Connection of Power Generating Modules to DNO Distribution Networks in accordance with EREC G99

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www.energynetworks.org

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This form should be used by Customers connecting any generating plant to the Distribution Network Operator (DNO) Distribution Network. Customers with generating plant are known as Generators in distribution network documentation and will be referred to as such in this document.

The form should be used by Generators connecting a new Generating Unit, or modifying plant in an existing Power Generating Facility. Note that Generating Units may comprise Electricity Storage plant and hence a Customer connecting Electricity Storage plant to the DNO Distribution Network is a Generator.

It is possible to connect almost any Power Generating Module[1] to the Distribution Network. In order for the connection to meet the requirements of a new Generator and the existing Customers it is important to ensure the new connection is properly designed and compliant with Engineering Recommendation G99. This means there is a need for information to be exchanged between you as the Generator and the local DNO. The Data Registration Code of the Distribution Code sets out the obligations on the Generator and DNO to exchange data as part of the design process and lists the data items that may need to be exchanged. The purpose of this application form is to simplify and clarify this data exchange process.

- If the rating of the Power Generating Module that you are applying to connect is 16 A per phase or less, you will probably be able to connect it using the far simpler connection process for Micro-generators complying with Engineering Recommendation G98.

- If the rating of the Power Generating Module that you are applying to connect is greater than 16 A per phase and less than 17 kW (or less than 50 kW three phase), you will probably be able to connect it using the connection process complying with Engineering Recommendation G99 and using Form A.1 in Engineering Recommendation G99.

This Application Form is for all other Generators and is in five parts.

The terms used in this form are aligned with those in Engineering Recommendation G99. Engineering Recommendation G99 contains a complete set of definitions and is available from the ENA website. This Application Form should be used for all Type A Power Generating Modules > 50 kW and all Type B, Type C and Type D Power Generating Modules. This Application Form will form part of the Power Generating Module Document (PGMD) for Type B, Type C and Type D Power Generating Modules. The PGMD is completed throughout the connection process and finalised before the DNO issues a Final Operational Notification.

Types of Power Generating Module are defined in Engineering Recommendation G99 and repeated below:

Type A: A Power Generating Module with a Connection Point below 110 kV and a Registered Capacity (ie rating) 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; or with a Connection Point below 110 kV and with Registered Capacity of 50 MW or greater.

1 Either a Synchronous Power Generating Module or a Power Park Module (made up of Generating Unit(s) which may comprise Electricity Storage plant)

Parts 1 to 3

These parts are required at the connection application stage to collate the initial data that the DNO requires to assess the connection application. In most cases this information should be sufficient for the DNO to complete the connection design and make a connection offer. In this case there will be no need for you to provide additional information. However, for some Power Generating Module connection applications, depending on the size of the Power Generating Module and the proposed point of connection, this initial submission of information may not be sufficient for the DNO to complete the connection design and make a connection offer. The DNO will advise you if you need to provide further information so that the connection design can be completed when the information provided in Parts 1-3 of the application form have been assessed by the DNO.

Part 4

If the DNO requires information in addition to that provided in Parts 1-3 of the application form, the DNO will request that Part 4 of the application form is completed. For example, if your Power Generating Module is greater than 150 kW the DNO is likely to require this information. This may be necessary to enable the connection design to be undertaken or may be required during the connection process as part of the completion of the Power Generating Module Document. Generally you will need to complete all of Part 4 of the application form appropriate to the type of Power Generating Module although the DNO may indicate if not all of this information is required.

Part 5

In some cases the DNO will require further information which is detailed in Part 5 of this application form to complete the connection design. The DNO will advise you if such information is required.

Guidance on completing the application form

The minimum information you should initially submit to the DNO is Parts 1, 2 and 3 of this application form. There is the option for you to complete Parts 1 to 4 of the application form and return all of these as part of the initial submission stage. This will speed up the DNO design process as there is unlikely to be a need for additional information to be provided at that stage. However this may result in you providing information that is not required in order for the DNO to design the connection.

The application forms can be downloaded from the ENA website and when completed they should be sent to your local DNO. Their contact details can be found by following the link below, along with a postcode search facility to find out who your local DNO is:

http://www.energynetworks.org/info/faqs/who-is-my-network-operator.html

The following section provides an overview of the information required to complete each part of the application form, which is divided into the following sections:

Part 1	Contact details, location and operational information	Initial submission
Part 1a	Supplementary contact details	Initial submission
Part 2	Power Generating Facility general data	Initial submission
Part 3	Power Generating Module model data	Initial submission
Part 3 Section 1a	Summary of the new Generating Units that comprise the Power Generating Module	Initial submission
Part 3 Section 1b	Summary of the existing Generating Units that comprise the Power Generating Module	Initial submission
Part 3 Section 2	Generating Unit data	Initial submission
Part 4a	Synchronous Power Generating Modules	Prior to synchronising
Part 4b	Power Park Module model data: Fixed speed induction Generating Units	Prior to synchronising
Part 4c	Power Park Module model data: Doubly fed induction Generating Units	Prior to synchronising
Part 4d	Power Park Module model data: Series inverter connected Generating Units	Prior to synchronising
Part 4e	Power Park Module model data: Electricity Storage plant	Prior to synchronising
Part 4f	Transformer information	Prior to synchronising
Part 5	Additional data which may be required by the DNO	Prior to synchronising

Part 1

This part of the application form is in two sections. Part 1 enables you to provide:

- Contact details for you and your consultant (if you have one).
- The location of your Power Generating Module.

Part 1a enables you to provide supplementary contact details for the Generator, Generating Unit installer and Electricity Storage plant installer, if applicable.

This data should be provided at the initial submission stage.

Part 2

Part 2 enables you to provide:

- Details of the import and export requirements for your site. It is important to make sure that you consider the import requirements for any load that you have on your site in addition to the export from the generation plant.
- Information about the fault level contribution from the Power Generating Facility at the Connection Point, although you do not need to provide this information here if more detailed fault level information is provided in Part 3 of the application form.

This data should be provided at the initial submission stage.

Part 3

This part of the application form requires general details about the Power Generating Modules being connected. This data should be provided at the initial submission stage.

Part 4

This part of the application form enables you to provide more detailed information about the Power Generating Modules that comprise the facility, including Electricity Storage, that you are applying to connect. The relevant section of Part 4 of the form should be completed for each different type of Generating Unit.

More information is required if the connection is likely to be at high voltage rather than at low voltage. If the Power Generating Module that you are looking to connect is larger than 150 kW you should assume that your site may be connected at high voltage and provide this additional information.

If there are any items on the application form that you are unsure about, it would be worth contacting the company you are arranging to buy your generation plant from as they should be able to provide some of the more technical information. If you are unable to provide some of the technical details for example if you have not yet decided who to buy your generation plant from, you can provide estimated data provided that you clearly indicate on the application form which data is estimated. You will need to confirm this data as soon as possible and always before the Power Generating Module is commissioned.

