G98 compliant **Power Generating Module**s, Offshore **Power Generating Module**sor offshore **Transmission System**s containing generation are outside the scope of this Engineering Recommendation.
  6. 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.
  7. 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.
  8. 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**.
  9. 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.
  10. 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 necessarily the same as in the **Distribution Code** for **Great Britain** and the **Grid Code** for **Great Britain**.
  11. 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.
  12. **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.
  13. **Power Generating Module**s which by agreement between the **Generator** and the **DNO** have the capability to run in island mode, as described in paragraph 9.6.3, will need to comply with the general requirements of this EREC 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 **System Restoration** services.
  14. 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**sof facilities for combined heat and power production embedded in the networks of industrial sites, where all of the following criteria are met:

1. the primary purpose of those facilities is to produce heat for production processes of the industrial site concerned;
2. 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**.

* 1. This document details connection process, technical and compliance requirements for **Type A**, **Type B**, **Type C** and **Type D Power Generating Module**s. The structure of the document is illustrated in Figure 2.1.

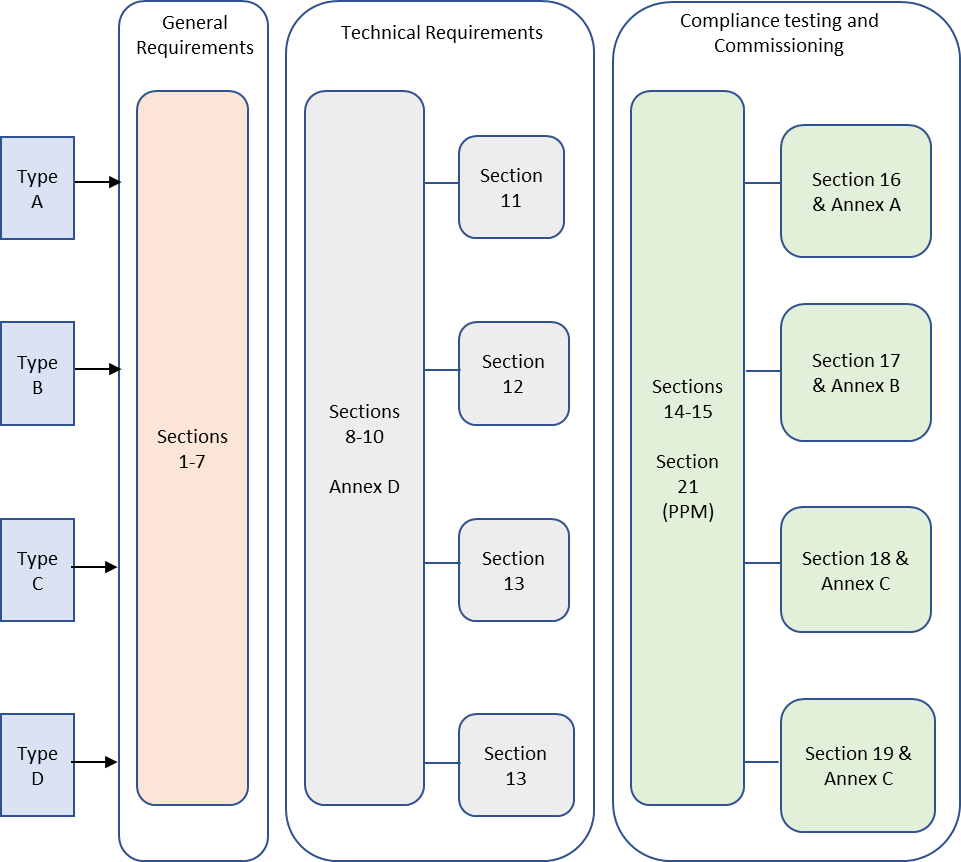


Figure 2.1 EREC G99 Document Structure

* 1. **Validity of Type Tests**
     1. **Power Generating** **Module**s that have been **Type Tested** to demonstrate compliance with previous amendments of EREC G99, and are already connected to a **Customer’s Installation**, are considered to be compliant with this current version of EREC G99. Where compliance of an item of plant and/or apparatus is demonstrated using **Manufacturers’ Information** or Equipment Certificate(s) the compliance should be with the version of EREC G99 that was current at the time of acceptance of the connection offer, or with any later version of this EREC G99.
     2. Where a revision to EREC G99 changes a requirement which a **Manufacturer** has previously certified as compliant, or introduces a new requirement, that certification for newly manufactured **Power Generating Modules**, or components thereof, becomes invalid from the date that the revised requirement in the revision of EREC G99 becomes operative. **Manufacturer**s will need to submit updated certifications for EREC G99 compliance for any relevant **Power Generating Module** which is connected on or after the date the new or revised requirement becomes operative.
     3. For **Type Tested Power Generating Module**s, the relevant requirements are those that are principally laid out in sections 9 to 14 of this EREC G99 and which are generally expected to be demonstrated in accordance with the provisions of sections 15 to 19 of EREC G99. Minor revisions to EREC G99 which are clarifications and do not change the underlying requirements are not classed as being a change to the relevant requirements and therefore do not need **Manufacturer**s to repeat tests and re-certify.

# Normative references

* 1. **The following referenced documents, in whole or part, are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.**
  2. **Regulations and Directives**

**Health and Safety at Work etc. Act (HASWA):**

The Health and Safety at Work etc. Act 1974 also referred to as HASAW or HSW, is the primary piece of legislation covering occupational health and safety in the United Kingdom. The Health and Safety Executive is responsible for enforcing the Act and a number of other Acts and Statutory Instruments relevant to the working environment.

**Electricity Safety, Quality and Continuity Regulations (ESQCR):**

**The Electricity Safety, Quality and Continuity Regulations** 2002 (Amended 2006) - Statutory Instrument Number 2665 -HMSO ISBN 0-11-042920-6 abbreviated to **ESQCR** in this document.

**Electricity at Work Regulations (EaWR):**

The Electricity at Work regulations 1989 abbreviated to EaWR in this document.

* 1. **Standards publications**

**BS 7671: Requirements for Electrical Installations**

IET Wiring Regulations.

**BS EN 50549 series**

Requirements for generating plants to be connected in parallel with distribution networks.

**BS EN 50160**

Voltage characteristics of electricity supplied by public electricity networks.

**BS 7430:**

Code of Practice for Earthing.

**BS EN 61000 series\***

Electromagnetic Compatibility (EMC).

**BS EN 61508 series\***

Functional safety of electrical/ electronic/ programmable electronic safety-related systems.

**BS EN 60255 series\***

Measuring relays and protection equipment.

**BS EN 61810 series\***

Electromechanical Elementary Relays.

**BS EN 60947 series\***

Low Voltage Switchgear and Controlgear.

**BS EN 61869-2:**

Instrument transformers. Additional requirements for current transformers.

**BS EN 60034-4:**

Methods for determining synchronous machine quantities from tests.

**BS EN 61400-12-1:**

Wind turbines. Power performance measurements of electricity producing wind turbines.

**BS EN 62116**

Test procedure of islanding prevention measures for utility-interconnected photovoltaic Inverters.

**IEC 60909 series\***

Short-circuit currents in three-phase a.c. systems. Calculation of currents.

**IEC TS 61000-6-5:**

Electromagnetic Immunity Part 6.5 Generic Standards. Immunity for Power Station and Substation Environments.

**IEC 60364-7-712:**

Electrical installations of buildings – Special installations or locations – Solar photovoltaic (PV) power supply systems.

*\*****Where standards have more than one part, the requirements of all such parts shall be satisfied, so far as they are applicable.***

* 1. **Other publications**

**ENA Engineering Recommendation G5**

Harmonic voltage distortion and the connection of harmonic sources and/or resonant plant to transmission systems and distribution networks in the United Kingdom.

**ENA Engineering Recommendation G12**

Requirements for the application of protective multiple earthing to low voltage networks.

**ENA Engineering Recommendation G74**

Procedure to meet the requirements of IEC 909 for the calculation of short-circuit currents in three-phase AC power systems.

**ENA Engineering Recommendation G83**

Recommendations for connection of small-scale embedded generators (up to 16 A per phase) in parallel with public low voltage distribution networks.

**Engineering Recommendation 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 Networks on or after 27 April 2019.

**Engineering Recommendation G100**

Technical Requirements for Customers’ Export and Import Limitation Schemes.

**ENA Engineering Recommendation P2**

Security of Supply.

**ENA Engineering Recommendation P18**

Complexity of Distribution Circuits Operated at or above 22kV.

**ENA Engineering Recommendation P28**

Voltage fluctuations and the connection of disturbing equipment to transmission systems and distribution networks in the United Kingdom.

**ENA Engineering Recommendation P29**

Planning limits for voltage unbalance in the UK for 132 kV and below.

**ENA Technical Specification 41-24**

Guidelines for the design, installation, testing and maintenance of main earthing systems in substations.

**ENA Technical Specification 41-38**

Power installations exceeding 1 kV AC. – Design of high-voltage open-terminal stations.

**ENA Engineering Technical Report ETR 124**

Guidelines for actively managing power flows associated with the connection of a single distributed generation plant.

**ENA Engineering Report EREP 126**

Guidelines for actively managing voltage levels associated with the connection of a single distributed generation plant.

**ENA Engineering Report EREP 130**

Application guide for assessing the capacity of networks containing distributed generation.

**ENA and Department for Business, Energy and Industrial Strategy (BEIS) Distributed Energy Resources (DER) – Cyber Security Connection Guidance**

Guidance to support users in the design, development, deployment, connection and maintenance of new and existing DERs to the distribution networks to improve their cyber security.

**Publicly Available Specification (PAS) 1879**

Energy smart appliances – Demand side response operation – Code of practice.

# Terms and definitions

* 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.

**Anchor Plant Capability**

An ability in respect of an **Anchor Power Station**, for at least one of its **Generating Unit**sto start-up from shutdownand to energise a part of the **Distribution Network** and be synchronisedto the **Distribution Network** upon instruction from the **NETSO**, or instruction or signal from the **DNO,** within a time period defined in the **System Restoration** contract, without an external electrical power supply.

**Anchor Power Station**

A Power Generating Facility which is recognized by the NETSO or DNO, as having Anchor Plant 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 Unitswhere, 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 Unitsand 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**.

Connection Agreement

A contract between the **Distribution Network Operator** and the **Generator**, which includes the specific technical requirements for the **Power Generating Module** and the relevant requirements for the **Power Generating Facility**.

Connection Point

The interface at which the **Power Generating Module** or **Generator’s Installation** is connected to a **Distribution Network**, as identified in the **Connection Agreement**. For the avoidance of doubt, two or more connection circuits constitutes a single **Connection Point** for the purposes ofEREC G99.

Controller

A device for controlling the functional operation of a **Power Generating Module**.

CUSC

Has the meaning set out in the **Transmission Licence**.

Customer

A person who is the owner or occupier of an installation or premises that are connected to the **Distribution Network**.

Customer's Installation

The electrical installation on the **Customer**'s side of the **Connection Point** together with any equipment permanently connected or intended to be permanently connected thereto.

Detailed Planning Data (DPD)

Detailed additional data which the **DNO** requires under the Distribution Planning and Connection Code in support of **Standard Planning Data**.

Distribution Code

A code required to be prepared by a **DNO** pursuant to Standard Licence Condition 21 (**Distribution** **Code**) of a **Distribution** **Licence** and approved by the **Authority** as revised from time to time with the approval of, or by the direction of, the **Authority**.

Distribution Network

An electrical network for the distribution of electrical power from and to a third party[s] connected to it, a **Transmission System** or another **Distribution Network**.

Distribution Network Operator (DNO)

The person or legal entity named in Part 1 of the **Distribution Licence** and any permitted legal assigns or successors in title of the named party. A distribution licence is granted under Section 6(1)(c) of the **Electricity Act** 1989 (as amended by the Utilities Act 2000 and the Energy Act 2004).

Droop

The ratio of the per unit steady state change in speed (or frequency), to the per unit steady state change in **Active Power** output. Whilst not mandatory, it is often common practice to express **Droop** in percentage terms.

Electricity Act

The **Electricity Act** 1989 (as amended. including by the Utilities Act 2000 and the Energy Act 2004).

Electricity Safety, Quality and Continuity Regulations (ESQCR)

The statutory instrument entitled The **Electricity Safety, Quality and Continuity Regulations** 2002 as amended from time to time and including any further statutory instruments issued under the **Electricity Act** 1989 (as amended by the Utilities Act 2000 and the Energy Act 2004) in relation to the distribution of electricity.

Electricity Storage

**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.

Embedded Medium Power Station

A **Power Generating Facility** in England and Wales of 50MW or greater **Registered Capacity** but less than 100MW **Registered Capacity** connected to a **DNO**’s **Distribution Network**.

Energisation Operational Notification (EON)

A notification issued by the **DNO** to a **Generator** prior to energisation of its internal network.

Excitation System

The equipment providing the field current of a machine, including all regulating and control elements, as well as field discharge or suppression equipment and protective devices.

Exciter

The source of the electrical power providing the field current of a synchronous machine.

Fast Fault Current

A current injected by a **Power Park Module** during and after a voltage deviation caused by an electrical fault with the aim of identifying a fault by network protection systems at the initial stage of the fault, supporting system voltage retention at a later stage of the fault and system voltage restoration after fault clearance.

Fault Ride Through

The capability of **Power Generating Module**s to be able to remain connected to the **Distribution Network** and operate through periods of **Low Voltage** at the **Connection Point** caused by secured faults on the **Transmission System**.

Final Operational Notification (FON)

A notification issued by the **DNO** to a **Generator**, who complies with the relevant specifications and requirements in this EREC G99, allowing them to operate a **Power Generating Module** by using the **Distribution Network** connection.

Frequency Response Deadband

An interval used intentionally to make the frequency control unresponsive.

Frequency Response Insensitivity

The inherent feature of the control system specified as the minimum magnitude of change in the frequency or input signal that results in a change of output power or output signal.

Frequency Sensitive Mode (FSM)

The operating mode of a **Power Generating Module** in which the **Active Power** output changes in response to a change in system frequency, in such a way that it assists with the recovery to target frequency.

Fully Type Tested

A **Power Generating Module** with an **Intrinsic Design Capacity** ≤ 50 kW which has been tested to ensure that the design meets the relevant technical and compliance requirements of this EREC G99, and for which the **Manufacturer** has declared that all similar **Power Generating Module**s supplied will be constructed to the same standards and will have the same performance. In the case where **Interface Protection** functionality is included in the tested equipment, all similar products will be manufactured with the same protection settings as the tested product.

Generating Unit

Any apparatuswhich produces electricity. This includes micro-generatorsand controllable **Electricity Storage** devices. A **Vehicle to Grid Electric Vehicle** is considered as an **Electricity Storage** device. Where an electric vehicle and/or its charger have been configured such that the electric vehicle cannot operate as a **Vehicle to Grid Electric Vehicle**, then it shall be considered as a load and is not included in the requirements of this EREC G99.

Generator

A person who generates electricity under licence or exemption under the **Electricity Act** 1989 (as amended by the Utilities Act 2000 and the Energy Act 2004) and whose **Power Generating Facility** is directly or indirectly connected to a **Distribution Network**. For the avoidance of doubt, also covers any competent person or agent working on behalf of the **Generator**. Often referred to as a distributed orembedded generator. Also for the avoidance of doubt, any **Customer** with generation connected to that **Customer’s Installation** is a **Generator**.

Generator Performance Chart

A diagram showing the **Active Power** (MW) and **Reactive Power** (MVAr) capability limits within which a **Synchronous Power Generating Module** or **Power Park Module** at the **Generating Unit** terminals or the **Connection Point** as appropriate for the **Power Generating Facility** will be expected to operate under steady state conditions.

Generator's Installation

The electrical installation on the **Generator**'s side of the **Connection Point** together with any equipment permanently connected or intended to be permanently connected thereto.

Great Britain or GB

The landmass of England & Wales and Scotland, including internal waters.

Grid Code

The code which the **NETSO** is required to prepare under its **Transmission Licence** and have approved by the **Authority** as from time to time revised with the approval of, or by the direction of, the **Authority**.

High Voltage (HV)

A voltage exceeding 1000 V AC or 1500 V DC between conductors, or 600 V AC or 900 V DC between conductors and earth.

Installer

The person who is responsible for the installation of the **Power Generating Module**(s).

Interface Protection

The electrical protection required to ensure that any **Power Generating Module** is disconnected for any event that could impair the integrity or degrade the safety of the **Distribution Network**. **Interface Protection** may be installed on each **Power Generating Module** or at the **Connection Point** for the **Power Generating Facility**.

Interim Operational Notification (ION)

A notification from the **DNO** to a **Generator** acknowledging that the **Generator** has demonstrated compliance, except for the **Unresolved Issues** with this EREC G99 or with specific items in the **Connection Agreement** in respect of the plant and apparatusspecified in such notification.

Intermittent Power Source

The primary source of power for a **Generating Unit** that cannot be considered as controllable, eg wind, wave or solar.

**Intrinsic Design Capacity**

The designed maximum **Active Power** capacity of a **Generating Unit** or a **Power Generating Module**. In general this will be identical to the **Registered Capacity**, but can be a higher value where the **Manufacturer** has made specific provision for the maximum **Active Power** output to be limited to a defined value less than the designed maximum **Active Power** capacity. Such a limitation will be semi-permanent and designed in by the **Manufacturer**. It will not be amenable to adjustment by the **Generator**; any such adjustment shall be undertaken by personnel specifically empowered and equipped for that task by the **Manufacturer**. Where a **Manufacturer** offers a **Generating Unit** or **Power Generating Module** with a **Registered Capacity** that is less than the **Generating Unit**’s or **Power Generating Module**’s **Intrinsic Design Capacity**, all certification, especially type testing, must be done at the **Registered Capacity** (or fractions of it as required by the various tests) and not the **Intrinsic Design Capacity**.

Inverter

A device for conversion from Direct Current to nominal frequency Alternating Current.

IP Completion Day

As defined in section 39 of the European Union (Withdrawal Agreement) Act 2020.

Limited Frequency Sensitive Mode

A mode whereby within a range of system frequency the operation of a **Power Generating Module** is frequency insensitive.

Limited Frequency Sensitive Mode – Overfrequency (LFSM-O)

A **Power Generating Module** operating mode which will result in **Active Power** output reduction in response to a change in system frequency once the system frequency exceeds a certain value.

Limited Frequency Sensitive Mode – Underfrequency (LFSM-U)

A **Power Generating Module** operating mode which will result in **Active Power** output increase in response to a change in system frequency once the system frequency falls below a certain value.

Limited Operational Notification (LON)

A notification issued by the **DNO** to a **Generator** who had previously attained **FON** status but is temporarily subject to either a significant **Modification** or loss of capability resulting in non-compliance with the relevant specifications and requirements.

Low Voltage (LV)

A voltage normally exceeding extra-low voltage (50 V) but not exceeding 1000 V AC or 1500 V DC between conductors or 600 V AC or 900 V DC between conductors and earth.

Manufacturer

A person or organisation thatmanufactures **Generating Unit**s.

Manufacturer’s Data & Performance Report

A report submitted by a **Manufacturer** to the **DNO** relating to a specific version of a **Generating** **Unit** demonstrating the performance characteristics of such **Generating** **Unit** in respect of which the **DNO** has evaluated its relevance for the purposes of compliance.

Manufacturers’ Information

Information in suitable form provided by a **Manufacturer** in order to demonstrate compliance with one or more of the requirements of this EREC G99. Where Equipment Certificate(s) as defined in **Retained EU Law** (Commission Regulation (EU) 2016/631 (Network Code on the Requirements for Connection of Generators)) cover all or part of the relevant compliance points, the Equipment Certificate(s) demonstrate compliance without the need for further evidence for those aspects within the scope of the Equipment Certificate.

Minimum Regulating Level (MRL)

The minimum **Active Power** output down to which the **Power Generating Module** can control **Active Power**.

Minimum Stable Operating Level (MSOL)

The minimum **Active Power** output at which the **Power Generating Module** can be operated stably for an unlimited time.

Modification

Any actual or proposed replacement, renovation, modification, alteration or construction by a **Generator** to any **Power Generating Module**, or the manner of its operation.

National Electricity Transmission System Operator (NETSO)

National Grid Electricity System Operator in its capacity as operator of the national **Transmission System**.

Over-Excitation Limiter

Shall have the meaning ascribed to that term in IEC 34-16-1.

Phase (Voltage) Unbalance

The ratio (in percent) between the root mean square (RMS) values of the negative sequence component and the positive sequence component of the voltage.

Point Of Common Coupling

The point on a **Distribution Network,** electrically nearest the **Customer’s Installation,** at which other **Customer**s are, or may be, connected.

Power Factor

The ratio **of Active Power** to apparent power.

Power Generating Facility (PGF)

A facility that converts primary energy into electrical energy and which consists of one or more **Power Generating Module**s connected to a **Network** at one or more **Connection Point**s.

Power Generating Module (PGM)

Either a **Synchronous Power Generating Module** or a **Power Park Module**.

Power Generating Module Document (PGMD)

A document provided by the **Generator** to the **DNO** for a **Type** **B**, **Type** **C or Type D** **Power Generating Module**s which confirms that the **Power Generating Module**’s compliance with the technical criteria set out in this EREC G99 has been demonstrated and provides the necessary data and statements, including a statement of compliance.

Power Park Module (PPM)

A **Generating Unit** or ensemble of **Generating** **Unit**s (including **Electricity Storage** devices) generating electricity, which is either asynchronously connected to the network or connected through power electronics, and that may be connected through a transformer and that also has a single **Connection Point** to a **Distribution Network**.

Power System Stabiliser (PSS)

Equipment controlling the output of a **Power Generating Module** in such a way that power oscillations of the machine are damped. Input variables may be speed, frequency, or power or a combination of variables.

Q/Pmax

The ratio of **Reactive Power** to the **Registered Capacity**. The relationship between **Power Factor** and **Q/Pmax** is given by the formula:-

**Power Factor** = ]

Rapid Voltage Change (RVC)

The change in RMS voltage over several cycles.

Rated Field Voltage

Shall have the meaning ascribed to that term in IEC 34-16-1:1991 [equivalent to British Standard BS4999 Section 116.1: 1992].

Rated Import Capacity

The normal maximum **Active Power** capacity of a **Power Generating Module** incorporating **Electricity Storage**, ie the maximum possible flow of **Active Power** into the **Power Generating Module** terminals when replenishing its energy store.

Reactive Power (Q)

The product of voltage and current and the sine of the phase angle between them which is normally measured in kilovar (kVAr) or megavar (MVAr).

Registered Capacity (Pmax)

The normal maximum **Active Power** capacity of:

* A **Generating Unit**; or
* A **Power Generating Module** (in the case of a **Power Park Module**, the lesser of the **Inverter**(s) rating or the rating of the energy source); or
* A **Power Generating Facility**,

as declared by the **Generator** taking into account the **Active Power** consumed when producing the same and the production of the required **Reactive Power** at the **Connection Point**. For the purposes of the **Small Generation Installation** procedure the **Registered Capacity** of a **Power Generating Module** can be a limited (eg by software) to be less than the **Intrinsic Design Capacity** of the **Power Generating Module**.

Retained EU Law

As defined in European Union (Withdrawal) Act 2018 as amended by the European Union (Withdrawal Agreement) Act 2020.

Small Generation Installation

A Generator’s Installation that comprises one or more Low Voltage Power Generating Modules[[3]](#footnote-6) each with an Intrinsic Design Capacity of no more than 32 A and where the aggregate Registered Capacity of all the Power Generating Modules is no more than 60 A.

Slope

The ratio of the steady state change in voltage, as a percentage of the nominal voltage, to the steady state change in **Reactive Power** output, in per unit of **Reactive Power** capability. For the avoidance of doubt, the value indicates the percentage voltage reduction that will result in a 1 per unit increase in **Reactive Power** generated.

Standard Planning Data (SPD)

General information required by the **DNO** under the Distribution Planning Code.

Station Transformer

A transformer supplying electrical power to the auxiliaries of a **Power Generating Facility**, which is not directly connected to the **Power Generating Module** terminals (typical voltage ratio being 132/11 kV).

Step Voltage Change

Following system switching, a fault or a planned outage, the change from the initial voltage level to the resulting voltage level after all the **Power Generating Module** **Automatic Voltage Regulator (AVR)** and static VAR compensator (SVC) actions, and transient decay (typically 5 s after the fault clearance or system switching have taken place), but before any other automatic or manual tap-changing and switching actions have commenced.

Supplier

1. A person supplying electricity under an Electricity Supply Licence; or
2. A person supplying electricity under exemption under the **Electricity Act** 1989 (as amended by the Utilities Act 2000 and the Energy Act 2004); or

in each case acting in its capacity as a **Supplier** of electricity to **Customer**s.

System Restoration

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 electricity supplies cannot be restored without recourse to the System Restoration Capability of an Anchor Power Station.

System Stability

The ability of the system, for a given initial operating condition, to regain a state of operating equilibrium, after being subjected to a given system disturbance, with most system variables within acceptable limits so that practically the whole system remains intact.

Synchronous Power Generating Module

Means an indivisible set of **Generating Unit**s (ie one or more units which cannot operate independently of each other) (including **Electricity Storage** devices) which can generate electrical energy such that the frequency of the generated voltage, the generator speed and the frequency of network voltage are in a constant ratio and thus in **Synchronism**. Each set of **Generating Unit**swhich cannot run independently from each other (such as those **Generating Unit**s on a common shaft or as part of an integrated **CCGT Module**), but can run independent of any other generating equipment, form an individual **Synchronous Power Generating Module**.Any prime mover and alternator combination that can run as an independent unit (irrespective of normal operating practice) is a **Synchronous Power Generating Module**.

This is illustrated in Figure 4.1a and b.

Synchronism

The condition under which a **Power Generating Module** or system is connected to another system so that the frequencies, voltage and phase relationships of that **Power Generating Module** or system, as the case may be, and the system to which it is connected are similar within acceptable tolerances.

Total System

The integrated system of connected **Power Generating Module**s**, Transmission System, Distribution Network**s and associated electrical demand.

Transmission Licence

The licence granted under Section 6(1)(b) of the **Electricity Act**.

Transmission System

A system of **High Voltage** lines and plant owned by the holder of a **Transmission Licence** and operated by the **NETSO,** which interconnects **Power Generating Facilities** and substations.

Type A

A **Power Generating Module** with a **Connection Point** below 110 kV and a **Registered Capacity** of 0.8 kW or greater but less than 1 MW.

Type B

A **Power Generating Module** with a **Connection Point** below 110 kV and **Registered Capacity** of 1 MW or greater but less than 10 MW.

Type C

A **Power Generating Module** with a **Connection Point** below 110 kV and a **Registered Capacity** of 10 MW or greater but less than 50 MW.

Type D

A **Power Generating Module** with a **Connection Point** at or greater than 110 kV, and/or with a **Registered Capacity** of 50 MW or greater.

Type Tested

A product which has been tested to ensure that the design meets the relevant requirements of this EREC G99, and for which the **Manufacturer** has declared that all similar products supplied will be constructed to the same standards and will have the same performance. The **Manufacturer**’s declaration will define clearly the extent of the equipment that is subject to the tests and declaration. In the case where **Interface Protection** functionality is included in the tested equipment, all similar products will be manufactured with the same protection settings as the tested product.

Examples of products which could be **Type Tested** include **Generating Unit**s, **Inverter**s and the **Interface Protection**.

Unresolved Issues

Any relevant EREC G99requirements identified by the **DNO** with which the **Generator** has not demonstrated compliance to the **DNO**’sreasonable satisfaction at the date of issue of the **Interim Operational Notification** and/or **Limited Operational Notification** and which are detailed in such **Interim Operational Notification** and/or **Limited Operational Notification**.

Under-excitation Limiter

Shall have the meaning ascribed to that term in IEC34-16-1.

Vehicle to Grid Electric Vehicle

An electric vehicle and any associated internal or external charging devices forming part of a **Customer’s Installation** that can import electricity from and export electricity to that **Customer’s Installation**.

* 1. Illustrative examples of **Power Generating Module** types and categorisation

Figures 4.2 to 4.6 illustrate examples of different **Power Generating Module**scomprising **Power Park Module**sand **Synchronous Power Generating Module**sto assist with the interpretation of **Power Park Module** categorisation.

Figure 4.7 illustrates an example of a **Small Generation Installation**.

**Key to following Figures:**

ST: Steam Turbine

GT: Gas Turbine

HR: Heat Recovery Unit

CP: **Connection Point**

|  |  |
| --- | --- |
|  | **Synchronous Power Generating Module** |
| C | Clutch |
|  | **Inverter** or asynchronous **Generating Unit** |
|  | **Electricity Storage** device |
|  | Photovoltaic source |
|  | Wind turbine |
|  | Doubly fed induction generator |

**Simplified CCGT (1)**

Synchronous Power Generating Module

**CP**

**ST**

**HR**

**GT**

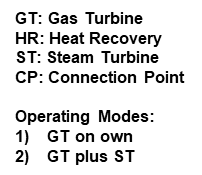
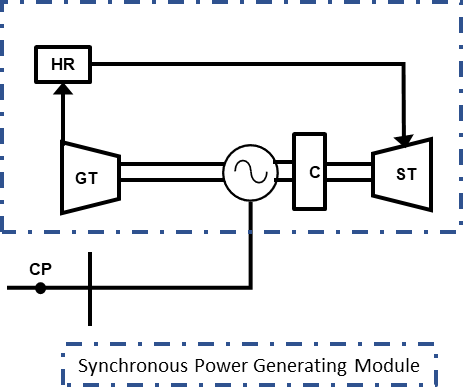


Figure 4.1a Example of a Synchronous Power Generating Module comprising a gas turbine (GT) with a steam turbine (ST) on a separate shaft (simplified diagram)



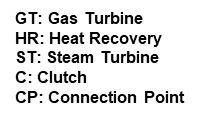
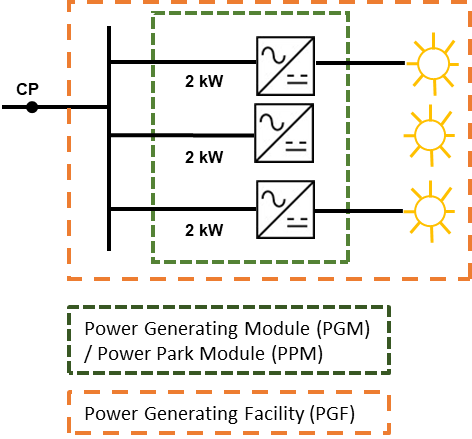


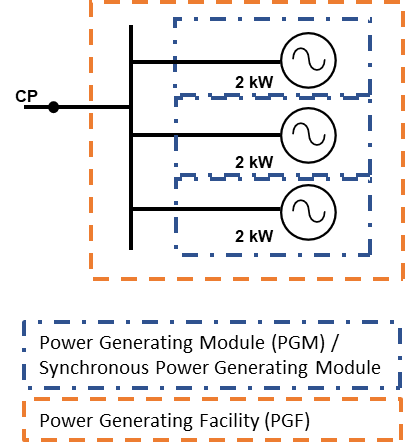
Figure 4.1b Example of a Synchronous Power Generating Module comprising a gas turbine (GT) with a steam turbine (ST) on the same shaft (simplified diagram)



1. 3 x 2 kW **Inverter** connected **Generating Units**

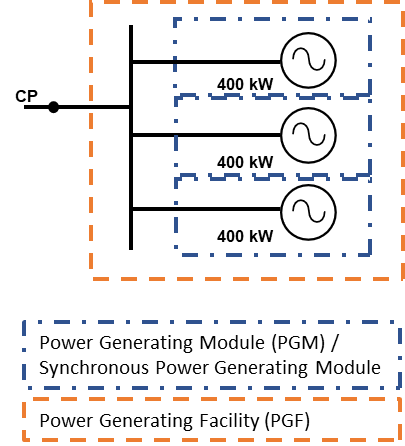
= 6 kW **Type A Power Park Module**

= 6 kW **Power Generating Facility**



1. 3 x 2 kW **Type A Synchronous Power Generating Module**s

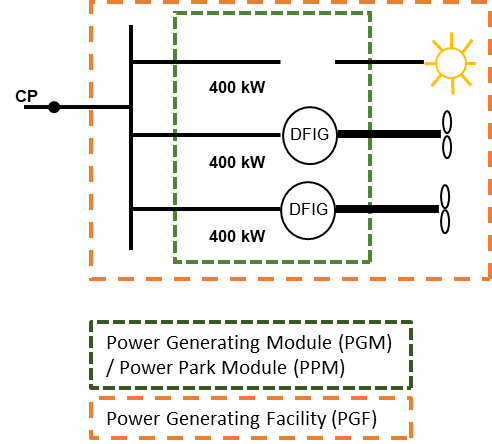
= 6 kW **Power Generating Facility**



1. 3 x 400 kW **Type A Synchronous Power Generating Module**s

= 1.2 MW **Power Generating Facility**

Figure 4.2 Examples of Type A Power Generating Modules

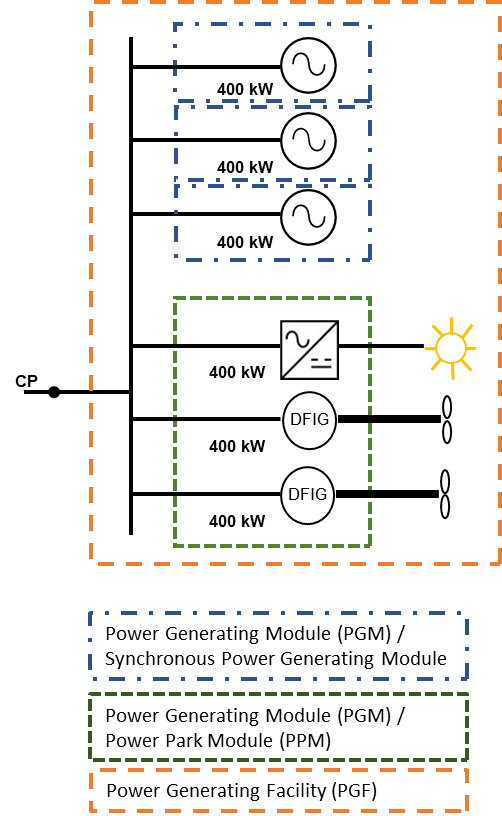


1 x 400 kW **Inverter** connected plus 2 x 400 kW asynchronous **Generating Unit**s

= 1.2 MW **Type B Power Park Module**

= 1.2 MW **Power Generating Facility**

Figure 4.3 Example of Type B Power Generating Modules

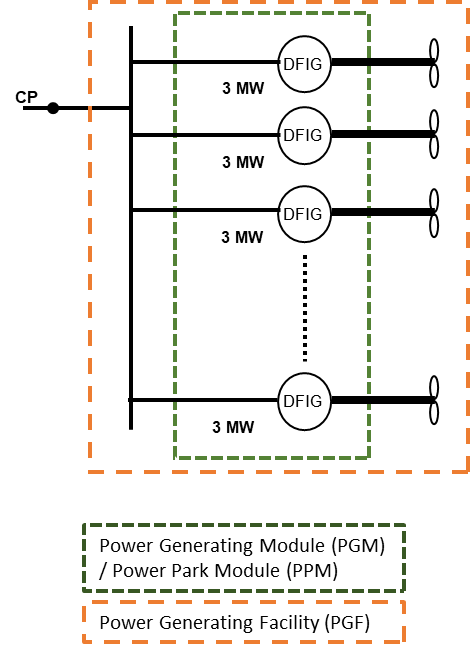


3 x 400 kW **Type A Synchronous Power Generating Module**s plus 1 x 400 kW **Inverter** connected and 2 x 400 kW asynchronous **Generating Units**

= 3 x 400 kW **Type A Synchronous Power Generating Module**s plus 1 x 1.2 MW **Type B Power Park Module**

= 2.4 MW **Power Generating Facility**

Figure 4.4 Example of combination of Type A and Type B Power Generating Modules in same Power Generating Facility



25 x 3 MW asynchronous **Generating Unit**s

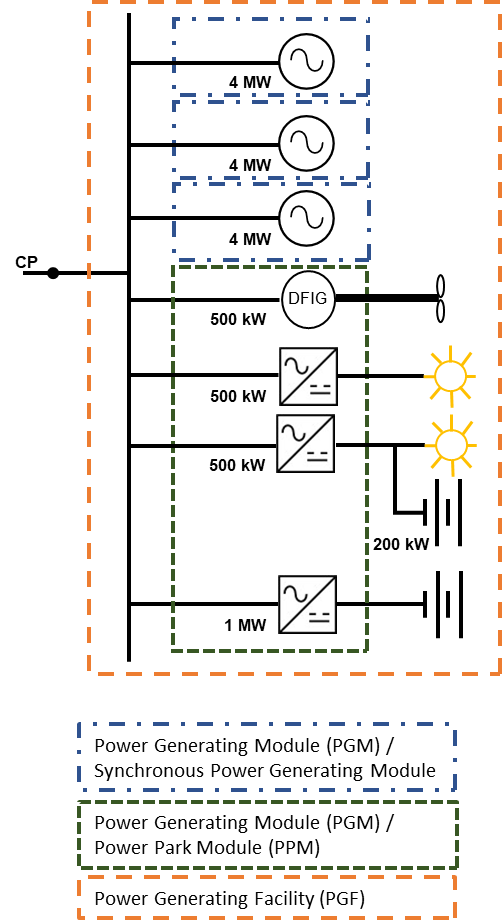
= 1 X 75 MW **Type D Power Park Module**

= 1 x 75 MW **Type D Power Generating Module**

= 75 MW **Power Generating Facility**

(**Embedded Medium Power Station** in England and Wales, large power station in Scotland)

Figure 4.5 Example of Type D Power Generating Facility comprised of a number of Generating Units



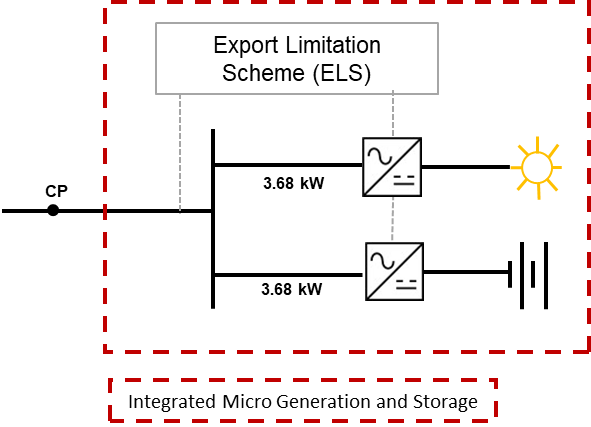
3 x 4 MW **Type B** Gas Engines plus 1 x 500 kW asynchronous **Generating Unit** plus 1 x 500 kW **Inverter** plus 1 x 500 kW **Inverter** with 200 kW Integral **Electricity Storage** plus 1 MW **Electricity Storage** device

= 3 x 4 MW **Type B Synchronous Power Generating Module**s plus (1.5 MW + 1 MW) 2.5 MW **Type B Power Park Module**

= 14.5 MW **Power Generating Facility** (Large power station in North of Scotland)

Note the **Electricity Storage** device using the same **Inverter** as the PV does not contribute to the **Power Park Module Registered Capacity**, because the **Registered Capacity** is based on the **Inverter** rating. The **Electricity Storage** device using a dedicated **Inverter** is included in the **Park Module[[4]](#footnote-7)** and **Power Generating Facility Registered Capacity**.

Figure 4.6 Example of Connection of Electricity Storage devices



1 x 3.68 kW PV Inverter plus 1 x 3.68 kW Electricity Storage device

= 7.36 kW Power Park Module

= 7.36 kW Power Generating Facility

Figure 4.7 Example of a Small Generation Installation

# Legal Aspects

5.1 The operation and design of the electricity system in **Great Britain** is defined principally by Directive 2009/72/EC as it has effect immediately before **IP Completion Day**, the Electricity Act 1989, 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 This EREC has been written to comply with the requirements of **Retained EU Law** (Commission Regulation (EU) 2016/631 (Network Code on the Requirements for Connection of Generators)), referred to as 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**sto 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**sand 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:

1. maintain supplies to their **Customer**s within defined statutory voltage and frequency limits;
2. comply with the “Security of Supply” criteria defined in EREC P2;
3. meet improving standards of supply in terms of customer minutes lost (CMLs) and the number of customer interruptions (CIs);
4. ensure that the **Distribution Network**s at all voltage levels are adequately earthed;
5. facilitate competition in the connection, generation and supply of electricity.

5.7 Under conditions of **System Restoration** it is recognized that **DNO**s may modify some or all of the requirements (a) to (c) of paragraph 5.6 for the duration of **System Restoration** 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.

5.9 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.

5.10 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.

5.11 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**.

5.12 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**.

5.13 All **Generator**s have to comply with the appropriate parts of the **ESQCR**.

5.14 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**.

5.15 **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.

5.16 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.

5.17 Under the terms of the **Electricity Act**, generation of electricity is a licensed activity, although the Secretary of State, may by order[[5]](#footnote-8) 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.

5.18 **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.

5.19 **Generator**s wishing to trade ancillary services with the **NETSO** will need appropriate contracts in place with the **NETSO** in its role as Great Britain System Operator.

5.20 In **GB** law[[6]](#footnote-9), **Electricity Storage** is treated just as generation. Accordingly, this EREC G99 includes **Electricity Storage** in the definition of a **Generating Unit**.

# Connection Application

## General

6.1.1 This document describes the processes that shall be adopted for both connection of a single **Power Generating Module** and installations that comprise of a number of **Power Generating Module**s.

6.1.2 **Type A** **Power Generating Module**(s) ≤ 16A per phase and EREC G98 compliant

6.1.2.1 A connection procedure to facilitate the connection and operation of **Fully** **Type Tested** **Power Generating Module**s with aggregate **Registered Capacity** of less than or equal to 16 A per phase in parallel with public **Low Voltage** **Distribution Network** is given in EREC G98 and is not considered further in this document. These are referred to as micro-generators.

6.1.3 **Power Park Modules**

6.1.3.1 Where an installation comprises a single **Generating Unit**, the application process, technical and commissioning requirements are based on the **Registered Capacity** of that **Generating Unit**. Where an installation comprises multiple **Generating Unit**s the application process, technical and commissioning requirements will generally be based on the **Registered Capacity** of each **Power Park Module,** and also on the extent to which each **Power Park Module** is **Type Tested**. However, note that if the aggregated capacity of all the **Power Park Module**s in the **Power Generating Facility** (ie the **Registered Capacity** of 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 relevant parts of the **Grid Code**. Similarly, 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 6.4.4 and 13.8.

6.1.3.2 Where a new **Generating Unit** is connected to an existing installation the treatment of the addition will depend on the EREC under which the existing installation was connected. If the existing installation was connected under EREC G59 or EREC G83 then the new **Generating Unit** will be treated as a separate **Power Park Module** and managed for compliance with this EREC G99 as a separate **Power Generating Module**. If, however, the existing installation was commissioned in compliance with EREC G98 or EREC G99, then the new **Power Park Module** shall be added to the aggregate capacity of the complete installation which shall be used to determine which EREC is applicable.

6.1.4 **Synchronous Power Generating Modules**

6.1.4.1 Where an installation comprises a single **Synchronous Power Generating Module** or multiple **Synchronous Power Generating Module**s, the application process, technical and commissioning requirements are based on the **Registered Capacity** of each **Synchronous Power Generating Module**.

6.1.4.2 Where one or more new **Synchronous Power Generating Module**(s) is to be connected to an existing installation then each new **Power Generating Module** will be treated as a separate **Synchronous Power Generating Module**. Only the new **Power Generating Module** will be required to meet the requirements of this EREC G99 or EREC G98 if applicable. However, note that if the aggregated capacity of all the **Power Generating Module**s in the **Power Generating Facility** (ie the **Registered Capacity** of 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 relevant parts of the **Grid Code**. Similarly, 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 paragraphs 6.4.4 and 13.8.

6.1.5 Illustrative examples

6.1.5.1 Table 6.1 is provided to illustrate some of the connection scenarios and the EREC requirements.

6.1.5.2 In respect of Table 6.1 the aggregate **Registered Capacity** of all the **Power Generating Module**s in the **Power Generating Facility** will be taken into account when the **DNO** considers the effect of the connection on the **Distribution Network**.

