Grid Code Harmonisation for SEM
Wind in the SEM - Impact on the EirGrid Grid Code - Version 5

A) Wind in the SEM & the Application of the T&SC Rules

1) Summary of Classification of Wind Farms in the SEM

According to V1.3 of the SEM Trading and Settlement Code (T&SC), Wind Power Units can be classified as Variable Generator Units or Autonomous Generator Units.

Autonomous Generator Units are automatically registered as Price Taker Generator Units. The SO will not be able to/ obliged to send instructions to wind farms. They will not be included in Reserve Constrained Unit Commitment (RCUC). They will not have to provide availability declarations nor will the TSO have to provide an individual Wind Power Unit forecast for it.[1]

According to the T&SC Wind Farms which are Dispatchable are classified as Variable Generator Units and can register as Price Maker Units or Price Taker Units *(ref: 2.38, 2.39, 2.40)*

Wind Farms which are classified as Variable Generator Units and register as Price Taker Units will have to provide availability declarations and the TSO will have to provide an individual Wind Power Unit forecast for it as it will be included in the RCUC.

Wind Farms which as classified as Variable Generator Units and register as Price Maker Units will have to provide availability declarations and the TSO will have to provide a Wind Power Unit forecast for wind farm as it will be included in the RCUC.

2) Curtailment & Constraining

At present, there is no formal approved policy document that makes a distinction between constraints [for transmission reasons] and curtailment [for wind reasons] and any compensation for either or both. The Regulators are currently considering this issue and a consultation paper is expected to issue shortly.

3) Wind Dispatch/ Wind Control

1) **Autonomous Wind Farms**
   (e.g. pre-Wind Grid Code wind farms or <5MW distribution-connected wind farms in Ireland; WFPS pre-April 1st 2005 wind farms and wind farms <5MW in Northern Ireland)
   Autonomous Wind Farms will not be subject to dispatch, curtailment or constraint instructions and therefore will not have to reduce their output.

2) **Variable Price Taker Units**
   (e.g. currently called WFPS in Ireland and PDWFPS in Northern Ireland. These will both change to Controllable WFPS in both Grid Codes following the introduction of the SEM.)
   Variable Price Taker Units (VPT) may be subject to a curtailment and/or constraint instruction.

   EIRGRID:
   The mechanism by which Curtailment Instructions or Constraint Instructions will be issued to VPT is via EirGrid's Energy Management System (EMS) system. The process will be as follows:

[1] An individual wind power forecast will be produced for *all* wind farms.

a. The Active Power Control Set-point will be entered into the EMS system.
b. The APC Setpoint ('Curtailment' or 'Constraint' Instruction) is issued to the Wind Power Unit.
c. The Instruction is captured in the EMS system and exported to the Historical Information System, HIS.
d. The HIS will then export the data to the Operational Data Store, ODS.
e. The instruction is then taken from ODS and used to create a single set of dispatch instructions.
f. These are in turn, translated into XML and sent to SMO via a web service.

An application is being developed to differentiate between different types of instructions. In the long term (but not for Day 1).

3) Variable Price Maker Units

(e.g. category does not exist in either code at present; will be called Dispatchable WFPS in Ireland & Northern Ireland for SEM.)

VPM will be subject to dispatch instructions.

EIRGRID/ SONI:

The mechanism by which Dispatch Instructions will be issued to VPM is via the **EDIL interface**. The process will be as follows:

- The NCC operator will issue a Dispatch Instruction to the Variable Price Maker wind farm via the Electronic Dispatch Instruction Logger, EDIL.
- The Wind Farm Responsible Operator accepts the instruction and implements it.
- The Dispatch Instruction will be exported in the same way as Dispatch Instructions to Generation Units (via the NESS system into the output NGDI file)
- The NGDI file will be saved in ODS and then wrapped into XML and sent via web service to the SMO.