The application form enables you to provide detailed technical information about the generation plant you are applying to connect. It is split into five sections. The first four sections relate to particular types of Power Generating Module. You only need to complete the section relating to the type of Power Generating Module that you are applying to connect ie. Part 4a, 4b, 4c or 4d. Use one form for each type of Generating Unit. Part 4e enables you to provide additional information about Electricity Storage plant. Part 4f enables you to provide information about any transformers that you plan to use.

Each section should be copied as many times as required for the plant being connected. This data can be provided at the initial submission stage, and must be provided prior to commissioning.

Applications for Generating Units that are to be operated in infrequent short-term parallel mode do not need to provide data about voltage control or frequency response. It should be noted that due to different technical requirements a Generating Unit purchased and connected to operate in infrequent short-term parallel mode may not be suitable to be connected in long-term parallel mode in the future. If it is likely that the Generating Unit will be required to operate in long-term parallel mode in the future, this should be considered from the outset.

Part 5

Part 5 of this form enables you to provide additional data that may be required by the DNO prior to issue of the Final Operational Notification.

When completing Parts 1-4, if you are unable to provide some of the technical details, if for example you have not yet decided who to buy your generation plant from, you can provide estimated data provided that you clearly indicate on the application form which data is estimated. You will need to confirm this data as soon as possible and always before the Power Generating Module is commissioned.

Version Control – please continue as required

The Standard Application Form is used as an iterative document, developed as your connection and commission process develops. When you formally resubmit this application form to the DNO (eg with additional or updated information), you should use this page to note the issue number, date of submission and any notes on changes, in order to maintain version control.

Issue #

Date

Issue #

Date

Note re amendment

Issue #

Date

Note re amendment

Issue #

Date

Note re amendment

Part 1

To be completed for all new connections

Applicant's Details

Company Name

Company Registered No.

Postal Address

Contact Name

Email Address

Telephone No.

Consultant or Agent's Details (if applicable)

Consultants Name

Postal Address

Contact Name

Email Address

Telephone No.

Power Generating Facility location and operation

Power Generating Facility name

Site Postal Address or attach a site boundary plan (1:500)
Please insert the file name of the attachment here

Details of technology (eg Solar, Wind, Biomass, Diesel/CHP, Electricity Storage)

Is this a new site or an existing site where an extension is proposed?
(Data about existing sites should be submitted in Part 3)

◯ New ◯ Existing

Details of any existing Connection Agreements held by the Customer at or in the vicinity of the proposed or existing Connection Point

Details of any existing Import MPAN (for any existing import metering system)

Details of any existing Export MPAN (for any existing export metering system)

Target date for provision of connection / commissioning of Power Generating Modules

Connection Point (OS grid ref or description)

Preferred Connection Point voltage

V

Single line diagram of any on-site existing or proposed electrical plant or, where available, operation diagrams. Please attach.
Please insert the file name of the attachment here.

Please indicate whether you require a Budget Estimate or Formal Quote

- ◯ Budget Estimate
- ◯ Formal Quote

If you have opted for a Formal Quote, please answer the following question:

Where network capacity is limited, a Flexible or Active Network Management connection may be available. Please contact your DNO for further information on the availability of a Flexible or Active Network Management connection in your area. ANM is not currently available in all areas.

Based on information provided by your DNO, please indicate your preferred type of connection:

- ◯ Flexible or Active Network Management Connection (Constrained Connection – Discussion with DNO and your expected 12 month generation export profile required)
- ◯ Unconstrained Connection

What level of security is required for the connection?

The DNO will assume a single circuit connection to the Power Generating Module is required unless otherwise stated below. Options include:

- ◯ Manually switched alternative connection
- ◯ Automatic switched alternative connection
- ◯ Firm connection (secure for first circuit outage)
- ◯ Other (please describe)

Part 1a – additional contact details

Generator Details

If the Applicant is also the Generator then there is no need to complete this section

Generator Name

Company Registered No.

Postal Address

Contact Name

Email Address

Telephone No.

Installer Details (if applicable)

Installer Name

Postal Address

Contact Name

Email Address

Telephone No.

Point of Contact for the DNO

Select as appropriate

- ◯ Applicant
- ◯ Generator
- ◯ Installer
- ◯ Consultant or Agent

Part 2

To be completed for all Power Generating Facilities

Site export requirements:

Firm export requirements (see Note 1):

Maximum Active Power export		MW
Maximum Reactive Power export		MVAr
Maximum Reactive Power import		MVAr

Non-firm export requirements:

Maximum Active Power export		MW
Maximum Reactive Power export		MVAr
Maximum Reactive Power import		MVAr

Site import requirements (Firm import requirements):

Maximum Active Power import		MW
Maximum Reactive Power import		MVAr
Maximum Reactive Power export		MVAr

Non-firm import requirements:

Maximum Active Power import		MW
Maximum Reactive Power import		MVAr
Maximum Reactive Power export		MVAr

Total Site maximum fault current contribution (you may prefer to provide the required information in Part 3 - see Note 2)

Peak asymmetrical short circuit current at 10ms (ip) for a 3φ short circuit fault at the Connection Point		kA
RMS value of the initial symmetrical short circuit current (Ik") for a 3φ short circuit fault at the Connection Point		kA
RMS value of the symmetrical short circuit current at 100ms (Ik(100)) for a 3φ short circuit fault at the Connection Point		kA

Power Generating Module interface arrangements (see Note 3)

Means of connection, disconnection and synchronising between the DNO and the Generator, please insert file name of attachment if this information is being provided as a diagram

Electricity Storage Plant operation

Maximum power swing of the storage device (see Part 4e for example) MW

Please describe the operational mode (eg float charge)

Note 1 – This section relates to operating conditions when the Power Generating Facility is exporting Active Power. The Active Power export and associated maximum Reactive Power export and/or import should be stated for operation at registered capacity. The firm import / export requirements relate to the capacity available in a first circuit outage event on the DNOs system. The non-firm import / export requirements relate to the capacity available when the DNOs system is intact.

This information will be used by the DNO when assessing your application. Actual requirements for operating conditions such as the Power Generating Module operating mode and power factor will be agreed as part of the Connection Offer.

Registered Capacity can apply to:

i) a Power Generating Facility. This is the total maximum Active Power capacity of the Power Generating Module(s) in the Power Generating Facility, minus the power consumed by the generation process. For a Power Generating Facility with no other site demand you should take account of the requirement to produce Reactive Power at the Connection Point which will mean considering other equipment such as transformers and cables connecting the Generating Units to the Connection Point. For a Power Generating Facility embedded in a private network with demand it is recommended that you discuss the requirement for the production of Reactive Power with the DNO. Hence the Registered Capacity (kW) will generally be less the than Apparent Power (kVA).

ii) a Power Generating Module. This is the maximum Active Power capacity of the Generating Unit(s) comprising the Power Generating Module, minus the power consumed by the generation process. It needs to take account of the requirement to produce Reactive Power at the Connection Point. Hence the Registered Capacity (kW) will generally be less than the Apparent Power (kVA). Where a Power Generating Module comprises inverters, the maximum Active Power capacity of the Generating Unit(s) is the lesser of the Inverter(s) rating or the rating of the energy source.