Table 6.1 Examples of connection scenarios

| Scenario Number | Details of the existing **Power Generating Facility** | Planned expansion to the **Power Generating Facility** | Compliance requirements |
| --- | --- | --- | --- |
| 0 | Nil | **Type A** **Generating Unit**(s) | The unit(s) comprise a new **Power Generating Module** for compliance EREC G99[[7]](#footnote-10). |
| **1** | **Synchronous** **Power Generating Module**scommissioned under EREC G83 or EREC G59 | **Synchronous Power Generating Module**s  Figure 6.1 | Original and additional **Power Generating Module**s treated separately. Only additional **Power Generating Module**s need to comply with EREC G997; the entire **Power Generating Facility** needs to comply with operational requirements. |
| **2** | **Synchronous Power Generating Module**scommissioned under EREC G98 or EREC G99 | **Synchronous Power Generating Module**s  Figure 6.2 | Original and additional **Power Generating Module**s treated separately. All **Power Generating Module**s need to comply with EREC G99[[8]](#footnote-11) and with operational requirements. |
| **3** | **Synchronous** **Power Generating Module**scommissioned under EREC G83 or EREC G59 and **Synchronous Power Generating Module**scommissioned under EREC G98 or EREC G99 | **Synchronous Power Generating Module**s  Figure 6.3 | Original and additional **Power Generating Module**s treated separately. Additional **Power Generating Module**s need to comply with EREC G998; all need to comply with operational requirements. |
| **4** | **Power Park Module** commissioned under EREC G83 or EREC G59 | Asynchronous **Generating Unit**s  Figure 6.4 | New units form a new **Power Park Module**. Original and additional **Power Park Module**s treated separately. Only additional **Power Park Module**s need to comply with EREC G997; all need to comply with operational requirements. |
| **5** | **Power Park Module** commissioned under EREC G98 or EREC G99 | Asynchronous **Generating Unit**s  Figure 6.5 | Units aggregated to form a new single **Power Generating Module**. Compliance required for the new module size, with EREC G998 and with operational requirements. |
| **6** | **Power Park Module** commissioned under EREC G98 or EREC G99 | **Electricity Storage** DC coupled (ie connected to the existing **Inverter**swith no change to **Inverter**s)  Figure 6.6 | No compliance effect. Compliance remains based on existing **Inverter**s, ie on the existing **Power Park Module**. **Generator**sshall, under their **Connection Agreement** apply to the **DNO** before connecting new **Electricity Storage** devices. |
| **7** | **Power Park Module** commissioned under EREC G98 or EREC G99 | **Electricity Storage** AC coupled – ie storage complete with its own **Inverter**s  Figure 6.7 | The new **Electricity Storage** devices form an independent **Power Park Module** which needs to comply with EREC G99, although is exempt from certain requirements as listed in Annex A.4. |
| **8** | **Electricity Storage** commissioned under EREC G83 or EREC G59 | **Electricity Storage** AC coupled – ie storage complete with its own **Inverter**s  Figure 6.8 | Original and additional **Electricity Storage** devices treated separately. Additional **Electricity Storage** devices need to comply with EREC G99; all need to comply with operational requirements. |
| **9** | **Electricity Storage** commissioned under EREC G98 or EREC G99 | **Electricity Storage** AC coupled – ie storage complete with its own **Inverter**s  Figure 6.9 | **Electricity Storage** devices aggregated to form a new single **Power Generating Module**. Compliance required for the new module size, with EREC G99 and with operational requirements. |
| **10** | **Electricity Storage** and / or **Solar Power Park Module** commissioned under EREC G98 or EREC G99 | **Vehicle to Grid Electric Vehicle** connected at AC  Figure 6.10 | The **Inverter** on board the **Vehicle to Grid Electric Vehicle** is a **Power Generating Module**.  The **Customer** is a **Generator** and must ensure that the **Vehicle to Grid Electric Vehicle** and installation is fully compliant with EREC G99. |
| **11** | **Electricity Storage** and / orSolar **Power Park Module** commissioned under EREC G98 or EREC G99 | **Vehicle to Grid Electric Vehicle** connected DC  Figure 6.11 | The **Vehicle to Grid Electric Vehicle** **Inverter** is a **Power Generating Module**.  The **Customer** is a **Generator** and must ensure that the **Vehicle to Grid Electric Vehicle** installation is fully compliant with EREC G99. |
| **12** | **Electricity Storage** commissioned under EREC G98 or EREC G99 | Combined **Vehicle to Grid Electric Vehicle** and solarPV connected at DC  Figure 6.12 | Existing **Electricity Storage** devices aggregated with the combined **Vehicle to Grid Electric Vehicle** and solar PV to form a new **Power Generating Module**. Compliance required for the new module size, with EREC G99 and with operational requirements.  The **Customer** is a **Generator** and must ensure that the **Vehicle to Grid Electric Vehicle** installation is fully compliant with EREC G99. |

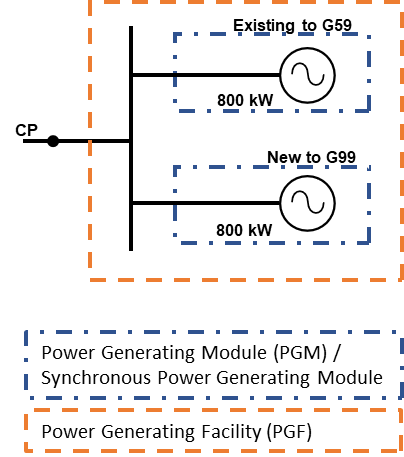


Figure 6.1. Example: 1 x 800 kW Synchronous Power Generating Module to EREC G59 plus 1 x 800 kW Type A Synchronous Power Generating Module to EREC G99  
= 1.6 MW Power Generating Facility

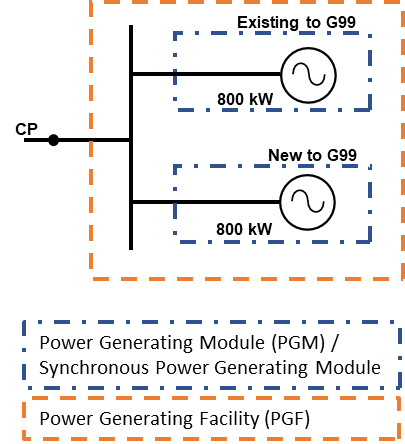


Figure 6.2. Example: 2 x 800 kW Type A Synchronous Power Generating Modules to EREC G99  
= 1.6 MW Power Generating Facility

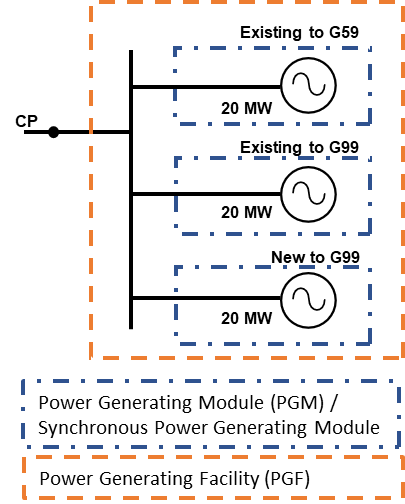
****

Figure 6.3. Example: Existing: 2 x 20 MW Type C Synchronous Power Generating Modules with new unit:3 x 20 MW Type C Synchronous Power Generating Modules

= 60 MW Power Generating Facility (Embedded Medium Power Station in England & Wales / large power station in Scotland)

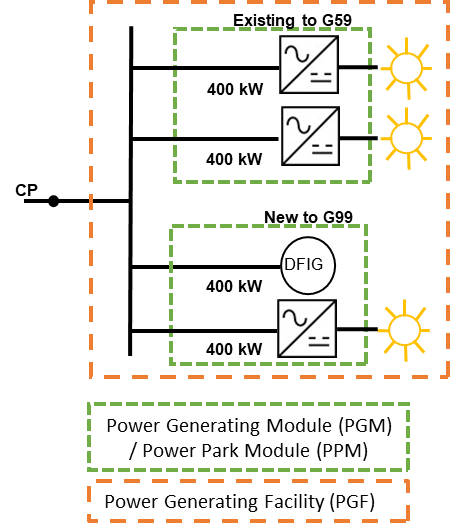
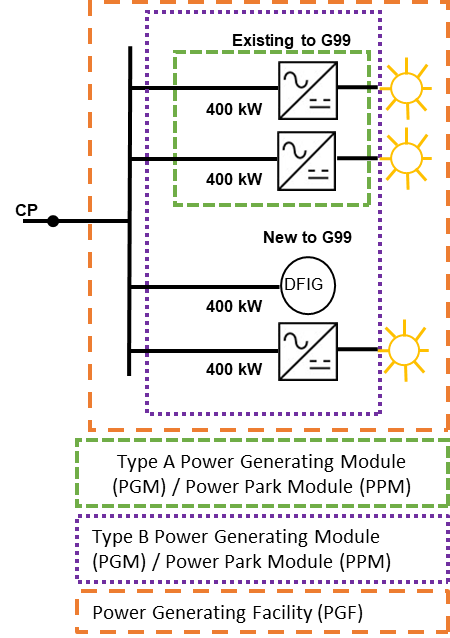
****

Figure 6.4. Example: 1 x 800 kW Power Park Module to EREC G59 plus 1 x 800 kW Type A Power Park Module to EREC G99

= 1.6 MW Power Generating Facility

****

Note: The addition of new **Inverter** connected or asynchronous **Generating** **Units** to an existing **Power Park Module**, which was installed under EREC G99, takes the **Power Generating Module** from **Type A** to **Type B**, hence the existing **Generating Unit**s technical requirements will change in accordance with this EREC G99.

Figure 6.5. Example: 1 x 800 kW Type A Power Park Module to EREC G99 plus later expansion of 2 x 400 kW Generating Units

= 1 x 1.6 MW Type B Power Park Module

= 1.6 MW Power Generating Facility

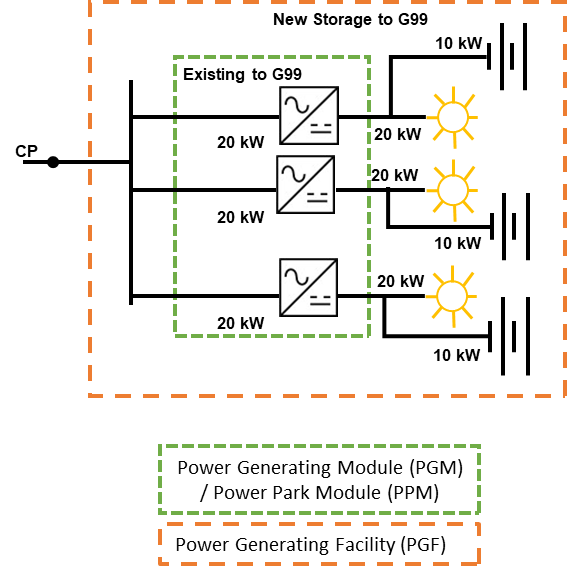


Figure 6.6. Example: Existing 60 kW Type A Power Park Module to EREC G99 plus later addition of 3 x 10 kW Electricity Storage devices (Compliance remains the same)

= 60 kW Power Generating Facility

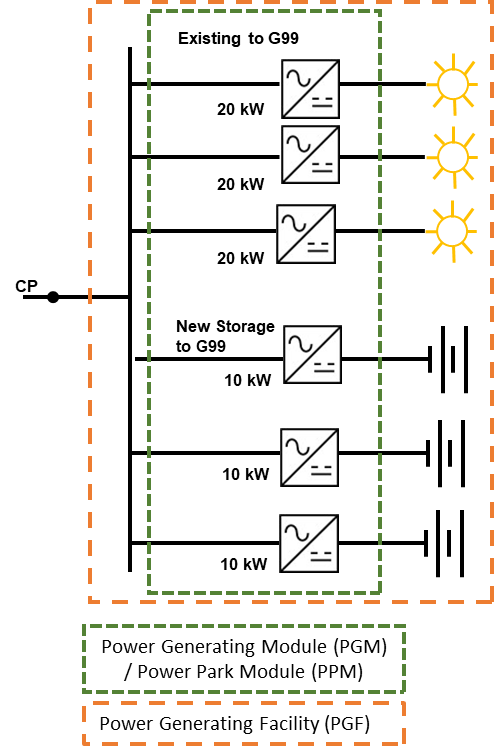
****

Figure 6.7. Example: Existing 60 kW Type A Power Park Module to EREC G99 plus later addition of 3 x 10 kW Electricity Storage devices with own Inverters

= (60 kW + 30 kW) 90 kW Type A Power Park Module

= 90 kW Power Generating Facility

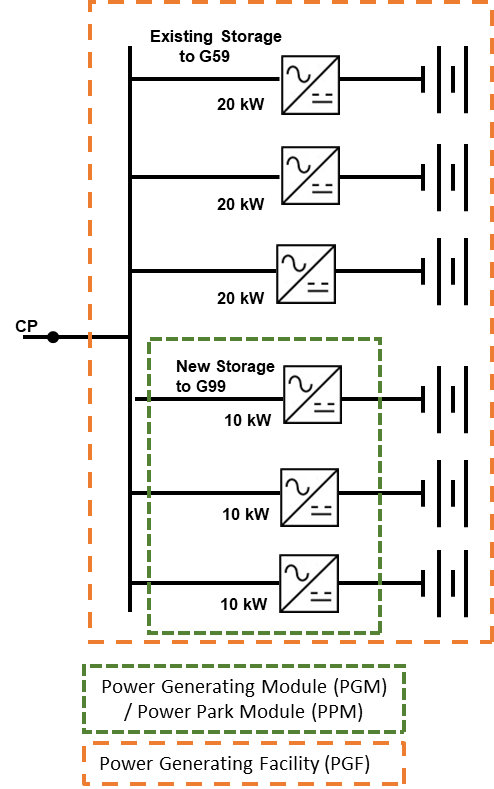


Figure 6.8. Example: Existing 3 x 20 kW Electricity Storage devices to EREC G59 plus later addition of 3 x 10 kW Electricity Storage devices with own Inverters

= 60 kW Electricity Storage + 30 kW Type A Power Park Module

= 90 kW Power Generating Facility

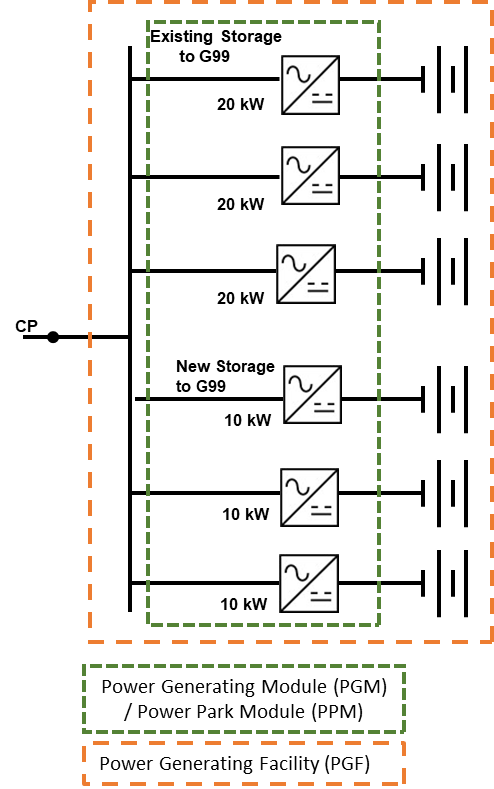


Figure 6.9. Example: Existing 60 kW Type A Power Park Module to EREC G99 plus later addition of 3 x 10 kW Electricity Storage devices with own Inverters

= (60 kW + 30 kW) 90 kW Type A Power Park Module

= 90 kW Power Generating Facility

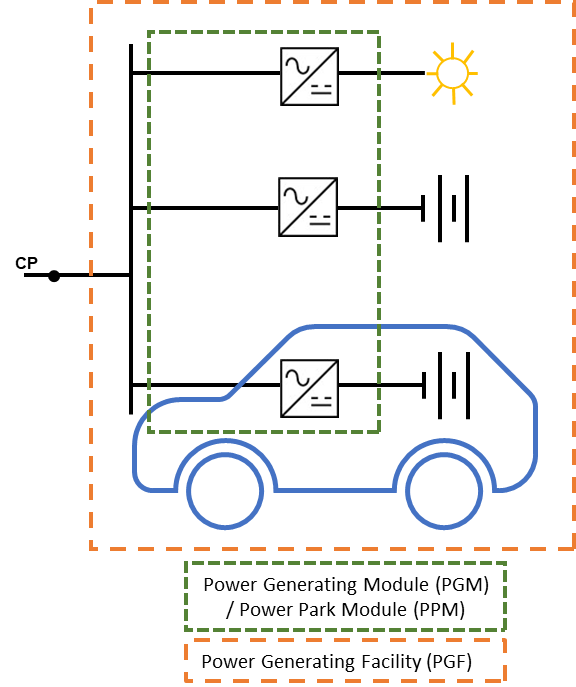


Figure 6.10 Example of a Vehicle to Grid Electric Vehicle where the charging device is included in the EV and there is a stationary Electricity Storage device and a solar PV Power Park Module at the same premises

The Vehicle to Grid Electric Vehicle is a Generating Unit. The Power Generating Module is comprised of the stationary Electricity Storage device, the solar PV Power Park Module and the Vehicle to Grid Electric Vehicle.

Before a Vehicle to Grid Electric Vehicle is connected to the fixed installation the Customer must ensure there is an appropriate Connection Agreement with the DNO and that the whole Power Generating Module is compliant with this EREC G99.

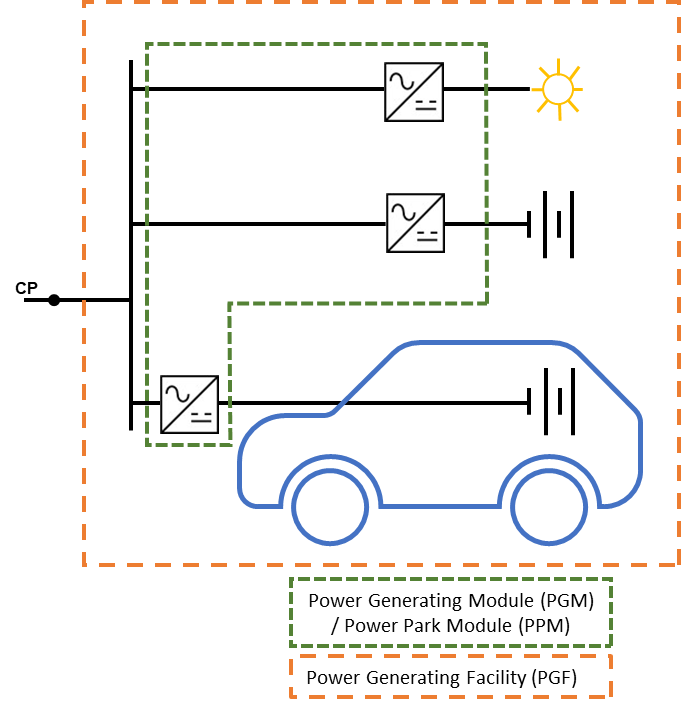
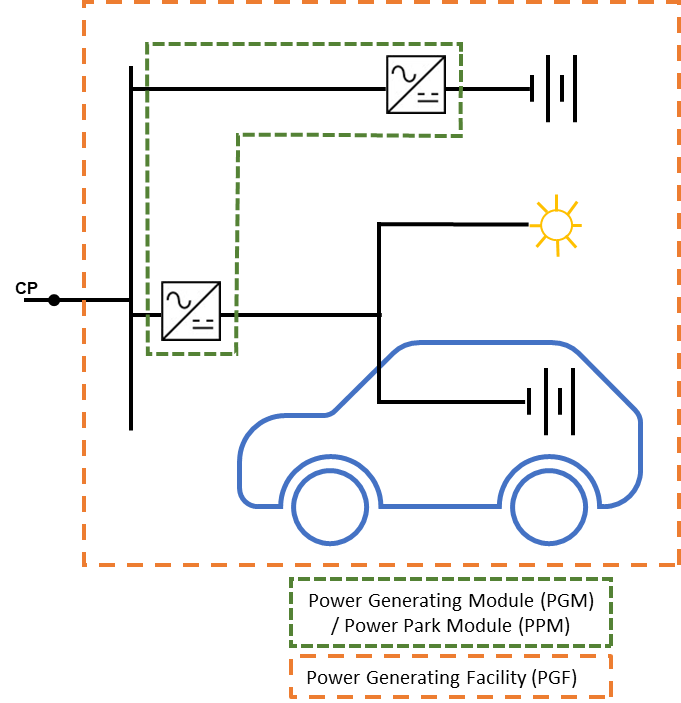


Figure 6.11 Example of a Vehicle to Grid Electric Vehicle where the Inverter is located in the Customer’s Installation and there is a stationary Electricity Storage device and a solar PV Power Park Module at the same premises

The Vehicle to Grid Electric Vehicle charging device in the Customer’s Installation is a Generating Unit. The Power Generating Module is comprised of the stationary Electricity Storage device, the solar PV Power Park Module and the Vehicle to Grid Electric Vehicle Generating Unit.

Before an **Vehicle to Grid Electric Vehicle** is connected to the fixed installation the **Customer** must ensure there is an appropriate **Connection Agreement** with the **DNO** and that the whole **Power Generating Module** is compliant with EREC G99.



The Vehicle to Grid Electric Vehicle Inverter is combined with the solar PV and is a Power Park Unit. The Power Generating Module is comprised of the stationary Electricity Storage device and the combined Vehicle to Grid Electric Vehicle and solar PV Power Park Unit.

Before an **Vehicle to Grid Electric Vehicle** is connected to the fixed installation the **Customer** must ensure there is an appropriate **Connection Agreement** with the **DNO** and that the **Power Generating Module** is compliant with EREC G99.

Figure 6.12 Example of a Vehicle to Grid Electric Vehicle with a combined Inverter also facilitating solar PV and a stationary Electricity Storage device at the same premises

6.1.6 Interaction with the **NETSO**

6.1.6.1 It should be noted that if the aggregate **Registered Capacity** of all **Power Generating Module**(s) (synchronous together with asynchronous) on one or more sites in common ownership is >50 MW, then the **Generator** becomes licensable.

6.1.6.2 **Generator**swith an agreementwiththe **NETSO** may be required to comply with applicable requirements of the **Grid Code**. Where **Grid Code** requirements apply, it is the **Generator**’sresponsibility to comply with the relevant parts of both the **Distribution Code** and **Grid Code**.

6.1.6.3 In the case where the **Generator** has a Bilateral Embedded Generation Agreement (BEGA) with the **NETSO**, the **Generator** shall demonstrate compliance with this EREC G99 to the **DNO**, and any additional **Grid Code** compliance requirements shall be demonstrated by the **Generator** to the **NETSO**. In these cases the **Generator** will make the **Generator**’s interim and final **PGMD**, and/or the **Generator**’s **FON**, available to the **NETSO** on request. The **NETSO** may seek confirmation from the **DNO** of the compliance status of the **Power Generating Module** as recorded on the **Generator**’s **PGMD**.

6.1.6.4 In the case of an embedded large power station, the **NETSO** will be responsible for confirming the **Generator**’s compliance with all **Grid Code** requirements. In general this will mean that the requirements of Sections 12-13 and 17-19 will be superseded by the equivalent requirements in the **Grid Code**. The **DNO** will remain responsible for ensuring the **Generator**’s compliance with the remaining parts of this EREC G99.

* 1. **Application for Connection**

Information about the **Power Generating Module**(s) is needed by the **DNO** so that it can assess the effect that a Power Generating Facility may have on the **Distribution Network**. This EREC G99 details the parameters to be supplied by a **Generator** wishing to connect **Power Generating Module**(s) that do not comply with EREC G98 to a **Distribution Network**. This EREC G99 also enables the **DNO** to request more detailed information if required.

**Small Generation Installation** procedures

* + - 1. Where, typically in a domestic, or similarly small **Low Voltage** installation, the **Generator** wishes to install one or more small **Generating Units** where the **Intrinsic Design Capacity** of all existing and intended **Generating Units** is not greater than 32 A per phase, the provisions of the appropriate **Small Generation Installation** procedure can be followed provided that the **Generator’s Installation** meets the appropriate conditions set out below. Different connection procedures apply depending on the exact capacities and capabilities of the **Generating Units** and control equipment installed, as summarised in the table below:

| Application Procedure | All individual **Intrinsic Design Capacities** | All individual **Registered Capacities** | Aggregate of **Registered Capacities** | EREC G100 limitation scheme required? |
| --- | --- | --- | --- | --- |
| EREC G98 | -[[9]](#footnote-12) | ≤ 16 A | ≤ 16 A | No |
| EREC G99 SGI-1 | ≤ 32 A | ≤ 16 A | ≤ 16 A | No |
| EREC G99 SGI-2 | ≤ 32 A | ≤ 16 A | ≤ 32 A | 16 A |
| EREC G99 SGI-3 | ≤ 32 A | ≤ 32 A | ≤ 60 A | 32 A |

* + - 1. **Small Generation Installation** Procedure-1

(a) This procedure SGI-1 applies where the following conditions are met:

1. The new and existing **Generating Units** are located in a single **Generator’**s **Installation**;
2. All of the **Generating Units** (including **Electricity Storage** devices) are connected via EREC G98 or G99 **Fully Type Tested** inverters;[[10]](#footnote-13)
3. The Intrinsic Design Capacity of each Generating Unit is no more than 32 A;
4. Any Generating Unit with an Intrinsic Design Capacity of greater than 16 A has its Registered Capacity limited to 16 A; and
5. The total aggregate Registered Capacities of all Generating Units (including **Electricity Storage** devices) is no more than 16 A per phase;

(b) If all the conditions above are satisfied, the **Generator** can install and commission all the **Power Generating Modules** and shall submit notification in the format as shown in Form A3-3 (Annex A.1). Note that the **DNO** may provide a method of submitting this information electronically on line etc.

(c) If the **Generator** wishes to increase the **Active Power** output of one or more **Generating Unit**s comprising the **Power Generating Module** from its current **Registered Capacity** such that condition 4 above is no longer satisfied, ie to change or remove the limitation on output, an application in a format as shown in Form A1-1 or Form A1-2 (as applicable and included in Annex A.1) shall be submitted to the **DNO**.

* + - 1. **Small Generation Installation** Procedure-2.

(a) This procedure SGI-2 applies where the **Generator** wishes to install one or more **Generating Units** and the following conditions, which are essentially the conditions that were applicable for the “Integrated Micro Generation and Storage” procedure in previous versions of EREC G99, are met:

1. The new and existing **Generating Unit**s are located in a single **Generator’s** **Installation**;
2. All of the **Generating Unit**s (including **Electricity Storage** devices) are connected via EREC G98 or G99 **Fully Type Tested** inverters;[[11]](#footnote-14)
3. The **Intrinsic Design Capacity** of each new and existing **Generating Unit** is no more than 32A per phase;
4. The **Registered Capacity** of each new and existing **Generating Unit** is no more than 16A per phase;
5. The total aggregate **Registered Capacities** of all the **Generating Unit**s (including **Electricity Storage** devices) is less than 32 A per phase; and
6. An EREC G100 **Fully Type Tested** export limitation scheme is present that limits the export from the **Generator’s Installation** to the **Distribution Network** to no more than 16 A per phase.

(b) If all the conditions above are satisfied, the **Generator** should complete an application in a format as shown in Form A1-2 (Annex A.1). Note that the **DNO** may provide a method of submitting this information electronically on line etc.

(c) The **DNO** will assess the application. No **Power Generating Modules** should be installed or commissioned before this **DNO** assessment is complete and the **Generator** has been advised of the outcome of this assessment. The **DNO** will provide the results of the assessment within 10 working days of receiving the application in (b) above. Given the lower limit of **Registered Capacities** allowed in this procedure SGI-2 compared to that of SGI-3, the **DNO** will generally apply less complex checks than in procedure SGI-3.

(d) The planned commissioning date stated on the application form shall be between 10 working days and 3 months from the date that the application is submitted to the **Distribution Network Operator**. Confirmation of the commissioning of each **Power Generating Module** shall be made no later than 28 days after commissioning (where tests and checks are not witnessed in accordance with 16.3.1). Confirmation shall be provided in a format as shown in Form A3-2 (Annex A.3).

(e) If, at (c) above, the **DNO** determines that further analysis is required before a connection offer can be made, the **DNO** will confirm this. This confirmation ends the SGI-2 process for this application which will then be progressed in line with the **DNO’**s standard application process. No **Power Generating Modules** should be installed or commissioned before the standard application process completes.

* + - 1. **Small Generation Installation** Procedure-3.

(a) This procedure SGI-3 applies where the following conditions are met:

1. The new and existing **Generating Unit**s are located in a single **Generator’s Installation**;
2. All of the **Generating Unit**s (including **Electricity Storage** devices) are connected via EREC G98 or EREC G99 **Fully Type Tested** inverters;[[12]](#footnote-15)
3. The **Intrinsic Design Capacity** of each new and existing **Generating Unit** is no more than 32 A.
4. The total aggregate **Registered Capacities** of all the **Generating Unit**s (including **Electricity Storage** devices) is less than 60 A per phase; and
5. An EREC G100 **Fully Type Tested** export limitation scheme is present that limits the export from the **Generator’s Installation** to the **Distribution Network** to 32 A per phase.
6. Condition 5 above can be waived if the aggregate of the **Registered Capacities** of the **Power Generating Units** is no more than 32 A.

(b) If all the conditions above are satisfied, the **Generator** should submit an application in a format as shown in Form A1-2 (Annex A.1). Note that the **DNO** may provide a method of submitting this information electronically on line etc.

(c) The **DNO** will make an initial assessment of the application. No **Power Generating Modules** should be installed or commissioned before this initial **DNO** assessment is complete and the **Generator** has been advised of the outcome of this initial assessment. The **DNO** will confirm within 10 working days of the submission whether it is necessary for the **DNO** to undertake site specific analysis of the application, taking into account the **Intrinsic Design Capacities**, the aggregated **Registered Capacities** of the **Generating Units** and the local network conditions. Where the **DNO** has identified there is a need for further analysis, no further submission of information is required, but installation and commissioning must not proceed until the **DNO** has established if it is necessary to upgrade the network, and whether such work may be chargeable to the **Generator**, if the **Generator** wishes to go ahead with the installation.

(d) The planned commissioning date stated on the application form shall be between 10 working days and 3 months from the date that the application is submitted to the **DNO**. Confirmation of the commissioning of each **Power Generating Module** shall be made no later than 28 days after commissioning (where tests and checks are not witnessed in accordance with 16.3.1). Confirmation shall be provided in a format as shown in Form A3-2 (Annex A.3).

6.2.3 **Power Generating Facilities** which include **Type A Power Generating Module**s

6.2.3.1 For **Type A** **Power Generating Module**s the compliance, testing and commissioning requirements are detailed in Section 16 of this EREC G99.

6.2.3.2 The **Generator** should apply to the local **DNO** for connection using the **DNO**’s Standard Application Form (available from the **DNO**’s website). On receipt of the application, the **DNO** will assess whether any **Distribution Network** studies are required and whether there is a requirement to witness the commissioning tests. In some cases studies to assess the impact on the **Distribution Network** may need to be undertaken before a firm quotation can be provided to the **Generator**. On acceptance of the quote, any works at the connection site and any associated facilitating works will need to be completed before the **Power Generating Module** can be commissioned. On successful completion of the commissioning tests, the **DNO** will sanction permanent energisation of the **Power Generating Module** in accordance with Section 16 of this EREC G99.

6.2.4 **Power Generating Facilities** which include **Type B**, **Type C** or **Type D Power Generating Module**s

6.2.4.1 The connection process is similar to that described in paragraph 6.2.2 above, although detailed system studies will almost certainly be required and consequently the **Generator** might need to provide additional information. The information should be provided using the Standard Application Form (generally available from the **DNO**’s website). The data that will generally be required is defined in the **Distribution Code**, Data Registration Code (DDRC), Schedules 5a, 5b and 5c.

6.2.4.2 For **Type B** and **Type C** **Power Generating Module**s the compliance, testing and commissioning requirements are detailed in Sections 17 and 18 respectively of this EREC G99. On successful completion of a **Type B** or **Type C Power Generating Module** **Document** the **DNO** will issue a **Final Operational Notification** to the **Generator**.

6.2.4.3 For a **Type D Generating Unit**, once all the relevant documents have been provided to the **DNO** to its satisfaction, the **DNO** will issue an **Energisation Operational Notification** to the **Generator** followed by an **Interim Operational Notification** and a **Final Operational Notification**. This staged process is described further in Section 19 of this EREC G99.

6.2.4.4 **Generators** who own **Type B** and **Type C** **Power Generating Module**s do not have permanent rights to operate their **Power Generating Module**s without a valid **Final Operational Notification** which will be issued by the **DNO** following completion of the commissioning tests and process, refer to paragraphs 17.4.3 and 18.4.3.

6.2.4.5 **Generator**s who own **Type D Power Generating Module**s do not have rights to operate their **Power Generating Module**s without either:

1. a valid **Final Operational Notification**, refer to paragraph 19.5.4;
2. an **Interim Operational Notification**, refer to paragraph 19.3.6; or
3. a **Limited Operational Notification**, refer to paragraph 19.6.4.1.

## System Analysis for Connection Design Type A, Type B, Type C and Type D Power Generating Modules

6.3.1 **DNO**s use a variety of modelling tools to undertake system analysis. Their exact needs for data and models will vary dependent on the voltage level, size, and location of the connection. Generally the **DNO** will seek the key information from the **Generato**r via the application forms referred to in 6.2 above. Occasionally the **DNO** may also need additional data for modelling purposes and will seek this information in accordance with the requirements of this document and the **Distribution Code**.

6.3.2 In the course of planning and designing a power system, it is often necessary for the **DNO** to model a small section of the wider system in detail. This could be an embedded system at 132 kV or less, which is connected to the **Transmission System** (400/275 kV) via one or more step-down transformers.

6.3.3 For **Power Generating Facilities** connected at **HV**, it is generally necessary to build an equivalent model of the **Distribution Network**. An example is shown as Figure 6.13 below.



Figure 6.13 Example equivalent Total System representation

This model will typically include an equivalent source representing existing **Power Generating Module**s fault level arising from asynchronous plant (EREC G74), interconnection impedances, loads, and possibly the **Generator’**s proposal for reactive compensation plant. The parameters of these elements will depend upon the selection of the boundary nodes between the equivalent and detailed networks in the model.

6.3.4 It may be beneficial to model some of the ‘active’ elements in full detail. Supergrid, grid, primary and other transformers can be considered active for the purpose of determining voltage control limits. Knowledge of the voltage control set points, transformer tap changer deadbands, and control methods is often essential. Also a knowledge of which items of **Power Generating Module**s are mainly responsible for the range of fault contributions offered at the **Connection Point** by the **DNO** is a useful addition. Fault contribution may also arise from other rotating plant – shown here as an equivalent asynchronous motor (EREC G74).

6.3.5 This equivalent **Total System** model will not accurately represent the fast dynamic (sub second) behaviour of the active elements within the **Distribution Network** and **Transmission System**.

6.3.6 Control systems for **Synchronous Power Generating Modules** and prime movers have traditionally been provided and modelled in transparent transfer-function block diagram form. These models have been developed over many years and include lead/lag elements, gains, limiters and non-linear elements and may be tuned to obtain a satisfactory response for the particular **Power Generating Module** and grid connection. Such models will still generally satisfy the present requirements.

6.3.7 In general detailed models of a **Type A** or **Type B** **Power Generating Module** are not required. Where the **DNO** deems it necessary to ensure **System Stability** and security appropriately detailed models of **Type A** or **Type B** **Power Generating Module**s and their control systems shall be supplied. Detailed models, including control systems, are always required for **Type C** and **Type D** **Power Generating Module**s.**Generator**s shall submit detailed models in respect of **Generating Units** which are aggregated into a **Power Park Module**.

6.3.8 **DNO**s will need appropriate modelling data from **Power Generating Module Manufacturer**s to undertake system analysis. Note that it is the **Generator**’s responsibility to ensure the necessary information is submitted to the **DNO**.

6.3.8.1 All simulation models used to demonstrate compliance with this EREC G99 shall be validated before the final submission of the **PGMD** to the **DNO**.

6.3.8.2 Simulations studies are required for **Type B, Type C** and **Type D Power Generating Module**s as explained in Annex B.4 and Annex C.7 as applicable.

6.3.8.3 **Generator**s with **Type B Power Generating Module**s will need to submit appropriate modelling information. The traditional approach outlined in paragraph 6.3.6 will be appropriate for **Type B Power Generating Module**s.

6.3.8.4 **Generator**s with **Type C** and **Type D Power Generation Module**s will need to submit appropriate simulation models of the **Power Generating Module**. The model will normally be requested in a compiled form suitable for use with the particular variety of power system analysis software used by the **DNO** or the **NETSO**. Recently there is a move by **Manufacturer**s to create ‘black-box’ models of their **Power Generating Module**s (see Section 21). These are programmed for compatibility with industry standard power analysis modelling packages. This is in order to protect the **Manufacturer**’s intellectual property and so lessen the need for confidentiality agreements between parties. There are potential advantages and disadvantages to this approach, but it must be generally welcomed provided that the two main disadvantages of this approach, as described below, can be resolved:

1. The model shall not be software ‘version’ specific ie will work in all future versions, or has an assurance of future upgrades for a particular software package;
2. The **Manufacturer** shall provide assurance that the black box model correctly represents the performance of the **Power Generating Module** for load flow, fault level and transient analysis for the typical range of faults experienced by **DNO**s. This includes providing guidance on the model or study cases and scenarios, should the **DNO** request such information.

## Provision of Information

6.4.1 General

6.4.1.1 **Power Generating Facilities** can have a significant effect on the **DNO**’s **Distribution Network** and as a result its **Customer**s. To enable the **DNO** to assess the impact embedded **Power** **Generating** **Module**s will have on the **DNO**’s **Distribution** **Network**, the **Generator** will be required to supply information to the **DNO**.

6.4.1.2 Except for **Fully Type Tested Type A Power Generating Module**s(including **Small Generation Installations**), **Generator**sshall provide the following minimum information to the **DNO** during the connection application process or otherwise as requested by the **DNO**:-

|  |  |
| --- | --- |
| Data Requirement | Relevant EREC G99 section |
| (a) **Power Generating Facility** and site data for all embedded **Power Generating Facilities** | 6.4.2 and Schedule 5a of the DDRC |
| (b) **Power Generating Module** data for all embedded **Power Generating Module**s | 6.4.3 and Schedule 5b of the DDRC |
| (c) **Power Generating Module** data for specified types of embedded **Power Generating Module**s  5c(i) **Synchronous** **Power Generating Module**s  5c(ii) Fixed speed induction **Power Generating Module**s  5c(iii) Double fed induction **Power Generating Module**s  5c(iv) Converter connected **Power Generating Module**s  5c(v) Transformers | 6.4.3 and Schedules 5c of the DDRC |
| (d) **Power Generating Module** data for **Embedded Medium Power Station**s | 6.4.4 and Schedules 5c of the DDRC |

6.4.1.3 When applying for connection to the **DNO**’s **Distribution Network**, **Generator**sshall also refer to the **Distribution Code**, DPC5, General requirements for connection.

6.4.1.4 The **DNO** will use the information provided to model the **DNO**’s **Distribution Network** and to decide what method of connection will need to be employed and the voltage level to which the connection should be made. If the **DNO** reasonably concludes that the nature of the proposed connection or changes to an existing connection requires more detailed consideration then further information may be requested. It is unlikely that more information than that specified in paragraph 6.4.2 will be required for **Power Generating Facilities** who are to be connected at **Low Voltage** and have a **Registered Capacity** of less than 50 kVA, or connected at other than **Low Voltage** and have a **Registered Capacity** of less than 300 kVA.

6.4.2 Information Required for all **Type A**, **Type B**, **Type C** and **Type D Power Generating Facilities**

6.4.2.1 It will be necessary for each **Generator** to provide to the **DNO** information on physical and electrical characteristics of the **Power Generating Facility** and the site as a whole as set out in Schedule 5a of the Distribution Data Registration Codebefore entering into an agreement to connect any **Power Generating Module** onto the **DNO**’s **Distribution Network:-**

The information required includes:

(a) Details of the proposed **Connection Point** (geographical and electrical) and connection voltage.

(b) The number and types of **Power Generating Module**s and the total capacity of the **Power Generating Facility** and auxiliary supplies under various operating conditions.

(c) Sketches of systemlayout:

Operation Diagramsshowing the electrical circuitry of the existing and proposed main features within the **Generator’s Installation** and showing as appropriate busbar arrangements, phasing arrangements, earthing arrangements, switching facilities and operating voltages.

(d) Interface Arrangements:

(i) The means of synchronisation between the **DNO** and **Generator**;

(ii) Details of arrangements for connecting with earth that part of the **Generator** systemdirectly connected to the **DNO**’s **Distribution Network**.

(iii) The means of connection and disconnection which are to be employed.

(iv) Precautions to be taken to ensure the continuance of safe conditions should any earthed neutral point of the **Power Generating Facility**’ssystemoperated at **HV** become disconnected from earth.

More detailed information than that contained above might need to be provided, subject to the type and size of **Power Generating Module** or the point at which connection is to be made to the **DNO**’s **Distribution Network**. This information will need to be provided by the **Generator** at the reasonable request of the **DNO**.

6.4.3 Additional **Power Generating Module**, Plant and Equipment Data Required for some **Power Generating Facilities**

6.4.3.1 The **Standard Planning Data** and **Detailed Planning Data** specified in Schedule 5b and Schedule 5c of the Distribution Data Registration Codemay be requested by the **DNO** from the **Generator** before entering into an agreement to connect any **Power Generating Module** onto the **DNO**’s **Distribution Network**.This information can be provided in the Standard Application Form (generally available from the **DNO**’s website).

6.4.3.2 The information specified in Schedule 5b of the Distribution Data Registration Codeincludes generic data for all **Power Generating Module**s.

6.4.3.3 The information specified in Schedule 5c of the Distribution Data Registration Code includes the more detailed electrical parameters of individual **Power Generating Module**sand associated plant such as transformers, **Power Factor** correction equipment. The information required is classified as **Standard Planning Data** and **Detailed Planning Data** for each of the following categories of **Power Generating Module**s:

1. **Synchronous Power Generating Module**s
2. Fixed speed induction **Power Generating Module**s
3. Doubly fed induction **Power Generating Module**s
4. Series converter connected **Power Generating Module**s
5. Transformers

6.4.4 Extra Information for **Embedded Medium Power Stations** to be provided to Meet **Grid Code** Requirements

6.4.4.1 Where a **Generator** in respect of a **Power Generating Facility** is a party to the **CUSC** this paragraph 6.4.4 will not apply.

6.4.4.2 The **DNO** has an obligation under ECC3.3 of the **Grid Code** to submit certain planning data relating to **Embedded Medium Power Station**s to the **NETSO**. The relevant data requirements of the **Grid Code** are listed in ECC3.3 of the **Grid Code**. It is incumbent on the **Embedded Medium Power Station Generator** to provide this data listed in ECC3.3 of the **Grid Code** to the **DNO**.

6.4.4.3 In addition to supplying the **DNO** with details of **Power Generating Module**sthere is a requirement for the **Generator** to provide information to the **NETSO** where it has been specifically requested by the **NETSO** in the circumstances provided for under the **Grid Code**.

6.4.5 Information Provided by the **DNO** to **Generators**

6.4.5.1 In accordance with condition 12 and condition 25 of its **Distribution Licence** the **DNO** is required to provide certain information to **Generator**s**,** as set out in DPC4.5, so that they have the opportunity to identify and evaluate opportunities to connect to the **DNO**’s **Distribution Network**.Comprehensive information on the **DNO**’s **Distribution Network** operating at 33 kV and above is made available to **Generator**sthrough the Long Term Development Statements provided under licence condition 25 of the **Distribution Licence**.Schedule 5d of the Distribution Data Registration Codeis indicative of the type of network data the **DNO** is required to provide to **Generator**sfor identifying opportunities for connection of generation at voltages below 33 kV. On the production of Schedule 5d data for a **Generator**, the **DNO** will update any relevant data that would otherwise be provided from the Long Term Development Statement.

# Connection Arrangements

## Operating Modes

**Power Generating Module**s may be designed to operate principally in parallel with the **DNO’s Distribution Network**, or in island mode. EREC G99 does not have any requirements for generation that runs permanently in island mode and which has no connection to the **DNO’s Distribution Network** at any time. This gives rise to four operating modes within the scope of this EREC G99 as shown in Table 7.1.

Table 7.1 – Operating Modes

|  |  |  |  |
| --- | --- | --- | --- |
|  | | Parallel Operation | |
| No | Yes |
| Customer Island Operation | No | Not  applicable | Long Term Parallel Operation without Islanding (OM1) |
| Yes | Switched-Alternative (OM4) | Long Term Parallel Operation with Islanding (OM2) |
| Infrequent Short Term Parallel Operation (OM3) |

In summary the operating modes (OM) are:

* OM1 - Long term parallel without islanding capability;
* OM2 - Long term parallel with islanding capability;
* OM3 – Infrequent short term paralleling (ie predominantly island operation); and
* OM4 - Switched-alternative – ie no parallel operation.

The requirements for each operating mode are further expanded below:

* OM1: this is the default operating mode for generation within the scope of this EREC G99, and for OM1 all of this EREC G99 applies with the exception of sections 7.2, 7.3 and 7.4.
* OM2: in section 7.2 below.
* OM3 in section 7.3 below.
* OM4 in 7.4 below.

Wherever a **Generator**’s **Power Generating Module** is intended to operate in long term parallel operation with the **DNO**’s **Distribution Network**, the design of the **Power Generating Module** and the **Customer’s Installation** must meet the requirements for long term parallel operation (ie operating modes OM1 and/or OM2) and comply with all the appropriate requirements of this EREC G99.

In the case that a **Power Generating Module** is designed to switch between any of the four modes of operation, it shall be designed to comply with the requirements for each mode.

In the case that it is intended to operate a **LV** electrical installation with **Power Generating Modules** with an aggregate **Registered Capacity** not exceeding 16A per phase, ie a **Power Generating Facility** that would otherwise be in the scope of EREC G98, the **Power Generating Module**s must be **Fully Type Tested**.

Equipment other than **Generating Units** (eg traction loads, lift motors etc) may act as a short term source of energy, and inject electrical energy into the **Customer’s Installation** when they operate in a regenerative mode. In general EREC G99 will not apply as there will be no need to make any specific design accommodation for such equipment as it is unlikely that they will support any possible power island for a significant length of time. Where such equipment can act as a source of electrical energy for more than a few seconds (say typically 20 s), the **DNO** will advise the **Customer** if the **Customer’s Installation** requires any special consideration such as reverse power protection on a case by case basis.

In general the technical requirements in this EREC G99 will not apply for non-controllable storage technology such as synchronous compensators and synchronous flywheels and also not apply to rotary uninterruptible power supplies. This is because there will be no need to make any specific design accommodation for such equipment as it is unlikely that they will support any possible power island for a significant length of time. Where such equipment can act as a source of electrical energy for more than a few seconds (say typically 20 s), the **DNO** will advise the **Customer** if the **Customer’s Installation** requires any special consideration, such as reverse power protection or short circuit current contribution assessment, on a case by case basis.

## OM2 – Long Term Parallel Operation with Islanding Capability

7.2.1 This refers to the frequent or long-term operation of **Power Generating Module**s in parallel with the **Distribution Network**, irrespective of whether the **Power Generating Module** operates in island mode at some times. Unless otherwise stated, all sections in this EREC G99 except 9.6.3 are applicable to this mode of operation.

7.2.2 When a long term parallel operation **Power Generating Module** operates in island mode, the **Power Generating Module** is required to comply with the specific requirements relating to islanding capability which are set out in section 9.6.2 of this EREC G99.

## OM3 - Infrequent Short-Term Parallel Operation

This mode of operation typically enables **Power Generating Module**s to operate as a standby to the **DNO**’s supply. A short term parallel is required to maintain continuity of supply during changeover and to facilitate testing of the **Power Generating Module**. The specific requirements for this mode of operation are set out in section 9.6.3 of this EREC G99.

## OM4 – Switched-Alternative Operation

General

7.4.1.1 As the generation does not run in parallel with the **DNO’s Distribution Network** much of this EREC G99 does not apply. This section 7.4 must be complied with, and the guidance of section 8 for earthing arrangements should be followed as appropriate.

7.4.1.2 Under this mode of operation it is not permissible to operate a **Power Generating Module** in parallel with the **Distribution Network**. Regulation 21 of the **ESQCR** states that it is the **Generator**’s responsibility to ensure that all parts of the **Power Generating Module** have been disconnected from the **Distribution Network** and remain disconnected while the **Power Generating Module** is operational. The provisions of this EREC G99 do not generally apply and the earthing, protection, instrumentation etc. for this mode of operation are the responsibility of the **Generator**, however, where such a **Power Generating Module** is to be installed, the **DNO** shall be given the opportunity to inspect the equipment and witness commissioning of any changeover equipment and interlocking.

7.4.1.3 The changeover devices shall be of a ‘fail-safe’ design so that one circuit controller cannot be closed if the other circuit controller in the changeover sequence is closed, even if the auxiliary supply to any electro-mechanical devices has failed. Changeover methods involving transfer of removable fuses or those having no integral means of preventing parallel connection with the **Distribution Network** are not acceptable. The equipment shall not be installed in a manner which interferes with the **DNO**’s cut-out, fusegear or circuit breaker installation, at the supply terminals or with any metering equipment.

7.4.1.4 The direct operation of circuit-breakers or contactors shall not result in the defeat of the interlocking system. For example, if a circuit-breaker can be closed mechanically, regardless of the state of any electrical interlocking, then it shall have mechanical interlocking in addition to electrical interlocking. Where an automatic mains fail type of **Power Generating Module** is installed, a conspicuous warning notice should be displayed and securely fixed at the **Connection** **Point**.

7.4.1.5 The **Power Generating Facility** shall use an earth electrode independent from the **Distribution Network**.

7.4.2 Changeover Operated at **HV**

7.4.2.1 Where the changeover operates at **HV**, the following provisions may be considered by the **Generator** to meet the requirements of Regulation 21 of the **ESQCR**:

1. An electrical interlock between the closing and tripping circuits of the changeover circuit breakers;
2. A mechanical interlock between the operating mechanisms of the changeover circuit breakers;
3. An electro-mechanical interlock in the mechanisms and in the control circuit of the changeover circuit breakers;
4. Two separate contactors which are both mechanically and electrically interlocked.

Electrically operated interlocking should meet the requirements of BS EN 61508.

7.4.2.2 Although any one method may be considered to meet the minimum requirement, it is recommended that two methods of interlocking are used wherever possible. The **Generator** shall be satisfied that any arrangement will be sufficient to fulfil the **Generator**’s obligations under the **ESQCR**.

7.4.3 Changeover Operated at **LV**

7.4.3.1 Where the changeover operates at **LV**, the following provisions may be considered by the **Generator** to meet the requirements of Regulation 21 of the **ESQCR**:

1. Manual break-before-make changeover switch;
2. Separate switches or fuse switches mechanically interlocked so that it is impossible for one to be moved when the other is in the closed position;
3. An automatic break-before-make changeover contactor;
4. Two separate contactors which are both mechanically and electrically interlocked;
5. A system of locks with a single transferable key.

Electrically operated interlocking should meet the requirements of BS EN 61508.

7.4.3.2 The **Generator** shall be satisfied that any arrangement will be sufficient to fulfil the **Generator**’s obligations under the **ESQCR**.

7.4.3.3 The switchgear that is used to separate the two systems shall break all four poles (3 phases and neutral). This prevents any phase or neutral current, produced by the **Power Generating Facility**, from flowing into the **DNO**’s **Distribution Network** when it operates as a switched alternative only supply.

## Phase Balance of Type A Power Generating Module output at LV

7.5.1 Connection of single phase **Power Generating Module**s may require **Distribution** **Network** reinforcement and extension before commissioning for technical reasons (such as voltage issues and unacceptable phase imbalance) depending on the point of connection and **Distribution** **Network** design.

7.5.2 A solution to these voltage issues and phase imbalance issues may be to utilise three phase **Power Generating Module**s or to use multiple single phase **Power Generating Module**s connected across three phases. For this arrangement the same export power will result in lower voltage rises due to decreased line currents and a three phase connected **Power Generating Module** is likely to result in significantly lower voltage rises than those created by a single phase connected **Power Generating Module**. If the individual **Power Generating Module**shave different ratings, current and voltage imbalance may occur.To maintain current and voltage imbalance within limits the **Generator** shall consider the phase that each **Power Generating Module** is connected to in an installation. In addition the **DNO** may define to a **Generator** the phases to which the **Power Generating Module**s in any given installation should be connected.

7.5.3 Where single phase **Power Generating Module**s are being used the **Generator** should design the installation on a maximum unbalance output of 32 A between the highest and lowest phase. Where there is a mixture of different technologies, or technologies which may be operational at different times (eg wind and solar) **Power Generating Module**s shall be connected to give a total imbalance of less than 32 A based on assumed worst case conditions, those being:

1. One **Power Generating Module** at maximum output with the other(s) at zero output – all combinations to be considered.
2. Both / all **Power Generating Module**s being at maximum output.