Dispatching VPM from EDIL is the best option because:

- All dispatchable plant is dispatched from a single point (EDIL)
- All price-making units are dispatched from a single point
- All price-making units are treated equally in respect of the data interfaces with the TSO
- The TSO will not directly control any price-making unit on the system – DI are sent via the EDIL system but the operator at the site carries out the instruction.

The proposed OC7.2 changes, SDC1 and SDC2 for the Grid Code post SEM ensure that all price making wind farms require EDIL.

3) Wind Availability Declarations

EIRGRID/ SONI:

Day Ahead Availability Declarations

Both Variable Price Makers and Variable Price Takers will have to submit an availability notice at 10am on the day preceding the Trading Day as per the Grid Code. The Grid Code does allow however, that the Availability Declaration to the Market Operator is adequate.

Real-Time Availability Declarations

Variable Price Maker will have to declare their availability through the EDIL system, like all other price-making Generator units.

EIRGRID:
Variable Price Taker will not be 'declaring' real-time availabilities through the EDIL. The wind farm will be sending a live Available Active Power signal to the EMS which will change when this available active power changes, due to changes in wind conditions.

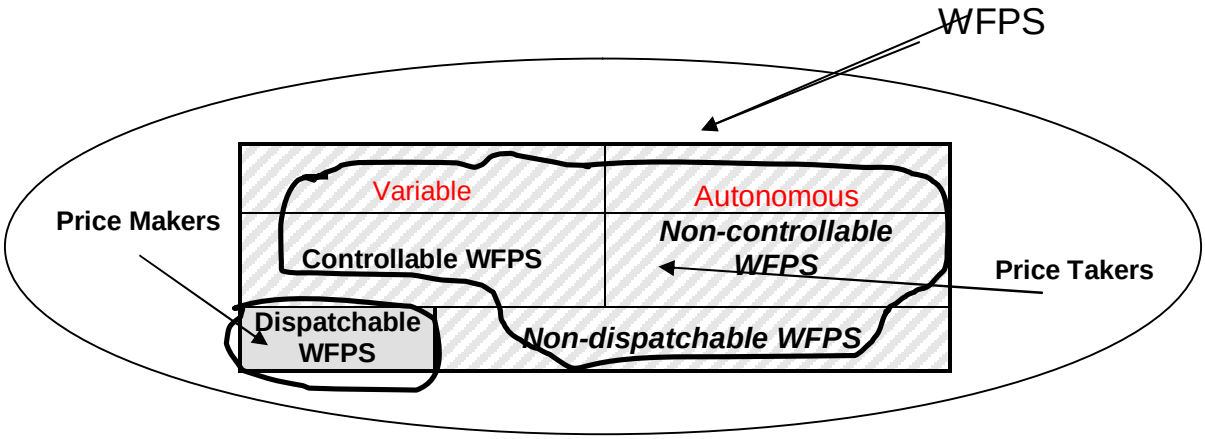
B) Impact on the EirGrid Grid Code

1. Summary of new nomenclature for all Wind Farms

For SEM, all wind farms will be categorised as **WFPS**. The SONI code defines wind farms in this way at present and this **WFPS** definition includes wind farms that are less than 5MW and those that pre-date the revised code. No similar category exists or is necessary in the EirGrid code at present but the Distribution Code will need to be changed to align it with the new categorisations. This can be done once all changes to the EirGrid and SONI codes are agreed.

If a wind farm needs to be controllable then it will be bound by all the terms covering **WFPS** and by the additional requirements set out for **Controllable WFPS.**
A **Controllable WFPS** (a wind farm that can automatically act upon a remote signal to adjust its **Active Power** output) is a wind farm that can comply with the EirGrid code at present; **Controllable WFPS** are equivalent to the **PDWFPS** in the existing SONI code.
For the avoidance of doubt, all references to **Wind Farm Power Station** in the EirGrid code will be changed to **Controllable WFPS** and all references to **PDWFPS** in the SONI code will be changed to **Controllable WFPS**.