Note 2 – The DNO needs to assess your application with respect to the fault contribution your equipment will make to their network. Your Power Generating Modules and any induction motors will contribute fault current if there is a fault on the network. The amount of fault current at the connection point depends on the characteristics of your Power Generating Modules, induction motors and the impedance of your network (transformers, cables and overhead lines).

Engineering Recommendation G74, ETR 120 and IEC 60909 provide guidance on fault current data. Additionally, fault current contribution data may be provided in the form of detailed graphs, waveforms and/or tables. Induction motors can contribute to the peak asymmetrical short circuit current at 10ms. If the fault current contribution is solely from Generating Units then this information need not be provided where detailed fault level contribution / impedance data is provided for each Generating Unit in Part 3 of this application form.

Note 3 – The interface arrangements need to be agreed and implemented between the User and DNO before energisation. This is detailed in Paragraph 6.4.2 of Engineering Recommendation G99. This information should include a diagram.

Part 3

To be completed for all Type A, Type B, Type C and Type D Power Generating Modules

Part 3 Section 1a -
summary of the new Generating Units that comprise the Power Generating Module

Part 3 Section 1b -
summary of the existing Generating Units that comprise the Power Generating Module

Part 3 Section 2 -
Generating Unit data

Part 3 Section 1a - summary of the new Generating Units that comprise the Power Generating Module The second section of Part 3 should be completed for each different Generating Unit. (See Note 4)

Power Generating Module general data

Name(s) / identifiers of Power Generating Modules. Where the Power Generating Module contains components or products that are type tested, include the type test reference numbers here.

Will any Generating Unit operate in island mode? ◯ Yes ◯ No

Will any Generating Unit supply electricity to on-site load? ◯ Yes ◯ No

Will the Generating Unit operate solely in infrequent short-term parallel operation mode ◯ Yes ◯ No

	Number of Generating units	Type of prime movers	Energy Source Availability (see Note 5)	Technology Production type (see Note 6)
Synchronous Power Generating Module			◯ Intermittent ◯ Non-intermittent	
Fixed speed induction Generating Unit			◯ Intermittent ◯ Non-intermittent	
Double fed induction Generating Unit			◯ Intermittent ◯ Non-intermittent	
Series inverter connected Generating Unit			◯ Intermittent ◯ Non-intermittent	
Electricity Storage Generating Unit			◯ Intermittent ◯ Non-intermittent	
Other (please specify			◯ Intermittent ◯ Non-intermittent	

Part 3 Section 1b - summary of any existing Generating Units that comprise the Power Generating Module

Power Generating Module general data

Name(s) / identifiers of Power Generating Modules. Reference the Engineering Recommendation under which the Power Generating Modules were connected (eg G83, G59, G98, G99)

Does any Generating Unit operate in island mode? ◯ Yes ◯ No

Does any Generating Unit supply electricity to on-site load? ◯ Yes ◯ No

	Number of Generating units	Type of prime movers	Energy Source Availability (see Note 5)	Technology Production type (see Note 6)
Synchronous Power Generating Module			◯ Intermittent ◯ Non-intermittent	
Fixed speed induction Generating Unit			◯ Intermittent ◯ Non-intermittent	
Double fed induction Generating Unit			◯ Intermittent ◯ Non-intermittent	
Series inverter connected Generating Unit			◯ Intermittent ◯ Non-intermittent	
Electricity Storage Generating Unit			◯ Intermittent ◯ Non-intermittent	
Other (please specify			◯ Intermittent ◯ Non-intermittent	

Note 4 - Synchronous Power Generating Modules are generally synonymous with Generating Unit in EREC G99 except certain cases, such as a Combined Cycle Gas Turbine (CCGT) Module for example. A CCGT Module can be comprised of a number of Generating Units.

A Power Generating Facility may be made up of a number of Synchronous Power Generating Modules.

Asynchronous or Inverter connected Power Generating Modules are defined as Power Park Modules in EREC G99 and are typically comprised of several Generating Units connected together.

A Power Generating Facility could comprise several Synchronous Power Generating Modules and one Power Park Module. The exception to this is when new plant is being connected to a Power Generating Facility where there are Power Generating Modules which were connected under EREC G83 or EREC G59 and EREC G99 should be referred to for more detailed consideration of this.

Note 5 - Intermittent and Non-intermittent Generation is defined in EREP 130 as follows:

Intermittent Generation: Generation plant where the energy source for the prime mover cannot be made available on demand.

Non-intermittent Generation: Generation plant where the energy source for the prime mover can be made available on demand.

Note 6 - The Production Type should be selected from the list below derived from the Manual of Procedures for the ENTSO-E Central Information Transparency Platform. Further details of in respect of the storage type are requested in Part 4e.

Biomass;

Fossil brown coal/lignite;

Fossil coal-derived gas;

Fossil gas;

Fossil hard coal;

Fossil oil;

Fossil oil shale;

Fossil peat;

Geothermal;

Hydro pumped storage;

Hydro run-of-river and poundage;

Hydro water reservoir;

Marine;

Nuclear;

Other renewable;

Solar;

Waste;

Wind offshore;

Wind onshore;

Other – battery storage;

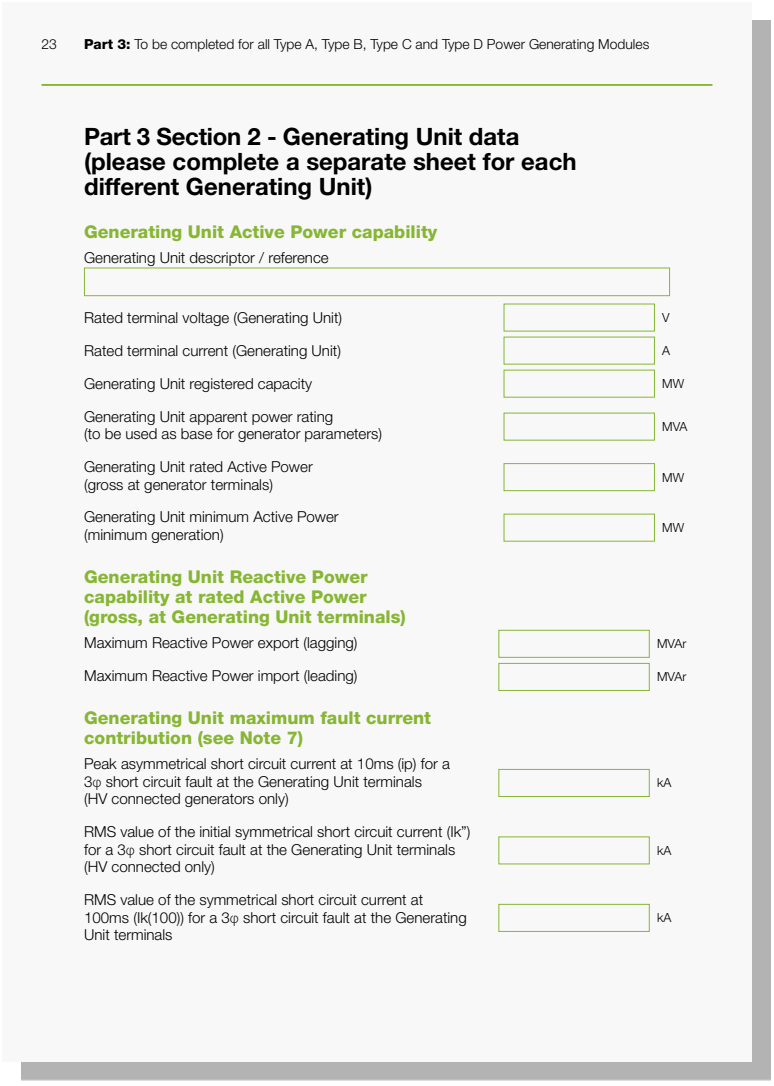
Other – storage not battery; or

Other.