A **Power Generating Module** technology which operates at different times due to location eg east and west facing roofs for PV, shall allow for the PV on one roof to be at full output and the PV on the other roof to be at zero output.

7.5.4 In order to illustrate these requirements examples of acceptable and unacceptable connections have been given in Annex A.5.

## Type A Power Generating Module capacity for single and split LV phase supplies

7.6.1 The maximum aggregate capacity of **Power Generating Module**s that can be connected to a single phase supply is 17 kW. The maximum aggregate capacity of **Power Generating Module**s that can be connected to a split single phase supply is 34 kW.

7.6.2 There is no requirement to provide intertripping between single phase **Inverter**s where these are installed on multi-phase supplies up to a limit of 17 kW per phase (subject to the balance of site output as per Section 7.5). A single phase 17 kW connection may result in an imbalance of up to 17 kW following a **Distribution Network** or **Power Generating Module** outage. However the connection design should result in imbalance under normal operation to be below 16 A between phases as noted above.

7.6.3 **Power Generating Facilities** with a capacity above 17 kW per phase are expected to comprise three phase units. The requirement to disconnect all phases following a fault in the **Generator’s Installation** or a **Distribution Network** outage applies to three phase **Power Generating Module**s only and will be tested as part of the compliance testing of the **Power Generating Module**. In some parts of the country where provision of three phase networks is costly then the **DNO** may be able to provide a solution using single or spilt phase networks for **Power Generating Facilities** above the normal limits as set out above.

## Voltage Management Units in Generator’s Installation

7.7.1 Voltage Management Units are becoming more popular and use various methods, in most cases, to reduce the voltage supplied from the **DNO**’s **Distribution** **Network** before it is used by the **Generator**. In some cases where the **DNO**’s **Distribution** **Network** voltage is low they may increase the voltage supplied to the **Generator**. Some technologies are only designed to reduce voltage and cannot increase the voltage.

7.7.2 The use of such equipment has the advantage to the **Generator** of running appliances at a lower voltage and in some cases this can reduce the energy consumption of the appliance. Some appliances when running at a lower voltage will result in higher current consumption as the device needs to take the same amount of energy from the system to carry out its task.

7.7.3 If a Voltage Management Unit is installed between the **Connection Point** and the **Power Generating Module** in a **Generator’s Installation**, it may result in the voltage at the **Generator** side of the Voltage Management Unit remaining within the limits of the protection settings defined in Table 10.1 while the voltage at the **Connection Point** side of the unit might be outside the limits of the protection settings. This would negate the effect of the protection settings. Therefore, this connection arrangement is not acceptable and all **Power Generating Module**s connected to the **DNO**’s **LV Distribution Network** under this Engineering Recommendation shall be made on the **Connection Point** side of any Voltage Management Unit installed in a **Generator’s Installation**.

7.7.4 **Generator**s should note that the over voltage setting defined in Table 10.1 is 4% above the maximum voltage allowed for the voltage from the **DNO**’s **Distribution Network** under the **ESQCR** and that provided they have designed their installation correctly there should be very little nuisance tripping of the **Power Generating Module**. Frequent nuisance tripping of a **Power Generating Module** may be due to a fault in the **Generator’s Installation** or the operation of the **DNO**’s **Distribution Network** at too high a voltage. **Generator**s should satisfy themselves that their installation has been designed correctly and all **Power Generating Module**s are operating correctly before contacting the **DNO** if nuisance tripping continues. Under no circumstances should they resort to the use of Voltage Management Units installed between the **Connection Point** and the **Power Generating Module**.

## Power Generating Module Sharing System

* + 1. This section describes the additional requirements where a **Generator** provides **Active Power** to two or more independent **Customers** connected at **Low Voltage** via equipment designed to share the power generated by **Power Generating Module**(s) under a sharing arrangement.
    2. In such a sharing arrangement the **Power Generating Module**(s) are connected to each separate **Customers’ Installation** and power flow through these connections is arranged such that output from the **Power Generating Module**(s) is shared between them.
    3. The owner of the **Power Generating Module** is, for the purposes of this EREC G99, the **Generator**. The **Generator** need not have a direct electrical connection to the **DNO**’s **Distribution Network**. In some cases the connection will only be via the relevant **Customers’ Installation**s. In all cases the **Generator** shall have a suitable contract with the **DNO** for the installation and operation of the **Power Generating Module**.
    4. All **Customers** served by a **Power Generating Module** sharing arrangement must be connected to the same section of the **DNO**’s **Distribution Network** (ie supplied via a single set of **Low Voltage** fuses at the **DNO**’s substation or equivalent) and also have the same earthing arrangements (eg all be PME or all be SNE). Normally all the **Customers’ Installation**s will be within a single building. Any use of a sharing arrangement outside of a single building must be specifically agreed with the **DNO**.
    5. Where **Power Generating Module** output sharing is intended, the following requirements apply:
       1. The **Generator** is responsible for ensuring compliance with all the relevant requirements of this EREC G99, including specifically the requirements of this section 7.8.5.
       2. The equipment/installation shall be designed and constructed such that all protection in each **Customers’ Installation** and the **Generator’s Installation** will operate correctly by design for faults anywhere on the **Generator’s Installation** and **Customers’ Installation**s. Such protection shall also comply with the requirements of BS 7671. Particular attention should be paid to ensure that all parts of the **Customer’s Installation** and the **Generator’s Installation** that are within the protection zone of the **DNO**’s cut-out fuse are adequately protected.
       3. The equipment/installation shall be designed such that no **Active Power** can flow from any **Customer’s Installation** towards the **Power Generating Module**, ie to prevent **Active Power** flowing from one **Customer’s Installation** to another or from one **Customer’s Installation** to the **Generator’s Installation**. This restriction does not include any **Active Power** flow that is used purely for maintaining the equipment implementing the sharing arrangement in an operational state when the **Power Generating Module** is generating insufficient **Active Power**, ie the sharing arrangement equipment's parasitic demand: for example that required by a PV sharing arrangement in its quiescent state at night.
       4. An exception to section 7.8.5.3 is allowed where the **Generator** has incorporated **Electricity Storage** into the **Power Generating Module**. In this case the **Generator** will arrange, and demonstrate, that the **Active Power** flow into the **Electricity Storage** component matches the aggregate **Active Power** flowing from the **Generator’s Installation** and all the relevant **Customer’s Installation**s at all times. Under these circumstances all **Active Power** flows between the components of the sharing arrangement and the **Customers’ Installations** shall be in the same direction, ie towards the **Electricity Storage** component. If there is a mismatch in aggregate flows or direction the charging of the **Electricity Storage** shall cease immediately and an alarm raised.
       5. If a **Customer’s Installation** becomes de-energized from the **DNO**’s **Distribution Network** the equipment shall detect this condition and disconnect the **Power Generating Module** from that **Customer’s Installation**.
       6. Synchronizing facilities shall be in place and synchronising checks carried out that check for correct phasing each and every time a **Customer’s Installation** is to be connected to the **Generator’s Installation**. The detection of incorrect phasing shall trigger an alarm.
       7. In situations where the power sharing arrangement results in export of **Active Power** from the **Customers’ Installation**s to the **DNO**’s **Distribution Network**, the exported **Active Power** flows to the **DNO**’s **Distribution Network** shall be arranged to be balanced between the relevant **Customer**s’ **Connection Point**s. The characteristics of the distribution of exported **Active Power** shall be specified in the application, and the export per phase per **Customer** must not exceed 32A.
       8. All communication channels, ie those between the components of the equipment used to implement the sharing arrangement, and between those components and any part of **Customers’ Installation**s**,** shall be actively monitored, and failure of communication channels shall lead to the appropriate failsafe action, ie disconnection of the **Power Generating Module** from the relevant **Customer’s Installation** or the complete shut down of the **Power Generating Module** as appropriate, together with triggering an alarm.
       9. If any of the following are detected:
          1. An **Active Power** flow from any **Customer’s Installation** towards the **Power Generating Module** (apart from the parasitic demand referred to in 7.8.5.3 above);
          2. A mismatch between the aggregate **Active Power** flow from **Customers’ Installation**s to any **Electricity Storage** component of the **Power Generating Module** as described in section 7.8 5.4;
          3. An out of phase condition, as described in section 7.8.5.6; or
          4. A failure of any communication channel as described in section 7.8.5.8

an alarm shall be raised and communicated to the **Generator**.

* + - 1. Earthing arrangements shall be in accordance with BS 7671.
      2. The **Power Generating Module** sharing arrangement shall be capable of being switched off by the **Generator** and disconnected via lockable isolation devices from all **Customers’ Installation**s.
      3. In addition to the requirements of Section 14 ownership and operational boundaries, and the means of isolation of the **Power Generating Module**(s) and the connections between the **Generator’s Installation** and the **Customer’s Installation**, shall be clear for every **Customer**, the **Generator**, the **DNO** and for any operator of the network in a shared building. Appropriate labels shall be affixed at each **Customer**’s service position. A single line diagram of the overall installations shall be posted in the **Generator’s Installation** and at each **Customer**’sservice position.

# Earthing

## General

8.1.1 The earthing arrangements of the **Power Generating Module** shall satisfy the requirements of DPC4 of the **Distribution Code**.

8.1.2 The figures included in section 8 are summarised here:

|  |  |  |  |
| --- | --- | --- | --- |
| Connection Voltage | Operating Mode | Typical Installation Type | Figure |
| HV | OM4 | Industrial/commercial HV generation | 8.1 |
| HV | OM1 | Industrial/commercial HV generation | 8.2 |
| HV | OM2 | Industrial/commercial HV generation | 8.3 |
| HV | OM2 | Industrial/commercial HV generation | 8.4 |
| HV | OM2 | Industrial/commercial LV generation in HV system | 8.5 |
| LV | OM2 | Industrial/commercial | 8.6 |
| LV | OM4 | Industrial/commercial | 8.7 |
| LV | OM1 | Industrial/commercial | 8.8 |
| LV | OM2 | Industrial/commercial | 8.9 |
| LV | OM2 | Industrial/commercial non-synchronous generation | 8.10 |
| LV | OM2 | Industrial/commercial single phase non-synchronous generation | 8.11 |
| LV | OM1 | Domestic single phase non-synchronous | 8.12 |
| LV | OM2 | Domestic single phase non-synchronous – all Demand islanded | 8.13 |
| LV | OM2 | Domestic single phase non-synchronous – only essential Demand islanded | 8.14 |
| LV | OM3 | Industrial/commercial | 8.15 |

## Power Generating Modules with a Connection Point at HV

8.2.1 **HV Distribution Network**s may use direct, resistor, reactor or arc suppression coil methods of earthing the **Distribution Network** neutral. The magnitude and duration of fault current and voltage displacement during earth faults depend on which of these methods is used. The method of earthing, therefore, has an impact on the design and rating of earth electrode systems and the rating of plant and equipment.

8.2.2 To ensure compatibility with the earthing on the **Distribution Network** the earthing arrangements of the **Power Generating Module** shall be designed in consultation and formally agreed with the **DNO**. The actual earthing arrangements will also be dependent on the number of **Power Generating Module**s in use and the **Generator**s system configuration and method of operation. The system earth connection shall have adequate electrical and mechanical capability for the duty.

8.2.3 **HV Distribution Network**s operating at voltages below 132 kV are generally designed for earthing at one point only and it is not normally acceptable for **HV** **Generator**s or **HV Generator**s to connect additional **HV** earths when operating in parallel. One common exception to this rule is where the **Power Generating Module** uses an **HV** voltage transformer (VT) for protection, voltage control or instrumentation purposes and this VT requires an **HV** earth connection to function correctly.

8.2.4 **HV Distribution Network**s operating at 132 kV are generally designed for multiple earthing, and in such cases the earthing requirements should be agreed in writing with the **DNO**.

8.2.5 In some cases the **DNO** may allow the **Generator** to earth the **Generator**’s **HV** systemwhen operating in parallel with the **Distribution Network**. The details of any such arrangements shall be agreed in writing between the relevant parties.

8.2.6 **Generator**s shall take adequate precautions to ensure their **Power Generating Module** is connected to earth via their own earth electrodes when operating in isolation from the **Distribution Network**.

8.2.7 Typical earthing arrangements are given in Figures 8.1 to 8.5.

8.2.8 Earthing systems shall be designed, installed, tested and maintained in accordance with ENA TS 41-24, (Guidelines for the design, installation, testing and maintenance of main earthing systems in substations), BS7354 (Code of Practice for Design of Open Terminal Stations), BS7430 (Code of Practice for Earthing) and Engineering Recommendation S.34 (A guide for assessing the rise of earth potential at substation sites). Precautions shall be taken to ensure hazardous step and touch potential do not arise when earth faults occur on **HV** systems. Where necessary, **HV** earth electrodes and **LV** earth electrodes shall be adequately segregated to prevent hazardous earth potentials being transferred into the **LV Distribution Network**.



Figure 8.1 - Typical earthing arrangement for a HV Power Generating Module designed for Switched Alternative (OM4) Only

NOTE:

1. Interlocking between the busbar CB and the **Power Generating Module** CB is required to prevent parallel operation of the **Power Generating Module** and **DNO**’s **Distribution Network**



Figure 8.2 - Typical earthing arrangement for a HV Power Generating Module designed for Long Term Parallel Operation without Islanding (OM1)

The .

(2) The **Power Generating Module** is not designed to operate in island mode, ie it can only operate in OM1.



eadLong Term with Islanding (OM2)

NOTE:

(1) Protection, interlocking and control systems are designed to ensure that the busbar CB is open when the **Power Generating Module** operates independently from the **DNO**’s **Distribution Network**

(2) When the **Power Generating Module** operates independently from the **DNO**’s **Distribution Network** (ie the busbar CB is open) the neutral / earth switch is closed.

(3) When the **Power Generating Module** operates in parallel with the **DNO**’s **Distribution Network** (ie the busbar CB is closed) the neutral / earth switch is open.



eadLong Term with Islanding (OM2)

NOTE:

(1) Protection, interlocking and control systems are designed to ensure that the busbar CB is open when the **Power Generating Module**s operate independently from the **DNO**’s **Distribution Network**.

(2) If one **Power Generating Module** is operating independently from the **DNO**’s **Distribution Network** (ie the busbar CB is open) then its neutral switch is closed and the neutral / earth switch is closed.

(3) If both **Power Generating Module**s are operating independently from the **DNO**’s **Distribution Network** (ie the busbar CB is open) then one neutral switch is closed and the neutral / earth switch is closed.

(4) If one or both of the **Power Generating Module**s are operating in parallel with the **DNO**’s **Distribution Network** (ie the busbar CB is closed) then both neutral switches and the neutral /earth switch are open.

A diagram of a network

Description automatically generated

**Figure 8.5** - Typical earthing arrangement for an LV Power Generating Module Embedded within a Generator’s HV System and designed for Long Term Parallel Operation with Islanding (OM2)

NOTE:

(1) **HV** earthing is not shown.

(2) Protection, interlocking and control systems are designed to ensure that the busbar CB is open when the **Power Generating Module** operates independently from the **DNO**’s **Distribution Network**.

(3) When the **Power Generating Module** operates independently from the **DNO**’s **Distribution Network** (ie the busbar CB is open) the neutral / earth switch is closed.

(4) When the **Power Generating Module** operates in parallel with the **DNO**’s **Distribution Network** (ie the busbar CB is closed) the neutral / earth switch is open.

## Power Generating Modules with a Connection Point at LV

8.3.1 **LV Distribution Network**s are always solidly earthed, and the majority are multiple earthed. Design practice for protective multiple earthing is detailed in the Energy Networks Association publications including Engineering Recommendation G12, and in the references contained in those publications.

8.3.2 The winding configuration and method of earthing connection shall be agreed with the **DNO**.

8.3.3 In addition, where the **Power Generating Facility**’s **Connection Point** is at **Low Voltage** the following shall apply:

Where an earthing terminal is provided by the **DNO** it may be used by a **Power Generation Facility** for earthing the **Power Generating Module**, provided the **DNO** earth connection is of adequate capacity. If the **Power Generating Module** is intended to operate independently of the **DNO**’s supply, the **Power Generating Module** shall include an earthing system which does not rely upon the **DNO**’s earthing terminal. Where use of the **DNO**’s earthing terminal is retained, it shall be connected to the **Power Generating Module**s earthing system by means of a conductor at least equivalent in size to that required to connect the **DNO**’s earthing terminal to the installation.

Where the **Power Generating Module** may be operated as a switched alternative only to the **DNO**’s **Distribution Network**, the **Power Generation Facility** shall provide an independent earth electrode.

Where it is intended to operate in parallel with the **DNO**’s **Low Voltage Network** with the star point connected to the neutral and/or earthing system, precautions will need to be taken to limit the effects of circulating harmonic currents. It is permissible to insert an impedance in the supply neutral of the **Power Generating Module** for this purpose, for those periods when it is paralleled with the **DNO**’s **Distribution Network**. However, if the **Power Generating Module** is operating in isolation from the **DNO**’s **Distribution Network** it will be necessary to have the **Power Generating Module** directly earthed.

Where the **Power Generating Module**s are designed to operate independently from the **DNO**’s **Distribution Network** the switchgear that is used to separate the two systemsshall break all four poles (3 phases and neutral). This prevents any phase or neutral current, produced by the **Power Generating Module**, from flowing into the **DNO**’s **Distribution Network** when it operates as a switched alternative only supply.

The following Figures 8.6 to 8.15 show typical installations.

Diagram of a diagram of a network

Description automatically generated

**Figure 8.6** - Typical earthing arrangement for an LV Power Generating Module Connected to the DNO’s Distribution Network at HV and designed for Long Term Parallel Operation with Islanding (OM2)

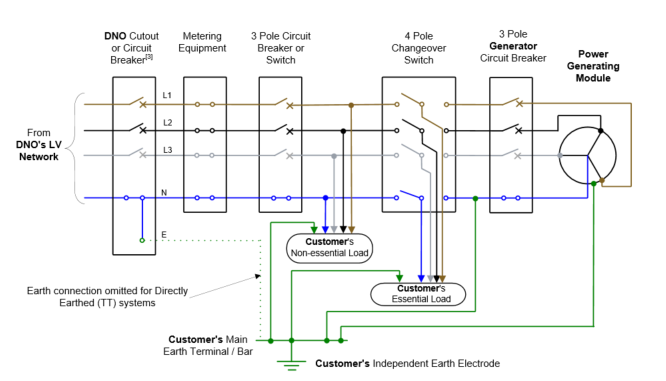
NOTE:

(1) **HV** earthing is not shown.

(2) Protection, interlocking and control systems are designed to ensure that the busbar CB is open when the **Power Generating Module** operates independently from the **DNO**’s **Distribution Network**.

(3) When the **Power Generating Module** operates independently from the **DNO**’s **Distribution Network** (ie the busbar CB is open) the neutral earth switch is closed.

(4) When the **Power Generating Module** operates in parallel with the **DNO**’s **Distribution Network** (ie the busbar CB is closed) the neutral / earth switch is open.



ea’sdSwitched Alternative (OM4)

NOTE:

(1) The **Power Generating Module** is not designed to operate in parallel with the **DNO**’s **Distribution Network**.

(2) The changeover switch shall disconnect each phase and the neutral (ie for a three phase system a 4 pole switch is required). This prevents current flowing and voltage being transferred between the **DNO Network** and the **Customer’s Installation** when operating in switched alternative mode.

(3) The **DNO** cut-out / circuit breaker shows a PME (TN-C-S) connection, however, the **Power Generating Module** earthing arrangement is also applicable to SNE (TNS) and direct earthing (TT) arrangements.

A diagram of a electrical system

Description automatically generated

ea’sdLong Term without Islanding (OM1)

NOTE:

(1) The **Power Generating Module** is not designed to operate in island mode, ie it can only operate in OM1.

(2) The **Generator**’s independent earth electrode is only required if the installation is Directly Earthed (TT).

(3) The **DNO** cut-out / circuit breaker shows a PME (TN-C-S) connection, however, the **Power Generating Module** earthing arrangement is also applicable to SNE (TNS) and direct earthing (TT) arrangements.

A diagram of a wiring diagram

Description automatically generated

**Figure 8.9** - Typical earthing arrangement for a three phase LV Power Generating Module Embedded within a Generator’s LV System and designed for Long Term Parallel Operation with Islanding (OM2)

NOTE:

(1) operatesin island modeisland mode

(2) The **DNO** cut-out / circuit breaker shows a PME (TN-C-S) connection, however, the **Power Generating Module** earthing arrangement is also applicable to SNE (TNS) and direct earthing (TT) arrangements.

A diagram of a electrical system

Description automatically generated

**Figure 8.10** - Typical earthing arrangement for a three phase LV Power Park Module Embedded within a Generator’s LV System and designed for Long Term Parallel Operation with Islanding (OM2)

NOTE:

(1) The **DNO** cut-out / circuit breaker shows a PME (TN-C-S) connection, however, the **Power Generating Module** earthing arrangement is also applicable to SNE (TNS) and direct earthing (TT) arrangements.

(2) When the **Power Generating Module** operates in island mode the switch that is used to isolate between these two systems shall disconnect each phase and neutral (ie for a three phase system a 4 pole switch is required). This prevents **Power Generating Module** neutral current from inadvertently flowing through the part of the **Generator**’s **Installation** that is not supported by the **Power Generating Module**.This switch should also close the **Power Generating Module** neutral and earth switches during island mode operation.

**A diagram of a electrical system

Description automatically generated**

**Figure 8.11** - Typical earthing arrangement for a single phase LV Power Park Module Embedded within a Generator’s LV System and designed for Long Term Parallel Operation with Islanding (OM2)

NOTE:

(1) When the **Power Generating Module** operates in island mode the switch that is used to isolate between these two systems shall disconnect both phase and neutral. This prevents **Power Generating Module** neutral current from inadvertently flowing through the part of the **Generator**’s **Installation** that is not supported by the **Power Generating Module**. This switch should also close the **Power Generating Module** neutral and earth switches during island mode operation.

(2) The **DNO** cut-out / circuit breaker shows a PME (TN-C-S) connection, however, the **Power Generating Module** earthing arrangement is also applicable to SNE (TNS) and direct earthing (TT) arrangements.

**A diagram of a generator

Description automatically generated**

**Figure 8.12** - Typical domestic earthing arrangement for a single phase LV Power Park Module Embedded within a Generator’s LV System and designed for Long Term Parallel Operation without Islanding (OM1)

NOTE:

1. Domestic single phase premises may be supplied from a three phase cut out in certain circumstances.
2. The **DNO** cut-out / circuit breaker shows a PME (TN-C-S) connection, however, the **Power Generating Module** earthing arrangement is also applicable to SNE (TNS) and direct earthing (TT) arrangements.

A diagram of a electrical system

Description automatically generated

**Figure 8.13 – Typical domestic earthing arrangements for Long Term Parallel Operation with Islanding supplying all loads (OM2)**

NOTE:

1. Domestic single premises may be supplied from a three phase cut out in certain circumstances.
2. The **DNO** cut-out / circuit breaker shows a PME (TN-C-S) connection, however, the **Power Generating Module** earthing arrangement is also applicable to SNE (TNS) and direct earthing (TT) arrangements.
3. When the **Power Generating Module** operates in island mode the backup interface used shall disconnect both phase and neutral. This prevents any current flow inadvertently feeding onto the **Distribution Network** when operating in island mode.
4. Manufacturer’s instructions for the backup interface and the design of the installation shall always be followed.

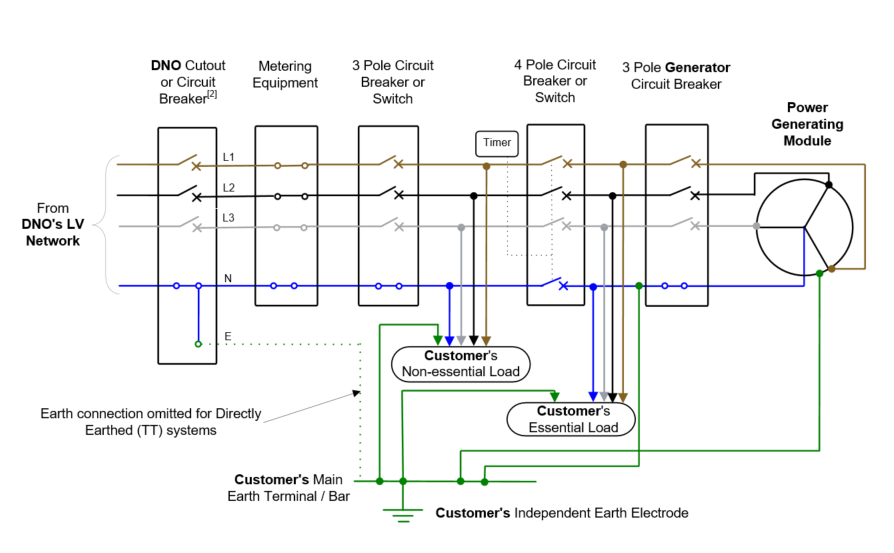
A diagram of a customer's electrical system

Description automatically generated

**Figure 8.14 – Typical domestic example of earthing arrangements for Long Term Parallel Operation with Islanding supplying only essential loads (OM2)**

NOTE:

1. Domestic single premises may be supplied from a three phase cut out in certain circumstances.
2. The **DNO** cut-out / circuit breaker shows a PME (TN-C-S) connection, however, the **Power Generating Module** earthing arrangement is also applicable to SNE (TNS) and direct earthing (TT) arrangements.
3. When the **Power Generating Module** operates in island mode the backup interface used shall disconnect all phases and neutral. This prevents any current flow inadvertently feeding onto the **Distribution Network** when operating in island mode.
4. Manufacturer’s instructions for the backup interface and the design of the installation shall always be followed.



**Figure 8.15 – Example of arrangements for Short Term Parallel Operation (OM3)**

NOTE:

(1) It is expected that the earthing of the **Power Generating Module** star point would be solid, ie there will not generally be a neutral/earth contactor for three phase installations – see 9.6.3.4(b)

(2) The **DNO** cut-out / circuit breaker shows a PME (TN-C-S) connection, however, the **Power Generating Module** earthing arrangement is also applicable to SNE (TNS) and direct earthing (TT) arrangements.

# Network Connection Design and Operation

## General Criteria

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

1. to comply with the obligations (to include security, frequency and voltage; voltage disturbances and harmonic distortion; auto reclosing and single phase protection operation).
2. 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.
   * 1. **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 **Anchor Plant Capability** as applicable. The technical connection requirements in this chapter are common to all **Power Generating Module**s.
     2. 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.
     3. 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.
     4. Every **Power Generating Module** and any associated equipment must be designed and operated appropriately to comply with cyber security requirements. The **Generator** shall consider all cyber security risks applicable to the **Power Generating Module** in terms of the communication between any energy management system etc and also in terms of interaction with any system of the **Manufacturer** for product management.
     5. As explained in paragraph 2.14 **DNO**s may modify certain aspects of the requirements of Section 9 for island operation, and paragraph 5.7 during **System Restoration**.
     6. The **Generator** shall provide information describing the high level cyber security approach, as well as the specific cyber security requirements complied with. The statement will make appropriate reference to the **Power Generating Facilities** compliance with:

* ETSI EN 303 645;
* relevant aspects of PAS 1879 “Energy smart appliances – Demand side response operation – Code of practice”;
* relevant aspects of “Distributed Energy Resources – Cyber Security Connection Guidance” published by BEIS and the ENA; and
* Any other relevant standard that has been incorporated in the design of the **Power Generating Module**.

## Network Connection Design for Power Generating Modules

9.2.1 The connection of new **Customer**s, including **Generator**s, to the **Distribution Network** should not generally increase the risk of interruption to existing **Customer**s. For example, alterations to existing **Distribution Network** designs that cause hitherto normally closed circuits to have to run on open standby such that other **Customer**s might become disconnected for the duration of the auto-switching times are deprecated.

9.2.2 Connection of **Power Generating Module**sto **Distribution Network**s will be subject to rules for managing the complexity of circuits. For example, EREC P18 sets out the normal limits of complexity of 132 kV circuits by stipulating certain restrictions to be applied when they are designed eg the operation of protective gear for making dead any 132 kV circuit shall not require the opening of more than seven circuit breakers and these circuit breakers shall not be located at more than four different sites. Each **DNO** will have similar policies for managing complexity of lower voltage circuits.

9.2.3 The security requirements for the connection of **Power Generating Module**sare subject to economic consideration by the **DNO** and the **Generator**. A firm connection for a **Power Generating Module** should allow the full export at the **Registered Capacity** across the required **Power Factor** operating rangeto be exported via the **Distribution Network** at all times of the year and after one outage on any one circuit of the **Distribution Network**. ETR 124 provides additional advice on the management of constraints and security.

9.2.4 The decision as to whether or not a firm connection is required should be by agreement between the **DNO** and the **Generator**. The **DNO** should be able to provide an indication of the likely duration and magnitude of any constraints so that the **Generator** can make an informed decision. The **Generator** should consider the financial implications of a non-firm connection against the cost of a firm connection, associated **Distribution Network** reinforcement and the risk of any constraints due to **Distribution Network** restrictions.

9.2.5 Where the **DNO** expects the **Power Generating Module** to contribute to system security, the provisions of EREC P2 and the guidance of EREP 130 will apply. In addition, the **Power Generating Module** should either remain synchronised and in parallel with the **Distribution Network** under the outage condition being considered or be capable of being resynchronised within the time period specified in EREC P2. There may be commercial issues to consider in addition to the connection cost and this may influence the technical method which is used to achieve a desired security of supply.

9.2.6 When designing a scheme to connect **a Power Generating Module**, consideration shall be given to the contribution which that **Power Generating Module** will make to short circuit current flows on the **Distribution Network**. The assessment of the fault level contribution from a **Power Generating Module** and the impact on the suitability of connected switchgear are discussed in Section 9.7.

9.2.7 It is clearly important to avoid unwanted tripping of the **Power Generating Module** particularly where the **Power Generating Module** is providing **Distribution Network** or **Total System** security. The quality of supply and stability of **Power Generating Module** performance are dealt with in Sections 9.4 and 9.5 respectively.

9.2.8 **Power Generating Module**smay be connected via existing circuits to which load and/or existing **Power Generating Module**sare also connected. The duty on such circuits, including load cycle, **Active Power** and **Reactive Power** flows, and voltage implications on the **Distribution Network** will need to be carefully reviewed by the **DNO**, taking account of maximum and minimum load and generation export conditions during system intact conditions and for maintenance outages of both the **Distribution Network** and **Power Generating Module**s. In the event of network limitations, ETR 124 provides guidance to **DNO**s on overcoming such limitations using active management solutions.

9.2.9 A **DNO** assessing a proposed connection of a **Power Generating Module** will also consider its effects on the **Distribution Network** voltage profile and voltage control employed on the **Distribution Network**. Voltage limits and control issues are discussed in Sections 11, 12 and 13 for each **Power Generating Module** type.

## Step Voltage Change and Rapid Voltage Change

9.3.1 The **Step Voltage Change** and **Rapid Voltage Change** caused by the connection and disconnection of **Power Generating Module**s from the **Distribution Network** shall be considered and be subject to limits to avoid unacceptable voltage changes being experienced by other **Customer**s connected to the **Distribution Network**. The magnitude of a **Step Voltage Change** depends on the method of voltage control, types of load connected and the presence of local generation.

9.3.2 Limits for **Step Voltage Change** and **Rapid Voltage Change** caused by the connection and disconnection of any **Customer**s equipment to the **Distribution Network** should be within the limits set out in EREC P28.

9.3.3 The voltage depression arising from transformer magnetising inrush current is a short-time phenomenon captured by considerations of **Rapid Voltage Change**. In addition the size of the depression is dependent on the point on wave of switching and the duration of the depression is relatively short in that the voltage recovers substantially in less than 1 s.

9.3.4 **Generator’s Installation**s shall be designed taking account of the advice in EREC P28 in respect of transformer energisation assessment such that transformer magnetising inrush current associated with normal routine switching operations does not cause voltage fluctuations outside those in EREC P28. To achieve this it may be necessary to install switchgear so that sites containing multiple transformers can be energised in stages.

9.3.5 These threshold limits shall be complied with at the **Point of Common Coupling** as required by EREC P28.

## Power Quality

* + 1. Introduction

9.4.1.1 The connection and operation of **Power Generating Module**smay cause **Phase (Voltage) Unbalance** and/or a distortion of the **Distribution Network** voltage waveform resulting in voltage fluctuations and harmonics.

* + 1. Flicker

9.4.2.1 Where the input motive powerof the **Power Generating Module** may vary rapidly, causing corresponding changes in the output power, flicker may result. The operation of a **Power Generating Module** including synchronisation, run-up and desynchronisation shall not result in flicker that breaches the limits for flicker that is non-compliant with EREC P28.

9.4.2.2 The supply impedance of the **Distribution Network** needs to be considered to ensure that the emissions produced by the **Power Generating Module** do not cause a problem on the **Distribution Network**.

9.4.2.3 For **Power Generating Module**s up to 17 kW per phase or 50 kW three phase voltage step change and flicker measurements as required by BS EN 61000-3-11 shall be made and recorded in the test declaration Form A2-1, Form A2-2 or Form A2-3 (Annex A.2) as applicable for the **Power** **Generating Module**.The **DNO** will use these declared figures to calculate the required maximum supply impedance required for the connection to comply with EREC P28. This calculation may show that the voltage fluctuations will be greater than those permitted and hence reinforcement of the **Distribution Network** may be required before the **Power Generating Module** can be connected. Detailed testing requirements are described in Annex A.7.

* + 1. Harmonic Emissions

9.4.3.1 Harmonic currents produced within the **Generator’s Installation** and modification of the harmonic impedance caused by the addition of the **Generator’s Installation** may cause excessive harmonic voltage distortion in the **Distribution Network**. The **Generator’s** **Installation** shall be designed and operated to comply with the planning criteria for harmonic voltage distortion as specified in EREC G5. EREC G5, like all planning standards referenced in this recommendation, is applicable at the time of connection of additional equipment to a **Generator’s Installation**.

9.4.3.2 For **Power Generating Module**s of up to 17 kW per phase or 50 kW three phase harmonic measurements as required by BS EN 61000-3-12 shall be made and recorded in the test declaration Form A2-1, Form A2-2 or Form A2-3 (Annex A.2) as applicable for the **Power Generating Module**. The **DNO** will use these declared figures to calculate the required maximum supply impedance required for the connection to comply with BS EN 61000-3-12 and will use this data in its design of the connection for the **Power Generating Module**. This standard requires a minimum ratio between source fault level and the size of the **Power Generating Module**, and connections in some cases may require the installation of a transformer between 2 and 4 times the rating of the **Power Generating Module** in order to accept the connection to a **DNO**’s **Distribution Network**. Detailed testing requirements are described in Annex A.7.

9.4.3.3 Where the **Power Generating Module** is connected via a long cable circuit the likelihood of a resonant condition is greatly increased, especially at 132 kV. This arises from the reaction of the transformer inductance with the cable capacitance. Resonance is likely in the low multiples of the fundamental frequency (8th-11th harmonic). The resonant frequency is also a function of the **Total System** fault level. If there is the possibility that this can change significantly eg by the connection of another **Power Generating Module** then a full harmonic study should be carried out.

* + 1. Voltage Imbalance

9.4.4.1 EREC P29 is a planning standard which provides limits for voltage unbalance caused by uneven loading of three phase supply systems. **Power Generating Module**s should be capable of performing satisfactorily under the conditions EREC P29 defines. The existing voltage unbalance on an urban **Distribution Network** rarely exceeds 0.5% but higher levels, in excess of 1%, may be experienced at times of high load and when outages occur at voltage levels above 11 kV. 1% may exist continuously due to unbalance of the system impedance (common on remote rural networks). In addition, account can be taken of the neutralising effect of rotating plant, particularly at 11 kV and below. BS EN 50160 contains details of the variations and disturbances to the voltage which shall be taken into account in selecting equipment of an appropriate specification for installation on or connected to the **Distribution Network**.

9.4.4.2 The level of voltage unbalance at the **Point of Common Coupling** should be no greater than 1.3% for systems with a nominal voltage below 33 kV, or 1% for other systems with a nominal voltage no greater than 132 kV. Overall, voltage unbalance should not exceed 2% when assessed over any one minute period. EREC P29, like all planning standards, is applicable at the time of connection.

9.4.4.3 For **Power Generating Facilities** of 50 kW or less Section 7.5 of this document specifies maximum unbalance of **Power Generating Module**s. Where these requirements are met then no further action is required by the **Generator**.

9.4.5 **Power Factor** correction equipment is sometimes used with **Power Park Module**s to decrease **Reactive Power** flows on the **Distribution Network**. Where the **Power Factor** correction equipment is of a fixed output, stable operating conditions in the event of loss of the **DNO** supply are extremely unlikely to be maintained, and therefore no special protective actions are required in addition to the standard protection specified in this document.

9.4.6 DC Injection

9.4.6.1 The effects of, and therefore limits for, DC currents injected into the **Distribution Network** is an area currently under investigation. Until these investigations are concluded the limit for DC injection is less than 0.25% of the AC rating per **Power Generating Module**.

9.4.6.2 The main source of these emissions are from transformer-less **Inverter**s.Where necessary DC emission requirements can be satisfied by installing a transformer on the AC side of an **Inverter**.

* 1. System Stability

9.5.1 Instability in **Distribution Network**s may result in unacceptable quality of supply and tripping of **Generator**s’ plant. In severe cases, instability may cascade across the **Distribution Network**, resulting in widespread tripping and loss of demand and generation. There is also a risk of damage to plant.

9.5.2 In general, **System Stability** is an important consideration in the design of **Power Generating Module** connections to the **Distribution Network** at 33 kV and above. Stability considerations may also be appropriate for some **Power Generating Module** connections at lower voltages. The risks of instability generally increase as **Power Generating Module** capacity increases relative to the fault level infeed from the **Distribution Network** at the **Connection Point**.

9.5.3 **System Stability** may be classified into several forms, according firstly to the main system variable in which instability can be observed, and secondly to the size of the system disturbance. In **Distribution Network**s, the forms of stability of interest are rotor angle stability and voltage stability.

9.5.3.1 Rotor angle stability refers to the ability of synchronous machines in an interconnected system to remain in **Synchronism** after the system is subjected to a disturbance.

9.5.3.2 Voltage stability refers to the ability of a system to maintain acceptable voltages throughout the system after being subjected to a disturbance.

9.5.3.3 Both rotor angle stability and voltage stability can be further classified according to the size of the disturbance.

9.5.3.4 Small-disturbance stability refers to the ability of a system to maintain stability after being subjected to small disturbances such as small changes in load, operating points of **Power Generating Module**s, transformer tap-changing or other normal switching events.

9.5.3.5 Large-disturbance stability refers to the ability of a system to maintain stability after being subjected to large disturbances such as short-circuit faults or sudden loss of circuits or **Power Generating Module**s.

9.5.3.6 Traditionally, large-disturbance rotor angle stability (also referred to as transient stability) has been the form of stability predominantly of interest in **Distribution Network**s with synchronous machines. However, it should be noted that the other forms of stability may also be important and may require consideration in some cases.

9.5.4 It is recommended thata **Power Generating Module** and its connection to the **Distribution Network** be designed to maintain stability of the **Distribution Network** for a defined range of initial operating conditions and a defined set of system disturbances.

9.5.4.1 The range of initial operating conditions should be based on those which are reasonably likely to occur over a year of operation. Variables to consider include system loads, system voltages, system outages and configurations, and **Power Generating Module** operating conditions.

9.5.4.2 The system disturbances for which stability should be maintained should be selected on the basis that they have a reasonably high probability of occurrence. It is recommended that these include short-circuit faults on single **Distribution Network** circuits (such as transformers, overhead lines and cables) and busbars, that are quickly cleared by main protection.

9.5.5 With the systemin its normal operating state, it is desirable that all **Power Generation Module**s remain connected and stable for each of the following credible fault outages;

* + 1. any one single circuit overhead line, transformer feeder or cable circuit, independent of length;
    2. any one transformer or reactor;
    3. any single section of busbar at or nearest the point of connection where busbar protection with a total clearance time of less than 200ms is installed; and
    4. if demand is to be secured under a second circuit outage as required by EREC P2, fault outages (a) or (b), overlapping with any pre-existing first circuit outage, usually for maintenance purposes. In this case the combination of circuit outages considered should be that causing the most onerous conditions for **System Stability**, taking account of the slowest combination of main protection, circuit breaker operating times and strength of the connections to the system remaining after the faulty circuit or circuits have been disconnected.

9.5.6 It should be noted that it is impractical and uneconomical to design for stability in all circumstances. This may include double circuit fault outages and faults that are cleared by slow protection. **Power Generating Module**s that become unstable following system disturbances shall be disconnected as soon as possible to reduce the risk of plantdamage and disturbance to the system.

9.5.7 Various measures may be used, where reasonably practicable, to prevent or mitigate system instability. These may include **Distribution Network** and **Power Generating Module** solutions, such as:

1. improved fault clearance times by means of faster protection;
2. improved performance of **Power Generating Module** control systems (excitation and governor/prime mover control systems; **Power System Stabiliser**s to improve damping);
3. improved system voltage support (provision from either **Power Generating Module** or **Distribution Network** plant);
4. reduced plant reactance’s (if possible);
5. installation of protection to identify pole-slipping; and
6. increased fault level infeed from the Distribution Network at the **Connection Point.**

In determining mitigation measures which are reasonably practicable, due consideration should be given to the cost of implementing the measures and the benefits to the **Distribution Network** and **Generator**s in terms of reduced risk of system instability.

* 1. Island Mode
     1. Apart from switched alternative (OM4 – which is covered specifically in section 7.4 above) there are three specific instances of island mode operation to be considered:
        + 1. Long term parallel operation with islanding capability (OM2)

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**;

(b) Infrequent short term parallel operation (OM3)

for standby generation, a short term parallel is required to maintain continuity of supply during changeover and to facilitate testing of the **Power Generating Module;** or

(c) DNO’s Distribution Network island

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**.

* + 1. Long Term Parallel Operation with Islanding (OM2)
       1. Where a **Generator** intends to operate the **Power Generating Module** so that it supplies all or part of 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.
       2. The **Customer’s Installation** may be designed for a **Power Generating Module** to be switched manually or automatically to supply all or part of the **Customer’s Installation** in island mode. If the switching is automatically initiated, this may be for a number of reasons, including loss of supply from the **DNO**’s **Distribution Network** and/or market/commercial signals etc. By default any protection or control equipment that the **Customer** installs to initiate islanding on the loss of the incoming supply shall have settings that match or are compatible with the settings of the interface protection required by section 10 of this EREC G99. Any settings that initiate islanding for disturbances which the section 10 interface protection would not consider a loss of mains must be specifically agreed with the **DNO** and recorded in the **Connection Agreement** – please see 9.6.2.7 below.
       3. Where the **Customer** uses the EREC G99 interface protection to detect loss of incoming supply the **Customer** shall demonstrate that the arrangement introduces no risk of interfering with the main function of the interface protection when operating in parallel mode.
       4. For **Power Generating Module**s incorporating **Electricity Storage** the overall design of the **Customer’s Installation** and its operation, should conform to the islanding requirements of the current edition of The IET’s Code of Practice “Electricity Energy Storage Systems”.
       5. The earthing and changeover arrangements shall be designed in accordance with the requirements of section 8 of this EREC G99 which are appropriate for both parallel and switched alternative operation (ie figures 8.1 - 8.4, 8.6 for HV connected **Customers**,figures 8.5, 8.7- 8.11, 8.15 for LV connected industrial or commercial **Customers** and figures 8.12 – 8.14 for domestic **Customers**. The exact designs of **Customer’s Installation**s will vary, but the functional requirements of these figures shall be implemented. **Power Generating Modules** **Manufacturers** may choose to include the necessary switchgear integrated into the **Power Generating Module**, or provide the necessary control functions to switch external contactors.
       6. 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**.
       7. Generation, including where consisting of or incorporating **Electricity Storage**, shall observe the **Fault Ride Through** requirements required in sections 12 or 13 of this EREC G99 as appropriate. **Customers’ Installations** where large demands are supplied from the **DNO’s Distribution Network**, but are backed up by generation or **Electricity Storage** running in long term parallel mode, shall not trip from the network to run in island mode for voltage disturbances which require the connected generation to ride through and remain operating in parallel with the **DNO’s Distribution Network**.
       8. An exception to 9.6.2.7 shall be allowed if:

1. the **Customer’s Installation** is not a generation-only site[[13]](#footnote-16); and
2. if the resultant change in **Active Power** flow at the **Connection Point** is
3. less than 5MW; and
4. less than 10% of the greater of the maximum export capacity or maximum import capacity.
   * + 1. Reconnection of the generation shall be in accordance with section 14.5 of this EREC G99.
     1. Infrequent Short Term Parallel Operation (OM3)
        1. This mode of operation typically enables **Power Generating Module**s to operate as a standby to the **DNO**’s supply. A short term parallel is required to maintain continuity of supply during changeover and to facilitate testing of the **Power Generating Module**. The specific requirements for this mode of operation are set out in section 9.6.3 of this EREC G99.
        2. In this mode of operation, parallel operation of the **Power Generating Module** and the **Distribution Network** will be infrequent and brief and under such conditions, it is considered acceptable to relax certain design requirements (such as protection requirements or earthing requirements), that would be applicable to long term parallel operation. Power Generating Modules that are designed for infrequent short term parallel operation only do not need to comply with sections 11, 12 or 13 of this EREC G99.
        3. As the design requirements for a **Power Generating Module** operating in this mode are relaxed compared with those for long term parallel operation, it is necessary for the **DNO** to specify a maximum frequency and duration of short term parallel operation, to manage the risk associated with the relaxed design requirement. Therefor the **Power Generating Module** may be permitted to operate in parallel with the **Distribution Network** for no more than 5 minutes in any month, and no more frequently than once per week. If the duration of parallel connection exceeds this period, or this frequency, then the **Power Generating Module** shall be considered as if it is, or can be, operated in long term parallel operation with islanding mode (ie OM2). An alternative frequency and duration may be agreed between the **DNO** and the **Generator** taking account of particular site circumstances and **Power Generating Module** design. An electrical time interlock should be installed to ensure that the period of parallel operation does not exceed the agreed period. The timer should be a separate device from the changeover control system such that failure of the auto changeover system will not prevent the parallel being broken.
        4. The following design variations from those in the remainder of this EREC G99 are appropriate for infrequent short term parallel operation:
5. Protection Requirements – Infrequent short term parallel operation requires only under/over voltage and under/over frequency protection. This protection only needs to be in operation for the time the **Power Generating Module** is operating in parallel. A specific Loss of Mains (LoM) protection relay is not required, although many multifunction relays now have this function built in as standard. Similarly, additional requirements such as neutral voltage displacement, intertripping and reverse power are not required. This is based on the assumptions that as frequency and duration of paralleling during the year are such that the chance of a genuine LoM event coinciding with the parallel operation is unlikely. However, if a coincidence does occur, consideration shall be given to the possibility of the **Power Generating Module** supporting an island of **Distribution Network** as under voltage or under frequency protection is only likely to disconnect the **Power Generating Module** if the load is greater than the **Power Generating Module** capacity. Consequently it is appropriate to apply different protection settings for infrequent short term parallel operation. As this **Power Generating Module** will not be expected to provide grid support or contribute to system security, more sensitive settings based on statutory limits would compensate for lack of LoM protection. Ultimately, if an island was established the situation would only persist for the duration of the parallel operation timer setting before generation was tripped. The recommended protection settings for infrequent short term parallel operation are given in section 10.6.7.2.
6. Connection with Earth – It is recommended that the **Power Generating Module**’s star points or neutrals are permanently connected to earth. In that way, the risks associated with switching are minimized and the undesirable effects of circulating currents and harmonics will be tolerable for the timescales associated with infrequent short-term parallel operation.
7. Fault Level – There is the need to consider the effect of the **Power Generating Module**’s contribution to fault level. The risks associated with any overstressing during infrequent short term parallel operation will need to be individually assessed and the process for controlling this risk agreed with the **DNO**.
8. Synchronising - The requirements of section 14.5 of this EREC G99 should be complied with. The installation should be designed such that the operation of a **Power Generating Module** does not produce voltage rises or steps at the **Connection Point** in excess of statutory limits. In general this should not be an issue with most infrequent short term parallel operation as at the time of synchronising with the **DNO’s Distribution Network** most sites will normally be generating only sufficient output to match the site load. Therefore the power transfer on synchronising should be small, with the **Power Generating Module** ramping down to transfer site load to the mains. If the **Power Generating Module** tripped at this point it could introduce a larger **Step** **Voltage Change** than would normally be acceptable for loss of **Power Generating Module** operating under a long term parallel arrangement but in this event it could be regarded as an infrequent event and subject to the requirements of Section 9.3.
9. Out-of-phase capabilities - All newly installed switchgear should be specified for the duty it is to undertake. Where existing switchgear which might not have this capability is affected by infrequent short term paralleling it is expected that it will not be warranted to replace it with switchgear specifically tested for out-of-phase duties, although the owner of each circuit breaker should specifically assess this. The synchronising circuit breaker (owned by the **Generator**) shall have this certified capability. For the avoidance of doubt, it is a requirement of the Electricity at Work Regulations that “no electrical equipment shall be put into use where its strength and capability may be exceeded in such a way as may give rise to danger.” Section 9.7 below provides more information on the assessment of such situations.
   * + 1. Some **Manufacturer**s have developed fast acting automatic transfer switches. These are devices that only make a parallel connection for a very short period of time, typically 100 – 200 ms. Under these conditions installing conventional **Interface Protection** with an operating time of 500 ms is not appropriate when the parallel will normally be broken before the protection has a chance to operate. There is however the risk that the device will fail to operate correctly and therefore a timer should be installed to operate a conventional circuit breaker if the parallel remains on for more than 1 s. The switch should be inhibited from making a transfer to the **DNO**’s **Distribution** **Network** whilst voltage and frequency are outside expected limits.
     1. **DNO**’s **Distribution Network** Island
        1. The provisions of this Section 9.6.4 apply to situations where island mode operation is envisaged both for the mutual benefit of **DNO**s and relevant **Generator**s. For **Anchor Power Station**s, additional or different technical requirements may be agreed and recorded in the **System Restoration** contract.
        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**sto 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.
        3. When considering whether **Power Generating Module**s can be permitted to operate in island mode,[[14]](#footnote-17) detailed studies need to be undertaken to ensure that the islanded system will remain stable and comply with all statutory obligations and relevant planning standards when separated from the remainder of the **Total System**. Before operation in island mode can be allowed, a contractual agreement between the **DNO** and **Generator** shall be in place and the legal liabilities associated with such operation shall be carefully considered by the **DNO** and the **Generator**. Consideration should be given to the following areas:
10. load flows, voltage regulation, frequency regulation, voltage unbalance, voltage flicker and harmonic voltage distortion;
11. earthing arrangements;
12. short circuit currents and the adequacy of protection arrangements;
13. **System Stability**;
14. re-synchronisation to the **Total System**; and
15. safety of personnel.
    * + 1. Suitable equipment will need to be installed to detect that an island situation has occurred and an intertripping scheme is preferred to provide absolute discrimination at the time of the event. Confirmation that a section of **Distribution Network** is operating in island mode, and has been disconnected from the **Total System**, will need to be transmitted to **the Power Generating Module**(s) protection and control schemes.
        2. The **ESQCR** requires that supplies to **Customers** are maintained within statutory limits at all times ie when they are supplied normally and when operating in island mode. Detailed system studies including the capability of the **Power Generating Module** and its control / protections systems will be required to determine the capability of the **Power Generating Module** to meet these requirements immediately as the island is created and for the duration of the island mode operation.
        3. The **ESQCR** also require that **Distribution Network**s are earthed at all times. **Generator**s, who are not permitted to operate their installations and plant with an earthed star-point when in parallel with the **Distribution Network**, shall provide an earthing transformer or switched star-point earth for the purpose of maintaining an earth on the system when islanding occurs. The design of the earthing system that will exist during island mode operation should be carefully considered to ensure statutory obligations are met and that safety of the **Distribution Network** to all users is maintained. Further details are provided in Section 8.
        4. Detailed consideration shall be given to ensure that protection arrangements are adequate to satisfactorily clear the full range of potential faults within the islanded system taking into account the reduced fault currents and potential longer clearance times that are likely to be associated with an islanded system.
        5. Switchgear shall be rated to withstand the voltages which may exist across open contacts under islanded conditions. The **DNO** may require interlocking and isolation of its circuit breaker(s) to prevent out of phase voltages occurring across the open contacts of its switchgear. Intertripping or interlocking should be agreed between the **DNO** and the **Generator** where appropriate.
        6. It will generally not be permissible to interrupt supplies to **DNO** **Customer**s for the purposes of re-synchronisation. The design of the islanded system shall ensure that synchronising facilities are provided at the point of isolation between the islanded network and the **DNO** supply. Specific arrangements for this should be agreed and recorded in **the Connection Agreement** with the **DNO**. If no facilities exist for the subsequent re-synchronisation with the rest of the **DNO**’s **Distribution Network** then the **Generator** will, under **DNO** instruction, ensure that the **Power Generating Module** is disconnected for re-synchronisation.