If a wind farm needs to be dispatchable then it will be bound by all the terms covering **WFPS** and by the requirements for **Controllable WFPS** and by the requirements for **Dispatchable WFPS**. **Dispatchable WFPS** (a wind farm that can act upon a dispatch instruction to adjust its output) is a wind farm that can comply with the EirGrid code at present and will have to comply with the new revised EirGrid code. This category does not exist in either code at present.



2 new terms need to be defined for the new EirGrid code (remove existing WFPS definition):

Controllable WFPS: A site containing at least one **WTG** which can automatically act upon a remote signal from the **TSO** to change its **Active Power** output.

Dispatchable Wind Farm Power Station: A **Controllable WFPS** which must have a **Control Facility** in order to be dispatched via an **Electronic Interface** by the **TSO**.

2. Use of term Dispatchable in the T&SC v1.3

The term "**Dispatchable**" in the T&SC:
means, in relation to a Generator Unit, the ability of the Generator Unit to receive and act upon an instruction given by the System Operator to the Participant's approved contact person or location to change the output or manner of operation of the Generator Unit in accordance with the relevant Grid Code

The term "**Generator Unit**" in the T&SC:
means a Generator, or other item of plant capable of being Dispatched, registered by a Participant under the Code. For the purposes of the Code a Generator Unit may be any one of the following types, without limitation: Demand Side Unit, Energy Limited Generator Unit, Interconnector Unit, Interconnector Error Unit, Interconnector Residual Capacity Unit, Netting Generator Unit, Pumped Storage Unit, Run-of-River Hydro Unit or Wind Power Unit

Upon registration with the SMO, each Generator Unit shall be classified as a Predicable Generator Unit, a Variable Generator Unit or an Autonomous Generator Unit (ref: 5.3). The following excerpts for the T&SC v1.3 apply:

Autonomous Generator Unit

5.4 A Generator Unit shall be classified as an Autonomous Generator Unit and a Price Taker Generator Unit if the Unit is not Dispatchable.

Variable Generator Unit

5.5 A Generator Unit shall be classified as a Variable Generator Unit if:

1. *the short-term availability of the Generator Unit is unpredictable as a result of its fuel source; and*
2. *the Generator Unit is a Wind Power Unit or a Run-of-River Hydro Unit; and*
3. *the Generator Unit is Dispatchable.*

In the terms of the Registration of Units, the following applies:

2.38 Parties may apply for registration of Generator Units which have Priority Dispatch for their entire capacity and which are Variable or Predictable Generator Units as either:

1. *A Price Maker Generator Unit; or*
2. *A Price Taker Generator Unit.*

2.39 A Party or Applicant registering an Autonomous Generator Unit shall register such Unit as a Price Taker Generator Unit.

2.40 Parties which have registered Units that have Priority Dispatch as Variable Generator Units or Predictable Generator Units may change the status of such Unit(s) as Price Taker Generator Units or Price Maker Generator Units by application to the Market Operator, giving at least 29 days notice pursuant to Agreed Procedure 4 "Data Transaction Submission and Validation".

Priority Dispatch under the T&SC v1.3: *means priority dispatch as afforded under governing legislation in either Jurisdiction*

3. Definitions for Dispatchable in the EirGrid Code

The term '**Dispatchable**' is not used in the Grid Code v2.0. The most commonly applicable term used in the Grid Code is Centrally Dispatched Generation Units (CDGUs), which is defined as:

CDGU: A **Generation Unit** which is normally subject to the **TSO's Dispatch Instructions**

It is proposed to modify this to:
Centrally Dispatched Generating Unit (CDGU): A **Generating Unit** within a **Generating Plant** subject to **Central Dispatch**, which comprises, unless specified otherwise a **Thermal Plant** including a **CCGT Installation**, a **Dispatchable WFPS**, **Hydro Plant** and **Pumped Storage Plant** in respect of its **Pumped Storage Generation**.

4. Changes to OC7.2 to allow for EDIL for Dispatchable WFPS:

The text shown in red below is to be added to OC7 in EirGrid's Grid Code.