Part 3 Section 2 - Generating Unit data

Please complete a separate sheet for each different Generating Unit

If you are connecting more than one different Generating Unit you should complete a separate Part 3 form for each different Generating Unit. Master versions of the Part 3 form are separately available for this purpose.



23 **Part 3:** To be completed for all Type A, Type B, Type C and Type D Power Generating Modules

Part 3 Section 2 - Generating Unit data (please complete a separate sheet for each different Generating Unit)

Generating Unit Active Power capability

Generating Unit descriptor / reference

Rated terminal voltage (Generating Unit)		V
Rated terminal current (Generating Unit)		A
Generating Unit registered capacity		MW
Generating Unit apparent power rating (to be used as base for generator parameters)		MVA
Generating Unit rated Active Power (gross at generator terminals)		MW
Generating Unit minimum Active Power (minimum generation)		MW

Generating Unit Reactive Power capability at rated Active Power (gross, at Generating Unit terminals)

Maximum Reactive Power export (lagging)		MVAr
Maximum Reactive Power import (leading)		MVAr

Generating Unit maximum fault current contribution (see Note 7)

Peak asymmetrical short circuit current at 10ms (ip) for a 3φ short circuit fault at the Generating Unit terminals (HV connected generators only)		kA
RMS value of the initial symmetrical short circuit current (Ik") for a 3φ short circuit fault at the Generating Unit terminals (HV connected only)		kA
RMS value of the symmetrical short circuit current at 100ms (Ik(100)) for a 3φ short circuit fault at the Generating Unit terminals		kA

Part 3 Section 2 - Generating Unit data (please complete a separate sheet for each different Generating Unit)

Generating Unit Active Power capability

Generating Unit descriptor / reference

Rated terminal voltage (Generating Unit)		V
Rated terminal current (Generating Unit)		A
Generating Unit registered capacity		MW
Generating Unit apparent power rating (to be used as base for generator parameters)		MVA
Generating Unit rated Active Power (gross at generator terminals)		MW
Generating Unit minimum Active Power (minimum generation)		MW

Generating Unit Reactive Power capability at rated Active Power (gross, at Generating Unit terminals)

Maximum Reactive Power export (lagging)		MVAr
Maximum Reactive Power import (leading)		MVAr

Generating Unit maximum fault current contribution (see Note 7)

Peak asymmetrical short circuit current at 10ms (ip) for a 3φ short circuit fault at the Generating Unit terminals (HV connected generators only)		kA
RMS value of the initial symmetrical short circuit current (Ik") for a 3φ short circuit fault at the Generating Unit terminals (HV connected only)		kA
RMS value of the symmetrical short circuit current at 100ms (Ik(100)) for a 3φ short circuit fault at the Generating Unit terminals		kA

Impedance data for fault current contribution calculations (see Note 7)

Are there any transformers between the Generating Unit and the Connection Point?	◯ Yes ◯ No	
Number of Generating Units connected to the transformer		Number
Rated apparent power of the transformer		MVA
Positive sequence reactance of the transformer		per unit
For sites with significant other impedance (multiple transformers, cables or overhead lines) between the Generating Unit and the Connection Point sketch of site detailing generator connection and impedances provided	◯ Sketch ◯ SLD	
This information can be detailed on the single line diagram (SLD) provided in Part 1		

Note 7 – See Engineering Recommendation G74, ETR 120 and IEC 60909 for guidance on fault current data. Additionally, fault current contribution data may be provided in the form of detailed graphs, waveforms and/or tables.

If you have a site with several Power Generating Modules or induction motors you can complete the site maximum fault level contribution information in Part 2 and you do not need to complete these fault current contribution entries. In this case it is likely that the DNO will require completion of Part 4 at a later stage.

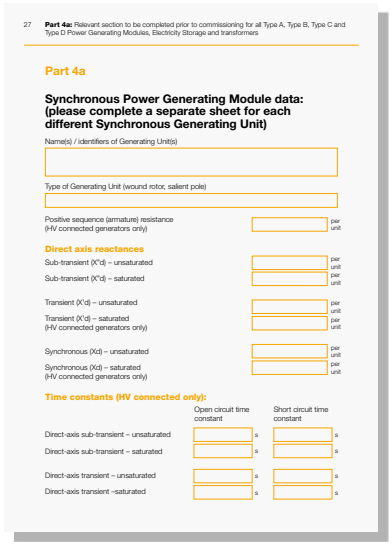
If you are providing the Generating Unit maximum fault current contribution it is necessary to provide any other significant site impedance data to enable the DNO to calculate the fault current contribution from the Generating Unit(s) at the Connection Point. A sketch marked with the transformer and circuit resistance and reactance should be provided. This can be in ohms or per unit. If provided in per unit the base should be stated. This can be provided per meter together with the total circuit length, or for the total circuit length.

Part 4

Relevant section to be completed prior to commissioning for all Type A, Type B, Type C and Type D Power Generating Modules, Electricity Storage and transformers

Please complete a separate sheet for each different Generating Unit

There are Part 4 forms for each type of Generating Unit category. If you are connecting more than one different Generating Unit of the same category (eg two different sized synchronous Generating Units) then you should complete a separate Part 4 form for each different Generating Unit. Master versions of the Part 4 form (Parts 4a, 4b, 4c, 4d and 4e) are separately available for this purpose.



27 **Part 4a:** Relevant section to be completed prior to commissioning for all Type A, Type B, Type C and Type D Power Generating Modules, Electricity Storage and transformers

Part 4a

Synchronous Power Generating Module data: (please complete a separate sheet for each different Synchronous Generating Unit)

Name(s) / identifiers of Generating Unit(s)

Type of Generating Unit (wound rotor, salient pole)

Positive sequence (armature) resistance (HV connected generators only) — per unit

Direct axis reactances

Sub-transient (X'd) – unsaturated — per unit

Sub-transient (X'd) – saturated — per unit

Transient (X'd) – unsaturated — per unit

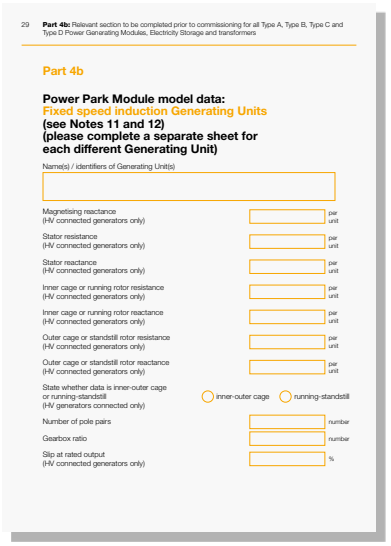
Transient (X'd) – saturated (HV connected generators only) — per unit