## Fault Contributions and Switchgear Considerations

* + 1. Under the **ESQCR** and the **EaWR** the **Generator** and the **DNO** have legal duties to ensure that their respective systems are capable of withstanding the short circuit currents associated with their own equipment and any infeed from any other connected system.
    2. The **Generator** may accept that protection installed on the **Distribution Network** can help discharge some of the legal obligations relating to fault clearance and, if requested, the **DNO** should consider allowing such faults on the **Generator’s Installation** to be detected by **DNO** protection systems and cleared by the **DNO**’s circuit breaker. The **DNO** will not allow the **Generator** to close the **DNO**’s circuit breaker nor to synchronise using the **DNO**’s circuit breaker. In all such cases the exact nature of the protection afforded by the **DNO**’s equipment should be agreed and documented. The **DNO** may make a charge for the provision of this service.
    3. The design and safe operation of the **Generator’s Installation** and the **DNO’s Distribution Network** depend upon accurate assessment of the contribution to the short circuit current made by all the **Power Generating Module**s operating in parallel with the **Distribution** **Network** at the instant of fault and the **Generator** should discuss this with the **DNO** at the earliest possible stage.
    4. Short circuit current calculations should take account of the contributions from all synchronous and asynchronous infeeds including induction motors and the contribution from Inverter connected **Power Generating Module**s. The prospective short circuit ‘make’ and ‘break’ duties on switchgear should be calculated to ensure that plant is not potentially over-stressed. The maximum short circuit duty might not occur under maximum generation conditions; it may occur during planned or automatic operations carried out either on the **Distribution Network** or **Transmission System**. Studies shall consider all credible **Distribution Network** running arrangements which are likely to increase **Distribution Network** short circuit levels. The level of load used in the assessment should reflect committed projects as well as the existing loads declared in the **DNO**’s Long Term Development Statement (LTDS). Guidance on short circuit calculations is given in EREC G74.
    5. The connection of a **Power Generating Module** can raise the **Distribution Network** reactance/resistance (X/R) ratio. In some cases, this will place a more onerous duty on switchgear by prolonging the duration of the **DC** component of fault current from fault inception. This can increase the proportion of the **DC** component of the fault current and delay the occurrence of current zeros with respect to voltage zeros during the interruption of fault current. The performance of connected switchgear shall be assessed to ensure safe operation of the **Distribution Network**. The performance of protection may also be impaired by partial or complete saturation of current transformers resulting from an increase in **Distribution Network** X/R ratio.
    6. Newly installed protection systems and circuit breakers for **Power Generating Module** connections should be designed, specified and operated to account for the possibility of out-of-phase operation. It is expected that the **DNO**’s metering/interface circuit breaker will be specified for this duty, but in the case of existing circuit breakers on the **Distribution Network**, the **DNO** will need to establish the possibility or otherwise of the **DNO**’s protection (or the **Generator**’s protection if arranged to trip the **DNO**’s circuit breaker) initiating a circuit breaker trip during a period when one of more **Power Generating Module**s might have lost **Synchronism** with the **Total System**. Where necessary, switchgear replacement, improved security arrangements and other control measures should be considered to mitigate this risk.
    7. When connection of a **Power Generating Module** is likely to increase short circuit currents above **Distribution Network** design ratings, consideration should be given to the installation of reactors, sectionalising networks, connecting the **Power Generating Module** to part of the **Distribution Network** operating at a higher voltage, changing the **Power Generating Module** specification or other means of limiting short circuit current infeed. If fault limiting measures are not cost effective or feasible or have a significant effect on other users, **Distribution Network** plant with the potential to be subjected to short circuit currents in excess of its rating should be replaced or reference made to the relevant **Manufacturer** to determine whether or not the existing plant rating(s) can be enhanced. In situations where **Distribution Network** design ratings would be exceeded in infrequent but credible **Distribution Network** configurations, then constraining the **Power Generating Module** off during periods of such **Distribution Network** configurations may provide a suitable solution. When assessing short circuit currents against **Distribution Network** design ratings, suitable safety margins should be allowed to cater for tolerances that exist in the **Distribution Network** data and **Power Generating Module** parameters used in system modelling programs. On request from a **Generator** the **DNO** will provide the rationale for determining the value of a specific margin being used in **Distribution Network** studies.
    8. For busbars with three or more direct connections to the rest of the **Total System**, consideration may be given to reducing fault levels by having one of the connections 'open' and on automatic standby. This arrangement will only be acceptable provided that the loss of one of the remaining circuits will not cause the group to come out of S**ynchronism**, cause unacceptable voltage excursions or overloading of **Distribution Network** or **Transmission System** plant and equipment. The use of the proposed **Power Generating Module** to prevent overloading of **Distribution Network** plant and equipment should be considered with reference to EREC P2.
    9. Disconnection of a **Power Generating Module** shall be achieved by the separation of mechanical contacts unless the disconnection is at **Low Voltage** and the equipment at the point of disconnection contains appropriate self monitoring of the point of disconnection, in which case an appropriate electronic means such as a suitably rated semiconductor switching device would be acceptable. The self monitoring facility shall incorporate fail safe monitoring to check the voltage level at the output stage. In the event that the solid state switching device fails to disconnect the **Power Generating Module**, the voltage on the output side of the switching device shall be reduced to a value below 50 V within 0.5 s. For the avoidance of doubt, this disconnection is a means of providing LoM disconnection and not as a point of isolation to provide a safe system of work.

# Protection

## 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:

1. 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).
2. 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.
3. 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.
4. 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**.
5. 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 **DNO’s Distribution Network** island mode operation or has entered into a **System Restoration** contract, the **DNO** and the **Generator** shall agree variations to the standard arrangements described in this Section 10 to the extent necessary to facilitate island mode operation and/or **System Restoration**.

## Coordinating with DNO’s Distribution Network’s Existing Protection

10.2.1 It will be necessary for the protectionassociated with **Power Generating Module**s to coordinate with the **Protection** associated with the **DNO**’s **Distribution Network** as follows:-

1. For **Power Generating Module**s **directly** connected to the **DNO**’s **Distribution Network** the **Power Generating Module** shall meet the target clearance times for fault current interchange with the **DNO**’s **Distribution Network** in order to reduce to a minimum the impact on the **DNO**’s **Distribution Network** of faults on circuits owned by **the Generator**. The **DNO** will ensure that the **DNO** protection settings meet its own target clearance times.

The target clearance times are measured from fault current inception to arc extinction and will be specified by the **DNO** to meet the requirements of the relevant part of the **Distribution Network**.

1. The settings of any protection controlling a circuit breaker or the operating values of any automatic switching device at any point of connection with the **DNO**’s **Distribution Network**, as well as the **Generator**’s maintenance and testing regime, shall be agreed between the **DNO** and the **Generator** in writing during the connection consultation process.

It will be necessary for the **Power Generating Module** protection to coordinate with any auto-reclose policy specified by the **DNO**. In particular **the Power Generating Module** protection should detect a loss of mains situation and disconnect the **Power Generating Module** in a time shorter than any auto reclose dead time. This should include an allowance for circuit breaker operation and generally a minimum of 0.5 s should be allowed for this. For auto-reclosers set with a dead time of 3 s, this implies a maximum **Interface Protection** response time of 2.5 s. Where auto-reclosers have a dead time of less than 3 s, there may be a need to reduce the operating time of the **Interface Protection**. For **Type Tested** **Power Park Module**s no changes are required to the operating times irrespective of the auto-reclose times. In all other cases where the auto-recloser dead time is less than 3 s the **Generator** will need to agree site-specific **Interface** **Protection** settings with the **DNO**.

10.2.2 Specific protection required for **Power Generating Module**s

In addition to any protection installed by the **Generator** to meet the requirements of the **Power Generating Facility** and statutory obligations, the **Generator** shall install protection to achieve the following objectives:

1. For all **Power Generating Module**s:
   1. To disconnect the **Power Generating Module** from the system when a system abnormality occurs that results in an unacceptable deviation of the frequency or voltage at the **Connection Point**, recognizing the requirements to ride through faults as detailed in Sections 12.3 and 13.4; and
   2. To ensure the automatic disconnection of the **Power Generating Module** or **Generating Unit**, or where there is constant supervision of an installation, the operation of an alarm with an audio and visual indication, in the event of any failure of supplies to the protective equipment that would inhibit its correct operation.
2. For polyphase **Power Generating Modules**:
   1. To inhibit connection of **Power Generating Module**s to the system unless all phases of the **DNO**’s **Distribution Network** are present and within the agreed ranges of protection settings; and
   2. To disconnect the **Power Generating Module** from the system in the event of the loss of one or more phases of the **DNO**’s **Distribution Network**;
3. For single phase **Power Generating Module**s:
4. To inhibit connection of **Power Generating Module**s to the system unless that phase of the **DNO**’s **Distribution Network** is present and within the agreed ranges of protection settings; and
5. To disconnect the **Power Generating Module** from the system in the event of the loss of that phase of the **DNO**’s **Distribution Network**;

## Protection Requirements

* + 1. Suitable protection arrangements and settings will depend upon the particular **Generator** installation and the requirements of the **DNO**’s **Distribution Network**. These individual requirements shall be ascertained in discussions with the **DNO**. To achieve the objectives above, the protection shall include the detection of:
* Under Voltage (1 stage);
* Over Voltage (2 stage);
* Under Frequency (2 stage);
* Over Frequency (1 stage); and
* Loss of Mains (LoM).

The LoM protection will depend for its operation on the detection of some suitable parameter, for example, rate of change of frequency (RoCoF), or unbalanced voltages. More details on LoM protection are given in Section 10.4.

There are different protection settings dependent upon the system voltage at which the **Power Generating Module** is connected (**LV** or **HV**).

Protection settings for **Power** **Generating Facilities** over 100 MW **Registered Capacity** shall be consistent with **Grid Code** requirements. Loss of Mains protection will only be permitted at these sites if sanctioned by the **NETSO**– see Section 10.4.2 below.

It is in the interest of **Generator**s**, DNO**s and **NETSO** that **Power Generating Module**sremains synchronised to the **Distribution Network** during system disturbances, and conversely to disconnect reliably for true LoM situations. Frequency and voltage excursions less than the protection settings should not cause protection operation. As some forms of LoM protection might not readily achieve the required level of performance (eg under balanced load conditions), the preferred method for **Power Generating Facilities** with a **Registered Capacity** greater than 50 MWis by means of intertripping. This does not preclude consideration of other methods that may be more appropriate for a particular connection.

* + 1. The protective equipment, provided by the **Generator**, to meet the requirements of this section shall be installed in a suitable location that affords visual inspection of the protection settings and trip indicators and is secure from interference by unauthorised personnel.
    2. Installation of automatic reconnection systems for **Type B**, **Type C** and **Type D** shall be subject to prior authorisation by the **DNO**. Unless **Generators** of **Type D** **Power Generating Module**s have prior authorisation from the **DNO** for the installation of automatic reconnection systems, they shall obtain authorisation from the **DNO**, or **NETSO** where the **Generator** has a **CUSC** contract, as applicable, prior to synchronisation.
    3. The frequency and voltage at the **DNO**’s side of the supply terminals at the **Connection Point** shall be within the frequency and voltage ranges of the **Interface Protection** as listed in paragraph 10.6.7 for at least 20 s before **the Power Generating Module** is allowed to automatically reconnect to the **DNO’s Distribution Network**. There is in general no maximum admissible ramp rate for **Active Power** output on connecting or reconnecting, although it is a requirement to state the assumed maximum ramp rate for the **Power Generating Module** as part of the application for connection. If a network specific issue requires a maximum admissible ramp rate of **Active Power** output on connection it will be specified by in the **Connection Agreement**.
    4. If automatic resetting of the protective equipment is used, there shall be a time delay to ensure that healthy supply conditions exist for a minimum continuous period of 20 s. Reset times may need to be coordinated where more than one **Power Generating Module** is connected to the same feeder. The automatic reset shall be inhibited for faults on the **Generator’s Installation**.
    5. Protection equipment is required to function correctly within the environment in which it is placed and shall satisfy the following standards:
* BS EN 61000 (Electromagnetic Standards);
* BS EN 60255 (Electrical Relays);
* BS EN 61810 (Electrical Elementary Relays);
* BS EN 60947 (Low Voltage Switchgear and Control gear); and
* BS EN 61869 (Instrument Transformers; Additional requirements for current transformers).

Where these standards have more than one part, the requirements of all such parts shall be satisfied, so far as they are applicable.

* + 1. Protection equipment and protection functions may be installed within, or form part of the **Power Generating Module** control equipment as long as:

1. the control equipment satisfies all the requirements of Section 10 including the relevant standards specified in paragraph 10.3.6;
2. the **Power Generating Module** shuts down in a controlled and safe manner should there be an equipment failure that affects both the protection and control functionality, for example a power supply failure or microprocessor failure; and
3. the equipment is designed and installed so that protection calibration and functional tests can be carried out easily and safely using secondary injection techniques (ie using separate **Low Voltage** test equipment). 
   * 1. The health of protection tripping and/or auxiliary supplies must be monitored such that any failure of these supplies is either brought to the immediate attention of the **Generator** via an automatic alarm that is monitored by the **Generator** in real time, or the failure of the protection tripping and/or auxiliary supplies causes the **Power Generation Module** or **Generating Unit** to be tripped, and reconnection prevented before restoration of the protection tripping and/or auxiliary supplies that have been lost.

## Loss of Mains (LoM)

10.4.1 To achieve the objectives of Section 10.1.1, in addition to protection installed by the **Generator** for the **Generator**’s own purposes, the **Generator** shall install protection to achieve (amongst other things) disconnection of the **Power Generating Module** from the **Distribution Network** in the event of loss of one or more phases of the **DNO**’s supply. This LoM protection is required to ensure that the **Power Generating Module** is disconnected, to ensure that the requirements for **Distribution Network** earthing, and out-of-**Synchronism** closure are complied with and that **Customer**s are not supplied with voltage and frequencies outside statutory limits.

10.4.2 LoM protection is required for all **Type A, Type B and Type C Power Generating Module**s. For **Type D Power Generating Module**sthe **DNO** will advise if LoM protection is required. The requirements of paragraph 10.6.2 apply to LoM protection for all **Power Generating Module**s.

10.4.3 A problem can arise for **Generator**s who operate **Power Generating Module**sin parallel with the **Distribution Network** prior to a failure of the network supply because if a **Power Generating Module** continues to operate in some manner, even for a relatively short period of time, there is a risk that when the network supply is restored the **Power Generating Module** will be out of **Synchronism** with the **Total System** and suffer damage. LoM protection can be employed to disconnect the **Power Generating Module** immediately after the supply is lost, thereby avoiding damage to the **Power Generating Module**.

10.4.4 Where the amount of **Distribution Network** load that the **Power Generating Module** will attempt to pick up following a fault on the **Distribution Network** is significantly more than its capability the **Power Generating Module** will rapidly disconnect or stall. However, depending on the exact conditions at the time of the **Distribution Network** failure, there may or may not be a sufficient change of load on the **Power Generating Module** to be able to reliably detect the failure. The **Distribution Network** failure may result in one of the following load conditions being experienced by the **Power Generating Module**:

1. The load may slightly increase or reduce, but remain within the capability of the **Power Generating Module**. There may even be no change of load;
2. The load may increase above the capability of the prime mover, in which case the **Power Generating Module** will slow down, even though the alternator may maintain voltage and current within its capacity. This condition of speed/frequency reduction can be easily detected; or
3. The load may increase to several times the capability of the **Power Generating Module**, in which case the following easily detectable conditions will occur:

* Overload and accompanying speed/frequency reduction;
* Over current and under voltage on the alternator.

10.4.5 Conditions (b) and (c) are easily detected by the under and over voltage and frequency protection required in this document. However, condition (a) presents most difficulty, particularly if the load change is extremely small and therefore there is a possibility that part of the **Distribution Network** supply being supplied by the **Power Generating Module** will be out of **Synchronism** with the **Total System**. LoM protection is designed to detect these conditions.

10.4.6 LoM signals can also be provided by means of intertripping signals from circuit breakers that have operated in response to the **Distribution Network** fault.

10.4.7 The LoM protection can utilise one or a combination of the passive protection principles such as reverse **Active Power** flow, reverse **Reactive Power** and rate of change of frequency (RoCoF). Alternatively, active methods such as reactive export error detection or frequency shifting may be employed. These may be arranged to trip the interface circuit breaker at the **DNO - Generator** interface, thus, leaving the **Power Generating Module** available to satisfy the load requirements of the site or the **Power Generating Module** circuit breaker can be tripped, leaving the breaker at the interface closed and ready to resume supply when the **Distribution Network** supply is restored. The most appropriate arrangement is subject to agreement between the **DNO** and **Generator**.

10.4.8 Protection based on measurement of reverse flow of **Active Power** or **Reactive Power** can be used when circumstances permit and shall be set to suit the **Power Generating Module** rating, the site load conditions and requirements for **Reactive Power**.

10.4.9 Where the **Power Generating Facility** capacity is such that the site will always import power from the **Distribution Network**, a reverse power relay may be used to detect failure of the supply. It will usually be appropriate to monitor all three phases for reverse power.

10.4.10 However, where the **Power Generating Facilities** normal mode of operation is to export power, it is not possible to use a reverse power relay and consequently failure of the supply cannot be detected by measurement of reverse power flow. The protection should then be specifically designed to detect loss of the mains connection using techniques to detect the rate of change of frequency and/or **Power Factor**. All these techniques are susceptible to **Distribution Network** conditions and the changes that occur without islanding taking place. These relays shall be set to prevent islanding but with the best possible immunity to unwanted nuisance operation.

10.4.11 RoCoF relays use a measurement of the period of the mains voltage cycle. The RoCoF technique measures the rate of change in frequency caused by any difference between prime mover power and electrical output power of the **Power Generating Module** over a number of cycles. RoCoF relays should normally ignore the slow changes but respond to relatively rapid changes of frequency which occur when the **Power Generating Module** becomes disconnected from the **Total System**. The voltage vector shift technique is not an acceptable loss of mains protection.

10.4.12 Should spurious tripping present a nuisance to the **Generator**, the cause shall be jointly sought with the **DNO**. Raising settings on any relay to avoid spurious operation may reduce a relay's capability to detect islanding and it is important to evaluate fully such changes. Annex D.2 provides some guidance for assessments, which assume that during a short period of islanding the trapped load is unchanged. In some circumstances it may be necessary to employ a different technique, or a combination of techniques to satisfy the conflicting requirements of safety and avoidance of nuisance tripping. In those caseswhere the **DNO** requires LoM protection this shall be provided by a means not susceptible to spurious or nuisance tripping, eg intertripping.

10.4.13 For a radial or simple **Distribution Network** controlled by circuit breakers that would clearly disconnect the entire circuit and associated **Power Generating Module**, for a LoM event an intertripping scheme can be easy to design and install. For meshed or ring **Distribution Network**s, it can be difficult to define which circuit breakers may need to be incorporated in an intertripping scheme to detect a LoM event and the inherent risks associated with a complex system should be considered alongside those associated with a simple, but potentially less discriminatory LoM relay.

10.4.14 It is the responsibility of the **Generators** to incorporate what they believe to be the most appropriate technique or combination of techniques to detect a LoM event in their protection systems. This will be based on knowledge of the Power **Generating Module,** site and network load conditions. The **DNO** will assist in the decision making process by providing information on the **Distribution Network** and its loads. The settings applied shall be biased to ensure detection of islanding under all practical operating conditions.

## Additional DNO Protection

* + 1. Following the **DNO** connection study, the risk presented to the **Distribution** **Network** by the connection of a **Power Generating Module** may require additional protection to be installed and may include the detection of:
* Neutral Voltage Displacement (NVD);
* Over Current;
* Earth Fault; and
* Reverse Power.

This protection will normally be installed on equipment owned by the **DNO** unless otherwise agreed between the **DNO** and **Generator**. This additional protection may be installed and arranged to operate the **DNO** interface circuit breaker or any other circuit breakers, subject to the agreement of the **DNO** and the **Generator**.

The requirement for additional protection will be determined by each **DNO** according to the size of **Power Generating Module**, point of connection, network design and planning policy. This is outside the scope of this document.

When intertripping is considered to be a practical alternative, for detecting a LoM event, to using discriminating protection relays, the intertripping equipment would be installed by the **DNO**.

* + 1. Neutral Voltage Displacement (NVD) Protection
       1. Section 9.6 states that the **DNO** will undertake detailed consideration to ensure that protection arrangements are adequate to satisfactorily clear the full range of potential faults within an islanded system.
       2. Section 10.4 describes LoM protection which the **Generator** shall install to achieve (amongst other things) disconnection of the **Power Generating Module** from the **Distribution Network** in the event of loss of one or more phases of the DNO’s supply.
       3. Where a **Power Generating Module** inadvertently operates in island mode, and where there is an earth fault existing on the **DNO**’s **HV Distribution Network** NVD protection fitted on the **DNO**’s **HV** switchgear will detect the earth fault and disconnect the **HV** system from the island.
       4. **DNO**s need to consider specific investigation of the need for NVD protection when, downstream of the same prospective island boundary, there are one or more **Power Generating Module**s (with an output greater than 200 kVA per unit) having the enabled capacity to dynamically alter **Active Power** and **Reactive Power** output in order to maintain voltage profiles, and where such aggregate embedded generation output exceeds 50% of prospective island minimum demand.
       5. As a general rule for generation installations connected at 20 kV or lower voltages **DNO**s will not require NVD protection for the following circumstances:
* Single new **Power Generating Module** connection, of any type with an output less than 200 kVA;
* Multiple new **Power Generating Module** connections, of any type, on a single site, with an aggregated output less than 200 kVA;
* Single or multiple new **Power Generating Module** connections, of any type, where the voltage control is disabled or not fitted, on a single site, and where the aggregate output is greater than 200 kVA;
* Single or multiple new **Power Generating Module** connections, of any type, and where the voltage control is enabled, on a single site, where the aggregate output is greater than 200 kVA, but where the aggregate output is less than 50% of the prospective island minimum demand.

It should be noted that above is a “general rule”; each **DNO** will have differing network designs and so the decision will be made by the **DNO** according to the size of the **Power Generating Module**, **Connection Point**, network design and planning policy. This is outside the scope of this document.

* + - 1. If the assessed minimum load on a prospective island is less than twice the maximum combined output of new **Power Generating Module** consideration should be given to use of NVD protection as a part of the **Interface Protection**. The consideration should include an assessment of:

1. The specification of the capability of the LoM protection, including the provision of multiple independent detection techniques;
2. The influence of activation of pre-existing NVD protection already present elsewhere on the same prospective island; and
3. The opportunity arising from asset change/addition associated with the proposed new **Power Generating Module** connection eg the margin of additional cost associated with NVD protection.

## Protection Settings

* + 1. The following notes aim to explain the settings requirements as given in Section below.
    2. Loss of Mains

A LoM protection of the RoCoF type will generally be appropriate for **Type A**, **Type B** and **Type C** **Power Generating Module**s, but this type of LoM protection shall not be installed for **Power Generating Facilities** at or above 50 MW. In those cases where the **DNO** requires LoM protection this shall be provided by a means not susceptible to spurious or nuisance tripping, eg intertripping.

* + 1. Under Voltage

In order to help maintain **Total System** **Stability**, the protection settings aim to facilitate transmission fault ride through capability (as required in Sections 12.3 and 13.3 below). The overall aim is to ensure that **Power Generating Module** is not disconnected from the **Distribution Network** unless there is material disturbance on the **Distribution Network**, as disconnecting generation unnecessarily will tend to make an under voltage situation worse. To maximize the transmission fault ride through capability a single under voltage setting of - 20% with a time delay of 2.5 s should be applied.

* + 1. Over Voltage

Over voltages are potentially more dangerous than under voltages and hence the acceptable excursions from the norm are smaller and time delays shorter, a 2-Stage over voltage protection[[15]](#footnote-18) is to be applied as follows:

* Stage 1 (**LV**) should have a setting of +14% (ie the **LV** statutory upper voltage limit of +10%, with a further 4% permitted for voltage rise internal to the **Generator’s Installation** and measurement errors ), with a time delay of 1.0 s (to avoid nuisance tripping for short duration excursions);
* Stage 2 (**LV**) should have a setting of +19% with a time delay of 0.5 s (ie recognising the need to disconnect quickly for a material excursion);
* Stage 1 (**HV**) should have a setting of +10% with a time delay of 1.0 s (ie the **HV** statutory upper voltage limit of +6%, with a further 4% permitted for voltage rise internal to the **Generator’s Installation** and measurement errors), with a time delay of 1.0 s to avoid nuisance tripping for short duration excursions);
* Stage 2 (**HV**) should have a setting of +13% with a time delay of 0.5 s (ie recognising the need to disconnect quickly for a material excursion).

To achieve high utilisation and **Distribution Network** efficiency, it is common for the **HV** **Distribution Network** to be normally operated near to the upper statutory voltage limits. The presence of a **Power Generating Module** within such a **Distribution Network** may increase the risk of the statutory limit being exceeded, eg when the **Distribution Network** is operating abnormally. In such cases the **DNO** may specify additional over voltage protection at the **Power Generating Module Connection Point**. This protection will typically have an operating time delay long enough to permit the correction of transient over voltages by automatic tap-changers.

* + 1. Over Frequency

**Power Generating Module**s are required to stay connected to the **Total System** for frequencies up to 52 Hz for up to 15 minutes so as to provide the necessary regulation to control the **Total System** frequency to a satisfactory level. In order to prevent the unnecessary disconnection of a large volume of smaller **Power Generating Module**s, for all **LV** and **HV** connected **Power Generating Module**sa single stage protection is to be applied that has a time delay of 0.5 s and a setting of 52 Hz. If the frequency rises to or above 52 Hz as the result of an undetected islanding condition, the **Power Generating Module** will be disconnected with a delay of 0.5 s plus circuit breaker operating time.

* + 1. Under Frequency

**All Power Generating Facilities** are required to maintain connection unless the **Total System** frequency falls below 47.5 Hz for 20 s or below 47 Hz.

For all **LV** and **HV** connected **Power Generating Module**, the following 2-stage under frequency protection should be applied:

* Stage 1 should have a setting of 47.5 Hz with a time delay of 20 s;
* Stage 2 should have a setting of 47.0 Hz with a time delay of 0.5 s;
  + 1. Protection Settings

10.6.7.1

Table 10.1 Settings for Long-Term Parallel Operation

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Protection Function | **Type A, Type B and Type C Power Generating Module**s | | | | **Type D Power Generating Module**s **and Power Generating Facilities with a Registered Capacity > 50 MW** | |
| **LV** Protection(1) | | **HV** Protection(1) | |
| Trip Setting | Time Delay Setting | Trip Setting | Time Delay Setting | Trip Setting | Time Delay Setting |
| U/V | Vφ-n† -20% | 2.5 s\* | Vφ-φ‡ -20% | 2.5 s\* | Vφ-φ‡- 20% | 2.5 s\* |
| O/V st 1 | Vφ-n† + 14% | 1.0 s | Vφ-φ‡ + 10% | 1.0 s | Vφ-φ‡ + 10% | 1.0 s |
| O/V st 2 | Vφ-n†+ 19%$ | 0.5 s | Vφ-φ‡ + 13% | 0.5 s |  |  |
| U/F st 1 | 47.5 Hz | 20 s | 47.5 Hz | 20 s | 47.5 Hz | 20 s |
| U/F st 2 | 47.0 Hz | 0.5 s | 47.0 Hz | 0.5 s | 47.0 Hz | 0.5 s |
| O/F | 52.0 Hz | 0.5 s | 52.0 Hz | 0.5 s | 52.0 Hz | 0.5 s |
| LoM (RoCoF)# | 1 Hzs-1 time delay 0.5 s | | 1 Hzs-1 time delay 0.5 s | | Intertripping expected | |

1. **HV** and **LV** Protection settings are to be applied according to the voltage at which the voltage related protection reference is measuring, eg:

If the EREC G99 protection takes its voltage reference from an **LV** source then **LV** settings shall be applied. Where a private non-standard **LV** network exists the settings shall be calculated from **HV** settings values as indicated by Section 10.6.14;

If the EREC G99 protection takes its voltage reference from an **HV** source then **HV** settings shall be applied.

†A value of 230 V shall be used in all cases for **Power Generating Facilities** connected to a **DNO**’s **LV** **Distribution Network** ie the U/V **LV** trip setting is 184 V, the O/V stage 1 setting is 262.2 V and the O/V stage 2 setting is 273.7 V.

‡A value to suit the nominal voltage of the **HV** **Connection Point**.

\* Might need to be reduced if auto-reclose times are <3 s. (see 10.2.1).

# Intertripping may be considered as an alternative to the use of a LoM relay.

$ For voltages greater than 230 V +19% which are present for periods of<0.5 s the **Power Generating Module** is permitted to reduce/cease exporting in order to protect the **Power Generating Module**.

The required RoCoF protection requirement is expressed in Hertz per second (Hzs-1). The time delay should begin when the measured RoCoF exceeds the threshold expressed in Hzs‑1. The time delay should be reset if measured RoCoF falls below that threshold. The relay shall not trip unless the measured rate remains above the threshold expressed in Hzs-1 continuously for 500 ms. Setting the number of cycles on the relay used to calculate the RoCoF is not an acceptable implementation of the time delay since the relay would trip in less than 500 ms if the system RoCoF was significantly higher than the threshold.

1. Note that the times in the table are the time delays to be set on the appropriate relays. Total protection operating time from condition detection to circuit breaker opening will be of the order of 100 ms longer than the time delay settings in the above table with most circuit breakers, slower operation is acceptable in some cases.

The **Manufacturer** shall ensure that the **Interface Protection** in a **Type Tested Power Generating Module** is capable of measuring voltage to an accuracy of ±1.5% of the nominal value and of measuring frequency to ± 0.2% of the nominal value across its operating range of voltage, frequency and temperature.

10.6.7.2

Table 10.2 – Settings for Infrequent Short-Term Parallel Operation

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Protection Function | **Type A, Type B and Type C Power Generating Module** | | | |
| **LV** Protection | | **HV** Protection | |
| Trip Setting | Time Delay Setting | Trip Setting | Time Delay Setting |
| U/V | Vφ-n† -10% | 0.5 s | Vφ-φ‡ -6% | 0.5 s |
| O/V | Vφ-n† + 14% | 0.5 s | Vφ-φ‡ + 6% | 0.5 s |
| U/F | 49.5 Hz | 0.5 s | 49.5 Hz | 0.5 s |
| O/F | 50.5 Hz | 0.5 s | 50.5 Hz | 0.5 s |

†A value of 230 V shall be used in all cases for **Power Generating Facilities** connected to a **DNO**’s **LV** **Distribution Network** (ie the U/V **LV** trip setting is 207 V and the O/V trip setting is 262.2 V).

‡A value to suit the voltage of the **HV** **Connection Point**.

* + 1. Over and Under voltage protection shall operate independently for all three phases in all cases.
    2. The settings in Table 10.1 should generally be applied to all **Power Generating Module**s. In exceptional circumstances **Generator**s have the option to agree alternative settings with the **DNO** if there are valid justifications in that the **Power Generating Module** may become unstable or suffer damage with the settings specified in Table 10.1. The agreed settings should be recorded in the **Connection Agreement**.
    3. Once the settings of relays have been agreed between the **Generator** and the **DNO** they shall not be altered without the written agreement of the **DNO**. Any revised settings should be recorded again in the amended **Connection Agreement**.
    4. The under/over voltage and frequency protection may be duplicated to protect the **Power Generating Module** when operating in island mode although different settings may be required.
    5. For **LV** connected **Power Generating Module**s the voltage settings will be based on the 230 V nominal system voltage. In some cases **Power Generating Module**s may be connected to **LV** systems with non-standard operating voltages. Paragraph 10.6.14 details how suitable settings can be calculated based upon the **HV** connected settings in Table 10.1. Note that **Power Generating Module**s with non-standard **LV** protection settings need to be agreed by the **DNO** on a case by case basis.
    6. Where an installation contains **Power Factor** correction equipment which has a variable susceptance controlled to meet the **Reactive Power** demands, the probability of sustained generation is increased. For **LV** installations, additional protective equipment provided by the **Generator**, is required as in the case of self-excited asynchronous machines.
    7. Non-Standard private **LV** networks calculation of appropriate protection settings

The standard over and under voltage settings for **LV** connected **Power Generating Module**s have been developed based on a nominal voltage of 230 V. Typical **DNO** practice is to purchase transformers with a transformer winding ratio of 11000:433, with off load tap changers allowing the nominal winding ratio to be changed over a range of ± 5% and with delta connected **HV** windings. Where a **DNO** provides a connection at **HV** and the **Generator** uses transformers of the same nominal winding ratio and with the same tap selection as the **DNO** then the standard **LV** settings in Table 10.1 can be used for **Power Generating Module**s connected to the **Generator**’s **LV** network. Where a **DNO** provides a connection at **HV** and the **Generator**’s transformers have different nominal winding ratios, and he chooses to take the protection reference measurements from the **LV** side of the transformer, then the **LV** settings stated in Table 10.1 should not be used without the prior agreement of the **DNO**. Where the **DNO** does not consider the standard **LV** settings to be suitable, the following method shall be used to calculate the required **LV** settings based on the **HV** settings for **Type A** and **Type B Power Generating Facilities** stated in Table 10.1.

Identify the value of the transformers nominal winding ratio and if using other than the nominal tap, increase or decrease this value to establish a **LV** system nominal value based on the transformer winding ratio and tap position and the **DNO**s declared **HV** system nominal voltage.

For example a **Generator** is using an 11,000 V to 230/400 V transformer and it is proposed to operate it on tap 1 representing an increase in the **HV** winding of +5% and the nominal **HV** voltage is 11,000 V.

VLVsys =VLVnom xVHVnom/VHVtap

VLVsys = 230 x 11000/11550 = 219 V

Where:

VLVsys – **LV** system voltage

VLVnom - **LV** system nominal voltage (230 V)

VHVnom - **HV** system nominal voltage (11,000 V)

VHVtap – **HV** tap position

The revised **LV** voltage settings required therefore would be:

OV stage 1 = 219 x 1.1 = 241 V

OV stage 2 = 219 x 1.13 = 247.5 V

UV = 219 x 0.8 = 175 V

The time delays required for each stage are as stated in Table 10.1.

Where **Power Generating Module**s are designed with balanced 3 phase outputs and no neutral is required then phase to phase voltages can be used instead of phase to neutral voltages.

This approach should only be used by prior arrangement with the host **DNO**. Where all other requirements of EREC G99 would allow the **Power Generating Module** to be **Fully Type Tested**, the **Manufacturer** may produce a declaration in a similar format to Annex A.2 for presentation to the **DNO** by the **Generator**, stating that all **Power Generating Module**s produced for a particular **Power Generating Facility** comply with the revised over and under voltage settings. All other required data should be provided as for **Type Tested Power Generating Module**s as required by EREC G99. This declaration should make reference to a particular **Power Generating Facility** and its declared **LV** system voltage. These documents should not be registered on the ENA web site as they will not be of use to other **Generator**s who will have to consult with the **Manufacturer** and **DNO** to agree settings for each particular **Power Generating Facility**.

* + 1. The **Generator** shall provide a means of displaying the protection settings so that they can be inspected if required by the **DNO** to confirm that the correct settings have been applied. The **Manufacturer** needs to establish a secure way of displaying the settings in one of the following ways:
  1. A display on a screen which can be read;
  2. A display on an electronic device which can communicate with the **Power Generating Module** and confirm that it is the correct device by means of a Identification number / name permanently fixed to the device and visible on the electronic device screen at the same time as the settings;
  3. Display of all settings including nominal voltage and current outputs, alongside the identification number / name of the device, permanently fixed to the **Power Generating Module**.

The provision of loose documents, documents attached by cable ties etc., a statement that the device conforms with a standard, or provision of data on adhesive paper based products which are not likely to survive due to fading, or failure of the adhesive, for at least 20 years is not acceptable.

The protection arrangements (including changes to protection arrangements) for individual schemes will be agreed between the **Generator** and the **DNO** in accordance with this document.

* + 1. Whilst the protection schemes and settings for internal electrical faults should mitigate any damage to the **Power Generating Module** they shall not jeopardise the performance of a **Power Generating Module**, in line with the requirements set out in this EREC G99.
    2. The **Generator** shall organise its protection and control devices in accordance with the following priority ranking (from highest to lowest) for T**ype B, Type C and Type D Power Generating Modules:**

1. network and **Power Generating Module** protection;
2. synthetic inertia, if applicable;
3. frequency control (**Active Power** adjustment -if any);
4. power restriction (if any); and
5. power gradient constraint (if any).
   * 1. For the avoidance of doubt, where an internal fault on the **Power Generating Module** occurs during any significant event on the **Total System**, the **Power Generating Module**’s internal protection should trip the module to ensure safety and minimise damage to the **Power Generating Module**.

## Typical Protection Application Diagrams

* + 1. This Section provides some typical protection application diagrams in relation to parallel operation of **Power Generating Module**s within **DNO** **Distribution Network**s. The diagrams only relate to **DNO** requirements in respect of the connection to the **Distribution Network** and do not necessarily cover the safety of the **Generator’s** **Installation**. The diagrams are intended to illustrate typical installations.

Figure 10.1 - List of Symbols used in Figures 10.2 to 10.6.

Figure 10.2 - Typical Protection Arrangement for an **HV Power Generating Module** Connected to a **DNO**’s **HV Distribution Network** Designed for Parallel Operation Only.

Figure 10.3 - Typical Protection Arrangement for an **HV Power Generating Module** Connected to a **DNO**’s **HV Distribution Network** Designed for both Independent Operation (ie Standby Operation) and Parallel Operation.

Figure 10.4 - Typical Protection Arrangement for an **LV Power Generating Module** Connected to a **DNO**’s **HV Distribution Network** and designed for both Independent Operation (ie Standby Operation) and Parallel Operation.

Figure 10.5 - Typical Protection Diagram for an **LV Power Generating Module** Connected to a **DNO**’s **LV Distribution Network** Designed for Parallel Operation Only.

Figure 10.6 - Typical Protection Diagram for an **LV Power Generating Module** Connected to a **DNO**’s **LV Distribution Network** Designed for both Independent Operation (ie Standby Operation) and Parallel Operation.

**Diagram Notes:**

a. Neutral Voltage Displacement Protection

With arc suppression coil systems, the NVD relay should be arranged to provide an alarm only.

b. Reverse Power Protection

Reverse power protection may be either a standard three phase reverse power relay set to operate at above the agreed level of export into the **Distribution Network**, or a more sensitive relay if no export is permitted.

c. Directional Protection

In some cases overcurrent protection may afford adequate back-up protection to the **Distribution Network** during system faults. However, where increased sensitivity is required, three phase directional overcurrent IDMT relays, or alternative voltage based protection may be used.

d. Load Limitation Relay

Three phase definite time overcurrent relays, in addition to providing overload protection, could be arranged to detect phase unbalance. This condition may be due to pulled joints or broken jumpers on the incoming **DNO** underground or overhead **HV** supply.

NB Items (c) and (d) are alternatives and may be provided as additional protection.

e. Phase Unbalance Protection

Three phase thermal relays for detecting phase unbalance on the incoming **DNO** **HV** supply, eg pulled joints, broken jumpers or uncleared unbalanced faults.

f. Supply Healthy Protection

Some form of monitoring or protection is required to ensure that the **DNO**’s supply is healthy before synchronising is attempted. This could be automatic under and over voltage monitoring, applied across all three phases, together with synchronising equipment designed such that closing of the synchronising circuit breaker cannot occur unless the requirements of paragraph 10.3.4 are met.



Figure 10.1 - List of Symbols in Figures 10.2 – 10.6



Figure 10.2 - Typical Protection Arrangement for an HV Power Generating Module Connected to a DNO’s HV Distribution Network Designed for Long Term Parallel Operation without Islanding (OM1)



Figure 10.3 - Typical Protection Arrangement for an HV Power Generating Module Connected to a DNO’s HV Distribution Network Long Term Parallel Operation with Islanding (OM2)



Figure 10.4 - Typical Protection Arrangement for an LV Power Generating Module Connected to a DNO’s HV Distribution Network and designed for Long Term Parallel Operation with Islanding (OM2)



Figure 10.5 - Typical Protection Diagram for an LV Power Generating Module Connected to a DNO’s LV Distribution Network Designed for Long Term Parallel Operation without Islanding (OM1)



Figure 10.6 - Typical Protection Diagram for an LV Power Generating Module Connected to a DNO’s LV Distribution Network Designed Long Term Parallel Operation with Islanding (OM2)

# Type A Power Generating Module Technical Requirements

## Power Generating Module Performance and Control Requirements – General

* + 1. The requirements of this Section 11 do not apply in full to:

(a) **Power Generation Facilities** that are designed and installed for infrequent short-term parallel operation only; or

(b) **Electricity Storage** **Power Generation Module**s within the **Power Generating Facility** commissioned before 01 September 2022.

Refer to Annex A.4 for details.

* + 1. The **Active Power** output of a **Power Generating Module** should not be affected by voltage changes within the statutory limits declared by the **DNO** in accordance with the **ESQCR**.
    2. **Power Generating Module**s connected to the **DNO**’s **Distribution Network** shall be equipped wit**h** a logic interface (input port) in order to cease **Active Power** output within 5 s **following** an instruction being received at the input port.
       1. By default the **DNO** logic interface will take the form of a simple binary output that can be operated by a simple switch or contactor. When the switch is closed the **Power Generating Module** can operate normally. When the switch is opened the **Power Generating Module** will reduce its **Active Power** to zero within 5 s. The signal from the **Power Generating Module** that is being switched can be either AC (maximum value 240 V) or DC (maximum value 110 V). If the **DNO** wishes to make use of the facility to cease **Active Power** output the **DNO** will agree with the **Generator** how the communication path is to be achieved.
    3. Each item of a **Power Generating Module** and its associated control equipment shall be designed for stable operation in parallel with the **Distribution Network**.
    4. When operating at **Registered Capacity** the **Power Generating Module** shall be capable of operating at a **Power Factor** within the range 0.95 lagging to 0.95 leading relative to the voltage waveform unless otherwise agreed with the **DNO**.
    5. As part of the connection application process the **Generator** shall agree with the DNO the set points of the control scheme for voltage control, **Power Factor** control or **Reactive Power** control as appropriate. The control scheme, the settings, and any changes to the settings, shall be agreed with the **DNO** and recorded in the **Connection Agreement**. The information to be provided is detailed in Schedule 5a and Schedule 5b of the Data Registration Code.
    6. Load flow and **System Stability** studies may be necessary to determine any output constraints or post fault actions necessary for n-1 fault conditions and credible n-2 conditions (where n-1 and n-2 conditions are the first and second outage conditions as, for example, specified in EREC P2) involving a mixture of fault and planned outages. The **Connection Agreement** should include details of the relevant outage conditions. It may be necessary under these fault conditions, where the combination of **Power Generating Module** output, load and through flow levels leads to circuit overloading, to rapidly disconnect or constrain the **Power Generating Module**.