OC7.2.3 SCOPE

OC7.2.3.1 OC7.2 applies to the **TSO** and to **Users**, which term in OC7.2 means:

(a) **Generators**;
(b) **Dispatchable WFPSs**;
(c) **Distribution System Operator**; and
(d) **Demand Customers**.

OC7.2.4 CONTACT LOCATIONS

….

OC7.2.4.5 DISPATCHABLE WFPSs

OC7.2.4.5.1 The **Dispatchable WFPS's** contact locations and personnel referred to in this Section OC7.2.4.2 shall be notified by the **Dispatchable WFPS** to the **TSO** prior to connection and thereafter updated as appropriate.

OC7.2.4.5.2 The **Dispatchable WFPS** is required to provide a **Control Facility**. The **Dispatchable WFPS** shall ensure acting in accordance with **Good Industry Practice** that the **Control Facility** is staffed at appropriate staffing levels at all times.

OC7.2.4.5.3 The **Control Facility** shall be staffed by a **Responsible Operator(s)** who shall respond to communications from the **TSO** without undue delay (except where otherwise provided for by agreement between the **Dispatchable WFPS** and the

TSO, such agreement not to be unreasonably withheld) and are of suitable experience and training and are authorised to perform the following functions on behalf of the **Dispatchable WFPS:**

(a) to accept and execute **Dispatch Instructions** as per **SDC2**;

(b) to receive and acknowledge receipt of requests, for amongst other matters, operation outside the **Declared** values of **Availability**, **Ancillary Service** capability, or operation of the **Dispatchable WFPS** during **System Emergency Conditions**.

OC7.2.4.5.4 At any point in time, a single person shall be designated by the **Dispatchable WFPS** and notified to the **TSO** as the **Responsible Manager**. The **Responsible Manager** shall be responsible for dealing with the **TSO** on matters relating to the **Grid Code** other than as provided for in OC7.2.4.2.2 and OC7.2.4.2.3. In the event that the **Responsible Manager** is not a person on duty at the **Control Facility**, then the **Responsible Manager** must be capable of being contacted from the **Control Facility** at all times, and in the event that the **TSO** issues a request to the **Control Facility** requiring the **Responsible Manager** to contact the **NCC**, the **Responsible Manager** shall comply with the request without undue delay and in any case within 15 minutes of the request.

OC7.2.4.5.5 The **Responsible Manager** shall be authorised by the **Dispatchable WFPS** to perform the following functions on behalf of the **Dispatchable WFPS**:

(a) to make **Declarations** for the **Dispatchable WFPS**;

(c) to communicate with respect to issues regarding **Outages** of the **Dispatchable WFPS**.

The **Dispatchable WFPS** may, from time to time, notify a replacement contact location and personnel which meets the foregoing requirements.

5. Proposed Modifications to SDC1 and SDC2

The proposed modifications to the SDCs ensure that any Grid Code User, including **Dispatchable WFPSs**, that register under the Trading and Settlement Code as a Price-Maker, are required to submit the relevant data to enable the TSOs to produce the Indicative Operations Schedule and that under SDC2 the User can receive a dispatch instruction from the TSO via an electronic interface, which is currently EDIL.

Controllable WFPSs will be also bound by SDC1.

Please refer to the proposed modifications to the text of SDC1 and SDC2 for more detail.