Synchronous (Xd) – unsaturated — per unit

Synchronous (Xd) – saturated (HV connected generators only) — per unit

Time constants (HV connected only):

	Open circuit time constant	Short circuit time constant
Direct-axis sub-transient – unsaturated	s	s
Direct-axis sub-transient – saturated	s	s
Direct-axis transient – unsaturated	s	s
Direct-axis transient –saturated	s	s



29 **Part 4b:** Relevant section to be completed prior to commissioning for all Type A, Type B, Type C and Type D Power Generating Modules, Electricity Storage and transformers

Part 4b

Power Park Module model data: Fixed speed induction Generating Units (see Notes 11 and 12) (please complete a separate sheet for each different Generating Unit)

Name(s) / identifiers of Generating Unit(s)

Magnetising reactance (HV connected generators only) — per unit

Stator resistance (HV connected generators only) — per unit

Stator reactance (HV connected generators only) — per unit

Inner cage or running rotor resistance (HV connected generators only) — per unit

Inner cage or running rotor reactance (HV connected generators only) — per unit

Outer cage or standstill rotor resistance (HV connected generators only) — per unit

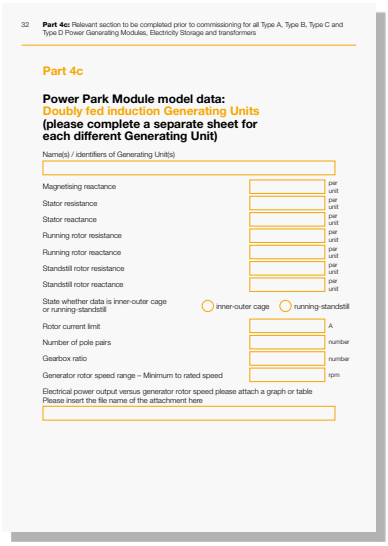
Outer cage or standstill rotor reactance (HV connected generators only) — per unit

State whether data is inner-outer cage or running-standstill (HV generators connected only) — ◯ inner-outer cage ◯ running-standstill

Number of pole pairs — number

Gearbox ratio — number

Slip at rated output (HV connected generators only) — %



32 **Part 4c:** Relevant section to be completed prior to commissioning for all Type A, Type B, Type C and Type D Power Generating Modules, Electricity Storage and transformers

Part 4c

Power Park Module model data: Doubly fed induction Generating Units (please complete a separate sheet for each different Generating Unit)

Name(s) / identifiers of Generating Unit(s)

Magnetising reactance — per unit

Stator resistance — per unit

Stator reactance — per unit

Running rotor resistance — per unit

Running rotor reactance — per unit

Standstill rotor resistance — per unit

Standstill rotor reactance — per unit

State whether data is inner-outer cage or running-standstill — ◯ inner-outer cage ◯ running-standstill

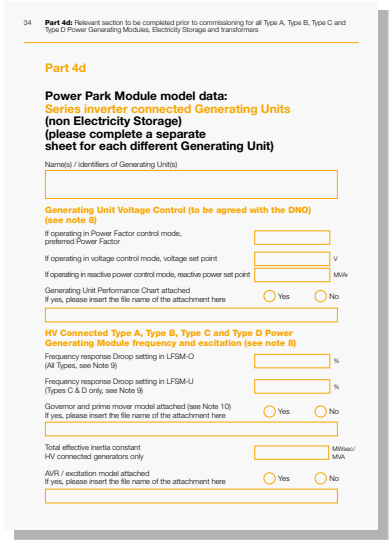
Rotor current limit — A

Number of pole pairs — number

Gearbox ratio — number

Generator rotor speed range – Minimum to rated speed — rpm

Electrical power output versus generator rotor speed please attach a graph or table
Please insert the file name of the attachment here



34 **Part 4d:** Relevant section to be completed prior to commissioning for all Type A, Type B, Type C and Type D Power Generating Modules, Electricity Storage and transformers

Part 4d

Power Park Module model data: Series inverter connected Generating Units (non Electricity Storage) (please complete a separate sheet for each different Generating Unit)

Name(s) / identifiers of Generating Unit(s)

Generating Unit Voltage Control (to be agreed with the DNO) (see note 8)

If operating in Power Factor control mode, preferred Power Factor

If operating in voltage control mode, voltage set point — V

If operating in reactive power control mode, reactive power set point — MVAr

Generating Unit Performance Chart attached
If yes, please insert the file name of the attachment here — ◯ Yes ◯ No

HV Connected Type A, Type B, Type C and Type D Power Generating Module frequency and excitation (see note 8)

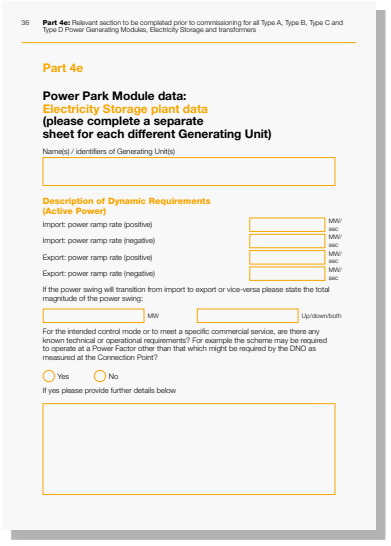
Frequency response Droop setting in LFSM-O (All Types, see Note 9) — %

Frequency response Droop setting in LFSM-U (Types C & D only, see Note 9) — %

Governor and prime mover model attached (see Note 10)
If yes, please insert the file name of the attachment here — ◯ Yes ◯ No

Total effective inertia constant HV connected generators only — MWsec/MVA

AVR / excitation model attached
If yes, please insert the file name of the attachment here — ◯ Yes ◯ No



36 **Part 4e:** Relevant section to be completed prior to commissioning for all Type A, Type B, Type C and Type D Power Generating Modules, Electricity Storage and transformers

Part 4e

Power Park Module data: Electricity Storage plant data (please complete a separate sheet for each different Generating Unit)

Name(s) / identifiers of Generating Unit(s)

Description of Dynamic Requirements (Active Power)

Import: power ramp rate (positive) — MW/sec

Import: power ramp rate (negative) — MW/sec

Export: power ramp rate (positive) — MW/sec

Export: power ramp rate (negative) — MW/sec

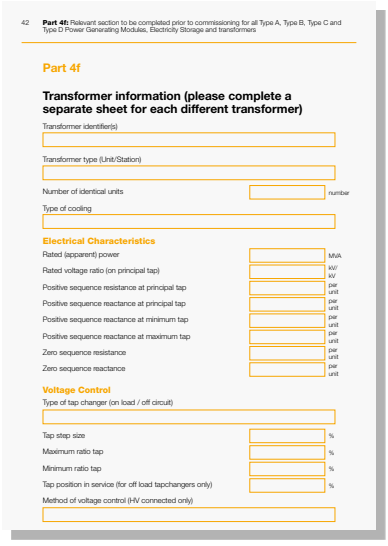
If the power swing will transition from import to export or vice-versa please state the total magnitude of the power swing:

MW — Up/down/both

For the intended control mode or to meet a specific commercial service, are there any known technical or operational requirements? For example the scheme may be required to operate at a Power Factor other than that which might be required by the DNO as measured at the Connection Point?