## Frequency response

* + 1. Under abnormal conditions automatic low-frequency load-shedding provides for load reduction down to 47 Hz. In exceptional circumstances, the frequency of the **DNO**’s **Distribution Network** could rise above 50.5 Hz. Therefore all **Power Generating Module**s shall be capable of continuing to operate in parallel with the **Distribution Network** in accordance with the following:

1. 47 Hz – 47.5 Hz Operation for a period of at least 20 s is required each time the frequency is within this range.
2. 47.5 Hz – 49.0 Hz Operation for a period of at least 90 minutes is required each time the frequency is within this range.
3. 49.0 Hz – 51.0 Hz Continuous operation of the **Power Generating Module** is required.
4. 51.0 Hz –51.5 Hz Operation for a period of at least 90 minutes is required each time the frequency is within this range.
5. 51.5 Hz – 52 Hz Operation for a period of at least 15 minutes is required each time the frequency is within this range.
   * 1. With regard to the rate of change of frequency withstand capability, a **Power Generating Module** shall be capable of staying connected to the **Distribution Network** and operate at rates of change of frequency up to 1 Hzs-1 as measured over a period of 500 ms unless disconnection was triggered by a rate of change of frequency type loss of mains protection or by the **Power Generating Module**’s own protection system for a co-incident internal fault as detailed in paragraph 10.6.18.
     2. Output power with falling frequency
        1. Each **Power** **Generating Module**, shall be capable of:
     3. continuously maintaining constant **Active Power** output for systemfrequency changes within the range 50.5 to 49.5 Hz; and
     4. (subject to the provisions of paragraph 11.2.1) maintaining its **Active Power** output at a level not lower than the figure determined by the linear relationship shown in Figure 11.1 for system frequency changes within the range 49.5 to 47 Hz for all ambient temperatures up to and including 25°C, such that if the system frequency drops to 47 Hz the **Active Power** output does not decrease by more than 5%. In the case of a **CCGT Module** this requirement shall be retained down to 48.8 Hz, which reflects the first stage of the automatic Low Frequency Demand Disconnection scheme. For system frequency below 48.8 Hz, the existing requirements shall be retained for a minimum period of 5 minutes while system frequency remains below 48.8Hz, and any special measure(s) that may be required to meet this requirement shall be kept in service during this period. After that 5 minute period, if system frequency remains below the 49.5 Hz threshold, the special measure(s) must be discontinued if there is a materially increased risk of the Gas Turbine tripping. The need for special measure(s) is linked to the inherent Gas Turbine **Active Power** output reduction caused by reduced shaft speed due to falling system frequency. Where the need for special measures is identified in order to maintain output in line with the level identified in Figure 11.1 these measures should still be continued at ambient temperatures above 25°C maintaining as much of the **Active Power** achievable within the capability of the plant.

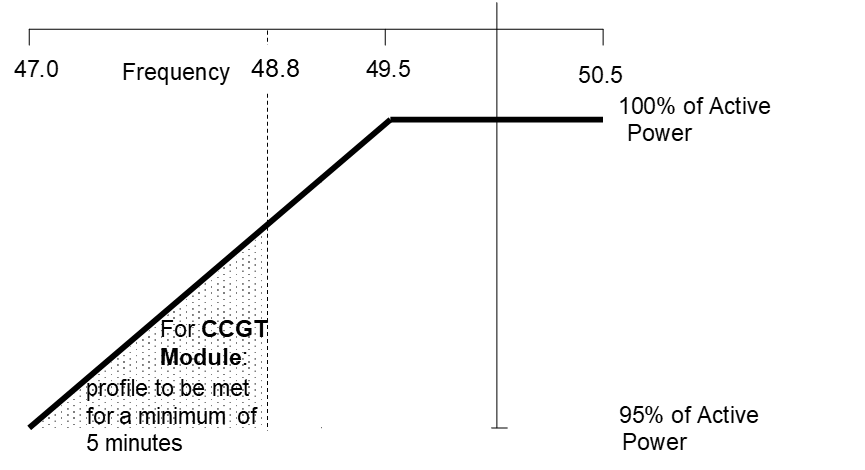


Figure 11.1 Change in Active Power with falling frequency

* + - 1. For the avoidance of doubt, in the case of a **Power Generating Module** using an **Intermittent Power Source** where the power input will not be constant over time, the requirement is that the **Active Power** output shall be independent of system frequencyunder (a) above and should not drop withsystem frequencyby greater than the amount specified in (b) above.
      2. **Electricity Storage Power Generating Module**swhen operating in an importing mode of operation:

11.2.3.3.1 Each **Generator** in respect of an **Electricity Storage Power Generating Module** is required to meet the requirements of 11.2.3.3.1 (a) – (f):

(a) Be capable of automatically maintaining its **Active Power** output within the shaded operating region shown in Figure 11.2 until the stored energy has been depleted. The **Electricity Storage Power Generating Module** could initially be operating at any level of import between zero **Active Power** and the **Rated Import Capacity** within a system frequency range of 50 Hz and 49.5 Hz as shown in Figure 11.2. The **Electricity Storage Power Generating Module** is only required to reach its **Registered** **Capacity** if the **Electricity Storage Power Generating Module** has headroom and the ability to increase **Active Power** output. A typical value of the **Droop** would be 0.6% where this does not result in control system instability or plant difficulties. In all cases the **Droop** shall be between 0.6% and 1.2% and shall be agreed with the **DNO**.

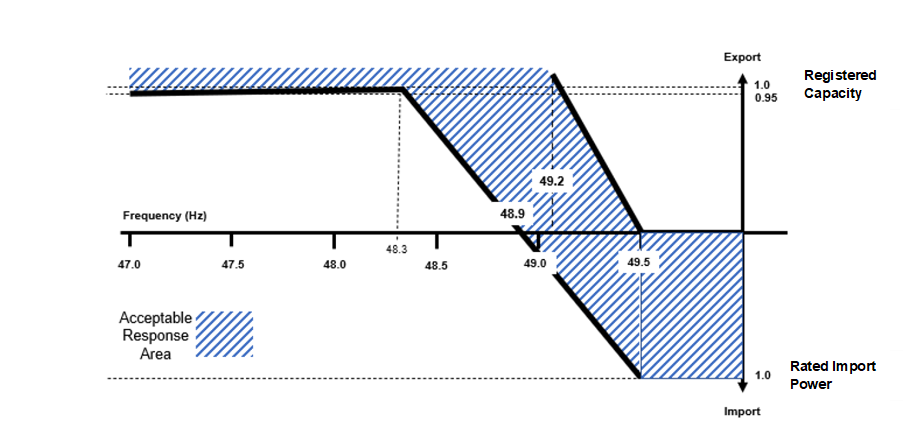
(b) Automatically respond in accordance with the characteristic of Figure 11.2 when the system frequency falls to 49.5 Hz and below.

(c) The reduction in **Active Power** import (during an import mode of operation), and the transition to the final value of **Active Power** output shall be continuously and linearly proportional, as far as is practicable, to the reduction in frequency below 49.5 Hz. **Active Power** output must be provided increasingly with time as required by 11.2.3.3.1 (d) below.

(d) As much as possible of the proportional reduction in **Active Power** import (when the **Electricity Storage Power Generating Module** is in a mode analogous to demand) must result from the frequency control device (or speed governor) action and must be achieved within 10 s of the time of the frequency decreases below 49.5 Hz. The **Electricity Storage Power Generating Module** shall be capable of initiating a power frequency response with an initial delay that is as short as possible. Delays that exceed 2 s shall be justified by the **Generator** providing technical evidence to the **DNO** and in any event as much as possible of the proportional reduction in **Active Power** import shall be achieved within 10 s. This performance requirement is to be maintained when the **Electricity Storage** device makes the transition to an **Active Power** export mode of operation unless the energy store is depleted, in which case it shall be required to operate at zero **Active Power** output.

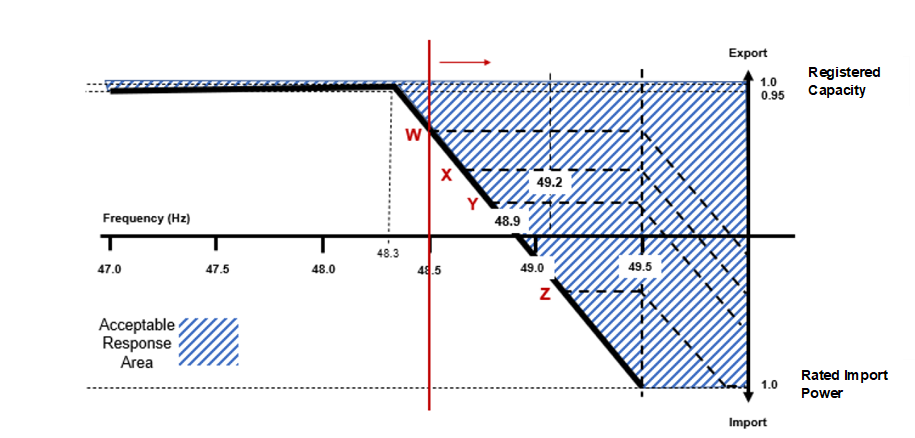
(e) Where the **Electricity Storage Power Generating Module** is not capable of making a transition from import operation to export operation within 20 s of the frequency falling to 49.2 Hz, then it shall immediately reduce its **Active Power** import to zero.

(f) If the **Electricity Storage Power Generating Module** has not achieved at least a zero **Active Power** import when the system frequency has reached 48.9 Hz, it shall be instantaneously tripped. Where an **Electricity Storage Power Generating Module** trips, it shall not reconnect to the system until the conditions of 10.3.3 to 10.3.5 are met.



**Figure 11.2 Active Power performance with falling frequency**

11.2.3.3.2 Where an **Electricity Storage Power Generating Module** has been importing and has responded in accordance with the requirements of 11.2.3.3.1, its performance, once the system frequency starts to rise above the minimum reached, shall be in accordance with Figure 11.3 in respect of the **Active Power** output and **Active Power** import. For example, Figure 11.3, illustrates the four operating points W, X, Y and Z. If points W, X, Y and Z denotes the minimum frequency that the **Total System** reached during a particular low system frequency event, as the system frequency starts to rise, the **Active Power** output of the **Electricity Storage Power Generating Module** should remain at a constant level (where the energy source has not been depleted) until 49.5 Hz is reached as denoted by the dashed black lines. Once the system frequency has risen above 49.5 Hz the **Electricity Storage Power Generating Module** is permitted to reduce **Active Power** output so long as it is operating within the shaded area above 49.5 Hz shown in Figure 11.3, unless the **Electricity Storage Power Generating Module** has insufficient capability in which case it shall operate at zero **Active Power**.



**Figure 11.3 Active Power performance with increasing frequency**

11.2.3.3.3 Where an **Electricity Storage Power Generating Module** is exporting **Active Power** to the **Total System** (including zero) and the system frequency falls below 49.5 Hz the requirements of 11.2.3.3.1 and 11.2.3.3.2 shall apply.

* + 1. **Limited Frequency Sensitive Mode – Overfrequency** 
       1. Each **Power Generating Module** shall be capable of reducing **Active Power** output in response to the frequency on the **Total System** when this rises above 50.4 Hz. The **Power Generating Module** shall be capable of operating stably during **LFSM-O** operation. If a **Power Generating Module** has been contracted to operate in **Frequency Sensitive Mode** the requirements of **LFSM-O** shall apply when the frequency exceeds 50.5 Hz.

1. The rate of change of **Active Power** output shall be at a minimum rate of 2% of output per 0.1 Hz deviation of system frequency above 50.4 Hz (ie a **Droop** of 10%) as shown in Figure 11. . For the avoidance of doubt, this would not preclude a **Generator** from designing the **Power Generating Module** with a **Droop** of less than 10%, but in all cases the **Droop** should be 2% or greater.
2. The **Power Generating Module** shall be capable of initiating a power frequency response with an initial delay that is as short as possible. If the initial delay exceeds 2 s the **Generator** shall justify the delay, providing technical evidence to the **DNO**,who will pass this evidence to the **NETSO**.
3. For deviations in frequency up to 50.9 Hz at least half of the proportional reduction in **Active Power** output shall be achieved within 10 s of the time of the frequency increase above 50.4 Hz. Refer to Figure A.7.10 for details.
4. For deviations in frequency beyond 50.9 Hz the measured rate of change of **Active Power** reduction shall exceed 0.5% s-1 of the initial output. Refer to Figure A.7.9 for details.
5. The **LFMS-O** response shall be reduced when the frequency subsequently falls again and, when to a value less than 50.4 Hz, at least half the proportional increase in **Active Power** shall be achieved in 10 s. For a frequency excursion returning from beyond 50.9 Hz the measured rate of change of **Active Power** increase shall t exceed 0.5% s-1.
6. If the reduction in **Active Power** is such that the **Power Generation Module** reaches its **Minimum Stable Operating Level**, it shall continue to operate stably at this level.



Pref is the reference **Active Power** to which ΔP is related and. ΔP is the change in **Active Power** output from the **Power Generating Module**.

Figure 11.4 Active Power Frequency Response capability when operating in LFSM-O

* + - 1. When the **Power Generating Module** is providing **Limited Frequency Sensitive Mode** **Overfrequency (LFSM-O)** response it shall continue to provide the frequency response until the frequency has returned to, or is below, 50.4 Hz.
      2. Steady state operation below **Minimum Stable Operating Level** is not expected but if system operating conditions cause operation below **Minimum Stable Operating Level** which give rise to operational difficulties then the **Generator** shall be able to return the output of the **Power Generating Module** to an output of not less than the **Minimum Stable Operating Level**.

## Fault Ride Through and Phase Voltage Unbalance

* + 1. Where it has been specifically agreed between the **DNO** and the **Generator** that a **Power Generating Facility** will contribute to the **DNO**’s **Distribution Network** security, (eg for compliance with EREC P2) the **Power Generating Module**(s) may be required to withstand, without tripping, the effects of a close up three phase fault and the **Phase (Voltage) Unbalance** imposed during the clearance of a close-up phase-to-phase fault, in both cases cleared by the **DNO**’s main protection. The **DNO** will advise the **Generator** in each case of the likely tripping time of the **DNO**’s protection, and for phase-phase faults, the likely value of **Phase (Voltage) Unbalance** during the fault clearance time.
    2. In the case of phase to phase faults on the **DNO**’s **Distribution Network** that are cleared by system back-up protectionwhich will be within the plant short time rating on the **DNO**’s **Distribution Network** the **DNO**, on request during the connection process, will advise the **Generator** of the expected **Phase (Voltage) Unbalance**.

## Voltage Limits and Control

* + 1. Where a **Power Generating Module** is remote from a **Network** voltage control point it may be required to withstand voltages outside the normal statutory limits. In these circumstances, the **DNO** should agree with the **Generator** the declared voltage and voltage range at the **Connection Point**. Immunity of the **Power Generating Module** to voltage changes of ± 10% of the declared voltage is recommended, subject to design appraisal of individual installations.
    2. The connection of a **Power Generating Module** to the **Distribution Network** shall be designed in such a way that operation of the **Power Generating Module** does not adversely affect the voltage profile of and voltage control employed on the **Distribution Network**. EREP 126 provides **DNO**s with guidance on active management solutions to overcome voltage control limitations. Information on the voltage regulation and control arrangements will be made available by the **DNO** if requested by the **Generator**.
    3. The final responsibility for control of **Distribution Network** voltage does, however, remain with the **DNO**.
    4. Automatic Voltage Control (AVC) schemes employed by the **DNO** often assume that power flows from parts of the **Distribution Network** operating at a higher voltage to parts of the **Distribution Network** operating at lower voltages. Export from **Power Generating Module**s in excess of the local loads may result in power flows in the reverse direction. In this case AVC referenced to the **Low Voltage** side may not operate correctly without an import of **Reactive Power** and relay settings appropriate to this operating condition. When load current compounding is used with the AVC and the penetration level of **Power Generating Module**sbecomes significant compared to normal loads, it may be necessary to switch any compounding out of service.
    5. **Power Generating Module**s can cause problems if connected to networks employing AVC schemes which use negative reactance compounding and line drop compensation due to changes in **Active Power** and **Reactive Power** flows. EREP 126 provides guidance on connecting generation to such networks using techniques such as removing the generation circuit from the AVC scheme using cancellation CTs.

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# Type B Power Generating Module Technical Requirements

## Power Generating Module Performance and Control Requirements - General

* + 1. The requirements of this Section 12 do not apply in full to:

1. **Power Generation Facilitie**sthat are designed and installed for infrequent short-term parallel operation only; or
2. **Electricity Storage** **Power Generation Module**s within the **Power Generating Facility** commissioned before 01 September 2022.

Refer to Annex A.4 for details.

* + 1. The **Active Power** output of a **Power Generating Module** should not be affected by voltage changes within the statutory limits declared by the **DNO** in accordance with the **ESQCR**.
    2. **Power Generating Module**s shall be equipped with a communication interface (input port) in order to be able to reduce **Active Power** output following an instruction at the input port.
       1. **DNO**s currently are developing active network management approaches and there is no common standard for communication interfaces.
       2. Protocols currently in use between **DNO**s and **Generator**s include simple current loop; DNP3 and IEC 61850.
       3. The **DNO** will discuss and agree with the **Generator** for each **Power** **Generating** **Facility** the protocol to be used, including how any risks of maloperation etc are to be managed.
       4. By default if nothing is specified by the **DNO** then a simple hard-wired current loop interface should be provided where a 4 mA to 20 mA DC signal corresponding to 0 pu to 1.0 pu of **Registered Capacity Active Power**.
       5. The **Active Power** reduction will be either between 1.0 pu of **Registered Capacity** **Active Power** and zero, or between 1.0 pu of **Registered Capacity Active Power** and **Minimum** **Stable Operating Level**. In the latter case the **Generator** will agree with the **DNO** how zero output can be achieved, including the option of using the logic interface as described in paragraph 11.1.3.1.
       6. If the **DNO** wishes to make use of the facility to reduce **Active Power** output the **DNO** will agree with the **Generator** the communication interface and other necessary equipment that will be needed.
    3. The **Power Generating Module** and its associated control equipment shall be designed for stable operation in parallel with the **Distribution Network**.
    4. Load flow and **System Stability** studies may be necessary to determine any output constraints or post fault actions necessary for n-1 fault conditions and credible n-2 conditions (where n-1 and n-2 conditions are the first and second outage conditions as, for example, specified in EREC P2) involving a mixture of fault and planned outages. The **Connection Agreement** should include details of the relevant outage conditions. It may be necessary under these fault conditions, where the combination of **Power Generating Module** output, load and through flow levels leads to circuit overloading, to rapidly disconnect or constrain the **Power Generating Module**.

## Frequency response

* + 1. Under abnormal conditions automatic low-frequency load-shedding provides for load reduction down to 47 Hz. In exceptional circumstances, the frequency of the **DNO**’s **Distribution Network** could rise above 50.5 Hz. Therefore all **Power Generating Module**s shall be capable of continuing to operate in parallel with the **Distribution Network** in accordance with the following:

1. 47 Hz – 47.5 Hz Operation for a period of at least 20 s is required each time the frequency is within this range;
2. 47.5 Hz – 49.0 Hz Operation for a period of at least 90 minutes is required each time the frequency is within this range;
3. 49.0Hz – 51.0 Hz Continuous operation of the **Power Generating Module** is required;
4. 51.0 Hz –51.5 Hz Operation for a period of at least 90 minutes is required each time the frequency is within this range; and
5. 51.5 Hz – 52 Hz Operation for a period of at least 15 minutes is required each time the frequency is within this range.
   * 1. With regard to the rate of change of frequency withstand capability, a **Power Generating Module** shall be capable of staying connected to the **Distribution Network** and operate at rates of change of frequency up to 1 Hzs-1 as measured over a period of 500 ms unless disconnection was triggered by a rate of change of frequency type loss of mains protection or by the **Power Generating Module**’s own protection system for a co-incident internal fault as detailed in paragraph 10.6.18.
     2. Output power with falling frequency
        1. Each **Power** **Generating Module**, shall be capable of:
     3. continuously maintaining constant **Active Power** output for systemfrequency changes within the range 50.5 to 49.5 Hz; and
     4. (subject to the provisions of paragraph 12.2.1) maintaining its **Active Power** output at a level not lower than the figure determined by the linear relationship shown in Figure 12.1 for system frequency changes within the range 49.5 to 47 Hz for all ambient temperatures up to and including 25°C, such that if the system frequency drops to 47 Hz the **Active Power** output does not decrease by more than 5%. In the case of a **CCGT Module** this requirement shall be retained down to 48.8 Hz, which reflects the first stage of the automatic Low Frequency Demand Disconnection scheme. For system frequency below 48.8 Hz, the existing requirements shall be retained for a minimum period of 5 minutes while system frequency remains below 48.8 Hz, and any special measure(s) that may be required to meet this requirement shall be kept in service during this period. After that 5 minute period, if system frequency remains below the 49.5 Hz threshold, the special measure(s) must be discontinued if there is a materially increased risk of the Gas Turbine tripping. The need for special measure(s) is linked to the inherent Gas Turbine **Active Power** output reduction caused by reduced shaft speed due to falling system frequency. Where the need for special measures is identified in order to maintain output in line with the level identified in Figure 12.1 these measures should still be continued at ambient temperatures above 25°C maintaining as much of the **Active Power** achievable within the capability of the plant.

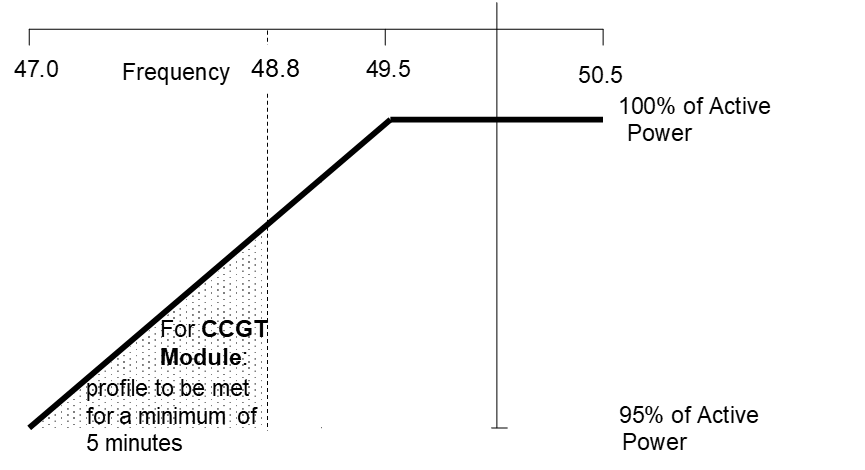


Figure 12.1 Change in Active Power with falling frequency

* + - 1. For the avoidance of doubt, in the case of a **Power Generating Module** using an **Intermittent Power Source** where the power input will not be constant over time, the requirement is that the **Active Power** output shall be independent of system frequencyunder (a) above and should not drop withsystem frequencyby greater than the amount specified in (b) above.
      2. **Electricity Storage Power Generating Module**swhen operating in an importing mode of operation

12.2.3.3.1 Each **Generator** in respect of an **Electricity Storage Power Generating Module** is required to meet the requirements of 12.2.3.3.1 (a) – (f):

(a) Be capable of automatically maintaining its **Active Power** output within the shaded operating region shown in Figure 12.2 until the stored energy has been depleted. The **Electricity Storage Power Generating Module** could initially be operating at any level of import between zero **Active Power** and the **Rated Import Capacity** within a system frequency range of 50 Hz and 49.5 Hz as shown in Figure 12.2. The **Electricity Storage Power Generating Module** is only required to reach its **Registered** **Capacity** if the **Electricity Storage Power Generating Module** has headroom and the ability to increase **Active Power** output. A typical value of the **Droop** would be 0.6% where this does not result in control system instability or plant difficulties. In all cases the **Droop** shall be between 0.6% and 1.2% and shall be agreed with the **DNO**.

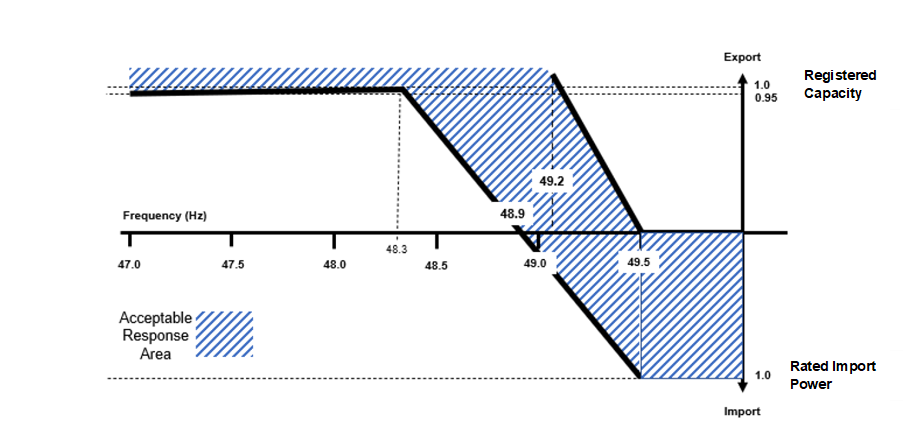
(b) Automatically respond in accordance with the characteristic of Figure 12.2 when the system frequency falls to 49.5 Hz and below.

(c) The reduction in **Active Power** import (during an import mode of operation), and the transition to the final value of **Active Power** output shall be continuously and linearly proportional, as far as is practicable, to the reduction in frequency below 49.5 Hz. **Active Power** output must be provided increasingly with time as required by 12.2.3.3.1 (d) below.

(d) As much as possible of the proportional reduction in **Active Power** import (when the **Electricity Storage Power Generating Module** is in a mode analogous to demand) must result from the frequency control device (or speed governor) action and must be achieved within 10 s of the time of the frequency decreases below 49.5 Hz. The **Electricity Storage Power Generating Module** shall be capable of initiating a power frequency response with an initial delay that is as short as possible. Delays that exceed 2 s shall be justified by the **Generator** providing technical evidence to the **DNO** and in any event as much as possible of the proportional reduction in **Active Power** import shall be achieved within 10 s. This performance requirement is to be maintained when the **Electricity Storage** device makes the transition to an **Active Power** export mode of operation unless the energy store is depleted, in which case it shall be required to operate at zero **Active Power** output.

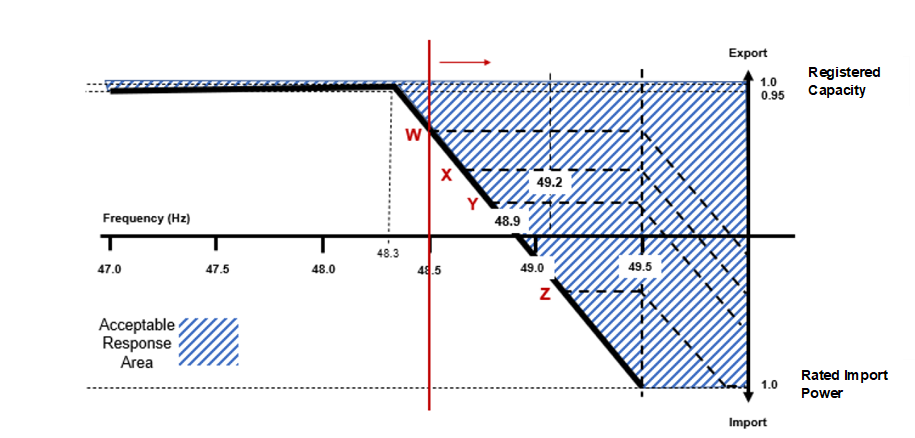
(e) Where the **Electricity Storage Power Generating Module** is not capable of making a transition from import operation to export operation within 20 s of the frequency falling to 49.2 Hz, then it shall immediately reduce its **Active Power** import to zero.

(f) If the **Electricity Storage Power Generating Module** has not achieved at least a zero **Active Power** import when the system frequency has reached 48.9 Hz, it shall be instantaneously tripped. Where an **Electricity Storage Power Generating Module** trips, it shall not reconnect to the system until the conditions of 10.3.3 to 10.3.5 are met.



**Figure 12.2 Active Power performance with falling frequency**

12.2.3.3.2 Where an **Electricity Storage Power Generating Module** has been importing and has responded in accordance with the requirements of 12.2.3.3.1, its performance, once the system frequency starts to rise above the minimum reached, shall be in accordance with Figure 12.3 in respect of the **Active Power** output and **Active Power** import. For example, Figure 12.3, illustrates the four operating points W, X, Y and Z. If points W, X, Y and Z denotes the minimum frequency that the **Total System** reached during a particular low system frequency event, as the system frequency starts to rise, the **Active Power** output of the **Electricity Storage Power Generating Module** should remain at a constant level (where the energy source has not been depleted) until 49.5 Hz is reached as denoted by the dashed black lines. Once the system frequency has risen above 49.5 Hz the **Electricity Storage Power Generating Module** is permitted to reduce **Active Power** output so long as it is operating within the shaded area above 49.5 Hz shown in Figure 12.3, unless the **Electricity Storage Power Generating Module** has insufficient capability in which case it shall operate at zero **Active Power**.



**Figure 12.3 Active Power performance with increasing frequency**

12.2.3.3.3 Where an **Electricity Storage Power Generating Module** is exporting **Active Power** to the **Total System** (including zero) and the system frequency falls below 49.5 Hz the requirements of 12.2.3.3.1 and 12.2.3.3.2 shall apply.

* + 1. **Limited Frequency Sensitive Mode – Overfrequency** 
       1. Each **Power Generating Module** shall be capable of reducing **Active Power** output in response to the frequency on the **Total System** when this rises above 50.4 Hz. The **Power Generating Module** shall be capable of operating stably during **LFSM-O** operation. If a **Power Generating Module**, has been contracted to operate in **Frequency Sensitive Mode** the requirements of **LFSM-O** shall apply when the frequency exceeds 50.5 Hz.

1. The rate of change of **Active Power** output shall be at a minimum rate of 2% of output per 0.1 Hz deviation of system frequency above 50.4 Hz (ie a **Droop** of 10%) as shown in Figure 12.4. For the avoidance of doubt, this would not preclude a **Generator** from designing the **Power Generating Module** with a **Droop** of less than 10%, but in all cases the **Droop** should be 2% or greater.
2. The **Power Generating Module** shall be capable of initiating a power frequency response with an initial delay that is as short as possible. If the initial delay exceeds 2 s the **Generator** shall justify the delay, providing technical evidence to the **DNO**,who will pass this evidence to the **NETSO**.
3. For deviations in frequency up to 50.9 Hz at least half of the proportional reduction in **Active Power** output shall be achieved within 10 s of the time of the frequency increase above 50.4 Hz.
4. For deviations in frequency beyond 50.9 Hz the measured rate of change of **Active Power** reduction shall exceed 0.5% s-1 of the initial output.
5. The **LFMS-O** response shall be reduced when the frequency subsequently falls again and, when to a value less than 50.4 Hz, at least half the proportional increase in **Active Power** shall be achieved in 10 s. For a frequency excursion returning from beyond 50.9 Hz the measured rate of change of **Active Power** increase shall exceed 0.5% s-1.
6. If the reduction in **Active Power** is such that the **Power Generation Modul**e reaches its **Minimum Stable Operating Level**, it shall continue to operate stably at this level.



Pref is the reference **Active Power** to which ΔP is related and. ΔP is the change in **Active Power** output from the **Power Generating Module**.

Figure 12.4 Active Power Frequency Response capability when operating in LFSM-O

* + - 1. When the **Power Generating Module** is providing **Limited Frequency Sensitive Mode Overfrequency (LFSM-O)** response it shall continue to provide the frequency response until the frequency has returned to or is below 50.4 Hz.
      2. Steady state operation below **Minimum Stable Operating Level** is not expected but if system operating conditions cause operation below **Minimum Stable Operating Level** which give rise to operational difficulties then the **Generator** shall be able to return the output of the **Power Generating Module** to an output of not less than the **Minimum Stable Operating Level**.

## Fault Ride Through and Phase Voltage Unbalance

* + 1. Paragraphs 12.3.1.1 to 12.3.1.7 inclusive set out the **Fault Ride Through**, principles and concepts applicable to **Synchronous** **Power Generating Module**s and **Power Park Modules**, subject to disturbances from faults on the **Network** up to 140 ms in duration.
       1. Each **Synchronous Power Generating Module** and **Power Park Module** is required to remain connected and stable for any balanced and unbalanced fault where the voltage at the **Connection Point** remains on or above the heavy black line shown in Figures 12.5 and 12.6 below.
       2. The voltage against time curves defined in Table 12.1 and Table 12.2 express the lower limit (expressed as the ratio of its actual value and its reference 1pu) of the actual course of the phase to phase voltages (or phase to earth voltage in the case of asymmetrical/unbalanced faults) on the networkvoltage level at the **Connection Point** during a symmetrical or asymmetrical/unbalanced fault, as a function of time before, during and after the fault.



Figure 12.5 - Voltage against time curve applicable to Type B Synchronous Power Generating Modules

Table 12.1 Voltage against time parameters applicable to Type B Synchronous Power Generating Modules

|  |  |  |  |
| --- | --- | --- | --- |
| **Voltage parameters (pu)** | | **Time parameters (s)** | |
| Uret | 0.3 | tclear | 0.14 |
| Uclear | 0.7 | trec1 | 0.14 |
| Urec1 | 0.7 | trec2 | 0.45 |
| Urec2 | 0.9 | trec3 | 1.5 |



Figure 12.6 - Voltage against time curve applicable to Type B Power Park Modules

Table 12.2 Voltage against time parameters applicable to Type B Power Park Modules

|  |  |  |  |
| --- | --- | --- | --- |
| **Voltage parameters (pu)** | | **Time parameters (s)** | |
| Uret | 0.1 | tclear | 0.14 |
| Uclear | 0.10 | trec1 | 0.14 |
| Urec1 | 0.10 | trec2 | 0.14 |
| Urec2 | 0.85 | trec3 | 2.2 |

* + - 1. In addition to the requirements in 12.3.1.2 to 12.3.1.6:

1. Each **Power Generating Module** shall be capable of satisfying the above requirements at the **Connection Point** when operating at **Registered Capacity** output and maximum leading **Power Factor** as specified in paragraph 12.5.1.
2. The pre-fault voltage shall be taken to be 1.0 pu and the post fault voltage shall not be less than 0.9 pu.
3. The **DNO** will publish fault level data under maximum demand conditions in the Long Term Development Statements. To allow a **Generator** to model the **Fault Ride Through** performance of its **Power Generating Module**s, the **DNO** will provide generic fault level values derived from typical cases. Where necessary, on reasonable request the **DNO** will specify the pre-fault and post fault short circuit capacity (in MVA) at the **Connection Point** and will provide additional network data as may reasonably be required for the **Generator** to undertake such study work.
4. The protection schemes and settings for internal electrical faults shall not jeopardise **Fault Ride Through** performance as specified in Section 12.3. For the avoidance of doubt, where an internal fault on the **Power Generating Module** occurs during a **Fault Ride Through** condition, the **Power Generating Module**’s internal protection should trip the module to ensure safety and minimise damage.
5. Each **Power Generating Module** shall be designed such that, for faults with a duration of 140 ms or less, within 0.5 s of restoration of the voltage at the **Connection Point** to 90% of nominal voltage or greater, **Active Power** output shall be restored to at least 90% of the level immediately before the fault. Once **Active Power** output has been restored to the required level, **Active Power** oscillations shall be acceptable provided that:
6. The total active energy delivered during the period of the oscillations is at least that which would have been delivered if the **Active Power** was constant.
7. The oscillations are adequately damped.
8. In the event of power oscillations, **Power Generating Module**s shall retain steady state stability when operating at any point on the **Generator Performance Chart**.

For **Power Park Module**s, comprising switched reactive compensation equipment (such as mechanically switched capacitors and reactors), such switched reactive compensation equipment shall be controlled such that it is not switched in or out of service during the fault but may act to assist in post fault voltage recovery.

* + 1. In addition to paragraphs 12.3.1.1 – 12.3.1.7, where it has been specifically agreed between the **DNO** and the **Generator** that a **Power Generating Facility** will contribute to the **DNO**’s **Distribution Network** security (eg for compliance with EREC P2) the **Power Generating Module**(s) may be required to withstand, without tripping, the effects of a close up three phase fault and the **Phase (Voltage) Unbalance** imposed during the clearance of a close-up phase-to-phase fault, in both cases cleared by the **DNO**’s main protection. The **DNO** will advise the **Generator** in each case of the likely tripping time of the **DNO**’sprotection, and for phase-phase faults, the likely value of **Phase (Voltage) Unbalance** during the fault clearance time.
    2. In the case of phase to phase faults on the **DNO**’s **Distribution Network** that are cleared by system back-up protectionwhich will be within the plant short time rating on the **DNO**’s **Distribution Network** the **DNO**, on request during the connection process, will advise the **Generator** of the expected **Phase (Voltage) Unbalance**.
    3. Other **Fault Ride Through** Requirements

1. In the case of a **Power Park Module**, the requirements in this Section 12.3. do not apply when the **Power Park Module** is operating at less than 5% of its **Registered Capacity** or during very high primary energy source conditions when more than 50% of the **Generating Unit**s in a **Power Park Module** have been shut down or disconnected under an emergency shutdown sequence to protect **Generator**’splant and apparatus.
2. For the avoidance of doubt, the requirements specified in this Section 12.3 do not apply to **Power Generating Module**s connected to an unhealthy circuit and islanded from the **Distribution Network** even for delayed auto reclosure times.
   1. Voltage Limits and Control
      1. Where **a Power Generating Module** is remote from a **Network** voltage control point it may be required to withstand voltages outside the normal statutory limits. In these circumstances, the **DNO** should agree with the **Generator** the declared voltage and voltage range at the **Connection Point**. Immunity of the **Power Generating Module** to voltage changes of ± 10% of the declared voltage is recommended, subject to design appraisal of individual installations.
      2. The connection of a **Power Generating Module** to the **Distribution Network** shall be designed in such a way that operation of the **Power Generating Module** does not adversely affect the voltage profile of and voltage control employed on the **Distribution Network**. EREP 126 provides **DNO**s with guidance on active management solutions to overcome voltage control limitations. Information on the voltage regulation and control arrangements will be made available by the **DNO** if requested by the **Generator**.
      3. Excitation Performance Requirements

12.4.3.1 Each **Synchronous Generating Unit** within a **Synchronous** **Power Generating Module** shall be equipped with a permanent automatic **Excitation System** that has the capability to provide constant terminal voltage (assuming a high enough **Network** source impedance to allow the **Power Generating Module** to achieve this while remaining within its ratings) at a selectable setpoint without instability over the entire operating range of the **Synchronous** **Power Generating Module**.

12.4.3.2 The **DNO** will agree with the **Generator** the operation of the control system of the **Synchronous Power Generating Module** or **Power Park Module** such that it shall contribute, as agreed, to voltage control or **Reactive Power** control or **Power Factor** control at the **Connection Point**. In some cases, for example, on large industrial sites etc where the **Power Generating Module** is embedded in the **Generator’s Installation**, the **DNO** and **Generator** might agree a different control point, such as the **Power Generating Module**’s terminals. The performance requirements of the control system including **Slope** (where applicable) shall be agreed between the **DNO** and the **Generator**.

12.4.3.3 As part of the connection application process the **Generator** shall agree with the **DNO** the set points of the control scheme for voltage control, **Power Factor** control or **Reactive Power** control as appropriate. These settings, and any changes to these settings, shall be agreed with the **DNO** and recorded in the **Connection Agreement**. The information to be provided is detailed in Schedule 5a and Schedule 5b of the Data Registration Code.

12.4.4 The final responsibility for control of **Distribution Network** voltage does, however, remain with the **DNO**.

12.4.5 Automatic Voltage Control (AVC) schemes employed by the **DNO** often assume that power flows from parts of the **Distribution Network** operating at a higher voltage to parts of the **Distribution Network** operating at lower voltages. Export from **Power Generating Module**s in excess of the local loads may result in power flows in the reverse direction. In this case AVC referenced to the **Low Voltage** side may not operate correctly without an import of **Reactive Power** and relay settings appropriate to this operating condition. When load current compounding is used with the AVC and the penetration level of **Power Generating Module**s becomes significant compared to normal loads, it may be necessary to switch any compounding out of service.

12.4.6 **Power Generating Module**s can cause problems if connected to networks employing AVC schemes which use negative reactance compounding and line drop compensation due to changes in **Active Power** and **Reactive Power** flows. EREP 126 provides guidance on connecting generation to such networks using techniques such as removing the generation circuit from the AVC scheme using cancellation CTs.

* 1. **Reactive Capability** 
     1. When supplying **Registered Capacity** all **Power Generating Module**s shall be capable of continuous operation at nominal voltage at any points between the limits of 0.95 **Power Factor** lagging and 0.95 **Power Factor** leading at the **Connection Point** or the **Generating Unit** terminals as appropriate for the **Power Generating Facility** and as agreed with the **DNO**.
     2. At **Active Power** output levels other than **Registered Capacity**, all **Synchronous Power Generating Module**s or **Generating Unit**s within a **Power Park Module** shall be capable of continuous operation at any point between the **Reactive Power** capability limits identified on the **Generator Performance Chart**. **Generator**s should take any site demand such as auxiliary supplies and the **Active Power** and **Reactive Power** losses of the **Power Generating Module** transformer or **Station Transformer** into account unless advised otherwise by the **DNO**.
     3. Where the **Power Generating Module** is contained within a **Customer’s Installation** comprising both demand and generation the **DNO** will advise the **Generator** if it is more appropriate for the **Power Factor** requirements to be specified at the **Power Generating Module** terminals, rather than at the **Connection Point**. Any specific **Power Factor** requirements will be documented in the **Connection Agreement**.
  2. **Fast Fault Current** Injection
     1. **Fast Fault Current** injection is necessary to support the **Total System** during a fault on the **Transmission System**. The design of **Fast Fault Current** injection is tailored to this, and does not relate directly to faults on the **Distribution Network**, not least as those will tend to have longer clearing times than those of the **Transmission System** for which **Fast Fault Current** injection is designed. In this Section 12.6 the faults referred to are **Transmission System** faults which clear within 140 ms and which will be seen in the **Distribution Network** as a voltage depression. For this section 12.6 voltage and current quantities are assumed to be positive phase sequence values.
     2. Each **Power Park Module** shall be required to satisfy the following requirements:

1. For any balanced fault on the **Transmission System** which results in the voltage at the **Connection Point** falling below 0.9 pu each **Power Park Module** shall, unless otherwise agreed with the **DNO**, be required to inject a reactive current IR that lies above the heavy black line shown in Figure 12.7.
2. Figure 12.7 defines the reactive current IR that is to be supplied during a fault on the **Transmission System** and which is dependent on the pre-fault operating conditions, and the voltage retained at the **Connection Point**. Each **Power Park Module** shall inject a reactive current IR which shall not be less than its pre-fault reactive current and which shall as a minimum increase with the fall in retained voltage each time the retained voltage at the **Connection Point** falls below 0.9 pu, whilst ensuring that the overall rating of the **Power Park Module** is not exceeded.

 **Figure 12.7 – locus of magnitude of injected Reactive Current**

1. In addition each **Power Park Module** shall be required to satisfy the reactive current requirements shown in Figures 12.8 which shows how the reactive current should be injected over time from the fault inception. The injected current shall be above the shaded area shown in Figure 12.8 (a) and Figure 12.8 (b) with priority being given to reactive current injection with any residual capability being supplied as active current. Under any fault condition, where the voltage falls below 0.9 pu, there would be no requirement for any **Power Park Module** or constituent **Generating Unit** to exceed its transient or steady state rating.

Figure 12.8(a) Chart showing area of reactive current injections for voltage depressions of ≤ 140 ms duration

**Figure 12.8(b) Chart showing area of Reactive Current injections for voltage depressions of > 140 ms duration**

1. For the purposes of this requirement, the maximum rated current is taken to be the maximum current each **Generating Unit** can supply when operating at **Registered Capacity** and 0.95 **Power Factor** at a nominal voltage of 1.0 pu. For example, in the case of a 1 MW **Power Park Module** the **Registered Capacity** would be taken as 1 MW and the rated **Reactive Power** would be taken as 0.33 MVAr (ie **Rated MW** output operating at 0.95 **Power Factor** lead or 0.95 **Power Factor** lag) giving a MVA rating of 1.05 MVA. If, in this example, the **Power Park Module** consisted of 5 x 200kW **Generating Units** and 1 x 100kVAr reactive compensation equipment, each **Generating Unit** would need to be rated to produce 200 kW and (330 kVAr – 100 kVAr) ÷ 5, ie 205.2 kVA.
2. All **Power Park Module** equipment shall be designed to ensure a smooth transition between any of its voltage, power factor or reactive control modes and fault ride through mode in order to prevent the risk of instability which could arise in the transition between the steady state voltage operating range and abnormal conditions where the retained voltage falls below 0.90 pu of nominal voltage. Such a requirement is necessary to ensure adequate performance between the pre-fault operating condition of the **Power Park Module** and its subsequent behaviour under fault conditions.
3. Each **Power Park Module** shall be designed to reduce the risk of transient over voltage levels arising following clearance of the fault and in order to mitigate the risk of any form of instability which could result. **Generators** shall be permitted to block or employ other means where the anticipated transient over voltage would otherwise exceed the 1.05 pu of nominal. Figures 12.8 (a) and Figure 12.8 (b) show the impact of variations in fault clearance time which shall be no greater than 140 ms. The **DNO** may agree requirements for the maximum transient over voltage withstand capability and associated time duration. Such capability and parameters will be recorded in the **Connection Agreement**. Where the **Generator** is able to demonstrate to the **DNO** that blocking or other control strategies are required in order to prevent the risk of transient over voltage excursions **Generators** are required to both advise and agree with the **DNO** the control strategy,which shall also include the approach taken to de-blocking.
4. To permit additional flexibility for example from **Power Park Modules** made up of full converter **Generating Units**, DFIG **Generating Units** or induction **Generating Units**, the **DNO** will permit transient deviations below the shaded area shown in Figures 12.8 (a) or Figure 12.8 (b) provided that the overall reactive current supplied over time is greater than the minimum requirement shown in Figures 12.8 (a) or Figure 12.8 (b). This agreement will be formalised in the **Connection Agreement**.
5. In the case of an unbalanced fault, each **Park Module** or each **Generating Unit** within a **Power Park Module** shall be required to inject maximum reactive current without exceeding the transient rating of the **Power Park Module** (or constituent element thereof).
   1. Operational monitoring
      1. At each **Power Generating Facility** the **DNO** will install its own Telecontrol/SCADA outstation which will generally meet all the **DNO**’s necessary and legal operational data requirements. The **DNO** will inform the **Generator** if additional specific data are required.

# Type C and Type D Power Generating Module Technical Requirements

## Power Generating Module Performance and Control Requirements

13.1.1 The requirements of this Section 13 do not apply in full to:

1. **Power Generation Facilities** that are designed and installed for infrequent short-term parallel operation only; or
2. **Electricity Storage** **Power Generation Module**s within the **Power Generating Facility** commissioned before 01 September 2022.

Refer to Annex A.4 for details.

* + 1. The **Active Power** output of a **Power Generating Module** should not be affected by voltage changes within the statutory limits declared by the **DNO** in accordance with the **ESQCR**.
    2. **Power Generating Module**s shall be capable of adjusting the **Active Power** setpoint in accordance with instructions issued by the **DNO**.

13.1.3.1 **DNO**s currently are developing active network management approaches and there is no common standard for communication interfaces.

13.1.3.2 **Protocols** currently in use between **DNO**s and **Generator**s include simple current loop; DNP3 and IEC 61850.

13.1.3.3 The **DNO** will discuss and agree with the **Generator** for each **Power** **Generating** **Facility** the protocol to be used, including how any risks of maloperation etc are to be managed.

13.1.3.4 By default if nothing it specified by the **DNO** then a simple hard-wired current loop interface should be provided where a 4 mA to 20 mA DC signal corresponding to 0 pu to 1.0 pu of **Registered Capacity Active Power**.

13.1.3.5 The **Active Power** reduction will be either between 1.0 pu of **Registered Capacity** **Active Power** and zero, or between 1.0 pu of **Registered Capacity Active Power** and **Minimum Stable Operating Level**. In the latter case the **Generator** will agree with the **DNO** how zero output can be achieved.

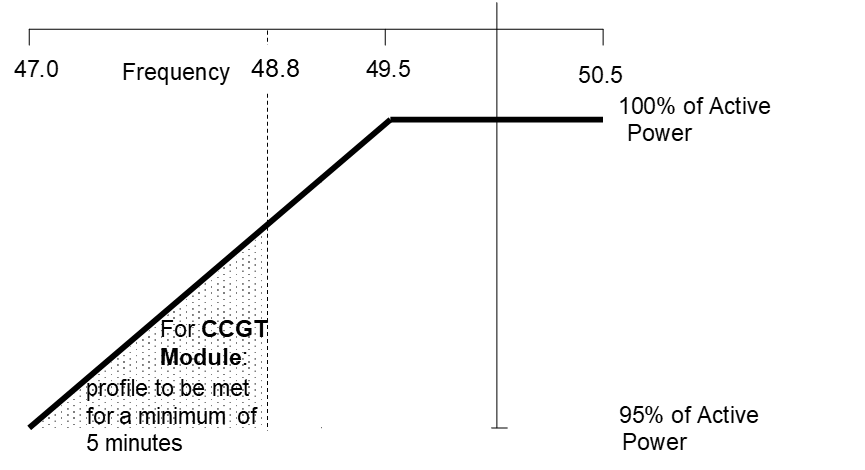
13.1.3.6 If the **DNO** wishes to make use of the facility to reduce **Active Power** output the **DNO** will agree with the **Generator** the communication interface and other necessary equipment that will be needed.