6. Proposed changes to WFPS1

In order to update the **WFPS1** to include for the nomenclature as above in section 1, all instances of **Wind Farm Power Station** are replaced with **Controllable WFPS.** See the appendix for the all the changes – there are 116 instances of **Wind Farm Power Station** that have been changed to **Controllable WFPS.**
In order to align WFPS1.7.5 and WFPS1.7.6 with both the new rules in the Trading and Settlement Code and the proposed SDC1, it is proposed to remove the words “with a MEC in excess of 30 MW” from WFPS1.7.5 and WFPS1.7.6. (see Appendix 1 for changes)

Appendix 1 – Changes to WFPS1

WFPS1 CONTROLLABLE WIND FARM POWER STATION GRID CODE PROVISIONS

WFPS 1 CONTROLLABLE WIND FARM POWER STATION GRID CODE PROVISIONS

WFPS1.1 INTRODUCTION

All **Generator**s connecting to the **Transmission System** are required to comply with the **Grid Code**. The **Grid Code** was originally developed with synchronous generators in mind. Since **Wind Turbine Generators** (**WTG)** do not have the same characteristics as synchronous generators, it was considered appropriate to develop a new set of **Grid Code** provisions specifically for **Controllable Wind Farm Power Stations**. Controllable WFPSs. This section of the **Grid Code** gives the specific requirements for ~~Wind Farm Power Station~~Controllable WFPS**s**.

WFPS1.2 OBJECTIVE

The primary objective of WFPS1 is to establish the technical rules which ~~Wind Farm Power Station~~Controllable WFPS**s** must comply with in relation to their connection to and operation on the **Transmission System**.

WFPS1.3 SCOPE

WFPS1.3.1 WFPS1 applies to the following **Users**:

(a) The **TSO**; and

(b) **Grid Connected** ~~Wind Farm Power Station~~Controllable WFPS**s**.

WFPS1.3.2 In addition to WFPS1, ~~Wind Farm Power Station~~Controllable WFPS**s** are required to comply with the following sections of the **Grid Code**:

- GC - General Conditions
- PC - Planning Code
- PCA – Planning Code Appendix
- CC- Connection Conditions excluding:
  - *CC 7.2.5.1*
  - *CC 7.2.5.2*
  - *CC7.3.1.1(a) to (h) and (j) to (u)*
  - *CC7.3.1.2*
  - *CC7.3.5*
  - *CC7.3.6*

- *CC7.3.7*
- *CC7.3.8*
- *CC.12.2*
- *CC.12.3*

- OC1
- OC2
- OC4 excluding:
  - *OC4.3.4*
  - *OC4.4.5.3*
  - *OC4.4.5.4*
  - *OC4.4.5.5*
- OC6
- OC7 excluding
  - *OC7.2.4.2*
- OC8
- OC9
- OC10 excluding
  - *OC10.5.7*
  - *OC10.7.1*
  - *OC10.7.2*
  - *OC10.7.3*
  - *OC10.7.4*
  - *OC10.7.6*
- OC11

In the **Grid Code**, where applicable, for the purposes of ~~**Wind Farm Power Station**~~**Controllable WFPS** references to **Generation Unit** or **Generator** should be interpreted to mean ~~**Wind Farm Power Station**~~**Controllable WFPS**.

WFPS1.4 FAULT RIDE THROUGH REQUIREMENTS

WFPS1.4.1 A ~~**Wind Farm Power Station**~~**Controllable WFPS** shall remain connected to the **Transmission System** for **Transmission System Voltage** dips on any or all phases, where the **Transmission System Phase Voltage** measured at the HV terminals of the **Grid Connected Transformer** remains above the heavy black line in *Figure WFPS1.1*.