◯ Yes ◯ No

If yes please provide further details below



42 **Part 4f:** Relevant section to be completed prior to commissioning for all Type A, Type B, Type C and Type D Power Generating Modules, Electricity Storage and transformers

Part 4f

Transformer information (please complete a separate sheet for each different transformer)

Transformer identifier(s)

Transformer type (Unit/Station)

Number of identical units — number

Type of cooling

Electrical Characteristics

Rated (apparent) power — MVA

Rated voltage ratio (on principal tap) — kV/kV

Positive sequence resistance at principal tap — per unit

Positive sequence reactance at principal tap — per unit

Positive sequence reactance at minimum tap — per unit

Positive sequence reactance at maximum tap — per unit

Zero sequence resistance — per unit

Zero sequence reactance — per unit

Voltage Control

Type of tap changer (on load / off circuit)

Tap step size — %

Maximum ratio tap — %

Minimum ratio tap — %

Tap position in service (for off load tapchangers only) — %

Method of voltage control (HV connected only)

Part 4a

Synchronous Power Generating Module data: (please complete a separate sheet for each different Synchronous Generating Unit)

Name(s) / identifiers of Generating Unit(s)

Type of Generating Unit (wound rotor, salient pole)

Positive sequence (armature) resistance (HV connected generators only)		per unit

Direct axis reactances

Sub-transient (X"d) – unsaturated		per unit
Sub-transient (X"d) – saturated		per unit
Transient (X'd) – unsaturated		per unit
Transient (X'd) – saturated (HV connected generators only)		per unit
Synchronous (Xd) – unsaturated		per unit
Synchronous (Xd) – saturated (HV connected generators only)		per unit

Time constants (HV connected only):

	Open circuit time constant		Short circuit time constant	
Direct-axis sub-transient – unsaturated		s		s
Direct-axis sub-transient – saturated		s		s
Direct-axis transient – unsaturated		s		s
Direct-axis transient –saturated		s		s

Generating Unit Voltage Control (to be agreed with the DNO) (see Note 8)

If operating in Power Factor control mode, preferred Power Factor

If operating in voltage control mode, voltage set point — V

If operating in reactive power control mode, reactive power set point — MVAr

Generating Unit Performance Chart attached
If yes, please insert the file name of the attachment here — ◯ Yes ◯ No

HV Connected Type A, Type B, Type C and Type D Power Generating Module frequency and excitation (see Note 8)

Frequency response Droop setting in LFSM-O (All Types, see Note 9) — %

Frequency response Droop setting in LFSM-U (Types C & D only, see Note 9) — %

Governor and prime mover model attached (see Note 10)
If yes, please insert the file name of the attachment here — ◯ Yes ◯ No

Inertia constant (Generating Unit and prime mover) (HV connected generators only) — MWsec/MVA

AVR / excitation model attached
If yes, please insert the file name of the attachment here — ◯ Yes ◯ No

Type C and Type D Power Generating Module additional frequency response (see Note 8)

Frequency response Droop setting in FSM (if applicable) — %

Frequency response mode — ◯ FSM ◯ LFSM

Part 4b

Power Park Module model data: Fixed speed induction Generating Units (see Notes 11 and 12) (please complete a separate sheet for each different Generating Unit)

Name(s) / identifiers of Generating Unit(s)

Magnetising reactance (HV connected generators only)		per unit
Stator resistance (HV connected generators only)		per unit
Stator reactance (HV connected generators only)		per unit
Inner cage or running rotor resistance (HV connected generators only)		per unit
Inner cage or running rotor reactance (HV connected generators only)		per unit
Outer cage or standstill rotor resistance (HV connected generators only)		per unit
Outer cage or standstill rotor reactance (HV connected generators only)		per unit
State whether data is inner-outer cage or running-standstill (HV generators connected only)	◯ inner-outer cage ◯ running-standstill	
Number of pole pairs		number
Gearbox ratio		number
Slip at rated output (HV connected generators only)		%

Shunt capacitance connected in parallel at % of rated output: Provide as values below or attach a graph

If attaching a graph, please insert the file name of the attachment here

Starting		kVAr
20%		kVAr
40%		kVAr
60%		kVAr
80%		kVAr
100%		kVAr

Active power and reactive power: Provide as values below or attach a graph

If attaching a graph, please insert the file name of the attachment here

Active power and reactive power import during start-up		MW-MVAr
Active power and reactive power import during switching operations eg '6 to 4 pole' change-over (HV connected generators only)		MW-MVAr

Under voltage protection setting & time delay

	Per Unit V		s

Generating Unit Voltage Control (to be agreed with the DNO) (see Note 8)

If operating in Power Factor control mode, preferred Power Factor

If operating in voltage control mode, voltage set point — V

If operating in reactive power control mode, reactive power set point — MVAr

Generating Unit Performance Chart attached — ◯ Yes ◯ No
If yes, please insert the file name of the attachment here

HV Connected Type A, Type B, Type C and Type D Power Generating Module frequency and excitation (see Note 8)

Frequency response Droop setting in LFSM-O (All Types, see Note 9) — %

Frequency response Droop setting in LFSM-U (Types C & D only, see Note 9) — %

Governor and prime mover model attached (see Note 10) — ◯ Yes ◯ No
If yes, please insert the file name of the attachment here

Total effective inertia constant (generator and prime mover) (HV connected generators only) — MWsec/MVA

AVR / excitation model attached — ◯ Yes ◯ No
If yes, please insert the file name of the attachment here

Type C and Type D Power Generating Module additional frequency response (see Note 8)

Frequency response Droop setting in FSM (if applicable) — %

Frequency response mode — ◯ FSM ◯ LFSM

Part 4c

Power Park Module model data: Doubly fed induction Generating Units (please complete a separate sheet for each different Generating Unit)

Name(s) / identifiers of Generating Unit(s)

Magnetising reactance		per unit
Stator resistance		per unit
Stator reactance		per unit
Running rotor resistance		per unit
Running rotor reactance		per unit
Standstill rotor resistance		per unit
Standstill rotor reactance		per unit
State whether data is inner-outer cage or running-standstill	◯ inner-outer cage ◯ running-standstill	
Rotor current limit		A
Number of pole pairs		number
Gearbox ratio		number
Generator rotor speed range – Minimum to rated speed		rpm

Electrical power output versus generator rotor speed please attach a graph or table
Please insert the file name of the attachment here

Generating Unit Voltage Control (to be agreed with the DNO) (see Note 8)

If operating in Power Factor control mode, preferred Power Factor

If operating in voltage control mode, voltage set point — V

If operating in reactive power control mode, reactive power set point — MVAr

Generating Unit Performance Chart attached — ◯ Yes ◯ No
If yes, please insert the file name of the attachment here