* + 1. Any changes to the **Active Power** or voltage/**Reactive Power** control setpoints shall result in the **Power Generating Module** achieving the new **Active Power** or voltage/**Reactive Power** output, as appropriate, within 2 minutes.
    2. Each item of a **Power Generating Module** and its associated control equipment shall be designed for stable operation in parallel with the **Distribution Network**.
    3. Load flow and **System Stability** studies may be necessary to determine any output constraints or post fault actions necessary for n-1 fault conditions and credible n-2 conditions (where n-1 and n-2 conditions are the first and second outage conditions as, for example, specified in EREC P2) involving a mixture of fault and planned outages. The **Connection Agreement** should include details of the relevant outage conditions. It may be necessary under these fault conditions, where the combination of **Power Generating Module** output, load and through flow levels leads to circuit overloading, to rapidly disconnect or constrain the **Power Generating Module**.
  1. **Frequency response**
     1. Under abnormal conditions automatic low-frequency load-shedding provides for load reduction down to 47 Hz. In exceptional circumstances, the frequency of the **DNO**’s **Distribution Network** could rise above 50.5 Hz. Therefore all **Power Generating Module**s shall be capable of continuing to operate in parallel with the **Distribution Network** in accordance with the following:

1. 47 Hz – 47.5 Hz Operation for a period of at least 20 s is required each time the frequency is within this range.
2. 47.5 Hz – 49.0 Hz Operation for a period of at least 90 minutes is required each time the frequency is within this range.
3. 49.0 Hz – 51.0 Hz Continuous operation of the **Power Generating Module** is required.
4. 51.0 Hz –51.5 Hz Operation for a period of at least 90 minutes is required each time the frequency is within this range.
5. 51.5 Hz – 52 Hz Operation for a period of at least 15 minutes is required each time the frequency is within this range.
   * 1. With regard to the rate of change of frequency withstand capability, a **Power Generating Module** shall be capable of staying connected to the **Distribution Network** and operate at rates of change of frequency up to 1 Hzs-1 as measured over a period of 500 ms unless disconnection was triggered by a rate of change of frequency type loss of mains protection or by the **Power Generating Module**’s own protection system for a co-incident internal fault as detailed in paragraph 10.6.18.
     2. Output power with falling frequency

13.2.3.1 Each **Power** **Generating Module**, shall be capable of:

1. continuously maintaining constant **Active Power** output for systemfrequency changes within the range 50.5 to 49.5 Hz; and
2. (subject to the provisions of paragraph 13.2.1) maintaining its **Active Power** output at a level not lower than the figure determined by the linear relationship shown in Figure 13.1 for system frequency changes within the range 49.5 to 47 Hz for all ambient temperatures up to and including 25°C, such that if the system frequency drops to 47 Hz the **Active Power** output does not decrease by more than 5%. In the case of a **CCGT Module** this requirement shall be retained down to 48.8 Hz, which reflects the first stage of the automatic Low Frequency Demand Disconnection scheme. For system frequency below 48.8 Hz, the existing requirements shall be retained for a minimum period of 5 minutes while system frequency remains below 48.8 Hz, and any special measure(s) that may be required to meet this requirement shall be kept in service during this period. After that 5 minute period, if system frequency remains below the 49.5 Hz threshold, the special measure(s) must be discontinued if there is a materially increased risk of the Gas Turbine tripping. The need for special measure(s) is linked to the inherent Gas Turbine **Active Power** output reduction caused by reduced shaft speed due to falling system frequency. Where the need for special measures is identified in order to maintain output in line with the level identified in Figure 13.1 these measures should still be continued at ambient temperatures above 25°C maintaining as much of the **Active Power** achievable within the capability of the plant.



**Figure 13.1 Change in Active Power with falling frequency**

13.2.3.1 For the avoidance of doubt, in the case of a **Power Generating Module** using an **Intermittent Power Source** where the power input will not be constant over time, the requirement is that the **Active Power** output shall be independent of system frequency under (a) above and should not drop with system frequency by greater than the amount specified in (b) above.

* + 1. **Limited Frequency Sensitive Mode – Overfrequency**

13.2.4.1Each **Power Generating Module** shall be capable of reducing **Active Power** output in response to frequency on the **Total System** when this rises above 50.4 Hz. The **Power Generating Module** shall be capable of operating stably during **LFSM-O** operation. If a **Power Generating Module**, has been contracted to operate in **Frequency Sensitive Mode** the requirements of **LFSM-O** shall apply when the frequency exceeds 50.5 Hz.

1. The rate of change of **Active Power** output shall be at a minimum a rate of 2% of output per 0.1 Hz deviation of system frequency above 50.4 Hz (ie a **Droop** of 10%) as shown in Figure 13.2. For the avoidance of doubt, this would not preclude a **Generator** from designing the **Power Generating Module** with a **Droop** of less than 10%, (for example between 3 – 5%), but in all cases the **Droop** should be 2% or greater.
2. The reduction in **Active Power** output shall be continuously and linearly proportional, as far as is practicable, to the excess of frequency above 50.4 Hz and shall be provided increasingly with time over the period specified in (c) below.
3. As much as possible of the proportional reduction in **Active Power** output shall result from the frequency control device (or speed governor) action and shall be achieved within 10 s of the time of the frequency increase above 50.4 Hz. The **Power Generating Module** shall be capable of initiating a power frequency response with an initial delay that is as short as possible. If the delay exceeds 2 s the **Generator** shall justify the delay, providing technical evidence to the **DNO**,who will pass this evidence to the **NETSO**.



Pref is the reference **Active Power** to which ΔP is related and. ΔP is the change in **Active Power** output from the **Power Generating Module**.

**Figure 13.2 Active Power Frequency Response capability when operating in LFSM-O**

13.2.4.2 When the **Power Generating Module** is providing **Limited Frequency Sensitive Mode Overfrequency (LFSM-O)** response it shall continue to provide the frequency response until the frequency has returned to or below 50.4 Hz.

13.2.4.3 Steady state operation below **Minimum Stable Operating Level** is not expected but if system operating conditions cause operation below **Minimum Stable Operating Level** which give rise to operational difficulties then the **Generator** shall be able to return the output of the **Power Generating Module** to an output of not less than the **Minimum Stable Operating Level**.

* + 1. **Limited Frequency Sensitive Mode – Underfrequency (LFSM-U)**

13.2.5.1 Each **Power Generating Module** shall be capable of increasing **Active Power** output in response to system frequency when this falls below 49.5 Hz. it is not anticipated **Power Generating Module**s are operated in an inefficient mode to facilitate delivery of **LFSM-U** response, but any inherent capability should be made available without undue delay. The **Power Generating Module** shall be capable of stable operation during **LFSM-U** **Mode**.

1. The rate of change of **Active Power** output shall be at a minimum a rate of 2 percent of output per 0.1 Hz deviation of system frequency below 49.5 Hz (ie a **Droop** of 10%) as shown in Figure 13.3 below. This requirement only applies if the **Power Generating Module** has headroom and the ability to increase **Active Power** output. In the case of a **Power Park Module** the requirements of Figure 13.3 shall be reduced pro-rata to the amount of **Generating Unit**s in service and available to generate. For example, for a **Power Park Module** with a **Registered Capacity** of 40 MW but with only 80% of the **Generating Unit**s in service Pref would be 32 MW. For the avoidance of doubt, this would not preclude a **Generator** from designing the **Power Generating Module** with a lower **Droop** setting, for example between 3 – 5%.
2. As much as possible of the proportional increase in **Active Power** output shall result from the frequency control device (or speed governor) action and shall be achieved for frequencies below 49.5 Hz. The **Power Generating Module** shall be capable of initiating a power frequency response with minimal delay. If the delay exceeds 2 s the **Generator** shall justify the delay, providing technical evidence to the **DNO** who will pass this evidence to the **NETSO**.
3. The actual delivery of **Active Power Frequency Response** in **LFSM-U** mode shall take into account

The ambient conditions when the response is to be triggered.

The operating conditions of the **Power Generating Module**. In particular limitations on operation near **Registered** **Capacity** at low frequencies.

The availability of primary energy sources.

1. In **LFSM-U** **Mode** the **Power Generating Module** shall be capable of providing a power increase up to its **Registered** **Capacity** (based on the number of **Generating Unit**s in service at that point in time).



Pref is the **Registered Capacity**, taking into account any **Interface Protection**s not in service to which ΔP is related and ΔP is the change in **Active Power** output from the **Power Generating Module**. The **Power Generating Module** has to provide a positive **Active Power** output change with a **Droop** of 10% or less based on Pref.

**Figure 13.3 - Limited Frequency Sensitive Mode – Underfrequency capability of Power Generating Modules**

13.2.5.2 **Limited Frequency Sensitive Mode Electricity Storage Power Generating Module** when operating in an importing mode of operation

13.2.5.2.1 Each **Generator** in respect of an **Electricity Storage Power Generating Module** is required to meet the requirements of 13.2.5.2.1 (a) – (f):

(a) Be capable of automatically maintaining its **Active Power** output within the shaded operating region shown in Figure 13.4 until the stored energy has been depleted. The **Electricity Storage Power Generating Module** could initially be operating at any level of import between zero **Active Power** and the **Rated Import Capacity** within a system frequency range of 50 Hz and 49.5 Hz as shown in Figure 13.4. The **Electricity Storage Power Generating Module** is only required to reach its **Registered** **Capacity** if the **Electricity Storage Power Generating Module** has headroom and the ability to increase **Active Power** output. A typical value of the **Droop** would be 0.6% where this does not result in control system instability or plant difficulties. In all cases the **Droop** shall be between 0.6% and 1.2% and shall be agreed with the **DNO**.

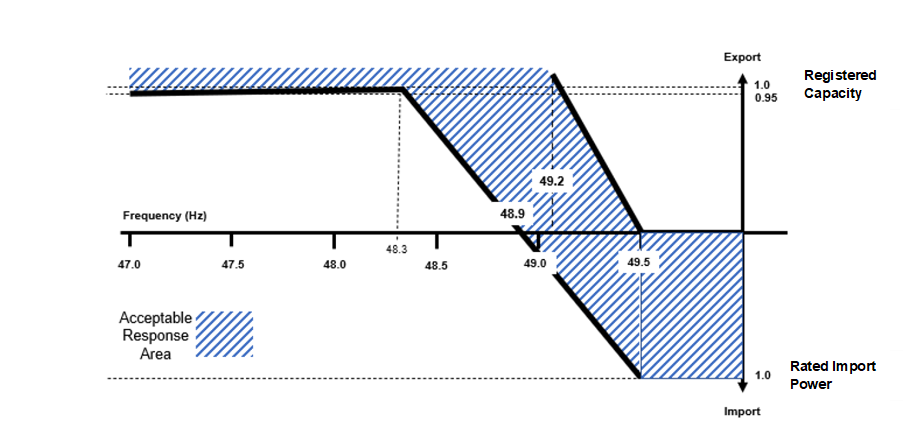
(b) Automatically respond in accordance with the characteristic of Figure 13.4 when the system frequency falls to 49.5 Hz and below.

(c) The reduction in **Active Power** import (during an import mode of operation), and the transition to the final value of **Active Power** output shall be continuously and linearly proportional, as far as is practicable, to the reduction in frequency below 49.5 Hz. **Active Power** output must be provided increasingly with time as required by 13.2.5.2.1 (d) below.

(d) As much as possible of the proportional reduction in **Active Power** import (when the **Electricity Storage Power Generating Module** is in a mode analogous to demand) must result from the frequency control device (or speed governor) action and must be achieved within 10 s of the time of the frequency decreases below 49.5 Hz. The **Electricity Storage Power Generating Module** shall be capable of initiating a power frequency response with an initial delay that is as short as possible. Delays that exceed 2 s shall be justified by the **Generator** providing technical evidence to the **DNO** and in any event as much as possible of the proportional reduction in **Active Power** import shall be achieved within 10 s. This performance requirement is to be maintained when the **Electricity Storage** device makes the transition to an **Active Power** export mode of operation unless the energy store is depleted, in which case it shall be required to operate at zero **Active Power** output.

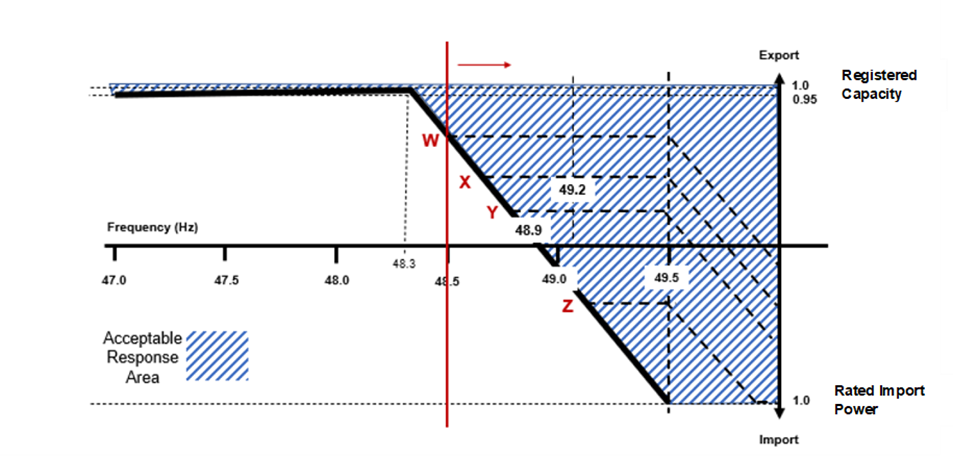
(e) Where the **Electricity Storage Power Generating Module** is not capable of making a transition from import operation to export operation within 20 s of the frequency falling to 49.2 Hz, then it shall immediately reduce its **Active Power** import to zero.

(f) If the **Electricity Storage Power Generating Module** has not achieved at least a zero **Active Power** import when the system frequency has reached 48.9 Hz, it shall be instantaneously tripped. Where an **Electricity Storage Power Generating Module** trips, it shall not reconnect to the system until the conditions of 10.3.3 to 10.3.5 are met.



**Figure 13.4 Active Power performance with falling frequency**

13.2.5.2.2 Where an **Electricity Storage Power Generating Module** has been importing and has responded in accordance with the requirements of 13.2.5.2.1, its performance, once the system frequency starts to rise above the minimum reached, shall be in accordance with Figure 13.4 in respect of the **Active Power** output and **Active Power** import. For example, Figure 13.5, illustrates the four operating points W, X, Y and Z. If points W, X, Y and Z denotes the minimum frequency that the **Total System** reached during a particular low system frequency event, as the system frequency starts to rise, the **Active Power** output of the **Electricity Storage Power Generating Module** should remain at a constant level (where the energy source has not been depleted) until 49.5 Hz is reached as denoted by the dashed black lines. Once the system frequency has risen above 49.5 Hz the **Electricity Storage Power Generating Module** is permitted to reduce **Active Power** output so long as it is operating within the shaded area above 49.5 Hz shown in Figure 13.5, unless the **Electricity Storage Power Generating Module** has insufficient capability in which case it shall operate at zero **Active Power**.



**Figure 13.5 Active Power performance with increasing frequency**

13.2.5.2.3 Where an **Electricity Storage Power Generating Module** is exporting **Active Power** to the **Total System** (including zero) and the system frequency falls below 49.5 Hz the requirements of 13.2.5.2.1 and 13.2.5.2.2 shall apply.

* + 1. **Frequency Sensitive Mode – (FSM)**

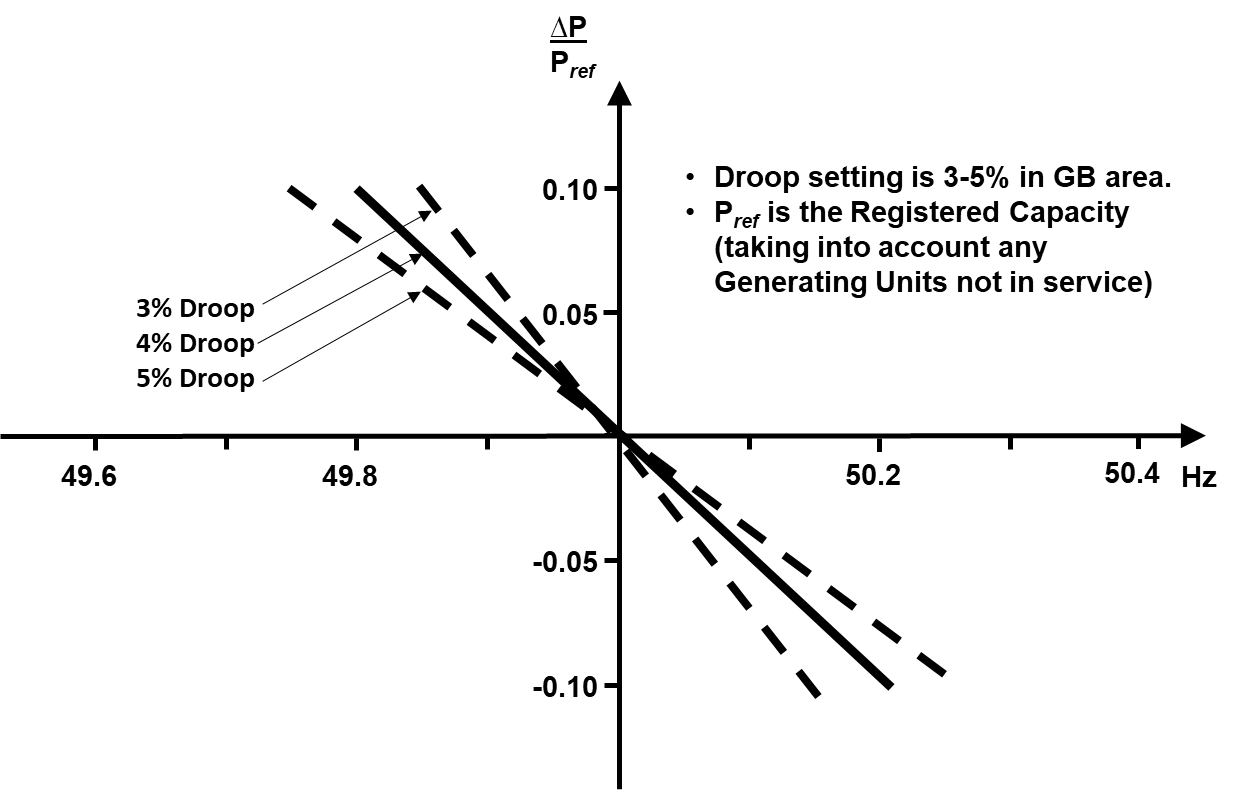
13.2.6.1 Each **Power Generating Module** will be capable of **FSM** in addition to **LFSM-O** and **LFSM-U**. By default **Power Generating Module**s will be set to operate in **LFSM**, unless the **Generator** has a specific contract with the **NETSO** to operate in **FSM**.

13.2.6.2 Each **Power Generating Module** shall be fitted with a fast acting proportional frequency control device (or turbine speed governor) and unit load controller or equivalent control device to provide frequency response under normal operational conditions. In the case of a **Power Park Module** the frequency or speed control device(s) may be on the **Power Park Module** or on each individual **Generating Unit** or be a combination of both.

13.2.6.3 The frequency control device (or speed governor) in coordination with other control devices shall control each **Power Generating Module** **Active Power** output with stability over the entire operating range of the **Power Generating Module**; and

13.2.6.4 **Power Generating Module**s shall also meet the following minimum requirements:

1. **Power Generating Module**s shall be capable of providing **Active Power Frequency Response** in accordance with the performance characteristic shown in Figure 13.6 and parameters in Table 13.1.



**Figure 13.6 – Frequency Sensitive Mode capability of Power Generating Modules and Power Park Modules**

**Table 13.1 – Parameters for Active Power Frequency Response in Frequency Sensitivity Mode including the mathematical expressions in Figure 13.6**

|  |  |
| --- | --- |
| **Parameter** | **Setting** |
| Nominal system frequency | 50 Hz |
| **Minimum Active Power** as a percentage of **Registered Capacity ()** | 10% |
| **Frequency Response Insensitivity** in mHz (ǀ) | ±15mHz |
| **Frequency Response Insensitivity** as a percentage of nominal frequency () | ±0.03% |
| **Frequency Response Deadband** in mHz | 0 (mHz) |
| **Droop** (%) | 3 – 5% |

1. In satisfying the performance requirements specified in paragraph 13.2.6.2 **Generator**s in respect of each **Power Generating Module** should be aware:-
2. in the case of over frequency, the **Active Power** **Frequency Response** is limited by the **Minimum Regulating Level**.
3. in the case of under frequency, the **Active Power** **Frequency Response** is limited by the **Registered Capacity**.
4. the actual delivery of **Active Power** **Frequency Response** depends on the operating and ambient conditions of the **Power Generating Module** when this response is triggered, in particular limitations on operation near **Registered Capacity** at lowfrequencies as specified in 13.2.5 and available primary energy sources.
5. The frequency control device (or speed governor) shall also be capable of being set so that it operates with an overall speed **Droop** of between 3 – 5%. The **Frequency Response Deadband** and **Droop** shall be able to be reset at any time and as required by the **DNO**. For the avoidance of doubt, in the case of a **Power Park Module** the speed **Droop** should be equivalent to a fixed setting between 3% and 5% applied to each **Generating Unit** in service.
6. In the event of a frequency step change, each **Power Generating Module** shall be capable of activating full and stable **Active Power** **Frequency Response** (without undue power oscillations), in accordance with the performance characteristic shown in Figure 13.7 and parameters in Table 13.2.



Pmax is the **Registered Capacity** to which Δ*Ρ* relates. ΔΡ is the change in **Active Power** output from the **Power Generating Module**. The **Power Generating Module** has to provide **Active Power** output ΔΡ up to the point ΔΡ1 in accordance with the times t1 and t2 with the values of ΔΡ1, t1and t2 being specified in Table 13.2. t1 is the initial delay. t2 is the time for full activation.

**Figure 13.7 Active Power Frequency Response capability**

**Table 13.2 – Parameters for full activation of Active Power Frequency Response resulting from a frequency step change**

|  |  |
| --- | --- |
| **Parameter** | **Setting** |
| **Active power** as a percentage of **Registered Capacity (**frequency response range**) ()** | 10% |
| Maximum admissible initial delay t1 for **Power Generating Module**s with inertia unless justified as specified in 13.2.6.4(d) | 2 s |
| Maximum admissible initial delay t1 for **Power Generating Module**s which do not contribute to system inertia unless justified as specified in 13.2.6.4(d) | 1 s |
| Activation time t2 | 10 s |

Table 13.2 also includes the mathematical expressions used in Figure 13.7.

1. The initial activation of **Active Power** primary frequency response shall not be unduly delayed. For **Power Generating Module**s with inertia the delay in initial **Active Power** **Frequency Response** shall not be greater than 2 s. For **Power Generating Module**s without inertia the delay in initial **Active Power** **Frequency Response** shall not be greater than 1 s. If the **Generator** cannot meet this requirement the **Generator** shall provide technical evidence to the **DNO,** who will pass this evidence to the **NETSO,** demonstrating why a longer time is needed for the initial activation of **Active Power** **Frequency Response**.
2. With regard to disconnection due to under frequency, **Generator**s responsible for **Power Generating Module**s capable of acting as a load, including but not limited to **Electricity Storage** devices and pumped-storage **Power Generating Module**s, shall be capable of disconnecting their load in case of under frequency which will be agreed with the **DNO**. For the avoidance of doubt, this requirement does not apply to station auxiliary supplies[[16]](#footnote-19).
3. In addition to the requirements of Section 13.2.6 each **Power Generating Module** shall be capable of meeting the minimum frequency response requirement profile subject to and in accordance with the provisions of Annex C.10.
   1. **Fault Ride Through**
      1. Paragraphs 13.3.1.1 to 13.3.1.10 inclusive set out the **Fault Ride Through**, principles and concepts applicable to **Synchronous** **Power Generating Module**s and **Power Park Module**s, subject to disturbances from faults on the **Network** up to 140 ms in duration.

13.3.1.1 Each **Synchronous Power Generating Module** and **Power Park Module** is required to remain connected and stable for any balanced and unbalanced fault where the voltage at the **Connection Point** remains on or above the heavy black line shown in Figures 13.8 to 13.11 below.

13.3.1.2 The voltage against time curves defined in Table 13.3 to Table 13.6 expresses the lower limit (expressed as the ratio of its actual value and its reference 1 pu) of the actual course of the phase to phase voltages (or phase to earth voltage in the case of asymmetrical/unbalanced faults) on the networkvoltage level at **Connection Point** during a symmetrical or asymmetrical/unbalanced fault, as a function of time before, during and after the fault.

13.3.1.3



**Figure 13.8 Voltage against time curve applicable to Type C and Type D Synchronous Power Generating Modules connected below 110 kV**

13.3.1.4

**Table 13.3 Voltage against time parameters applicable to Type C and Type D Synchronous Power Generating Modules connected below 110 kV**

|  |  |  |  |
| --- | --- | --- | --- |
| **Voltage parameters (pu)** | | **Time parameters (s)** | |
| Uret | 0.1 | tclear | 0.14 |
| Uclear | 0.7 | trec1 | 0.14 |
| Urec1 | 0.7 | trec2 | 0.45 |
| Urec2 | 0.9 | trec3 | 1.5 |

13.3.1.5



**Figure 13.9 - Voltage against time curve applicable to Type D Synchronous Power Generating Modules connected at or above 110 kV**

13.3.1.6

**Table 13.4 Voltage against time parameters applicable to Type D Synchronous Power Generating Modules connected at or above 110 kV**

|  |  |  |  |
| --- | --- | --- | --- |
| **Voltage parameters (pu)** | | **Time parameters (s)** | |
| Uret | 0 | tclear | 0.14 |
| Uclear | 0.25 | trec1 | 0.25 |
| Urec1 | 0.5 | trec2 | 0.45 |
| Urec2 | 0.9 | trec3 | 1.5 |

13.3.1.7



**Figure 13.10 - Voltage against time curve applicable to Type C and Type D Power Park Modules connected below 110 kV**

13.3.1.8

**Table 13.5 Voltage against time parameters applicable to Type C and Type D Power Park Modules connected below 110 kV**

|  |  |  |  |
| --- | --- | --- | --- |
| **Voltage parameters (pu)** | | **Time parameters (s)** | |
| Uret | 0.1 | tclear | 0.14 |
| Uclear | 0.10 | trec1 | 0.14 |
| Urec1 | 0.10 | trec2 | 0.14 |
| Urec2 | 0.85 | trec3 | 2.2 |

13.3.1.9



**Figure 13.11 - Voltage against time curve applicable to Type D Power Park Modules connected at or above 110 kV**

13.3.1.10

**Table 13.6 Voltage against time parameters applicable to Type D Power Park Modules connected at or above 110 kV**

|  |  |  |  |
| --- | --- | --- | --- |
| **Voltage parameters (pu)** | | **Time parameters (s)** | |
| Uret | 0 | tclear | 0.14 |
| Uclear | 0 | trec1 | 0.14 |
| Urec1 | 0 | trec2 | 0.14 |
| Urec2 | 0.85 | trec3 | 2.2 |

13.3.1.11 In addition to the requirements in 13.3.1.3 to 13.3.1.10:

1. Each **Power Generating Module** shall be capable of satisfying the above requirements at the **Connection Point** when operating at **Registered Capacity** output and maximum leading **Power Factor** as specified in paragraph 13.5.1.
2. The pre-fault voltage shall be taken to be 1.0 pu and the post fault voltage shall not be less than 0.9 pu.
3. **The DNO** will publish fault level data under maximum demand conditions in the Long Term Development Statements. To allow a **Generator** to model the **Fault Ride Through** performance of its **Power Generating Module**s, **the DNO** will provide generic fault level values derived from typical cases. Where necessary, on reasonable request the **DNO** will specify the pre-fault and post fault short circuit capacity (in MVA) at the **Connection Point** and will provide additional network data as may reasonably be required for the **Generator** to undertake such study work.
4. The protection schemes and settings for internal electrical faults shall not jeopardise **Fault Ride Through** performance as specified in paragraphs 13.3. For the avoidance of doubt, where an internal fault on the **Power Generating Module** occurs during a **Fault Ride Through** condition, the **Power Generating Module**’s internal protection should trip the module to ensure safety and minimise damage.
5. Each **Power Generating Module** shall be designed such within 0.5 s of restoration of the voltage at the **Connection Point** to 90% of nominal voltage or greater, **Active Power** output shall be restored to at least 90% of the level immediately before the fault. Once **Active Power** output has been restored to the required level, **Active Power** oscillations shall be acceptable provided that:

The total active energy delivered during the period of the oscillations is at least that which would have been delivered if the **Active Power** was constant.

The oscillations are adequately damped.

In the event of power oscillations, **Power Generating Module**s shall retain steady state stability when operating at any point on the **Generator Performance Chart**.

For **Power Park Module**s, comprising switched reactive compensation equipment (such as mechanically switched capacitors and reactors), such switched reactive compensation equipment shall be controlled such that it is not switched in or out of service during the fault but may act to assist in post fault voltage recovery.

* + 1. In addition to paragraphs 13.3.1.1 – 13.3.1.11 where it has been specifically agreed between the **DNO** and the **Generator** that a **Power Generating Facility** will contribute to the **DNO**’s **Distribution Network** security, (eg for compliance with EREC P2) the **Power Generating Module**(s) may be required to withstand, without tripping, the effects of a close up three phase fault and the **Phase (Voltage) Unbalance** imposed during the clearance of a close-up phase-to-phase fault, in both cases cleared by the **DNO**’s main protection. The **DNO** will advise the **Generator** in each case of the likely tripping time of the **DNO**’sprotection, and for phase-phase faults, the likely value of **Phase (Voltage) Unbalance** during the fault clearance time.
    2. In the case of phase to phase faults on the **DNO**’s **Distribution Network** that are cleared by system back-up protectionwhich will be within the plant short time rating on the **DNO**’s **Distribution Network** the **DNO**, on request during the connection process, will advise the **Generator** of the expected **Phase (Voltage) Unbalance**.
    3. Other **Fault Ride Through** Requirements

1. In the case of a **Power Park Module**, the requirements in paragraph 13.3 do not apply when the **Power Park Module** is operating at less than 5% of its **Registered Capacity** or during very high primary energy source conditions when more than 50% of the **Generating Unit**s in a **Power Park Module** have been shut down or disconnected under an emergency shutdown sequence to protect **Generator**’splant and apparatus.
2. For the avoidance of doubt, the requirements specified in this Section 13.3 do not apply to **Power Generating Module**sconnected to an unhealthy circuit and islanded from the **Distribution Network** even for delayed auto reclosure times.
   1. **Voltage Limits and Control**
      1. Where **a Power Generating Module** is remote from a **Network** voltage control point it may be required to withstand voltages outside the normal statutory limits. In these circumstances, the **DNO** should agree with the **Generator** the declared voltage and voltage range at the **Connection Point**. Immunity of the **Power Generating Module** to voltage changes of ± 10% of the declared voltage is recommended, but is mandatory for **Type D Power Generating Module**s, subject to design appraisal of individual installations.
      2. The connection of a **Power Generating Module** to the **Distribution Network** shall be designed in such a way that operation of the **Power Generating Module** does not adversely affect the voltage profile of and voltage control employed on the **Distribution Network**. EREP 126 provides **DNO**s with guidance on active management solutions to overcome voltage control limitations. Information on the voltage regulation and control arrangements will be made available by the **DNO** if requested by the **Generator**.
      3. **Synchronous Power Generating Module**s Excitation Performance Requirements

13.4.3.1 Each **Synchronous Generating Unit** within a **Synchronous** **Power Generating Module** shall be equipped with a permanent automatic **Excitation System** that has the capability to provide constant terminal voltage (assuming a high enough **Network** source impedance to allow the **Power Generating Module** to achieve this while remaining within its ratings) at a selectable setpoint without instability over the entire operating range of the **Synchronous** **Power Generating Module**.

13.4.3.2 The requirements for **Synchronous Generating Unit** excitation control facilities are specified in Annex C.4. The **DNO** will agree any **site** specific requirements with the **Generator**.

13.4.3.3 Unless otherwise required for testing in accordance **with** Annex C.8.2, the automatic excitation control system of a **Synchronous Power Generating Module** shall always be operated such that it controls the **Synchronous Generating Unit** terminal voltage to a value that is

* equal to its rated value; or
* only where provisions have been made in the **Connection Agreement**, greater than its rated value.

13.4.3.4 In some cases, particularly on large industrial sites etc where the **Power Generating Module** is embedded in the **Generator’s Installation**, the **DNO** and **Generator** might agree a different control point, such as the **Connection Point**.

* + 1. Voltage Control Performance Requirements for **Power Park Module**s

13.4.4.1 Each **Power Park Module** shall be fitted with a continuously acting automatic control system to provide control of the voltage at the **Connection Point** without instability over the entire operating range of the **Power Park Module**. Any plant or apparatus used to provide such voltage control within a **Power Park Module** may be located at the **Generating Unit** terminals, an appropriate intermediate busbar or the **Connection Point**. When operating below 20% **Registered Capacity** the automatic control system may continue to provide voltage control using any available reactive capability. If voltage control is not being provided the automatic control system shall be designed to ensure a smooth transition between the shaded area below 20% of **Active** **Power** output and the non-shaded area above 20% of **Active Power** output in Figure 13.15.

13.4.4.2 The performance requirements for a continuously acting Automatic Voltage Control system that shall be complied with by the **Generator** in respect of **Power Park Module**s are defined in Annex C.5. The **DNO** will agree any site specific requirements with the **Generator**.

* + 1. As part of the connection application process the **Generator** shall agree with the **DNO** the set points of the control scheme for voltage control, **Power Factor** control or **Reactive Power** control as appropriate. These settings, and any changes to these settings, shall be agreed with the **DNO** and recorded in the **Connection Agreement**. The information to be provided is detailed in Schedule 5a and Schedule 5b of the Data Registration Code.
    2. The final responsibility for control of **Distribution Network** voltage does however remain with the **DNO**.
    3. Automatic Voltage Control (AVC) schemes employed by the **DNO** often assume that power flows from parts of the **Distribution Network** operating at a higher voltage to parts of the **Distribution Network** operating at lower voltages. Export from **Power Generating Module**s in excess of the local loads may result in power flows in the reverse direction. In this case AVC referenced to the **Low Voltage** side may not operate correctly without an import of **Reactive Power** and relay settings appropriate to this operating condition. When load current compounding is used with the AVC and the penetration level of **Power Generating Module**sbecomes significant compared to normal loads, it may be necessary to switch any compounding out of service.
    4. **Power Generating Module**s can cause problems if connected to networks employing AVC schemes which use negative reactance compounding and line drop compensation due to changes in **Active Power** and **Reactive Power** flows. EREP 126 provides guidance on connecting generation to such networks using techniques such as removing the generation circuit from the AVC scheme using cancellation CTs.
  1. **Reactive Capability**
     1. All **Synchronous Power Generating Module**s shall be capable of satisfying the **Reactive Power** capability requirements at the **Connection Point** as defined in Figure 13.12 when operating at **Registered Capacity**. In some cases, for example, on large industrial sites etc where the **Power Generating Module** is embedded in the **Generator's Installation**, the **DNO** may specify a performance requirement for the **Power Generating Module** that fits within the rectangular boundary defined in Figure 13.12, ie an envelope agreed between the **DNO** and the **Generator** within the rectangle of Figure 13.12.  In such cases the **DNO** and **Generator** might agree a different control point, such as the **Power Generating Module**'s terminals. The performance requirements of the control system including **Slope** (where applicable) shall be agreed between the **DNO** and the **Generator**.
     2. At **Active Power** output levels other than **Registered Capacity** all **Generating Unit**s within a **Synchronous Power Generating Module** shall be capable of continuous operation at any point between the **Reactive Power** capability limit identified on the **Generator Performance Chart** at least down to the **Minimum Stable Operating Level**. At reduced **Active Power** output, **Reactive Power** supplied at the **Connection Point** shall correspond to the **Generator Performance Chart** of the **Synchronous Power Generating Module**, taking the auxiliary supplies and the **Active Power** and **Reactive Power** losses of the **Power Generating Module** transformer or **Station Transformer** into account.



**Figure 13.12 Reactive Power capability requirements (Synchronous Power Generating Modules)**

* + 1. At voltages above 1.05 pu, or below 0.95 pu a **Synchronous Power Generating Module** shall maintain the **Reactive Power** output and **Power Factor** as far as possible recognizing that outside of the envelope of Figure 13.12 it will be necessary  for the **Reactive Power** and/or **Power Factor** to be constrained by the capability as expressed on the **Generator Performance Chart**.
    2. All **Power Park Module**s with a **Connection Point** voltage above 33 kV, shall be capable of satisfying the **Reactive Power** capability requirements at the **Connection Point** as defined in Figure 13.13 when operating at **Registered Capacity**.



**Figure 13.13 Reactive Power capability requirements (Power Park Modules operating at Registered Capacity, voltage above 33 kV)**

* + 1. All **Power Park Module**s with a **Connection Point** voltage at or below 33 kV shall be capable of satisfying the **Reactive Power** capability requirements at the **Connection Point** as defined in Figure 13.14 when operating at **Registered Capacity**.



**Figure 13.14 Reactive Power capability requirements (Power Park Modules operating at Registered Capacity, voltage at or below 33 kV)**

* + 1. All **Power Park Module**s, shall be capable of satisfying the **Reactive Power** capability requirements at the **Connection Point** as defined in Figure 13.15 when operating below **Registered Capacity**. With all plant in service, the **Reactive Power** limits will reduce linearly below 50% **Active Power** output as shown in Figure 13.15 unless the requirement to maintain the **Reactive Power** limits defined at **Registered Capacity** under absorbing **Reactive Power** conditions down to 20% **Active Power** output has been specified by the **DNO**. These **Reactive Power** limits will be reduced pro rata to the amount of plant in service.



**Figure 13.15** **Reactive Power capability requirements (Power Park Modules operating below Registered Capacity)**

* 1. **Fast Fault Current Injection**
     1. **Fast Fault Current** injection is necessary to support the **Total System** during a fault on the **Transmission System**. The design of **Fast Fault Current** injection is tailored to this, and does not relate directly to faults on the **Distribution Network**, not least as these will tend to have longer clearing times than those of the **Transmission System** for which **Fast Fault Current** injection is designed. In this Section 13.6 the faults referred to are **Transmission System** faults which clear within 140 ms and which will be seen in the **Distribution Network** as a voltage depression. For this section 13.6 voltage and current quantities are assumed to be positive phase sequence values.
     2. Each **Power Park Module** shall be required to satisfy the following requirements.

1. For any balanced fault on the **Transmission System** which results in the voltage at the **Connection Point** falling below 0.9 pu each **Power Park Module** shall unless otherwise agreed with the **DNO**, be required to inject reactive current IR that lies above the heavy black line shown in Figure 13.16.



**Figure 13.16 – locus of magnitude of injected reactive current**

1. Figure 13.16 defines the reactive current IR that is to be supplied during a fault on the **Transmission System** and which is dependent on the pre-fault operating conditions, and the voltage retained at the **Connection Point**. Each **Power Park Module** shall inject a reactive current IR which shall not be less than its pre-fault reactive current and which shall as a minimum increase with the fall in retained voltage each time the retained voltage at the **Connection Point** falls below 0.9 pu, whilst ensuring that the overall rating of the **Power Park Module** is not exceeded
2. In addition each **Power Park Module** shall be required to satisfy the reactive current requirements shown in Figures 13.17 which shows how the reactive current should be injected over time from the fault inception. The injected current shall be above the shaded area shown in Figure 13.17 (a) or Figure 13.17 (b) with priority being given to reactive current injection with any residual capability being supplied as active current. Under any fault condition, where the voltage falls below 0.9 pu, there would be no requirement for any **Power Park Module** or constituent **Generating Unit** to exceed its transient or steady state rating.

**Figure 13.17(a) Chart showing area of Reactive Current injections for voltage depressions of ≤ 140 ms duration**

**Figure 13.17(b) Chart showing area of Reactive Current injections for voltage depressions of > 140 ms duration**

1. For the purposes of this requirement, the maximum rated current is taken to be the maximum current each **Generating Unit** can supply when operating at **Registered Capacity** and 0.95 **Power Factor** at a nominal voltage of 1.0 pu. For example in the case of a 10 MW **Power Park Module** the **Registered Capacity** would be taken as 10 MW and the rated **Reactive Power** would be taken as 3.28 MVAr (ie **Rated MW** output operating at 0.95 **Power Factor** lead or 0.95 **Power Factor** lag) giving an MVA rating of 10.53 MVA. If, in this example, the **Power Park Module** consisted of 5 x 2 MW **Generating Units** and 1 x 1 MVAr reactive compensation equipment, each **Generating Unit** would need to be rated to produce 2 MW and (3.3 MVAr - 1.0 MVAr) ÷ 5, ie 2.05 MVA
2. All **Power Park Module** equipment shall be designed to ensure a smooth transition between any of its voltage, power factor, or reactive power control modes and fault ride through mode in order to prevent the risk of instability which could arise in the transition between the steady state voltage operating range and abnormal conditions where the retained voltage falls below 0.90 pu of nominal voltage. Such a requirement is necessary to ensure adequate performance between the pre-fault operating condition of the **Power Park Module** and its subsequent behaviour under fault conditions.
3. Each **Power Park Module** shall be designed to reduce the risk of transient over voltage levels arising following clearance of the fault and in order to mitigate the risk of any form of instability which could result. **Generators** shall be permitted to block or employ other means where the anticipated transient over voltage would otherwise exceed the 1.05 pu of nominal. Figure 13.17 (a) and Figure 13.17 (b) show the impact of variations in fault clearance time which shall be no greater than 140 ms. The **DNO** may agree requirements for the maximum transient over voltage withstand capability and associated time duration. Such capability and parameters will be recorded in the **Connection Agreement**. Where the **Generator** is able to demonstrate to the **DNO** that blocking or other control strategies are required in order to prevent the risk of transient over voltage excursions **Generators** are required to both advise and agree with the **DNO** the control strategy,which shall also include the approach taken to de-blocking.
4. To permit additional flexibility for example from **Power Park Modules** made up of full converter **Generating Units**, DFIG **Generating Units** or induction **Generating Units**, the **DNO** will permit transient deviations below the shaded area shown in Figure 13.17 (a) or Figure 13.17 (b) provided that the reactive current supplied is greater than the minimum requirement shown in Figures 13.17 (a) or Figure 13.17 (b). This agreement will be formalised in the **Connection Agreement**.
5. In the case of an unbalanced fault, each **Power Park Module** or each **Generating Unit** within a **Power Park Module** shall be required to inject maximum reactive current without exceeding the transient rating of the **Power Park Module**.
   1. **Anchor Plant Capability and quick re-synchronisation** 
      1. The **National Electricity Transmission System** is equipped with **Anchor Power Station**s. It will be necessary for each **Generator** to notify the **DNO** if its **Power Generating Module** has a restart capability without connection to an external power supply, unless the **Generator** shall have previously notified the **NETSO** accordingly under the **Grid Code**. Such generation may be registered by the **NETSO** as a **Anchor Power Station**.
      2. In case of disconnection of the **Power Generating Module** from the **Distribution Network**, the **Power Generating Module** shall be capable of quick re-synchronisation if required by the **NETSO**. If the **NETSO** requires quick re-synchronisation it will agree the strategy with the **DNO** and the **Generator**. Where quick re-synchronisation is required:

(a) A **Power Generating Module** with a minimum re-synchronisation time greater than 15 minutes after its disconnection from any external power supply must be capable of houseload operation from any operating point on its **Power Generating Module** **Generator Performance Chart**. In this case, the identification of houseload operation must not be based solely on the **DNO**’s switchgear position signals; and

(b) **Power Generating Module**s shall be capable of houseload operation, irrespective of any auxiliary connection to the **Distribution Network**. The minimum operation time shall be specified by the **NETSO**, taking into consideration the specific characteristics of prime mover technology.

* 1. **Technical Requirements for Embedded Medium Power Stations**
     1. Where a **Generator** in respect of an **Embedded Medium Power Station** is a party to the **CUSC** this Section 13.8 will not apply.
     2. In addition to the requirements of this EREC G99, the **DNO** has an obligation under ECC 3.3 of the **Grid Code** to ensure that all relevant **Grid Code** Connection Condition requirements are met by **Embedded Medium Power Station**s. These requirements are summarised in ECC 3.4 of the **Grid Code**. It is incumbent on the **Generator** who owns any **Embedded Medium Power Station** to comply with the relevant **Grid Code** requirements listed in ECC3.4 of the **Grid Code** as part of compliance with this EREC G99.
     3. Where data is required by the **NETSO** from **Embedded Medium Power Station**s, nothing in the **Grid Code** or this EREC G99 precludes the **Generator** from providing the information directly to the **NETSO** in accordance with **Grid Code** requirements. However, a copy of the information should always be provided in parallel to the **DNO**.
     4. **Grid Code** Connection Conditions Compliance

13.8.4.1 The technical designs and parameters of the **Embedded Medium Power Station** shall comply with the relevant Connection Conditions of the **Grid Code**. A statement to this effect, stating compliance with ECP4.3 of the **Grid Code** is required to be presented to the **DNO** for onward transmission to the **NETSO**, before commissioning of the **Embedded Medium Power Station**. Note that the statement might need to be resubmitted post commissioning when assumed values etc have been confirmed.

13.8.4.2 Should the **Generator** make any material change to such designs or parameters as will have any effect on the statement of compliance referred to in paragraph 13.8.4.1, the **Generator** shall notify the change to the **DNO**, as soon as reasonably practicable, who will in turn notify the **NETSO**.

13.8.4.3 Tests to ensure **Grid Code** compliance may be specified by the **NETSO** in accordance with the **Grid Code**.It is the **Generator**’s responsibility to carry out these tests.

13.8.4.4 Where the **NETSO** can reasonably demonstrate that for **Total System** stability issues the **Embedded Medium Power Station** should be fitted with a **Power System Stabiliser**, the **NETSO** will notify the **DNO** who will then require it to be fitted.

* 1. **Operational monitoring**
     1. With regard to information exchange:
  2. **Power Generating Facilities** shall be capable of exchanging information with the **DNO** in real time or periodically with time stamping;
  3. the **DNO**, in coordination with the **NETSO**, shall specify the content of information exchanges including a precise list of data to be provided by the **Power Generating Facility**.
     1. At each **Power Generating Facility** the **DNO** will install its own Telecontrol/SCADA outstation which will generally meet all the **DNO**’s necessary and legal operational data requirements. The **DNO** will inform the **Generator** if additional specific data are required at the time of the connection offer.
     2. Additionally each **Power Generating Facility** shall;
     3. be fitted with fault recording and dynamic system monitoring facilities which shall be capable of recording system data including voltage, **Active Power**, **Reactive Power** and frequency in accordance with Annex C.6.
     4. The settings of the fault recording equipment and dynamic system monitoring equipment (which is required to detect poorly damped power oscillations) including triggering criteria shall be agreed between the **Generator** and the **DNO** and recorded in the **Connection Agreement**.
     5. The **DNO** may also specify that **Generator**s shall install power quality monitoring equipment. Any such requirement including the parameters to be monitored would be specified by the **DNO** in the **Connection Agreement**.
     6. Provisions for the submission of fault recording, dynamic system monitoring and power quality data to the **DNO** including the communications and protocols shall be specified by the **DNO** in the **Connection Agreement**.
     7. The **Generator** will provide all relevant signals in a format to be agreed between the **Generator** and the **DNO** for onsite monitoring. All signals shallbe suitably terminated in a single accessible location at the **Generator**s site.
     8. The **Generator** shall provide to the **DNO** a 230 V power supply adjacent to the signal terminal location.
     9. **Frequency Sensitive Mode** (**FSM**) monitoring in real time

13.9.6.1 Power **Generating Module**s shall be fitted with facilities to record and monitor the operation of **Active Power** **Frequency Response** in real time if the **Generator** has chosen to enter into an appropriate ancillary services commercial contract with the **NETSO**.

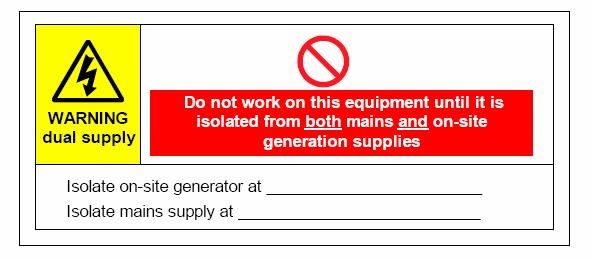
13.9.6.2 Provisions for the submission of **Frequency Sensitive Mode** data to the **DNO** including the data to be monitored, communications and protocols shall be specified, if required, by the **DNO** in the **Connection Agreement**.