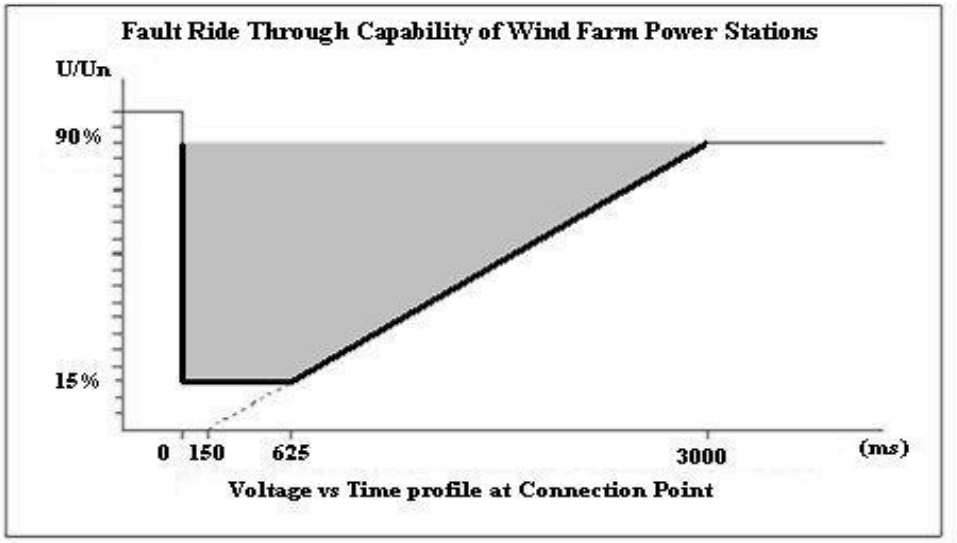


Figure WFPS1.1 - Fault Ride-Through Capability of ~~***Wind Farm Power Station***~~***Controllable WFPS*****s**

WFPS1.4.2 In addition to remaining connected to the **Transmission System**, the ~~**Wind Farm Power Station**~~**Controllable WFPS** shall have the technical capability to provide the following functions:

a) During the **Transmission System Voltage** dip the ~~**Wind Farm Power Station**~~**Controllable WFPS** shall provide **Active Power** in proportion to retained **Voltage** and maximise reactive current to the **Transmission System** without exceeding **WTG** limits. The maximisation of reactive current shall continue for at least 600 ms or until the **Transmission System Voltage** recovers to within the normal operational range of the **Transmission System** (ref. WFPS1.6.1), whichever is the sooner;

b) The ~~**Wind Farm Power Station**~~**Controllable WFPS** shall provide at least 90 % of its maximum **Available Active Power** as quickly as the technology allows and in any event within 1 second of the **Transmission**

System Voltage recovering to the normal operating range (ref. WFPS1.6.1).

WFPS1.5.1 TRANSMISSION SYSTEM FREQUENCY RANGES

~~**Wind Farm Power Station**~~**Controllable WFPS**s shall have the capability to:

a) operate continuously at normal rated output at **Transmission System Frequencies** in the range 49.5 Hz to 50.5 Hz;

b) remain connected to the **Transmission System** at **Transmission System Frequencies** within the range 47.5 Hz to 52.0 Hz for a duration of 60 minutes;

c) remain connected to the **Transmission System** at **Transmission System Frequencies** within the range 47.0 Hz to 47.5 Hz for a duration of 20 seconds required each time the **Transmission System Frequency** is below 47.5 Hz;

d) remain connected to the **Transmission System** during rate of change of **Transmission System Frequency** of values up to and including 0.5 Hz per second.

No additional **WTG** shall be started while the **Transmission System Frequency** is above 50.2 Hz.

WFPS1.5.2 ACTIVE POWER MANAGEMENT

A **Wind Farm Control System** shall be installed by the ~~**Wind Farm Power Station**~~**Controllable WFPS** to allow for the provision of **Active Power Control** and **Frequency Response** from the ~~**Wind Farm Power Station**~~**Controllable WFPS**. The **Wind Farm Control System** and **Frequency Response System** shall provide the functionality as specified in this section WFPS1.5.2.

WFPS1.5.2.1 Active Power Control

The **Wind Farm Control System** shall be capable of operating each **WTG** at a reduced level if the ~~**Wind Farm Power Station**~~**Controllable WFPS's Active Power** output has been restricted by the **TSO**. The **Wind Farm Control System** shall be capable of receiving an on-line **Active Power Control Set-point** sent by

the **TSO** and shall commence implementation of the set-point within 10 seconds of receipt of the signal from the **TSO**. The rate of change of output to achieve the **Active Power Control Set-point** should be no less than the maximum ramp rate settings of the **Wind Farm Control System**, as advised by the TSO, as per WFPS1.5.3.