HV Connected Type A, Type B, Type C and Type D Power Generating Module frequency and excitation (see Note 8)

Frequency response Droop setting in LFSM-O (All Types, see Note 9) — %

Frequency response Droop setting in LFSM-U (Types C & D only, see Note 9) — %

Governor and prime mover model attached (see Note 10) — ◯ Yes ◯ No
If yes, please insert the file name of the attachment here

Total effective inertia constant at rated speed (generator and prime mover) — MWsec/MVA

AVR / excitation model attached — ◯ Yes ◯ No
If yes, please insert the file name of the attachment here

Type C and Type D Power Generating Module additional frequency response (see Note 8)

Frequency response Droop setting in FSM (if applicable) — %

Frequency response mode — ◯ FSM ◯ LFSM

Part 4d

Power Park Module model data: Series inverter connected Generating Units (non Electricity Storage) (please complete a separate sheet for each different Generating Unit)

Name(s) / identifiers of Generating Unit(s)

Generating Unit Voltage Control (to be agreed with the DNO) (see Note 8)

If operating in Power Factor control mode, preferred Power Factor

If operating in voltage control mode, voltage set point — V

If operating in reactive power control mode, reactive power set point — MVAr

Generating Unit Performance Chart attached — Yes / No
If yes, please insert the file name of the attachment here

HV Connected Type A, Type B, Type C and Type D Power Generating Module frequency and excitation (see Note 8)

Frequency response Droop setting in LFSM-O (All Types, see Note 9) — %

Frequency response Droop setting in LFSM-U (Types C & D only, see Note 9) — %

Governor and prime mover model attached (see Note 10) — Yes / No
If yes, please insert the file name of the attachment here

Total effective inertia constant HV connected generators only — MWsec/MVA

AVR / excitation model attached — Yes / No
If yes, please insert the file name of the attachment here

Type C and Type D Power Generating Module additional frequency response (see Note 8)

Frequency response Droop setting in FSM (if applicable) _____ %

Frequency response mode ◯ FSM ◯ LFSM

Part 4e

Power Park Module data: Electricity Storage plant data (please complete a separate sheet for each different Generating Unit)

Name(s) / identifiers of Generating Unit(s)

Description of Dynamic Requirements (Active Power)

Import: power ramp rate (positive)		MW/sec
Import: power ramp rate (negative)		MW/sec
Export: power ramp rate (positive)		MW/sec
Export: power ramp rate (negative)		MW/sec

If the power swing will transition from import to export or vice-versa please state the total magnitude of the power swing:

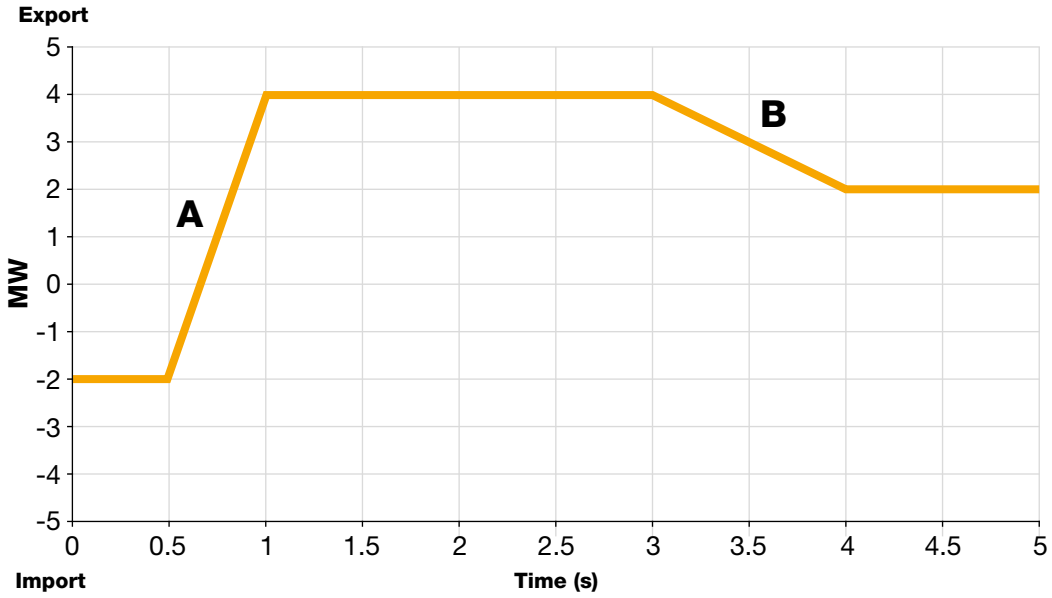
MW Up/down/both

For the intended control mode or to meet a specific commercial service, are there any known technical or operational requirements? For example the scheme may be required to operate at a Power Factor other than that which might be required by the DNO as measured at the Connection Point?

◯ Yes ◯ No

If yes please provide further details below

Example of Ramp Rate / Total Power Swing



A - Example of ramp which transitions from import to export

Ramp rate (Positive)	= (2+4) MW / 0.5sec	= 12 MW per sec
Total power swing	= (2+4) MW	= 6 MW

B - Example of ramp during export

Ramp rate (Negative)	= (4-2) MW / 1 sec	= 2 MW per sec
Total power swing	= (4-2) MW	= 2 MW

Generating Unit Voltage Control (to be agreed with the DNO) (see Note 8)

If operating in Power Factor control mode, preferred Power Factor

If operating in voltage control mode, voltage set point — V

If operating in reactive power control mode, reactive power set point — MVAr

Generating Unit Performance Chart attached
If yes, please insert the file name of the attachment here — ◯ Yes ◯ No

HV Connected Type A, Type B, Type C and Type D Power Generating Module frequency and excitation (see Note 8)

Governor and prime mover model attached (see Note 10)
If yes, please insert the file name of the attachment here — ◯ Yes ◯ No

Total effective inertia constant — MWsec/MVA

AVR / excitation model attached
If yes, please insert the file name of the attachment here — ◯ Yes ◯ No

Commercial Service (applicable to Electricity Storage Plant for each commercial service / mode of operation)

Name of the commercial service being provided and name of the company the service is being provided to (eg National Grid)

If the commercial service is being provided via a third party, the contact details for the third party service operator (eg an aggregator)

Is this a service which involves co-ordinated response with other Electricity Storage plant either on the Distribution Network, Transmission System, Private Network or aggregator? ◯ Yes ◯ No

If yes please provide further details below

Storage type (for each Electricity Storage Generating Unit referenced in Part 3 Section 1a or Section 1b, indicate whether the storage forms part of a CHP scheme and the storage type from the following list)

Does the storage form part of a CHP scheme?	◯ Yes	◯ No

Indicate the Electricity Storage technology type

Chemical

Ammonia	◯ Yes	◯ No
Hydrogen	◯ Yes	◯ No
Synthetic Fuels	◯ Yes	◯ No
Drop-in Fuels	◯ Yes	◯ No
Methanol	◯ Yes	◯ No
Synthetic Natural Gas	◯ Yes	◯ No