* 1. **Steady State Load Inaccuracies** 
     1. The standard deviation of load error at steady state load over a 30 minute period shall not exceed 2.5% of a **Power Generating Module**s **Registered Capacity**.Where a **Power Generating Module** is instructed to operate in frequency sensitive operation, allowance will be made in determining whether there has been an error according to the governor **Droop** characteristic registered under the DDRC.

For the avoidance of doubt, in the case of a **Power Park Module** allowance will be made for the full variation of mechanical power output.

1. **Installation, Operation and Control Interface**
   1. **General**
      1. Installations should be carried out by competent persons, who have sufficient skills and training to apply safe methods of work to install the **Power Generating Module** in compliance with this EREC. Ideally they should have recognized and approved qualifications relating to the fuel / energy sources and general electrical installations.
      2. Notwithstanding the requirements of this EREC, the installation should be carried out to the standards required in the **Manufacturer**’s installation instructions.
      3. The **Generator** and **DNO** shall give due regard to these requirements and ensure that all personnel are competent in that they have adequate knowledge and sufficient judgement to take the correct action when dealing with an emergency. Failure to take correct action may jeopardise the **Generator**’s equipment or the **Distribution Network** and give rise to danger.
      4. The **DNO** and the **Generator** shall agree in writing the salient technical requirements of the interface between their two systems. These requirements will generally be contained in the Site Responsibility Schedule and/or the **Connection Agreement.** In particular it is expected that the agreement will include:
2. the means of synchronisation between the **Generator’s Installation** and the **Distribution Network**, where appropriate;
3. the responsibility for plant, equipment and protection systems maintenance, and recording failures;
4. the means of connection and disconnection between the **Distribution Network** and **Generator’s Installation**;
5. key technical data eg import and export capacities, operating **Power Factor** range, **Interface Protection** settings;
6. the competency of all persons carrying out operations on their systems;
7. details of arrangements that will ensure an adequate and reliable means of communication between the **DNO** and **Generator**;[[17]](#footnote-20)
8. the obligation to inform each other of any condition, occurrence or incident which could affect the safety of the other’s personnel, or the maintenance of equipment and to keep records of the communication of such information;
9. the names of designated persons with authority to act and communicate on their behalf and their appropriate contact details;
10. the obligation of a **Generator** to notify the **DNO** of any operational incidents or failures of a **Power Generating Module** that affect its compliance with this EREC G99, without undue delay, after the occurrence of those incidents.
    * 1. **Generator**sshould be aware that many **DNO**sapply auto-reclose systems to **HV** overhead line circuits. This may affect the operations of directly connected **HV Power Generating Module**s and also **Power Generating Module**s connected to **LV Distribution Network**s supplied indirectly by **HV** overhead lines.
    1. **Isolation and Safety Labelling**
       1. Every **Generator**’s **Installation** which includes **Power Generating Module**soperating in parallel with the **Distribution Network** shall include a means of isolation capable of disconnecting the whole of the **Power Generating Module**[[18]](#footnote-21) infeed to the **Distribution Network**. This equipment will normally be owned by the **Generator**, but may by agreement be owned by the **DNO**.
       2. The **Generator** shall grant the **DNO** rights of access to the means of isolation without undue delay and the **DNO** shall have the right to isolate the **Power Generation Module**s infeed at any time should such disconnection become necessary for safety reasons and in order to comply with statutory obligations. The isolating device should normally be installed at the **Connection Point**, but may be positioned elsewhere with the **DNO**’s agreement.
       3. To ensure that **DNO** staff and that of the **Generator** and their contractors are aware of the presence of **a Power Generating Module**, appropriate warning labels should be used.
       4. Where the installation is connected to the **DNO** **LV Distribution Network** the **Generator** should generally provide labelling at the **Connection Point** (Fused Cut-Out), meter position, consumer unit and at all points of isolation within the **Generator’s** **Installation** to indicate the presence of a **Power Generating Module**. The labelling should be sufficiently robust and if necessary fixed in place to ensure that it remains legible and secure for the lifetime of the installation. The Health and Safety (Safety Signs & Signals) Regulations 1996 stipulates that labels should display the prescribed triangular shape, and size, using black on yellow colouring. A typical label, for both size and content, is shown below in Figure 14.1.

**Figure 14.1 Warning label**



Isolate on site Generating Unit at \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

**Isolate mains supply at** \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

* + 1. Where the installation is connected to the **DNO**’s **HV Distribution Network** the **Generator** should give consideration to the labelling requirements. In some installations eg a complex CHP installation, extensive labelling may be required, but in others eg a wind farm connection, it is likely to be clear that **Power Generating Module**s are installed on site and labelling may not be required. Any labels should comply with The Health and Safety (Safety Signs & Signals) Regulations 1996 which stipulates that labels should display the prescribed triangular shape, and size, using black on yellow colouring.
  1. **Site Responsibility Schedule**
     1. In order to comply with the Distribution Planning and Connection Code DPC 5.4.3 of the **Distribution Code** a Site Responsibility Schedule (SRS) should be prepared by the **DNO** in conjunction with the **Generator**. The SRS should clearly indicate the ownership, operational and maintenance responsibility of each item of equipment at the interface between the **Distribution Network** and the **Power Generating Module**, and should include an operational diagram so that all persons working at the interface have sufficient information so that they can undertake their duties safely and to minimise the risk of inadvertently interrupting supplies. The SRS should also record the agreed method of communication between the **DNO** and the **Generator**.Where the **Power Generating Facility** has a **Registered Capacity** of 50 kW (or 17 kW per phase) or less and is connected at **LV** then only compliance with paragraph 14.3.3 is required (this includes **Small Generation Installations**).
     2. The operational diagram should be readily available to those persons requiring access to the information contained on it. For example, this could be achieved by displaying a paper copy at the **Connection Point**, or alternatively provided as part of a computer based information system to which all site staff has access. The most appropriate form for this information to be made available should be agreed as part of the connection application process.
     3. In the case of a **LV** connected **Power Generating Module,** a simple diagram located at the **Connection Point** may be sufficient. The scope of the diagram should cover the **Distribution Network**, **Generator’s Installation** and the **Power Generating Module** as shown below in Figure 14.2, however the location of any metering devices, consumer unit and **Interface Protection** (together with their settings) within the **Generator**’s **Installation** should also be shown.



**Fig 14.2 – Example of an Operational Diagram**

* + 1. In the case of either long term parallel operation with islanding capability (OM2), or infrequent short term parallel operation (OM3), the diagram should show which of the **Customer**’s demands are supplied by the **Power Generating Module** when in islanded mode, where the disconnection of the island from the rest of the **Customer’s Installation** occurs, and the disposition of relevant switches and/or contactors, including those for switches the earthing arrangements between island and parallel mode. Figures 8.9, 8.13 or 8.14 can be used as relevant as an example of the appropriate level of detail.
    2. In the case of an **HV** connected **Power Generating Module** the diagram is likely to be more complex and contain more detailed information.
    3. In addition to preparing the diagram as part of the connection process, there are obligations on the **DNO** and the **Generator** to ensure that the Site Responsibility Schedule including the operational diagram are updated to reflect any changes on site. To facilitate this, the **Generator** shall contact the **DNO** when any relevant changes are being considered.
  1. **Operational and Safety Aspects**
     1. Where the **Connection Point** provided by the **DNO** for parallel operation is at **HV**, in addition to the provisions of DOC 8, the **Generator** shall ensure:

1. that a person with appropriate authority is available at all times to receive communications from the **DNO** Control Engineer so that emergencies, requiring urgent action by the **Generator**, can be dealt with adequately. Where required by the **DNO**, it will also be a duty of the **Generator’s** staff to advise the **DNO** Control Engineer of any abnormalities that occur on the **Power Generating Module** which have caused, or might cause, disturbance to the **Distribution Network**, for example earth faults;
2. Where in the case that it is necessary for the **Generator**’s staff to operate the **DNO**’s equipment, they shall first have been appropriately trained and designated as a **DNO** ‘Authorised Person’ for this purpose. The names of the **Generator**s authorised persons should be included on the Site Responsibility Schedule. All operation of **DNO** equipment shall be carried out to the specific instructions of the **DNO** Control Engineer in accordance with the **DNO**’s safety rules.
   * 1. For certain **Power Generating Module** connections to an **HV** **Connection Point**, the **Generator** and the **DNO** may have mutually agreed to schedule the **Active Power** and / or **Reactive Power** outputs to the **Distribution Network** to ensure stability of the local **Distribution Network**. The **DNO** may require agreement on specific written procedures to control the bringing on and taking off of such **Power Generating Module**s. The action within these procedures will normally be controlled by the **DNO** Control Engineer.
     2. Where the **Connection Point** provided by the **DNO** for parallel operation is at **LV**, the **DNO**, depending upon local circumstances, may require a similar communications procedure as outlined in sub-paragraph 14.4.1(a) above.
   1. **Synchronising and Operational Control**
      1. Before connecting two energised electrical systems, for example a **Distribution Network** and **Power Generating Module**, it is necessary to synchronise them by minimising their voltage, frequency and phase differences.
      2. Operational switching, for example synchronising, needs to take account of **Step Voltage Change**sas detailed in Section 9.3.
      3. Automatic synchronising equipment will be the norm which, by control of the **Power Generating Module**’s field system (**Automatic Voltage Regulator**) and governor, brings the incoming unit within the acceptable operating conditions of voltage and speed (frequency), and closes the synchronising circuit breaker. Manual synchronising can only be done with the specific agreement of the **DNO**.
      4. Where the **Power Generating Module** is resynchronising from islanded mode, ie where the **Power Generating Module** is supplying some or all of the demand in the **Customer’s Installation** resynchronisation will only be allowed such that any effect on the **DNO**’s **Distribution Network** is minimised, and must demonstrate compliance with the requirements of EREC P28 for the most onerous synchronizing conditions. In general auto resynchronisation should modify the **Power Generating Module** output to closely match the voltage, frequency and where applicable, the phase angle of the **DNO**’s **Distribution Network**. In addition to the **Generator** (or **Manufacturer** or **Installer**) demonstrating compliance with EREC P28, synchronization should not occur outside of the criteria below:
3. No more than 10% voltage difference,
4. A difference in **Frequency** no more than 400 mHz from the **System Frequency**, and
5. a phase angle displacement of no more than 15º.

In general **Power Generating Module**s should be designed to achieve values of a), b) and c) that ensure compliance with EREC P28 and are close to zero as possible in all cases.

* + 1. The facility to use the **DNO**’s interface circuit breaker for synchronising can only be used with the specific agreement of the **DNO**. **Power Generating Module**s shall be equipped with the necessary synchronisation facilities.
    2. The synchronising voltage supply may, with **DNO** agreement, be provided from a **DNO** owned voltage transformer. Where so provided, the voltage supplies should be separately fused at the voltage transformer.
    3. Where the **Generator's** **Installation** comprises ring connections with normal open points, it may not be economic to provide synchronising at all such locations. In such cases mechanical key interlocking may be applied to prevent closure unless one side of the ring is electrically dead. A circuit breaker or breakers will still, however, require synchronising facilities to achieve paralleling between the **Generator’s Installation** and the **DNO** supply.
    4. The conditions to be met in order to allow automatic reconnection when the **DNO** supply is restored are defined in Section 10.3. Where a **Generator** requires the **Power Generating Module** to continue to supply a temporarily disconnected section of the **Distribution Network** in island mode**,** the special arrangements necessary will need to be discussed with the **DNO**.

1. **Common Compliance and Commissioning Requirements for all Power Generating Modules**
   1. **Demonstration of Compliance**
      1. Where the **Generator** and the **DNO** agree that it is not practical to demonstrate the technical compliance requirements of this EREC G99 at the **Connection Point**, the **DNO** will accept demonstration of the requirements at the **Generating Unit** terminals.
      2. The **DNO** will allow the **Generator** to carry out alternative tests, provided that those tests are efficient and suffice to demonstrate that a **Power Generating Module** complies with the requirements of this EREC G99.
      3. Compliance at a **Customer’s Installation** with, for example:

* both **Electricity Storage** devices and demand, or
* both **Generating Unit**sand/or **Power Generating Modules** that are not **Electricity Storage** devices, and **Electricity Storage** devices,

can be demonstrated through the combined capability of all **Power Generating Modules** that form the **Generator’s Installation**. Demonstration that each **Power Generating Module** (including **Electricity Storage** devices) individually meets the requirements in this EREC G99 is required where the **Generator** intends to operate the **Generating Unit**s in their installation individually, for example, if the **Electricity Storage** devices are out of service.

For a **Type A Power Generating Module** comprised of more than one **Generating Unit** with separate primary energy sources, demonstration of compliance of each group of **Generating Unit**s with a separate primary energy source is an acceptable method of demonstrating compliance for the **Power Park Module**.

* 1. **Wiring for Type Tested Power Generating Modules**
     1. Where **Type Tested** components are wired together on site, ie not using specifically designed plugs and sockets for the purpose, it will be necessary to prove that all wiring has been correctly terminated by proving the functions which rely on the wiring. The **Generator** will submit to the **DNO** for agreement a schedule of the wiring connections to be made, the functions that they enable, and the tests to prove them. Satisfactory completion of the agreed tests will enable the **Power Generating Modules** to attain or retain **Type Tested** status. An example of this requirement is given in Form A2-4 (Annex A.2).
  2. **Commissioning Tests / Checks required at all Power Generating Facilities**
     1. The following checks shall be carried out by the **Installer** at all **Power Generating Facilities** and on all **Power Generating Module**s irrespective of whether they have been **Fully Type Tested** or **Type Tested**:
     2. Inspect the **Power Generating Facility** to check compliance with BS7671. Checks should consider:

Protection

Earthing and bonding

Selection and installation of equipment

* + 1. Check that suitable lockable points of isolation have been provided between the **Power Generating Module**s and the rest of the installation;
    2. Check that safety labels have been installed in accordance with paragraph 14.2;
    3. Check interlocking operates as required. Interlocking should prevent **Power Generating Module**s being connected to the **DNO**’s **Distribution Network** without being synchronised; and
    4. Where possible undertake a visual check that the correct protection settings have been applied in accordance with Table 10.1 or Form A2-4 Site Compliance and Commissioning test requirements Form (Annex A.2), Form B2-2 (Annex B.2) or Form C2-2 (Annex C.2) as applicable to **Type A**, **Type B** and **Type C** or **Type D** **Power Generating Module**srespectively.
    5. The following tests shall be carried out by the **Installer** at all **Power Generating Facilities** and on all **Power Generating Module**s irrespective of whether they have been **Fully Type Tested** or **Type Tested**:
    6. Complete functional tests to ensure each **Power Generating Module** synchronises with, and disconnects from, the **DNO**’s **Distribution Network** successfully and that it operates without tripping under normal conditions;
    7. Carry out an appropriate functional test to confirm that the **Interface Protection** operates when all phases are disconnected between the **Power Generating Module** and the **DNO**’s **Distribution Network**. For installations where the **Power Generating Module** is not designed to automatically switch to support the installation’s demand in island mode (ie all island operating modes except OM2), this test can be carried out by opening a suitably rated switch between the **Power Generating Module** and the **Connection Point** and checking that the supplies are disconnected between the **Power Generating Module** and the **DNO**’s **Distribution Network** quickly (eg within 1 s);
    8. Where the **Power Generating Module** is designed to support the demand of the installation automatically in island mode on failure of the incoming supply (ie those OM1 installations where this is a design requirement), the **Generator** will undertake a suitable test as agreed with the **DNO** (such as removing one or all of the voltage sensing supplies to the **Interface Protection** relay) to prove that under these conditions that the supplies are disconnected between the **Power Generating Module** and the **DNO**’s **Distribution Network** quickly (eg within 1 s);
    9. Check that once the phases are restored following the functional test described in (b) at least 20 s elapses before the **Power Generating Module**s re-connect to the **DNO**’s **Distribution Network** where automatic re-connection is permitted under 10.3.3;
    10. For any installations using an export limitation scheme, including those connecting under the **Small Generation Installation** procedures, the commissioning tests detailed in EREC G100 shall be carried out for the export limitation scheme, with the results recorded in the form contained in the relevant EREC G100 appendix. This is in addition to the **Power Generating Module** compliance and commissioning tests required by EREC G98 and this EREC G99.
    11. The tests and checks shall be carried out once the installation is complete, or, in the case of a phased installation (ie where **Generating Unit**s that comprise a **Power Generating Module** are installed in different phases), when that part of the installation has been completed. The results of these tests and checks shall be recorded on the installation forms included in Form A3-1 or Form A3-2 (Annex A.3), Form B3 (Annex B.3), or Form C3 (Annex C.3) as applicable to **Type A**, **Type B** and **Type C** or **Type D** **Power Generating Module**srespectively. In the case of a phased installation, this would result in the submission of multiple versions of Form A3-1, A3-2, B3 and C3 for the same **Power Generating Module**.
  1. **Additional Commissioning requirements for Non Type Tested Interface Protection**
     1. Where **Type Testing** or **Manufacturers’ Information** is not being used to demonstrate **Interface Protection** compliance, on site protection commissioning tests are required and the following describes how these should be carried out for the standard range of protection required. Where additional protection is fitted then this should also be tested, additional test requirements are to be agreed between the **DNO** and **Generator**.

The results of these tests shall be recorded in the schedule provided in the Form A2-4 (Annex A.2), Form B2-2 (Annex B.2) or Form C2-2 (Annex C.2) as applicable to **Type A**, **Type B** and **Type C** or **Type D** **Power Generating Module**s respectively; using the relevant sections for **HV** and **LV** protection along with any additional test results required.

1. Calibration and stability tests shall be carried out on the over voltage and under voltage protection for each phase, as described below:

* The operating voltage shall be checked by applying nominal voltage to the protection (so that it resets) and then slowly increasing this voltage (for over voltage protection) or reducing it (for under voltage protection) until the protection picks up. The voltage at which the protection picks up shall be recorded. Where the test equipment increases / decreases the voltage in distinct steps, these shall be no greater than 0.5% of the voltage setting. Each pickup value shall be within 1.5% of the required setting value.
* Timing tests shall be carried out by stepping the voltage from the nominal voltage to a value 4 V above the setting voltage (for over voltage protection) and 4 V below the setting (for under voltage protection) and recording the operating time of the protection. The operating time of the protection relay shall be no shorter than the setting and no greater than the setting + 100 ms.
* Stability tests (no-trip tests) shall also be carried out at the voltages and for the durations defined in Form A2-4 (Annex A.2), Form B2-2 (Annex B.2) or Form C2-2 (Annex C.2) as applicable to **Type A**, **Type B** and **Type C** or **Type D** **Power Generating Module**srespectively. The protection shall not trip during these tests.

1. Calibration and stability tests shall be carried out on the over frequency and under frequency protection as described below:

* The operating frequency shall be checked by applying nominal frequency to the protection (so that it resets) and then slowly increasing this frequency (for over frequency protection) or reducing it (for under frequency protection) until the protection picks up. The frequency at which the protection picks up shall be recorded. Where the test equipment increases / decreases the frequency in distinct steps, these shall be no greater than 0.1% of the frequency setting. Each pick up value shall be within 0.2% (ie 0.1 Hz) of the setting value.
* Timing tests shall be carried out by stepping the frequency from 0.3 Hz below the setting frequency to a value 0.3 Hz above the setting frequency (for over frequency protection) and 0.3 Hz above the setting frequency to 0.3 Hz below the setting frequency (for under frequency protection) and recording the operating time of the protection. The operating time of the protection relay shall be no shorter than the setting and no greater than the setting + 100 ms or the setting + 1% of the setting, whichever gives the longer time.
* Stability tests (no-trip tests) shall also be carried out at the frequencies and for the durations defined in the commissioning test record, Form A2-4 (Annex A.2), Form B2-2 (Annex B.2) or Form C2-2 (Annex C.2) as applicable to **Type A**, **Type B** and **Type C** or **Type D Power Generating Module**s respectively. The protection shall not trip during these tests.

1. Calibration tests for the rate of change of frequency protection, where used, shall be checked by first applying a voltage with the frequency of 51.0 Hz to the protection and then ramping this frequency down at 0.1 Hzs-1 less than the RoCoF protection setting until a frequency reaches 49.0 Hz. This test is repeated at increasing values of rate of change of frequency (in increments of 0.025 Hzs-1 or less) until the protection operates. The test shall be repeated for rising frequency but this time each test shall start at 49.0 Hz and end at 51.0 Hz. The operating values should be within 0.025 Hzs-1 of the required setting. Timing tests shall be carried out by applying a falling and a rising frequency at 0.1 Hzs-1 above the setting value and at 3 Hzs-1. The protection relay operating times shall be no longer than 1.0 s.
2. RoCoF and vector shift stability tests shall be performed on all **Interface Protection** relaysirrespective of the type of loss of mains protection employed for a particular **Power Generating Module** or **Power Generating Facility**. These tests are defined in the commissioning test record, Form A2-4 (Annex A.2), Form B2-2 (Annex B.2) or Form C2-2 (Annex C.2) as applicable to **Type A**, **Type B** and **Type C** or **Type D Power Generating Module**s respectively. The protection shall not trip during these tests.
   1. **Compliance of Vehicle to Grid Electric Vehicles**
      1. The owner of the installation where a **Vehicle to Grid Electric Vehicle** is connected to the **Distribution Network** is a **Generator** and is responsible for compliance of the **Vehicle to Grid Electric Vehicle** with this EREC G99.
   2. **Family approach to Type Testing**
      1. A family approach to type testing is acceptable, whereby **Generating Units** that are the same model and produced by the same **Manufacturer** but vary in electrical output can be considered to be **Type Tested** once one **Generating Unit** in the family has been shown to be compliant.[[19]](#footnote-22) The approach is permissible in the following range of **Generating Unit** electrical output:

* For **Synchronous Generating Units**:
  + Lower limit: 1/√10 (0.3162) times the tested **Generating Unit** nameplate rating (W)
  + Upper limit: √10 (3.162) times the tested **Generating Unit** nameplate rating (W)
* For all other **Generating Units**:
  + Lower limit: 1/√10 (0.3162) of tested **Generating Unit** nameplate rating (W)
  + Upper limit: 2 times tested **Generating Unit** nameplate rating (W)
    1. All absolute values (e.g. operating range tests) shall be transferred directly in the compliance forms of an assumed compliant **Generating Unit** of the same family. All relative results related to design **Active Power** or current (e.g. power quality fluctuation and flicker) from the tested **Generating Unit** shall be transferred to the compliance form of a **Generating Unit** in the same family according to the ratio of the respective nameplate rating (W) of the tested **Generating Unit** and the assumed compliant **Generating Unit**. For the avoidance of doubt, the **Manufacturer** shall register each **Generating Unit** in the family on the Energy Networks Association **Type Test** register.
    2. It is the responsibility of the **Manufacturer** to provide technical justification that the results are transferable. For example, the **Generating Unit**s have the same control systems.
  1. **Compliance demonstration for Infrequent Short-Term Parallel Power Generating Modules**
     1. Compliance of a **Power Generating Module** designed to operate in infrequent short-term parallel operation mode should be demonstrated for the applicable requirements and design variations as detailed in Section 7.3. As a minimum this shall include:
* Provision of a Standard Application Form
* Compliance with Section 8 (Earthing);
* Compliance with Section 9 (Network Connection Design and Operation);
* Compliance with Section 10 (Protection);
* Compliance with Section 14 (Installation, Operation and Control Interface); and
* Compliance with Section 15 (Common Compliance and Commissioning Requirements).
  + 1. It is recommended that the certification, connection and notification process for the applicable **Power Generating Module** type is followed, whilst taking into account the technical exclusions detailed in Annex A.4.3. Thus some rows in the compliance forms A2-1, A2-2, A2-3, B2 and C2 can be marked as exempt; for example in form B2, rows associated with **Reactive Power** capability and frequency performance can be noted “E” for exempt.
  1. **Compliance demonstration for long term parallel operation with islanding capability (OM2) and infrequent short term parallel operation (OM3)**
     1. In addition to all the verification of compliance activities associated with the relevant **Power Generating Module**, the **Generator**, **Manufacturer** or **Installer** shall document how switching, resynchronisation, and earthing is arranged such that the requirements of this EREC G99 are achieved.
     2. If the automatic resynchronisation has not been **Type Tested**, tests shall be done on site with the **Power Generating Module** (or relevant **Generating Unit**(s) as appropriate) loaded to no less than 80% of the **Registered Capacity** to demonstrate compliance with the requirements of 14.5.4.
  2. **Compliance monitoring**
     1. For all on site monitoring by the **DNO** where the **DNO** is witnessing compliance tests undertaken by the **Generator** shall provide all relevant test signals as agreed between the **Generator** and the **DNO**.
     2. The signals which shall be provided by the **Generator** to the **DNO** for onsite monitoring shall be of the following resolution, unless otherwise agreed by the **DNO**:

(a) 1 Hz for reactive range tests;

(b) 10 Hz for frequency control tests;

(c) 100 Hz for voltage control tests;

(d) 1 kHz for fast fault current measurements on **Power Park Modules**; and

(e) 100 Hz for other **Power Park Module** tests.

1. **Type A Compliance Testing, Commissioning and Operational Notification**
   1. **Type Test Certification**
      1. The **Power Generating Module** can comprise **Fully Type Tested** equipment or be made up of some **Type Tested** equipment and require additional site testing prior to operation. The use of **Fully Type Tested** equipment simplifies the connection process, the protection arrangements and reduces the commissioning test requirements.
      2. **Type Tested** certification is the responsibility of the **Manufacturer**. The **Manufacturer** shall submit the Type Test Verification Report confirming that the product has been **Type Tested** to satisfy the requirements of this EREC G99 to the Energy Networks Association (ENA) Type Test Verification Report Register. The report shall detail the type and model of the product tested, the test conditions and results recorded. The report can include reference to **Manufacturers’ Information**. Examples of the combination of the use of type testing and the provision of **Manufacturers’ Information** are given in Section 22.1. Further information about **Manufacturers’ Information** in respect of **Power Park Module**s is given in Section 21. A **Manufacturer** of a **Type Tested** product should allocate a **Manufacturer**’s reference number, which should be registered on the ENA Type Test Verification Report Register as the system reference.
      3. The required Type Test Verification Report and **declarations** including that for a **Fully Type Tested Power Generating Module** are shown in Annex A.2:

* Form A2-1 - Compliance Verification Report for **Synchronous** **Power Generating Module**s up to and including 50 kW,
* Form A2-2 - Compliance Verification Report for **Synchronous Power Generating Module**s > 50 kW and also for **Synchronous Power Generating Module**s ≤ 50 kW where the approach of this form is preferred to that in Form A2-1, or
* Form A2-3 - Compliance Verification Report for **Inverter** Connected **Power Generating Module**s.

The choice of compliance routes available is shown in Figure 16-1 below.

It is intended that the **Manufacturer**s will use the requirements of this EREC G99 to develop type verification certification (ie the Compliance Verification Report as shown in Annex A.2) for each of their **Power Generating Module** models.

Form A2-3 caters for all asynchronous and **Inverter** technologies of any size, with the exception of conventional induction **Generating Unit**s**. Manufacturer**s of induction **Generating Unit**s may find it more appropriate to use Forms A2-2 or A2-1 in preference to Form A2-3 (Annex A.2).



**Figure 16.1 Illustration of the choice of compliance route**

* + 1. Guidance for **Manufacturer**s on type testing for **Power Generating Module**s is included in Annex A.7 of this document.
    2. Compliance with the requirements detailed in this EREC G99 will ensure that the **Power Generating Module** is considered to be approved for connection to the **DNO**’s **Distribution Network**.
    3. The **Power Generating Module** shall comply with all relevant legal requirements and should be labelled in accordance with those requirements.
  1. **Connection Process**
     1. The **Installer** shall discuss the installation project with the local **DNO** at the earliest opportunity. The connection application will need to be in format as shown in Form A1-1 (Annex A.1) for **Power Generating Module**s less than 50 kW, Form A1-2 (Annex A.1) for **Small Generation Installations**, or for **Power Generating Module**s greater than 50 kW by using the Standard Application Form (generally available from the **DNO**’s website). Where a **Power Generating Module** is **Fully Type Tested** and registered with the Energy Networks Association Type Test Verification Report Register, the application should include the **Manufacturer**’sreference number (the system reference), and the compliance test results do not need to be submitted as part of the application.
     2. On receipt of the application, the **DNO** will assess:
* whether any **Distribution** **Network** studies are required;
* whether there is a need for work on the **Distribution Network** before the **Power Generating Module** can be connected to the **Distribution Network**; and
* whether there is a requirement to witness the commissioning tests and checks.
  + 1. Connection of the **Power Generating Module** is only allowed after the application for connection has been approved by the **DNO** and any **DNO** works facilitating the connection have been completed.
    2. Where a **Power Generating Module** is not **Fully Type Tested**, the Generator or **Installer** shall provide the **DNO** with a Compliance Verification Report as per Annex A.2 (Forms A2-1, A2-2 or A2-3 as applicable) confirming that the **Power Generating Module** has or will be tested to satisfy the requirements of this EREC G99. This should be provided prior to commencing commissioning.
    3. Where **Power Generating Module**s require connection to the **DNO**’s **Distribution Network** in advance of the commissioning date, for the purposes of testing, the **Power Generating Facility** shall comply with the requirements of the **Connection Agreement**. The **Generator** shall provide the **DNO** with a commissioning programme, which will be approved by the **DNO** if reasonable in the circumstances, to allow commissioning tests to be coordinated.
    4. Where commissioning tests are not witnessed, confirmation of the commissioning of each **Power Generating Module** will need to be made no later than 28 days after commissioning; the format and content shall be as shown in Form A3-1 (Annex A.3) Installation Document for **Type A** **Power Generating Module**s or Form A3-2 (Annex A.3) Installation Document for **Small Generation Installations**. The **Installer** or **Generator**, as appropriate, shall complete the declaration at the bottom of the Installation Document (Form A3-1 or Form A3-2) noting that this declaration also covers the Site Compliance and Commissioning Test Form Form A2-4 (Annex A.2). Where the tests are witnessed a copy shall be provided to the **DNO** at the time of commissioning.
    5. It is the responsibility of the **Generator** (which may be delegated to the **Installer**) to ensure that the relevant information is forwarded to the local **DNO**. The pro forma in Annex A are designed to:

1. simplify the connection procedure for both the **DNO** and the **Installer**;
2. provide the **DNO** with all the information required to assess the potential impact of the **Power Generating Module** connection on the operation of the **Distribution Network**;
3. inform the **DNO** that the **Generator’s** **Installation** complies with the requirements of this EREC G99;
4. allow the **DNO** to accurately record the location of all **Power Generating Module**s connected to the **Distribution Network**.
   1. **Witnessing and Commissioning**
      1. The **DNO** will not normally witness the commissioning checks and tests for **Fully Type Tested** **Power Generating Module**s or **Small Generation Installations** connected to the **DNO**’s **Distribution Network** at **LV**. In such cases, where the **DNO** does decide to witness it will advise this as part of the connection offer. Reasons for witnessing such installations may include:
5. A new **Installer** with no track record in the **DNO** area.
6. A check on the quality of an installation either on a random basis or as a result of problems that have come to light at previous installations.
   * 1. Where commissioning tests and checks are to be witnessed the **Installer** shall discuss and agree the scope of these tests with the **DNO** at an early stage of the project. The tests shall take account of the requirements in Section 15.3. The **Installer** shall submit the scope, date and time of the commissioning tests at least 15 days before the proposed commissioning date.
     2. Where the **DNO** chooses to witness the **Power Generating Module** commissioning tests and checks, the **DNO** shall charge the **Generator** for attendance of staff for witness testing in accordance with its charging regime.
     3. No parameter relating to the electrical connection and subject to type test verification certification shall be modified unless previously agreed in writing between the **DNO** and the **Generator**. **Generator** access to such parameters in **Type Tested** equipment shall be prevented by a password, pin or a physical switch that has the facility to be sealed in accordance with paragraph 10.1.4.
     4. The checks and tests as detailed in Section 15.2, 15.3 and 15.4 shall be undertaken to the extent applicable.
     5. Where Type Testing or **Manufacturers’ Information** is not being used to demonstrate the compliance of the **Interface Protection** the tests detailed in Section 15.4 shall be undertaken.
   1. **Operational Notification** 
      1. Notification that the **Power Generating Module** has been connected / commissioned is achieved by completing an Installation Document as per Annex A.3, which also includes the relevant details on the **Generator’s Installation** required by the **DNO**.
      2. The **Installer**, or an agent acting on behalf of the **Installer**, shall supply separate Installation Documents (Form A3-1 (Annex A.3) for **Type A** **Power Generating Module**s or Form A3-2 (Annex A.3) for **Small Generation Installations**) for each **Power Generating Facility** installed under EREC G99 to the **DNO**. Documentation shall be supplied either at the time of commissioning (where tests are witnessed) or within 28 days of the commissioning date (where the tests are not witnessed) and may be submitted electronically.

Installers installing domestic micro-generating plant using the connect and notify process through the Connect Direct platform (<https://connect-direct.energynetworks.org/>) shall provide a clear photograph of the cut out with the application so it can be visually checked for suitability.

* + 1. **Generator**s who own **Type A** **Power Generating Module**s do not have permanent rights to operate their **Power Generating Module**s until the commissioning tests have been successfully completed (and witnessed by the **DNO** if required) and the Installation Document has been fully completed and sent to the **DNO**.

1. **Type B Compliance Testing, Commissioning and Operational Notification**
   1. **General**
      1. Where the Generator has entered into a Bilateral Embedded Generation Agreement (BEGA) with the **NETSO**, please refer to the guidance in Section 6.1.6.
      2. Where **Power Generating Module**s require connection to the **DNO**’s **Distribution Network** in advance of the commissioning date, for the purposes of testing, the **Power Generating Facility** shall comply with the requirements of the **Connection Agreement**. The **Generator** shall provide the **DNO** with a commissioning programme, which will be approved by the **DNO** if reasonable in the circumstances, to allow commissioning tests to be coordinated. The tests shall take account of the requirements in Section 15.3 and Section 15.4 where applicable.
      3. The **Generator** shall use **Type Tested** equipment and/or **Manufacturers’ Information** and/or site tests, as well as demonstrating commissioning tests performed on the **Power Generating Module** in order to discharge the requirements of this document. Examples of the combination of the use of type testing and the provision of **Manufacturers’ Information** are given in Section 22.1. Further information about **Manufacturers’ Information** for **Inverter** connected **Power Park Module**s is given in Section 21. Note that the **DNO** shall charge the **Generator** for attendance of staff for witness testing in accordance with its charging regime. The **Generator** shall make arrangements for the **DNO** to witness the commissioning tests unless otherwise agreed with the **DNO**.
      4. It is the responsibility of the **Generator** to undertake commissioning tests / checks and to ensure the **Power Generating Facility** and **Power Generating Module**s meet all the relevant requirements.
      5. In addition to the commissioning tests and checks required under EREC G99, in exceptional circumstances further tests may be required by the **DNO** from the **Manufacturer**, **Supplier**, **Generator** or **Installer** of the **Power Generating Module**s as may be required to satisfy legislation and other standards.
   2. **Connection Process**
      1. The **Generator** shall discuss the project with the local **DNO** at the earliest opportunity. The **Generator** will need to provide information using the Standard Application Form (generally available from the **DNO**’s website) to allow detailed system studies to be undertaken. Connection of the **Power Generating Module** is only allowed after the application for connection has been approved by the **DNO** and any **DNO** works facilitating the connection have been completed.
      2. Not less than 28 days, or such shorter period as may be acceptable in the **DNO**’s reasonable opinion, prior to the **Generator** wishing to synchronise its **Power Generating Module** for the first time the **Generator** will submit to the **DNO** a **Power Generating Module** **Document** containing at least but not limited to the items referred to in paragraph 17.2.3.
      3. Items for submission in the **Power Generating Module Document**:
   3. updated **DDRC** data (both **Standard Planning Data** and **Detailed Planning Data**) with any estimated values assumed for planning purposes confirmed, or where practical, replaced by validated actual values, and by updated estimates for the future and by updated forecasts for **Forecast Data** items such as demand.In practice this data can be supplied by updating the information provided in the Standard Application Form.
   4. details of any special **Power Generating Module**(s) protection as applicable.
   5. simulation study carried out in accordance with the provisions of Annex B.4 and the results demonstrating compliance with EREC G99: Frequency Capability and **Frequency Sensitive Mode** requirements of paragraph 12.2, **Fault Ride Through** requirements of Section 12.3, reactive capability requirements of Section 12.5 and **Power Park Module** **Fast Fault Current** injection requirements of paragraph 12.6 unless agreed otherwise by the **DNO**.
   6. a detailed schedule of the tests and the procedures for the tests required to be carried out by the **Generator** to achieve a **Final Operational Notification**. Such schedule to be consistent with the requirements of Section 12 and Annex B.5 (in the case of a **Synchronous Power Generating Module**) or Annex B.6 (in the case ofa **Power Park Module**). It should be noted that whilst **Excitation System** and reactive capability tests are not part of the standard set of tests for **Type B Power Generating Module**s the **DNO** may require the tests to be undertaken. If the **DNO** does require tests, they shall be based on the tests in Annex C8 and C9 and shall be agreed with the **Generator**.
   7. copies of **Manufactures’ Information** where these are relied upon as part of the evidence of compliance.
      1. A **Power Generating Module Document** (**PGMD**) shall be submitted for each applicable **Power Generating Module**. An example of a **Power Generating Module Document** is given in Form B2-1 (Annex B.2).
      2. The **Generator** will give at least 28 days’ notice for the date of tests that are to be witnessed by the **DNO**. The **DNO** shall assess the schedule of tests submitted by the **Generator** and agree the test start date. The **DNO** can agree to a shorter period of notice than 28 days. Approval of the test start date, and agreement to a shorter period of notice than 28 days, shall be made in a timely manner and not be unreasonably withheld by the **DNO**.
      3. If the **Generator’s Installation** is not already energised the **DNO** and the **Generator** shall agree an energisation date at which time the **DNO** will energise the **Generator’s Installation** as agreed.
      4. The **Generator** shall undertake the initial synchronisation and commissioning tests in accordance with the test schedule and Section 17.3. The **DNO** may witness these tests.
      5. The **Generator** shall undertake other tests as necessary to demonstrate compliance with this EREC G99 to enable completion of the **Power Generating Module Document**. The **DNO** will witness these tests as agreed.
      6. The **Generator** shall apply for a **Final Operational Notification** by submitting the information as detailed in Section 17.4.
      7. The **DNO** will issue a **Final Operational Notification** as detailed in paragraph 18.4.3
   8. **Witnessing and Commissioning**
      1. The **Generator** is responsible for carrying out the tests and retains the responsibility for safety and personnel during the test.
      2. The tests as detailed in the **Power Generating Module Document** shall be carried out by the **Generator** (and which may be delegated to the **Installer**).
      3. The checks and tests as detailed in Section 15.2 and 15.3 shall be undertaken to the extent applicable.
      4. Where Type Testing or **Manufacturers’ Information** is not being used to demonstrate the compliance of the **Interface Protection** the tests detailed in Section 15.4 shall be undertaken.
      5. The tests and checks shall be carried out once the installation is complete, or, in the case of a phased installation (ie where **Generating Unit**s that comprise a **Power Generating Module** are installed in different phases), when that part of the installation has been completed. The results of these tests shall be recorded on the Installation and Commissioning Form B3 (Annex B.3) and the additional compliance and commissioning tests, Form B2-2 (Annex B.2) if applicable. The **Installer** or **Generator**, as appropriate, shall complete the declaration at the bottom of Form B3, sign and date it and provide a copy to the **DNO** at the time of commissioning.
      6. To aid completing the necessary tests, and to allow the interim export of energy for the **Generator**’s commercial purposes, at the discretion of the **DNO**, the **DNO** and the **Generator** may agree an interim operating regime, including issuing an **Interim Operational Notification**, pending completion of all the necessary tests and data submission.  In such cases the provisions of Section 17.4 shall be respected and Section 19.3 shall be used as a guide to the formality required.
      7. If compliance tests or simulations cannot be carried out as agreed between the **DNO** and the **Generator** due to reasons attributable to the **DNO**, then the **DNO** shall not unreasonably withhold the **Final Operational Notification** to be issued under Section 17.4.
   9. **Final Operational Notification**
      1. Prior to the issue of a **Final Operational Notification** the **Generator** shall submit to the **DNO** to the **DNO**’s satisfaction:
      2. updated DDRC data (both **Standard Planning Data** and **Detailed Planning Data**), with validated actual values and updated estimates for the future including forecast data items such as demand. In practice, this data can be supplied by updating the information provided in the Standard Application Form;
      3. evidence to the **DNO**’s satisfaction that demonstrates that the **Controller** simulation models and/or parameters within the simulation model (as required under DDRC schedule 5c) supplied to the **DNO** provide a reasonable representation of the behaviour of the **Generator**’s plant and apparatus;
      4. copies of **Manufacturers’ Information** where these are relied upon as part of the evidence of compliance;
      5. results from the tests carried out by the **Generator** to demonstrate compliance with relevant EREC G99 requirements including the tests witnessed by the **DNO**; and
      6. the Compliance Declaration signed by the **Generator**.
      7. items in paragraph 17.4.1 should be submitted by the **Generator** using the **Power Generating Module Document**, Form B2-1 (Annex B.2) and DDRC (via the Standard Application Form). For **Synchronous Power Generating Module**s submission should normally be within 28 days of first synchronisation or a longer period as may be agreed with the **DNO**. For **Power Park Module**s it is expected that the compliance testing and commissioning will not take longer than 6 months; however a phased approach or a longer period may be agreed with the **DNO**. Other than for the purposes of compliance testing and commissioning, the **Generator** has no permanent rights to operate the **Power Generating Module** until the **Final Operational Notification** is received.
      8. If the requirements of this Section 17.4 have been successfully met, the **DNO** will notify the **Generator** that compliance with the relevant EREC G99 provisions has been demonstrated for the **Power Generating Module**(s) as applicable through the issue of a **Final Operational Notification** as part of the **Connection Agreement**.
2. **Type C Compliance Testing, Commissioning and Operational Notification**
   1. **General**
      1. Where the **Power Generating Facility** constitutes a large power station, or where the **Generator** has entered into a Bilateral Embedded Generation Agreement (BEGA) with the **NETSO**, please refer to the guidance in Section 6.1.6.
      2. Where **Power Generating Module**s require connection to the **DNO**’s **Distribution Network** in advance of the commissioning date, for the purposes of testing, the **Power Generating Facility** shall comply with the requirements of the **Connection Agreement**. The **Generator** shall provide the **DNO** with a commissioning programme, which will be approved by the **DNO** if reasonable in the circumstances, to allow commissioning tests to be coordinated. The tests shall take account of the requirements in Section 15.3 and Section 15.4 where applicable.
      3. The **Generator** shall use **Type Tested** equipment and/or **Manufacturers’ Information** and/or site tests as well demonstrating all the commissioning tests performed on the **Power Generating Module** in order to discharge the requirements of this document. Further information about **Manufacturers’ Information** is given in Section 21. Examples of the combination of the use of type testing and the provision of **Manufacturers’ Information** are given in Section 22.1. Note that the **DNO** shall charge the **Generator** for attendance of staff for witness testing in accordance with its charging regime. The **Generator** shall make arrangements for the **DNO** to witness the commissioning tests unless otherwise agreed with the **DNO**.
      4. It is the responsibility of the **Generator** to undertake commissioning tests / checks and to ensure the **Power Generating Facility** and **Power Generating Module**s meet all the relevant requirements.
      5. In addition to the commissioning tests and checks required under EREC G99, further tests may be required by the **Manufacturer**, **Supplier**, **Generator** or **Installer** of the **Power Generating Module**s as may be required to satisfy legislation and other standards.
      6. In the case of a **Power Park Module** the proportion of the **Power Park Module** which can be simultaneously synchronised to the **Total System** shall not exceed 20% of the **Registered Capacity** of the **Power Park Module** (or the output of a single **Generating Unit** where this exceeds 20% of the **Power Park Module**’s **Registered Capacity**), until the **Generator** has completed the voltage control tests (detailed in Annex C.9.2) to the **DNO**’s reasonable satisfaction. Following successful completion of this test each additional **Generating Unit** should be included in the voltage control scheme as soon as is technically possible (unless the **DNO** agrees otherwise).
   2. **Connection Process**
      1. The **Generator** shall discuss the project with the local **DNO** at the earliest opportunity. The **Generator** will need to provide information using the Standard Application Form (generally available from the **DNO**’s website) to allow detailed system studies to be undertaken. Connection of the **Power Generating Module** is only allowed after the application for connection has been approved by the **DNO** and any **DNO** works facilitating the connection have been completed.
      2. Not less than 28 days, or such shorter period as may be acceptable in the **DNO**’s reasonable opinion, prior to the **Generator** wishing to synchronise its **Power Generating Module** for the first time the **Generator** will submit to the **DNO** a **Power Generating Module Document** containing at least but not limited to the items referred to in paragraph 18.2.3.
      3. Items for submission in the **Power Generating Module Document**:
   3. updated **DDRC** data (both **Standard Planning Data** and **Detailed Planning Data**), with any estimated values assumed for planning purposes confirmed or, where practical, replaced by validated actual values by updated estimates for the future and by updated forecasts for **Forecast Data** items such as demand. In practice, this data can be supplied by updating the information provided in the Standard Application Form.
   4. details of any special **Power Generating Module**(s) protection. This may include pole slipping protection and islanding protection schemes as applicable;
   5. the simulation models as detailed in Section 6.3 and Section 21 as applicable;
   6. simulation study carried out in accordance with the provisions of Annex C.7 and the results demonstrating compliance with the frequency capability and **Frequency Sensitive Mode** requirements of paragraph 13.2, **Fault Ride Through** requirements of Section 13.3, reactive capability requirements of Section 13.5 and **Fast Fault Current** injection requirements of paragraph 13.6 unless agreed otherwise by the **DNO**;
   7. a detailed schedule of the tests and the procedures for the tests required to be carried out by the **Generator** to achieve a **Final Operational Notification**. Such schedule to be consistent with Section 13, Annex C.8 (in the case of a **Synchronous Power** **Generating Module**) or Annex C.9 (in the case ofa **Power Park Module**); and
   8. copies of **Manufactures Information** where these are relied upon as part of the evidence of compliance.
      1. A **Power Generating Module Document** (**PGMD**) shall be submitted for each applicable **Power Generating Module**. An example of a **Power Generating Module Document** is given in Form C2-1 (Annex C.2).
      2. The **Generator** will give at least 28 days’ notice for the date of tests that are to be witnessed by the **DNO**. The **DNO** shall assess the schedule of tests submitted by the **Generator** and agree the test start date. The **DNO** can agree to a shorter period of notice than 28 days. Approval of the test start date, and agreement to a shorter period of notice than 28 days, shall be made in a timely manner and not be unreasonably withheld by the **DNO**.
      3. If the **Generators Installation** is not already energised the **DNO** and the **Generator** shall agree an energisation date at which time the **DNO** will energise the **Generators Installation** as agreed.
      4. The **Generator** shall undertake the initial synchronisation and commissioning tests in accordance with the test schedule and Section 18.3. The **DNO** may witness these tests.
      5. The **Generator** shall undertake other tests as necessary to demonstrate compliance with this EREC G99 to enable completion of the **Power Generating Module Document**. The **DNO** will witness these tests as agreed.
      6. The **Generator** shall apply for a **Final Operational Notification** by submitting the information as detailed in Section 18.4.
      7. The **DNO** will issue a **Final Operational Notification** as detailed in paragraph 18.4.3
   9. **Witnessing and Commissioning**
      1. The **Generator** is responsible for carrying out the commissioning tests and retains the responsibility for safety and personnel during the test.
      2. The checks and tests as detailed in Section 15.2 and 15.3 shall be undertaken to the extent applicable.
      3. Where Type Testing or **Manufacturers’ Information** is not being used to demonstrate **Interface Protection** the tests detailed in Section 15.4 shall be undertaken.
      4. The tests as detailed in the **Power Generating Module Document** shall be carried out by the **Installer** or **Generator**.
      5. The tests and checks shall be carried out once the installation is complete, or, in the case of a phased installation (ie where **Generating Unit**s that comprise a **Power Generating Module** are installed in different phases), when that part of the installation has been completed. The results of these tests shall be recorded on the **Power Generating Module Document** Form C2-1 (Annex C.2) and the installation and commissioning document Form C3 (Annex C.3). The **Installer** or **Generator**, as appropriate, shall complete the declaration at the bottom of Form C3, sign and date it and provide a copy to the **DNO** at the time of commissioning.
      6. To aid completing the necessary tests, and to allow the interim export of energy for the **Generator**’s commercial purposes, at the discretion of the **DNO**, the **DNO** and the **Generator** may agree an interim operating regime, including issuing an **Interim Operational Notification**, pending completion of all the necessary tests and data submission.  In such cases the provisions of Section 18.4 shall be respected and Section 19.3 shall be used as a guide to the formality required.
      7. If compliance tests or simulations cannot be carried out as agreed between the **DNO** and the **Generator** due to reasons attributable to the **DNO**, then the **DNO** shall not unreasonably withhold the **Final Operational Notification** to be issued under Section 18.4.
   10. **Final Operational Notification**
       1. Prior to the issue of a **Final Operational Notification** the **Generator** shall submit to the **DNO** to the **DNO**’s satisfaction:
       2. updated DDRC data (both **Standard Planning Data** and **Detailed Planning Data**), with validated actual values and updated estimates for the future including forecast data items such as demand. In practice, this data can be supplied by updating the information provided in the Standard Application Form.
       3. evidence to the **DNO**’s satisfaction that demonstrates that the **Controller** simulation models and/or parameters within the simulation model (as required under DDRC schedule 5c) supplied to the **DNO** provide a reasonable representation of the behaviour of the **Generator**’s plant and apparatus;
       4. copies of **Manufacturers’ Information** where these are relied upon as part of the evidence of compliance;
       5. results from the tests carried out by the **Generator** to demonstrate compliance with relevant EREC G99 requirements including the tests witnessed by the **DNO**; and
       6. the Compliance Declaration signed by the **Generator**.
       7. The items in paragraph 18.4.1 should be submitted by the **Generator** using the **Power Generating Module Document**, Form C2-1 (Annex C.2), the Installation and Commissioning Form C3 (Annex C.3) and the DDRC (via the Standard Application Form). For **Synchronous Power Generating Module**s submission should normally be within 28 days of first synchronisation or a longer period as may be agreed with the **DNO**. For **Power Park Module**s it is expected that the compliance testing and commissioning will not take longer than 6 months; however a phased approach or a longer period may be agreed with the **DNO**. Other than for the purposes of compliance testing and commissioning, the **Generator** has no permanent rights to operate the **Power Generating Module** until the **Final Operational Notification** is received.
       8. If the requirements of this Section 18.4 have been successfully met, the **DNO** will notify the **Generator** that compliance with the relevant EREC G99 provisions has been demonstrated for the **Power Generating Module**(s) as applicable through the issue of a **Final Operational Notification** as part of the **Connection Agreement**.
3. **Type D Compliance Testing, Commissioning and Operational Notification**
   1. **General**
      1. A **Type D Power Generating Module** will be required to obtain an **Energisation Operational Notification** followed by an **Interim Operational Notification** and a **Final Operational Notification** as set out in this Section.
      2. Where the **Power Generating Facility** constitutes a large power station, or where the **Generator** has entered into a Bilateral Embedded Generation Agreement (BEGA) with the **NETSO**, please refer to the guidance in Section 6.1.6.
      3. The **Generator** will use **Type Tested** equipment and or use **Manufacturers’ Information** as well as demonstrating all the commissioning tests performed on the **Power Generating Module** in order to discharge the requirements of this document. Examples of the combination of the use of type testing and the provision of **Manufacturers’ Information** are given in Section 22.1. Further information about **Manufacturers’ Information** is given in Section 21. It is expected that the **DNO** will witness the commissioning tests for **Power Generating Module**s. Note that the **DNO** shall charge the **Generator** for attendance of staff for witness testing in accordance with its charging regime. The **Generator** shall make arrangements for the **DNO** to witness the commissioning tests unless otherwise agreed with the **DNO**.
      4. It is the responsibility of the **Generator** to undertake these commissioning tests / checks and to ensure the **Power Generating Facility** and **Power Generating Module**s meet all the relevant requirements.
      5. In addition to the commissioning tests and checks required under EREC G99, further tests may be required by the **Manufacturer**, **Supplier**, **Generator** or **Installer** of the **Power Generating Module**s as may be required to satisfy legislation and other standards.
   2. **Connection Process**
      1. The **Generator** shall discuss the project with the local **DNO** at the earliest opportunity. The **Generator** will need to provide information using the Standard Application Form (generally available from the **DNO**’s website) to allow detailed system studies to be undertaken. Connection of the **Power Generating Module** is only allowed after the application for connection has been approved by the **DNO** and any **DNO** works facilitating the connection have been completed. Once the construction phase commences, the **Generator** should submit an initial draft **Power Generating Module Document** to the **DNO**.
      2. In order to energise a **Generator**’s internal network it is necessary to obtain an **Energisation Operational Notification**. The following provisions apply in relation to the issue of an **Energisation Operational Notification** in respect of **Embedded Medium Power Station**s and **Type D** **Power Generating Module**s or **Power Park Module**s connecting to the **Distribution Network**. If the **Power Generating Facility** is 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) it should follow the procedures in the **Grid Code**.
      3. The items for submission prior to the issue of an **Energisation Operational Notification** are detailed below:
      4. updated DDRC Schedule 5 Planningdata (both **Standard Planning Data** and **Detailed Planning Data**), with any estimated values assumed for planning purposes confirmed or, where practical, replaced by validated actual values and by updated estimates for the future and by updated forecast data as required by the DDRC;
      5. details of the protection arrangements at the **Connection Point** and settings;
      6. The site responsibility schedule completed to the **DNO**’s satisfaction;
      7. any additional provisions in theconnection offer and or the **Connection Agreement**
      8. The items referred to in this Section shall be submitted using the appropriate DDRC schedules, Standard Application Form or **Power Generating Module Document** where applicable.
      9. Not less than 28 days, or such shorter period as may be acceptable in the **DNO**’s reasonable opinion, prior to the **Generator** wishing to energise its plant and apparatus for the first time the **Generator** will confirm in writing the plant and apparatus that is ready to be connected to the **DNO**’s **Distribution Network** specifying the items of plant and apparatus in a form acceptable to the **DNO**.
      10. If the conditions of Section 19.2 have been completed to the **DNO**’s reasonable satisfaction then the **DNO** shall issue an **Energisation Operational Notification**.
   3. **Interim Operational Notification** 
      1. The following provisions apply in relation to the issue of an **Interim Operational Notification** in respect of **Type D** **Power Generating Module**s.
      2. Not less than 28 days, or such shorter period as may be acceptable in the **DNO**’s reasonable opinion, prior to the **Generator** wishing to synchronise its plant and apparatus for the first time the **Generator** will submit to the **DNO** the items referred to in paragraph 19.3.3.
      3. Prior to the issue of an **Interim Operational Notification** the **Generator** shall submit to the **DNO** to the **DNO**’s satisfaction:
4. an update of any of the items required to achieve an **Energisation Operational Notification** and any updated DDRC data (both **Standard Planning Data** and **Detailed Planning Data**), with any estimated values assumed for planning purposes confirmed or, where practical, replaced by validated actual values and by updated estimates for the future and by updated forecasts for forecast data items such as demand;
5. details of any special **Power Generating Module**(s) protection. This may include Pole Slipping protection and islanding protection schemes as applicable;
6. a simulation study report in accordance with the provisions of Annex C.7 containing the results demonstrating compliance with EREC G99 **Frequency Sensitive Mode** requirements of paragraph 13.2.7, paragraph 13.2.4 (**LFSM-O**) and paragraph 13.2.5 (**LFSM-U**), **Fault Ride Through** requirements of Section 13.3 and **Fast Fault Current** injection requirements of Section 13.6 as applicable to the **Power Generating Module**(s)unless agreed otherwise by the **DNO**.If a **Power System Stabiliser** is fitted the appropriate studies should be undertaken in accordance with the **Grid Code**;
7. a detailed schedule of the tests and the procedures for the tests required to be carried out by the **Generator** to demonstrate compliance in order to gain a **Final Operational Notification**. Such schedule to be consistent with Section 13, Site testing and commission requirements, Annex C.7, together with Annex C.8 (in the case of **Synchronous Power Generating Module**s) or Annex C.9 (in the case of **Power Park Module**s); and
8. an interim Compliance Declaration completed by the **Generator** (including any **Unresolved Issues**) against the relevant EREC G99 requirements including details of any requirements that the **Generator** has identified that will not or may not be met or demonstrated. If applicable this should include a declaration that **Anchor Plant Capability** compliance has been obtained from the **NETSO**.
   * 1. The items in paragraph 19.3.3 are intended to be submitted by the **Generator** using the **Power Generating Module Document**, Form C2-1 (Annex C.2) and as required by the DDRC.
     2. The **DNO** shall assess the schedule of tests submitted by the **Generator** with the Notification of **Generator**’s Intention to Synchronise and shall determine whether such schedule has been completed to the **DNO**’s satisfaction.
     3. When the requirements of paragraph 19.3.3 have been met, the **DNO** will notify the **Generator** that the **Power Generating Module** be synchronised to the **Total System** through the issue of an **Interim Operational Notification**.
     4. No **Type D** **Power Generating Module** shall be synchronised to the **Total System** until the date specified by the **DNO** in the **Interim Operational Notification** issued in respect of the **Power Generating Module**(s).