WFPS1.5.2.2 Frequency Response

WFPS1.5.2.2.1 The **Frequency Response System** shall have the capabilities as displayed in the *Power-Frequency Response Curve* in *Figure WFPS1.2,* where the power and frequency ranges required for points A, B, C, D, E are defined below in *Table WFPS1.1 and Table WFPS1.2.*

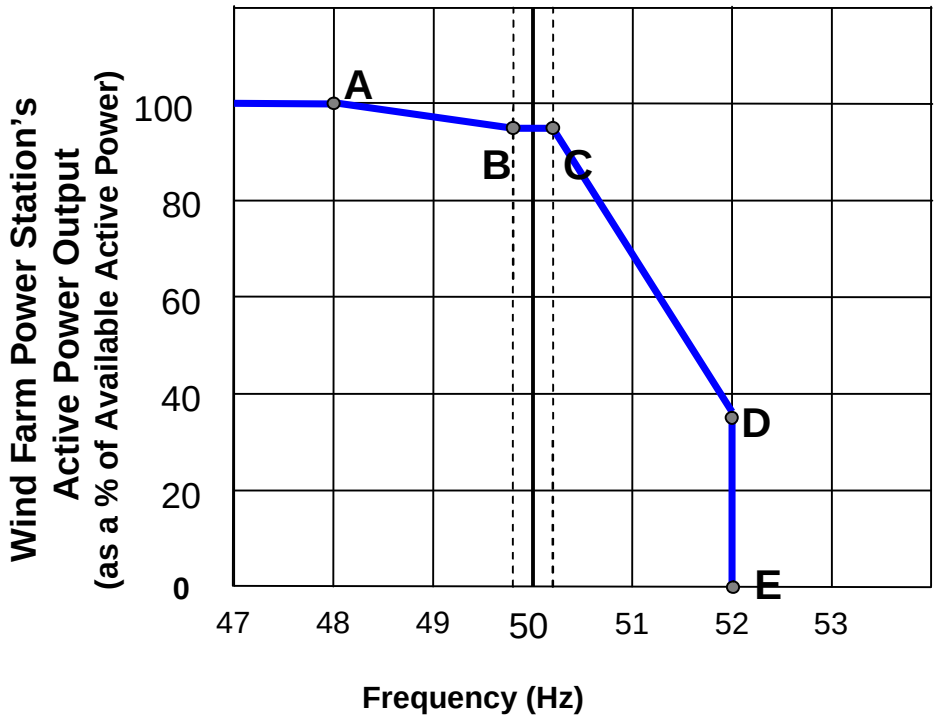


Figure WFPS1.2 – Example of Power-Frequency Response Curve.

WFPS1.5.2.2.2 Under normal **Transmission System Frequency** ranges, the ~~**Wind Farm Power Station**~~**Controllable WFPS** shall operate with an **Active Power** output as set by the line 'B' - 'C'. If the **Transmission System Frequency** falls below point 'B', then the **Frequency Response System** shall act to ramp up the ~~**Wind Farm Power Station**~~**Controllable WFPS's Active Power** output, in accordance with the **Frequency/Active Power** characteristic defined by the line 'B'-'A'.

WFPS1.5.2.2.3 Where the **Transmission System Frequency** is below the normal range and is recovering back towards the normal range, the **Frequency Response System** shall act to ramp down the ~~**Wind Farm Power Station**~~**Controllable WFPS's Active Power** output in accordance with the **Frequency/Active Power** characteristic defined by the line 'A'-'B'.

WFPS1.5.2.2.4 A **Frequency** dead-band shall be applied between the **Transmission System Frequencies** corresponding to points 'B' and 'C', where no change in the ~~**Wind Farm Power Station**~~**Controllable WFPS's Active Power** output shall be required.