Electrical

Supercapacitors	◯ Yes	◯ No
Superconducting Magnetic ES (SMES)	◯ Yes	◯ No

Mechanical

Adiabatic Compressed Air	◯ Yes	◯ No
Diabatic Compressed Air	◯ Yes	◯ No
Liquid Air Energy Storage	◯ Yes	◯ No
Pumped Hydro	◯ Yes	◯ No
Flywheels	◯ Yes	◯ No

Thermal

Latent Heat Storage	◯ Yes	◯ No
Thermochemical Storage	◯ Yes	◯ No
Sensible Heat Storage	◯ Yes	◯ No

Electrochemical

Classic Batteries

Lead Acid	◯ Yes	◯ No
Lithium Polymer (Li-Polymer)	◯ Yes	◯ No
Metal Air	◯ Yes	◯ No
Nickle Cadmium (Ni-Cd)	◯ Yes	◯ No
Sodium Nickle Chloride (Na-$NiCl_2$)	◯ Yes	◯ No
Lithium Ion (Li–ion)	◯ Yes	◯ No
Sodium Ion (Na–ion)	◯ Yes	◯ No
Lithium Sulphur (Li-S)	◯ Yes	◯ No
Sodium Sulphur (Na-S)	◯ Yes	◯ No
Nickle – Metal Hydride (Ni-MH)	◯ Yes	◯ No

Flow Batteries

Vanadium Red - Oxide	◯ Yes	◯ No
Zinc – Iron (Zn – Fe)	◯ Yes	◯ No
Zinc – Bromine (Zn – Br)	◯ Yes	◯ No

Other (please detail)

Part 4f

Transformer information (please complete a separate sheet for each different transformer)

Transformer identifier(s)

Transformer type (Unit/Station)

Number of identical units — number

Type of cooling

Electrical Characteristics

Rated (apparent) power		MVA
Rated voltage ratio (on principal tap)		kV/ kV
Positive sequence resistance at principal tap		per unit
Positive sequence reactance at principal tap		per unit
Positive sequence reactance at minimum tap		per unit
Positive sequence reactance at maximum tap		per unit
Zero sequence resistance		per unit
Zero sequence reactance		per unit

Voltage Control

Type of tap changer (on load / off circuit)

Tap step size		%
Maximum ratio tap		%
Minimum ratio tap		%
Tap position in service (for off load tapchangers only)		%

Method of voltage control (HV connected only)

Earthing Arrangements

Winding configuration (eg Dyn11) HV connected only

Method of earthing of high-voltage winding

Method of earthing of low-voltage winding

Note 8 – This information is not required for Power Generating Modules operating in infrequent short-term operating mode.

Note 9 – This note does not apply to Power Generating Modules operating in infrequent short-term operating mode. All Power Generating Modules must operate in Limited Frequency Sensitive Mode Over frequency (LFSM - O). FSM capability is mandatory for Type C and Type D. Generators may elect to operate their Power Generating Modules in Frequency Sensitive Mode as agreed in an Ancillary Service agreement with the National Electricity Transmission System Operator. All Type C and Type D Power Generating Modules must operate in Limited Frequency Sensitive Mode Under frequency (LFSM – U).

Note 10 – The data referred to in this note does not apply to Power Generating Modules operating in infrequent short term operating mode. For Type B Power Generating Modules where the DNO considers that the stability and security of the network is at risk, and has advised the Generator accordingly, sufficient data should be provided in order to build up a suitable Power Generating Module dynamic model for analysis. Alternatively a 'Black Box' dynamic model of the Power Generating Module may be provided. All models should be suitable for the software analysis package used by the DNO. This data should be provided for Type C and D Power Generating Modules.

Note 11 – Asynchronous generators may be represented by an equivalent synchronous data set.

Note 12 – Provide the data for each asynchronous generation set based on the number of pole sets (ie two data sets for dual speed 4/6 pole machines).

Part 5

Additional data which may be required by the DNO before Final Operational Notification is issued

Part 5a

Total Power Generating Facility output at Minimum Generation (net of auxiliary loads)

Minimum Generation (minimum Active Power export)		MW
Maximum Reactive Power export		MVAr
Maximum Reactive Power import		MVAr

Part 5b

Power Generating Facility Maximum fault current contribution – additional information

Short circuit time constant T", corresponding to the change from Ik" to $Ik_{(100)}$		s
Positive sequence X/R ratio at the instant of fault		number
Short circuit ratio		number

Part 5c

HV connected Synchronous Power Generating Module additional data

Quadrature axis reactances

Sub-transient (X"q) – unsaturated		per unit
Sub-transient (X"q) – saturated		per unit
Transient (X'q) – unsaturated		per unit
Transient (X'q) – saturated		per unit
Synchronous (Xq) – unsaturated		per unit
Synchronous (Xq) – saturated		per unit

Quadrature axis time constants.

	Open circuit time constant		Short circuit time constant	
Direct-axis sub-transient – unsaturated		s		s
Direct-axis sub-transient – saturated		s		s
Direct-axis transient – unsaturated		s		s
Direct-axis transient – saturated		s		s

Other

Stator leakage reactance (unsaturated)		per unit
Zero sequence resistance (earthed star only, including any neutral earthing resistance)		per unit
Zero sequence reactance (earthed star only, including any neutral earthing reactance)		per unit
Negative sequence resistance		per unit
Negative sequence reactance		per unit
Rated field current		A

Field current open circuit saturation curve (from 50% to 120% of rated terminal voltage)
Please provide a graph and insert the file name of the attachment here

Potier reactance (only required if the saturation factor is available)		per unit
Saturation factor (pu field current to produce 1.2pu terminal voltage on open circuit)		per unit

Part 5d

Wind Turbine Power Park Module Output data

For wind turbines only - IEC 61400-21 (P_{60} and $P_{0.2}$)

Maximum measured Active Power P_{60}		MW
Maximum measured Active Power $P_{0.2}$		MW

Part 5e

Power Park Module model data: HV connected fixed speed induction Generating Units additional data

Inertia constant of the generator rotor		MWsec/ MVA
Inertia constant of the prime mover rotor		MWsec/ MVA
Equivalent shaft stiffness between the two masses		Nm/ Electrical radian

Describe method of adding star capacitance over operating range. If electronic power factor control (eg SVC) is installed, provide details of the operating range and characteristics eg pf or MVAr range - operating regime: constant or voltage set-point / slope and response times.

Part 5f

Power Park Module model data: HV Connected Doubly fed induction Generating Units additional data

Inertia constant of the generator rotor at rated speed		MWsec/ MVA
Inertia constant of the prime mover rotor at rated speed		MWsec/ MVA
Equivalent shaft stiffness between the two masses		Nm/ Electrical radian

Part 5g

Power Park Module model data: Series inverter connected Generating Units (non Electricity Storage) additional data

Gearbox ratio		
Generator rotor speed range (minimum to rated speed)		rpm

Electrical power output versus generator rotor speed Please attach a graph or table
Please insert the file name of the attachment here

Inertia constant of the generator rotor at rated speed		MWsec/ MVA
Inertia constant of the prime mover rotor at rated speed		MWsec/ MVA
Equivalent shaft stiffness between the two masses		Nm/ Electrical radian