19.3.7.1 The **Interim Operational Notification** will be time limited, the expiration date being specified at the time of issue. The **Interim Operational Notification** may be renewed by the **DNO** for up to a maximum of 24 months from the date of the first issue of the **Interim Operational Notification**. The **DNO** may only issue an extension to an **Interim Operational Notification** beyond 24 months provided the **Generator** has applied for a derogation for any remaining **Unresolved Issues** to the **Authority** as detailed in Section 19.7.

* + 1. The **Generator** shall operate the **Power Generating Module** in accordance with the terms, arising from the **Unresolved Issues** of the **Interim Operational Notification**. Where practicable, the **DNO** will discuss such terms with the **Generator** prior to including them in the **Interim Operational Notification**.
    2. The **Interim Operational Notification** will include the following limitations:

1. In the case of a **Power Park Module** the **Interim Operational Notification** will limit the proportion of the **Power Park Module** which can be simultaneously synchronised to the **Total System** such that neither of the following figures is exceeded:
2. 20% of the **Registered Capacity** of the **Power Park Module** (or the output of a single **Generating Unit** where this exceeds 20% of the **Power Park Module**’s **Registered Capacity**); nor
3. 50 MW

until the **Generator** has completed the voltage control tests (detailed in Annex C.9.2) to the **DNO**’s reasonable satisfaction. Following successful completion of this test each additional **Generating Unit** should be included in the voltage control scheme as soon as is technically possible (unless the **DNO** agrees otherwise).

1. In the case of a **Synchronous Power Generating Module** employing a static **Excitation System** or a **Power Park Module** employing a **Power System Stabiliser**, the **Interim Operational Notification** may if applicable limit the maximum **Active Power** output and **Reactive Power** output of the **Synchronous Power Generating Module** or **CCGT Module** prior to the successful commissioning of any **Power System Stabiliser** to the **DNO**’s satisfaction.
   * 1. Operation in accordance with the **Interim Operational Notification** whilst it is in force will meet the requirements for compliance by the **Generator** of all the relevant provisions of this EREC G99.
     2. Other than **Unresolved Issues** that are subject to tests required prior to issue of a Final Operation Notification, the **Generator** shall resolve any **Unresolved Issues** prior to the commencement of the tests, unless the **DNO** agrees to a later resolution. The **Generator** shall liaise with the **DNO** in respect of such resolution. The tests that may be witnessed by the **DNO** are specified in paragraph 19.5.2.
     3. Not less than 28 days, or such shorter period as may be acceptable in the **DNO**’s reasonable opinion, prior to the **Generator** wishing to commence tests required to be witnessed by the **DNO** prior to issue of a Final Operation Notification, the **Generator** will notify the **DNO** that the **Power Generating Module**(s) is ready to commence such tests.
   1. **Witnessing and Commissioning**
      1. The **Generator** is responsible for carrying out the commissioning tests and retains the responsibility for safety and personnel during the test.
      2. The checks and tests as detailed in Section 15.2 and 15.3 shall be undertaken to the extent applicable.
      3. Where Type Testing or **Manufacturers’ Information** is not being used to demonstrate **Interface Protection** the tests detailed in Section 15.4 shall be undertaken.
      4. The tests as detailed in the **Power Generating Module Document** shall be carried out by the **Installer** or **Generator**.
      5. The tests and checks shall be carried out once the installation is complete, or, in the case of a phased installation (ie where **Generating Unit**s that comprise a **Power Generating Module** are installed in different phases), when that part of the installation has been completed. The results of these tests shall be recorded on the **Power Generating Module Document** Form C2-1 (Annex C.2) and the installation and commissioning document Form C3 (Annex C.3). The **Installer** or **Generator**, as appropriate, shall complete the declaration at the bottom of Form C3, sign and date it and provide a copy to the **DNO** at the time of commissioning.
   2. **Final Operational Notification**
      1. The following provisions apply in relation to the issue of a **Final Operational Notification** in respect of **Type D** **Power Generating Module**s.
      2. Prior to the issue of a **Final Operational Notification** the **Generator** shall have completed the tests specified in paragraph 19.5.2.1 to the **DNO**’s satisfaction to demonstrate compliance with the relevant EREC G99 provisions.

19.5.2.1 In the case of any **Power Generating Module** these tests will comprise one or more of the following as agreed with the **DNO**:

* + 1. Reactive capability tests to demonstrate that the **Power Generating Module** can meet the requirements of paragraph 13.5. **Synchronous Power Generating Module**s shall demonstrate **Reactive Power** capability following the procedure in Annex C.8. **Power Park Module**sshall demonstrate **Reactive Power** capability following the procedure in Annex C.9. These tests may be witnessed by the **DNO** on site if there is no metering to the **DNO**’s Control Centre.
    2. Voltage control system tests to demonstrate that the **Power Generating Module** can meet the requirements of paragraph 13.4.3 and paragraph 13.4.4 as applicable. **Synchronous Power Generating Module**s shall demonstrate **Excitation System** capability following the procedure in Annex C.8. **Power Park Module**sshall demonstrate **Excitation System** capability following the procedure in Annex C.9, and any site specific requirements. These tests may also be used to validate the **Excitation System** model or voltage control system model as applicable (DDRC schedule 5c). These tests may be witnessed by the **DNO**.
    3. Governor or frequency control system tests to demonstrate that the **Power Generating Module** can meet the requirements of paragraph 13.1.3 and Section 13.2. **Synchronous Power Generating Module**s shall demonstrate the governor and load controller response performance capability following the procedure in Annex C.8. **Power Park Generating Module**s shall demonstrate the governor and load controller response performance capability following the procedure in Annex C.9. These tests may also be used to validate the Governor model or frequency control system model as applicable (DDRC schedule 5c). These tests may be witnessed by the **DNO**.

19.5.2.2 The **DNO**’s preferred range of tests to demonstrate compliance with this EREC G99 are specified in Annex C.8 (in the case of **Synchronous Power Generating Module**s) or Annex C.9 (in the case of **Power Park Module**s) and are to be carried out by the **Generator** with the results of each test provided to the **DNO**. The **Generator** may carry out an alternative range of tests if this is agreed with the **DNO**. The **DNO** may agree a reduced set of tests where relevant **Manufacturers’ Information** has been provided*.*

19.5.2.3 Following completion of each of the tests specified in this Section 19.5, the **DNO** will notify the **Generator** whether, in the opinion of the **DNO**, the results demonstrate compliance with EREC G99.

19.5.2.4 The **Generator** is responsible for carrying out the tests and retains the responsibility for safety and personnel during the test.

* + 1. Items for submission prior to issue of the **Final Operational Notification**.

19.5.3.1 Prior to the issue of a **Final Operational Notification** the **Generator** shall submit to the **DNO** to the **DNO**’s satisfaction:

* + 1. updated Planning Code data (both **Standard Planning Data** and **Detailed Planning Data**), with validated actual values and updated estimates for the future including Forecast Data items such as demand;
    2. the items required in order to obtain the **Energisation Operational Notification** and the **Interim** **Operational Notification**, updated as necessary by the **Generator**;
    3. evidence to the **DNO**’s satisfaction that demonstrates that the **Controller** simulation models and/or parameters within the simulation model (as required under DDRC schedule 5c) supplied to the **DNO** provide a reasonable representation of the behaviour of the **Generator**’s plant and apparatus;
    4. copies of **Manufacturers’ Information** where these are relied upon as part of the evidence of compliance;
    5. results from the tests required in accordance with paragraph 19.5.2 carried out by the **Generator** to demonstrate compliance with relevant EREC G99 requirements including the tests witnessed by the **DNO**;
    6. the final Compliance Declaration signed by the **Generator** and a statement of any requirements that the **Generator** has identified that have not been met together with a copy of the derogation in respect of the same from the **Authority**.
    7. The items in paragraph 19.5.3 should be submitted by the **Generator** as required by the DDRC and the **Power Generating Module Document**, Form C2-1 (Annex C.2).
    8. If the requirements of paragraph 19.5.2 and paragraph 19.5.3 have been successfully met, the **DNO** will notify the **Generator** that compliance with the relevant EREC G99 provisions has been demonstrated for the **Power Generating Module**(s) as applicable through the issue of a **Final Operational Notification** as part of the **Connection Agreement**.
    9. If compliance tests or simulations cannot be carried out as agreed between the **DNO** and the **Generator** due to reasons attributable to the **DNO**, then the **DNO** shall not unreasonably withhold the **Final Operational Notification** to be issued under this Section 19.5 or other appropriate notification.
    10. If a **Final Operational Notification** cannot be issued because the requirements of paragraph 19.5.2 and paragraph 19.5.3 have not been successfully met prior to the expiry of an **Interim Operational Notification** then the **Generator** and/or the **DNO** shall apply to the **Authority** for a derogation. The provisions of paragraph 19.7 shall then apply.
    11. **Generators** who own **Type D Power Generating Module**s do not have rights to operate their **Power Generating Module**s without a valid **Final Operational Notification** or an **Interim Operational Notification** or a **Limited Operational Notification** which will be issued by the **DNO** following completion of the commissioning tests and process.
  1. **Limited Operational Notification** 
     1. Following the issue of a **Final Operational Notification** for a **Type D Power Generating Module** if:

1. the **Generator** becomes aware, that its plant and/or apparatus’ capability to meet any provisions of EREC G99, or where applicable the **Connection Agreement**, is not fully available then the **Generator** shall follow the process in paragraph 19.6.2 to paragraph 19.6.10; or,
2. The **DNO** becomes aware through monitoring as described in paragraph 13.9, that a **Generator** and/or apparatus’ capability to meet any provisions of EREC G99, or where applicable the **Connection Agreement**, then the **DNO** shall inform the **Generator**. Where the **DNO** and the **Generator** cannot agree from the monitoring as described in paragraph 13.9 whether the plant and/or apparatus is fully available and/or is compliant with the requirements of EREC G99 and where applicable the **Connection Agreement**, the **DNO** shall first issue an instruction requiring the **Generator** to carry out a test, before applying the process defined in Section 19.6 if applicable. Where the testing indicates that the plant and/or apparatus is not compliant with the requirements of EREC G99 and/or the **Connection Agreement**, or if the parties so agree, the process in paragraph 19.6.2 to paragraph 19.6.10 shall be followed.
   * 1. Immediately upon a **Generator** becoming aware that its **Power Generating Module** may be unable to comply with certain provisions of EREC G99 or (where applicable) the **Connection Agreement**, the **Generator** shall notify the **DNO** in writing. Additional details of any operating restrictions or changes in applicable data arising from the potential non-compliance and an indication of the date from when the restrictions will be removed and full compliance demonstrated shall be provided as soon as reasonably practical.
     2. Where the restriction notified in paragraph 19.6.2 is not resolved in 28 days then the **Generator** with input from and discussions with the **DNO**, shall undertake an investigation to attempt to determine the causes of and solution to the non-compliance. Such investigation shall continue for no longer than 56 days. During such investigation, the **Generator** shall provide to the **DNO** the relevant data which has changed due to the restriction in respect of paragraph 19.5.3 as notified to the **Generator** by the **DNO** as being required to be provided.
     3. Issue and Effect of **Limited Operational Notification**

19.4.6.1 Following the issue of a **Final Operational Notification**, the **DNO** will issue to the **Generator** a **Limited Operational Notification** if:

* + 1. by the end of the 56 day period referred to at 19.6.3 the investigation has not resolved the non-compliance to the **DNO**’s satisfaction; or
    2. The **DNO** is notified by a **Generator** of a **Modification** to its plant and apparatus; or
    3. The **DNO** receives a submission of data, or a statement from a **Generator** indicating a change in plant or apparatus or settings (including but not limited to governor and excitation control systems) that may in the **DNO**’s reasonable opinion, acting in accordance with Good Industry Practice be expected to result in a material change of performance.

19.4.6.2 The **Limited Operational Notification** will be time limited to expire no later than 12 months from the start of the non-compliance or restriction or from reconnection following a change. The **DNO** may agree a longer duration in the case of a **Limited Operational Notification** following a **Modification** or whilst the **Authority** is considering the application for a derogation in accordance with paragraph 19.7.1.

19.4.6.3 The **Limited Operational Notification** will notify the **Generator** of any restrictions on the operation of the **Synchronous Power Generating Module**(s), **CCGT Module**(s) or **Power Park Module**(s) and will specify the **Unresolved Issues**. The **Generator** shall operate in accordance with any notified restrictions and shall resolve the **Unresolved Issues**.

19.4.6.4 The **Generator** will be deemed compliant with all the relevant provisions of EREC G99 provided operation is in accordance with the **Limited Operational Notification**, whilst it is in force, and that the provisions of and referred to in Section 19.6 are complied with.

19.4.6.5 The **Unresolved Issues** included in a **Limited Operational Notification** will show the extent that the provisions of paragraph 19.5.2 (testing) and paragraph 19.5.3 (final data submission) shall apply. In respect of selecting the extent of any tests which may in the **DNO**’s view reasonably be needed to demonstrate the restored capability and in agreeing the time period in which the tests will be scheduled, the **DNO** shall, where reasonably practicable, take account of the **Generator**’s input to contain its costs associated with the testing.

19.4.6.6 In the case of a **Modification** the **Limited Operational Notification** may specify that the affected plant and/or apparatus or associated **Generating Unit**(s) shall not be synchronised until all of the following items, that in the **DNO**’s reasonable opinion are relevant, have been submitted to the **DNO** to the **DNO**’s satisfaction:

* + 1. updated Planning Code data (both **Standard Planning Data** and **Detailed Planning Data**);
    2. details of any relevant special **Power Generating Facility**, **Synchronous Power Generating Module**(s)or **Power Park Module**(s) protection as applicable. This may include Pole Slipping protection and islanding protection schemes;
    3. simulation study provisions of Annex C.7 and the results demonstrating compliance with EREC G99 requirements relevant to the **Modification** as agreed by the **DNO**;
    4. a detailed schedule of the tests and the procedures for the tests required to be carried out by the **Generator** to demonstrate compliance with EREC G99 requirements as agreed by the **DNO**. The schedule of tests shall be consistent with Annex C.8 or Annex C.9 as appropriate;
    5. an interim Compliance Declaration completed by the **Generator** (including any **Unresolved Issues**) against the relevant EREC G99 requirements including details of any requirements that the **Generator** has identified that will not or may not be met or demonstrated;
    6. any other items specified in the **Limited Operational Notification**.

19.4.6.7 The items referred to in paragraph 19.6.4.6 shall be submitted by the **Generator** as required by the DDRC and the **Power Generating Module Document**, Form C2-1 (Annex C.2).

19.4.6.8 In the case of **Synchronous Power Generating Module**(s) only, the **Unresolved Issues** of the **Limited Operational Notification** may require that the **Generator** shall complete the following tests to the **DNO**’s satisfaction to demonstrate compliance with the relevant provisions of EREC G99 prior to the **Synchronous Power Generating Module** being synchronised to the **Total System**:

* + 1. those tests required to establish the open and short circuit saturation characteristics of the **Synchronous Power Generating Module** (as detailed in Annex C.8.3) to enable assessment of the short circuit ratio. Such tests may be carried out at a location other than the **Power Generating Facility** site; and
    2. open circuit step response tests (as detailed in Annex C.8.2) to demonstrate compliance with Annex C.4.2.4.1 and Annex C5.2.3.1 as applicable.
    3. In the case of a **Modification**, not less than 28 days, or such shorter period as may be acceptable in the **DNO**’s reasonable opinion, prior to the **Generator** wishing to synchronise its plant and apparatus for the first time following the **Modification**, the **Generator** shall submit to the **DNO** the items referred to in paragraph 19.6.4.6.
    4. Other than **Unresolved Issues** that are subject to tests to be witnessed by the **DNO**, the **Generator** shall resolve any **Unresolved Issues** prior to the commencement of the tests, unless the **DNO** agrees to a later resolution. The **Generator** shall liaise with the **DNO** in respect of such resolution. The tests that may be witnessed by the **DNO** are specified in paragraph 19.5.2.2.
    5. Not less than 28 days, or such shorter period as may be acceptable in the **DNO**’s reasonable opinion, prior to the **Generator** wishing to commence tests listed as **Unresolved Issues** to be witnessed by the **DNO**, the **Generator** or will notify the **DNO** that the **Synchronous Power Generating Module**(s), **CCGT Module**(s) or **Power Park Module**(s) as applicable is ready to commence such tests.
    6. The items referred to in paragraph 19.5.3 and listed as **Unresolved Issues** shall be submitted by the **Generator** after successful completion of the tests.
    7. Where the **Unresolved Issues** have been resolved a **Final Operational Notification** will be issued to the **Generator**.
    8. If a **Final Operational Notification** has not been issued by the **DNO** within the 12 month period referred to in paragraph 19.6.4.2 (or where agreed following a **Modification** by the expiry time of the **Limited Operational Notification**) then the **Generator** and the **DNO** shall apply to the **Authority** for a derogation.
  1. **Processes Relating to Derogations**
     1. Whilst the **Authority** is considering the application for a derogation, the **Interim Operational Notification** or **Limited Operational Notification** will be extended to remain in force until the **Authority** has notified the **DNO** and the **Generator** of its decision.
     2. If the **Authority**:

1. grants a derogation in respect of the plant and/or apparatus, then the **DNO** shall issue **Final Operational Notification** once all other **Unresolved Issues** are resolved; or
2. decides a derogation is not required in respect of the plant and/or apparatus then the **DNO** will reconsider the relevant **Unresolved Issues** and shall issue a **Final Operational Notification** once all other **Unresolved Issues** are resolved; or
3. decides not to grant any derogation in respect of the plant and/or apparatus, then there will be no Operational Notification in place and the **DNO** will initiate a process to disconnect the **Power** **Generating** **Facility** from the **DNO**’s **Distribution Network**.
   * 1. Where an **Interim Operational Notification** or **Limited Operational Notification** is so conditional upon a derogation and such derogation includes any conditions (including any time limit to such derogation) the **Generator** will progress the resolution of any **Unresolved Issues** and / or progress and / or comply with any conditions upon such derogation and the provisions of paragraph 19.5 shall apply and shall be followed.
4. **Ongoing Obligations**
   1. **Periodic Testing for Power Generating Modules**
      1. The **DNO** shall have the right to request that the **Generator** carry out compliance tests and simulations according to a repeat plan or general scheme or after any failure, **Modification** or replacement of any equipment that may have an impact on the **Power Generating Module**’s compliance with the requirements of this EREC G99.
      2. The **DNO** will assess the results of the tests and inform the **Generator** of the outcome.
      3. It may be necessary to undertake ad-hoc testing to determine[[20]](#footnote-23), for example:
5. the voltage dip on synchronising;
6. the harmonic voltage distortion;
7. the voltage levels as a result of the connection of the **Power Generating Facilities** and to confirm that they remain within the statutory limits.
   * 1. The **Interface Protection** shall be tested by the **Generator** at intervals to be agreed with the **DNO**.
   1. **Operational Incidents affecting Compliance of any Power Generating Module**
      1. The **DNO** shall be notified of any operational incidents or failures of **Power Generating Module**s that affect its compliance with this EREC G99, without undue delay, after the occurrence of those incidents.
      2. The **DNO** shall have the right to request that the **Generator** arrange to have compliance tests undertaken after any failure or replacement of any equipment that may have an impact on the **Power Generating Module**’s compliance with this EREC G99. Note that where the replacement equipment is itself **Type Tested** or supported by appropriate **Manufacturers’ Information**, tests and checks on site can be limited to functional checks such as to comply with paragraph 15.2.
   2. **Changes to the Power Generating Facility or Power Generating Module**
      1. The **DNO** shall have the right to request that the **Generator** arrange to have compliance tests undertaken after any **Modification** or replacement of any equipment that may have an impact on the **Power Generating Module**’s compliance with this EREC G99.
      2. If during the lifetime of the **Power Generating Module**s it is necessary to replace a component that has an impact on the performance of a **Power Generating Module**, its protection system or **Interface Protection**, (excepting fault repair or routine maintenance) or to modify the **Registered Capacity** of a **Generating Unit**, **Power Generating Module**, the **Generator** shall notify the **DNO** before the **Modification** is initiated. The notification shall include any proposed changes to the **Registered Capacity** of a **Generating Unit** of the **Power Generating Module**. The **DNO** may require the **Generator** to submit data for the proposed revised component, **Generating Unit** or **Power Generating Module** using the Standard Application Form (together with a Decommissioning Form where a **Power Generating Module** is being decommissioned).
      3. The **DNO** and the **Generator** will agree whether the proposed **Modification** is significant or not.
      4. If the **Modification** is not significant then the **Generator** is only required to reconfirm the compliance with the requirements in this EREC G99 (or EREC G59 as applicable) in relation to the affected component.
      5. If a **Modification** is significant then the **Power Generation Module** shall comply with the latest version of this EREC G99 in full.
      6. The criteria that determine whether a **Modification** is significant are that the **Generator** is proposing to make a capital investment in the **Power Generating Module** and ;
      7. The **Registered Capacity** of the **Power Generating Module** will increase by 20% or more compared to its **Registered Capacity** when first commissioned, whether in one **Modification** or cumulatively; or
      8. The reactive power capability of the **Power Generating Module** will change by 20% or more compared to its reactive power capability when first commissioned, whether in one **Modification** or cumulatively; or
      9. The replacement of **Generating Unit**s and/or other components that individually or cumulatively comprise 80% or more of the **Registered Capacity** of the **Power Generating Module**. Where the **Generator** has agreed an increase in **Registered Capacity** with the **DNO**, the 80% is of the final **Registered Capacity** agreed with the **DNO**.
      10. Where a component, a **Generating Unit** or a **Power Generating Module** is replaced the following requirements apply irrespective of whether the **Modification** is significant or not:
      11. the replacement shall be compliant, or capable of being compliant, with this EREC G99, even if the original **Power Generating Module** was commissioned under EREC G59;
      12. the replacement shall be compliant, or capable of being compliant, with the requirements of this EREC G99 applicable to the **Registered Capacity** of the **Power Generating Module**. Where the replacement is part of a significant **Modification**, it is important to note that it is the final **Registered Capacity** of the modified **Power Generating Module** that determines the type of the **Power Generating Module** (ie **Type A**, **Type B**, **Type C** etc);
      13. compliance with the power quality requirements of EREC G5 and EREC P28 shall be maintained throughout the process of implementing the **Modification**;
      14. any changes that affect the requirements, or the contents, of the **Connection Agreement** shall be reflected in a revised **Connection Agreement**.
      15. Where a **Power Generating Module** consists of a single **Generating Unit** only, and where the **Generator** finds it cost prohibitive to comply with (a) or (b) of 20.3.7, when further modifications occur to the **Power Generating Module** that trigger any of the criteria in 20.3.6, including its complete replacement, then the **Power Generating Module** shall comply with the latest EREC G99 at that time.
      16. Where the components, particularly **Generating Unit**s, of a **Power Generating Module** are proposed to be replaced progressively over a period, even potentially a multi-year period, the **Generator** shall discuss the planned programme with the **DNO** and agree:
      17. what compliance confirmation activities will be required at each stage of the programme;
      18. what the final **Registered Capacity** of the **Power Generating Module** will be when the **Modification** is complete;
      19. The date by which compliance will be achieved. This date must be within six months of when the capacity of the replacement has reached 80% of the final **Registered Capacity** of the **Power Generating Module**;
      20. How compliance with EREC G5 and EREC P28 will be maintained, and if necessary, demonstrated throughout the programme.
      21. The energy sources of non-synchronous **Generating Unit**s (eg solar panels, battery storage etc) are not considered part of the non-synchronous **Generating Unit**.
      22. Replacement of components, or even **Generating Unit**s, with spare parts manufactured at the time of original installation, or to the original specification, do not constitute a significant **Modification**. However (excepting fault repair or routine maintenance) if more than 20% of the number of **Generating Unit**s comprising the **Power Generating Module** are affected, or if the cumulative contribution of the affected **Generating Unit**s to the **Power Generating Module**’s **Registered Capacity** is 20% or more, the **DNO** must be consulted before the work is commenced. Conversely where a component or **Generating Unit** is replaced with a modern equivalent, that replacement must be capable of being compliant with EREC G99.
      23. Where one or more **Power Generating Module**s are to be added or replaced at an existing **Customers Installation** and which were installed prior to the introduction of this EREC G99, it is not necessary to modify any other existing **Power Generating Module**s to comply with this document.
      24. Any increase to the aggregate **Registered Capacity** of small **Power Generating Module**(s) in **Customers Installation** above the 16 A per phase **EREC G83/EREC G98** threshold without triggering the criteria of 20.3.5 above does not of itself trigger a need for any of the **Power Generating Modules** to comply with the latest versions of those documents, but a new EREC G99application is required.
      25. **Customer’s Installation** **Customer’s Installation**
      26. For the special case where an existing **Power Generating Module** of less than 10 MW **Registered Capacity** (ie a **Type A or a Type B**) that complies with EREC G59 is being relocated to another existing site to replace an existing EREC G59 compliant **Power Generating Module** on that other site, then the relocated **Power Generation Module** will only need to comply with EREC G59 provided that the relocated **Power Generating Module** has a **Registered Capacity** less than or equal to the **Registered Capacity** of the **Power Generating Module** it is replacing.
      27. If an existing **Power Generating Module** is being relocated to an existing site where it has a greater **Registered Capacity** than the **Power Generating Module** it is replacing, or it is being relocated to a new site, then full compliance with this EREC G99 will be required.
   3. **Notification of Decommissioning**
      1. The **Generator** shall notify the **DNO** about the permanent decommissioning of a **Power Generating Module** by providing the information as detailed under Annex D.1. Documentation may be submitted by an agent or third party such as an aggregator, acting on behalf of the **Generator** and may be submitted electronically. Where the presence of **Power Generating Module**s is indicated in a bespoke **Connection Agreement**, it will be necessary to amend the **Connection Agreement** appropriately.
8. **Manufacturers’ Information applicable to Power Park Modules**
   1. **General**
      1. **Manufacturers’ Information** covers such information as type testing details, parameters or data, simulation models and reports on studies run using those models. The guidance in this Section 21 **Manufacturers’ Information** relates to simulation models.
      2. In most cases **Manufactures’ Information** is submitted by the **Generator** to the **DNO**. However, data and performance characteristics in respect of simulation models may be registered with the **DNO** by **Generating Unit** Manufacturers in the form of **Manufacturers’ Information**.
      3. A **Generator** planning to construct a new **Power Generating Facility** containing the appropriate version of **Generating Unit**s in respect of which **Manufacturers’ Information** has been submitted to the **DNO** may reference the **Manufacturers’ Information** in its submissions to the **DNO**. Any **Generator** considering referring to **Manufacturers’ Information** for any aspect of its plant and apparatus may contact the **DNO** to discuss the suitability of the relevant **Manufacturers’ Information** to its project to determine if, and to what extent, the data included in the **Manufacturers’ Information** contributes towards demonstrating compliance with those aspects of this EREC G99 applicable to the **Generator**. The **DNO** will inform the **Generator** if the reference to the **Manufacturers’ Information** is not appropriate or not sufficient for its project.
      4. The process to be followed by **Generating Unit** Manufacturers submitting **Manufacturers’ Information** shall be agreed by the **DNO**. Paragraph 21.2 below indicates the specific requirement areas in respect of which **Manufacturers’ Information** may be submitted by the **Manufacturer**.
      5. The **DNO** may maintain and publish a register of that **Manufacturers’ Information** which the **DNO** has received and accepted as being an accurate representation of the performance of the relevant plant and / or apparatus. Such register will clearly identify the **Manufacturer**, the model(s) of **Generating Unit**(s) to which the report applies and the provisions of EREC G99 in respect of which the report contributes towards the demonstration of compliance in such a way that these models can easily be identified for appropriate use in other similar projects. The inclusion of any report in the register does not in any way confirm that any **Power Park Module**s which utilise any **Generating Unit**(s) covered by a report is or will be compliant with EREC G99.

## Manufacturers’ Information submitted by the Manufacturer to the DNO, in respect of Generating Units may cover one (or part of one) or more of the following provisions:

* + 1. **Fault Ride Through** capability;
    2. **Power Park Module** mathematical model DDRC 5c.

## Reference to a Manufacturer’s Data & Performance Report in a Generator’s submission does not by itself constitute compliance with EREC G99.

## A Generator referencing Manufacturers’ Information should insert the relevant Manufacturers’ Information reference in the appropriate place in the submission forms detailed in the Annexes. The DNO will consider the suitability of Manufacturers’ Information in place of DDRC data submissions such as a mathematical model suitable for representation of the entire Power Park Module as per Annex B.4.4.5, Annex C.7.4.5, or Annex C.7.5.5 as applicable. Site specific parameters will still need to be submitted by the Generator.

## It is the responsibility of the Generator to ensure that the correct reference for the Manufacturers’ Information is used and the Generator by using that reference accepts responsibility for the accuracy of the information. The Generator shall ensure that the Manufacturer has kept the DNO informed of any relevant variations in plant specification since the submission of the relevant Manufacturers’ Information which could affect the validity of the information.

## The DNO may contact the Generating Unit Manufacturer directly to verify the relevance of the use of such Manufacturers’ Information. If the DNO believes the use some or all of such Manufacturers’ Information is incorrect or the referenced data is inappropriate, then the reference to the Manufacturers’ Information may be declared invalid by the DNO. Where, and to the extent possible, the data included in the Manufacturers’ Information is appropriate, the compliance assessment process will be continued using the data included in the Manufacturers’ Information.

1. **Type Testing and Annex information**
   1. **Fully Type Tested and Type Tested equipment**

The following matrix demonstrates where **Manufacturers’ Information** and compliance and installation checks on site can be combined to demonstrate **compliance** for each **Power Generating Module**.

|  |  |  |
| --- | --- | --- |
|  | **Manufacturers’ Information** | **Power Quality Assessment and Site Tests** |
| **Fully Type Tested** (**Type A** only ≤ 50 kW) | Registered as **Fully Type Tested** information on ENA website via the Compliance Verification Report  (Form A2-1, A2-2 or A2-3 as appropriate) | An assessment of compliance with EREC G5 and EREC P28 is necessary. This will generally allow connection of a **Fully Type Tested** device with no need for mitigation. However, where the fault level is unusually low (eg in remote rural locations) mitigation measures might be needed  Only installation checks required – as on the Installation Document (Form A3-1 or A3-2) |
| **Type Tested** (**Type A**) | Registered as product or component Type Test information on ENA Website using applicable parts of Compliance Verification Report (Form A2-1, A2-2 or A2-3); and/or  Supplied by the **Generator** using applicable parts of Compliance Verification Report (Form A2-1, A2-2 or A2-3) | Compliance of the installation with EREC G5 and EREC P28  Demonstration of technical requirements not covered by **Manufacturers’ Information**. (Form A3-1 or A3-2)  Standard installation checks (Form A3-1 or A3-2). Additional Site Compliance and Commissioning Checks (Form A2-4) may also be required |
| **Type Tested** (B, C, D) | Registered as product or component Type Test information on ENA Website; and/or  Supplied by the **Generator** | Compliance of the installation with EREC G5 and EREC P28  Demonstration of technical requirements not covered by **Manufacturers’ Information**. (Form B2-1 or Form C2-1)  Standard installation checks (Form B3 or Form C3).  Additional Site Compliance and Commissioning Checks (Form B2-2 or Form C2-2) may also be required |
| One off installation (B, C, D) | To be provided by the **Generator** for those aspects that cannot be demonstrated on site (including simulations etc) | Compliance of the installation with EREC G5 and EREC P28  Demonstration of technical requirements not covered by **Manufacturers’ Information**. (Form B2-1 or Form C2-1)  Standard installation checks also required (Form B3 or Form C3). Additional Site Compliance and Commissioning Checks (Form B2-2 or Form C2-2) may also be required |

* 1. **Annex Contents and Form Guidance**

|  |  |  |
| --- | --- | --- |
| **Annex** | **Application** | **Form Title** |
| A.0 | Cover Sheet for **Type A Power Generating Facility** Forms |  |
| A.1 | Connection Application for **Type A Fully Type Tested** (<50 kW) **Power Generating Module**s  Connection Application for **Small Generation Installations**  Connection application for Type A (<50 kW) **Power Generating Module**s where the output is shared with two or more **Customer**s  Note for all other **Power Generating Module**s the **DNO**’s Standard Application Form shall be used. | Form A1-1: Application for connection of **Power Generating Module**(s) with Total Aggregate Capacity <50 kW 3-phase or 17 kW single phase  Form A1-2: Application for connection of a **Small Generation Installation**  Form A1-3: Application for connection of **Power Generating Module**(s) with Total Aggregate Capacity < 50 kW 3-phase or 17 kW single phase where the output is shared with two or more **Customer**s |
| A.2 | Compliance report for **Type A Type Tested** | Form A2-1: Compliance Verification Report for **Synchronous Power Generating Module**s up to and including 50 kW  Form A2-2: Compliance Verification Report for **Synchronous Power Generating Module**s > 50 kW and also for **Synchronous Power Generating Module**s ≤ 50 kW where the approach of this form is preferred to that in Form A2-1  Form A2-3 Compliance Verification Report for **Inverter** Connected **Power Generating Module**s |
| A.2 | Additional Compliance and Commissioning test requirements for **Type A Power Generating Module**s | Form A2-4: Site Compliance and Commissioning test requirements for **Type A** **Power Generating Module**s |
| A.3 | Installation and Commissioning a **Power Generating Facility** comprising one or more **Type A Generating Module**s | Form A3-1: Installation Documentfor **Type A Power Generating Module**s  Form A3-2: Installation Document for **Small Generation Installations**  Form A3-3: Installation Notification Form for **Small Generation Installation** Procedure 1  Form A3-4: Installation Document for **Type A Power Generating Modules** where the output is shared between two or more **Customer**s |
| A.4 | Emerging Technologies and other Exceptions |  |
| A.5 | Example calculations to determine if unequal generation across different phases is acceptable or not |  |
| A.6 | Scenario examples in respect of the application of EREC G59 and EREC G99 to new or modified sites after 27/04/19 |  |
| A.7 | Requirements for Type Testing **Type A** **Power Generating Module**s |  |
| B.1 | Application | Refer to Standard Application Form |
| B.2-1 | Compliance documentation for **Type B Power Generating Module**s | Form B2-1: **Power Generating Module Document** for **Type B** **Power Generating Module**s |
| B.2-2 | Additional Compliance and Commissioning test requirements for **Type B** **Power Generating Module**s | Form B2-2 Site Compliance and Commissioning test requirements for **Type B** **Power Generating Module**s |
| B.3 | Installation and Commissioning Confirmation Form | Form B2: Installation and Commissioning Confirmation Form for **Type B** **Power Generating Module**s |
| B.4 | Simulation Studies for **Type B Power Generating Module**s |  |
| B.5 | Compliance Testing of **Type B Synchronous Power Generating Module**s |  |
| B.6 | Compliance testing of **Type B Power Park Module**s |  |
| C.1 | Application | Refer to Standard Application Form |
| C.2-1 | Compliance documentation for **Type C** and **Type D Power Generating Module**s | Form C2-1: **Power Generating Module Document** for **Type C and Type D Power Generating Module**s |
| C.2-2 | Additional Compliance and Commissioning test requirements for **Type C** and **Type D** **Power Generating Module**s | Form C2-2 Site Compliance and Commissioning test requirements for **Type C** and **Type D Power Generating Module**s |
| C.3 | Installation and Commissioning Confirmation Form | Form C3: Installation and Commissioning Confirmation Form for **Type C** and **Type D** **Power Generating Module**s |
| C.4 | Performance Requirements For Continuously Acting Automatic Excitation Control Systems For **Type C** and **Type D** **Synchronous Power Generating Module**s |  |
| C.5 | Performance Requirements For Continuously Acting Automatic Excitation Control Systems For **Type C** and **Type D Power Park Module**s |  |
| C.6 | Functional Specification for Fault Recording and Power Quality Monitoring Equipment Studies for **Type C** and **Type D Power Generating Module**s |  |
| C.7 | Simulation Studies for **Type C** and **Type D Power Generating Module**s |  |
| C.8 | Compliance Testing of **Type C** and **Type D Synchronous Power Generating Module**s |  |
| C.9 | Compliance Testing of **Type C** and **Type D Power Park Module**s |  |
| C.10 | Minimum Frequency Response Capabilities for **Type C** and **Type D Power Generating Module**s |  |
| D.0 | Decommissioning of any **Power Generating Module** | Form D1**: Decommissioning Confirmation** |
| D.1 | Additional Information Relating to **System Stability** Studies |  |
| D.2 | Loss of Mains Protection Analysis |  |
| D.3 | Main Statutory and other Obligations |  |
| D.4 | Summary of **Reactive Power** and voltage control requirements |  |

1. **Electricity Storage** devices shall meet the requirements of this EREC G99 but are not subject to the requirements of European Regulation (EU) 2016/631, European Regulation (EU) 2016/1388 and European Regulation EU 2016/1485. The requirements of this EREC G99 shall therefore be complied with by **Electricity Storage** devices under EREC G99 (and not under any of the aforementioned European Regulations). Any derogation sought for an **Electricity Storage** device shall be deemed a derogation from this EREC G99 only (and not from the aforementioned European Regulations). [↑](#footnote-ref-2)
2. **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. [↑](#footnote-ref-3)
3. In EREC G98 a **Power Generating Module** with nominal current up to and including 16 A per phase is known as a Micro-generator. [↑](#footnote-ref-6)
4. For storage commissioned before 01 September 22 please see Annex A4.2. [↑](#footnote-ref-7)
5. see <http://www.opsi.gov.uk/si/si2001/20013270.htm> [↑](#footnote-ref-8)
6. ESQR (2002) Part IV [↑](#footnote-ref-9)
7. Or EREC G98 if **Fully** **Type Tested** and 16A/phase or less. [↑](#footnote-ref-10)
8. Or EREC G98 if **Fully** **Type Tested** with an aggregate **Registered Capacity** of 16 A/phase or less. [↑](#footnote-ref-11)
9. G98 does not include the concept of **Intrinsic Design Capacity**. [↑](#footnote-ref-12)
10. Or **Type Tested** to EREC G83 or G59 where the **Power Generating Module** was connected prior to 27 April 2019. [↑](#footnote-ref-13)
11. Or **Type Tested** to EREC G83 or G59 where the **Power Generating Module** was connected prior to 27 April 2019. [↑](#footnote-ref-14)
12. Or **Type Tested** to EREC G83 or G59, where the **Power Generating Module** was connected prior to 27 April 2019. [↑](#footnote-ref-15)
13. ie a generation-only site as defined in Schedule 22 of the Distribution Connection and Use of System Agreement. [↑](#footnote-ref-16)
14. **Generator**s that intend to operate their installation in island mode cannot follow the **Integrated Micro Generation and Storage** procedure. [↑](#footnote-ref-17)
15. Over Voltage Protection is not intended to maintain statutory voltages but to detect islanding. [↑](#footnote-ref-18)
16. See foreword in respect of possible future arrangements [↑](#footnote-ref-19)
17. Reference shall be made to the Distributed Energy Resources – Cyber Security Connection Guidance published by the ENA and the Department for Business, Energy and Industrial Strategy (BEIS) and the PAS 1879 Energy smart appliances – Demand side response operation – Code of practice. [↑](#footnote-ref-20)
18. Where the **Power Generating Module** is designed to support part of the **Generator’s Installation** independently from the **DNO**’s **Distribution Network**, the switch that is used to separate the independent part of the **Generator’s Installation** from the **DNO**’s **Distribution Network** shall disconnect each phase and neutral. This prevents neutral current from inadvertently flowing through the part of the system that is not supported by the **Power Generating Module**. See also Figure 8.7 and 8.9. [↑](#footnote-ref-21)
19. This approach is taken in Germany by VDE, a standards, testing and certification institution. [↑](#footnote-ref-22)
20. Such periodic testing may be required due to system changes, **DNO** protection changes, fault investigations etc. [↑](#footnote-ref-23)