WFPS1.5.2.2.5 Once the **Transmission System Frequency** rises to a level above point 'C', the **Frequency Response System** shall act to ramp down the ~~**Wind Farm Power Station**~~**Controllable WFPS's Active Power** output in accordance with the **Frequency/Active Power** characteristic defined by the line 'C'-'D'-'E'. At **Transmission System Frequencies** greater than or equal to 'D'-'E', there shall be no **Active Power** output from the ~~**Wind Farm Power Station**~~**Controllable WFPS**.

WFPS1.5.2.2.6 Points 'A', 'B', 'C', 'D' and 'E' shall depend on a combination of the **Transmission System Frequency**, **Active Power** and **Active Power Control Set-point** settings. These settings may be different for each ~~**Wind Farm Power Station**~~**Controllable WFPS** depending on system conditions and ~~**Wind Farm Power Station**~~**Controllable WFPS** location. These settings are defined in *Table WFPS1.1* below.

Point	***Transmission System Frequency*** *(Hz)*	~~***Wind Farm Power Station***~~***Controllable WFPS*** ***Active Power*** *Output (% of* ***Available Active Power****)*
A	F_A	P_A
B	F_B	Minimum of : P_B or **Active Power Control Set-point** (converted to a % of **Available Active Power**)
C	F_C	Minimum of: P_C or **Active Power Control Set-point** (converted to a % of **Available Active**

		Power)
D	F_D	Minimum of: P_D **or** **Active Power Control Set-point** (converted to a % of **Available Active Power**)
E	F_E	P_E = 0 %

Table WFPS1.1: ***Transmission System Frequency*** *and %* ***Available Active Power*** *Settings for the Points 'A', 'B', 'C', 'D' and 'E' illustrated in Figure WFPS1.2*

Two settings for each of F_A, F_B, F_C, F_D, F_E, P_A, P_B, P_C, P_D and P_E shall be specified by the **TSO** at least 120 **Business Days** prior to the ~~**Wind Farm Power Station**~~**Controllable WFPS's** scheduled **Operational Date** (refer to 1.5.2.3 below). The ~~**Wind Farm Power Station**~~**Controllable WFPS** shall be responsible for implementing the appropriate settings during **Commissioning**.

Alterations to the **Active Power Control Set-point** may be requested in real-time by the **TSO** and the implementation of the set-point shall commence within 10 seconds of receipt of the signal from the **TSO**. The rate of change of output to achieve the **Active Power Control Set-point** should be no less than the maximum ramp rate settings of the **Wind Farm Control System**, as advised by the TSO, as per WFPS1.5.3.

WFPS1.5.2.2.7 The table below, *Table WFPS1.2,* shows the **Transmission System Frequency** and **Active Power** ranges for F_A, F_B, F_C, F_D, F_E, P_A, P_B, P_C, P_D and P_E.

	Transmission System Frequency *(Hz)*		***Available Active Power*** *(%)*	
			MEC > 10 MW	***5 MW < MEC ≤ 10 MW***
F_A	*47.0-51.0*	P_A	*50-100*	*100*
F_B	*49.5-51.0*	P_B	*50-100*	*100*
F_C	*49.5-51.0*	P_C		
F_D	*50.5-52.0*	P_D	*20-100*	*20-100*
F_E		P_E	*0*	*0*

Table WFPS1.2: ***Transmission System Frequency*** *&* ***Active Power*** *ranges appropriate to Figure WFPS1.2.*

For the **Transmission System Frequency** values in *Table WFPS1.2* above, $F_A \leq F_B \leq F_C \leq F_D = F_E$.

WFPS1.5.2.2.8 Alterations to the ~~**Wind Farm Power Station**~~**Controllable WFPS's Active Power** output, triggered by **Transmission System Frequency** changes, shall be achieved by proportionately altering the **Active Power** output of all available **WTG**s as opposed to switching individual **WTG**s on or off, insofar as possible.

WFPS1.5.2.2.9 No time delay other than those necessarily inherent in the design of the **Frequency Response System** shall be introduced. The response rate of each available online **WTG** shall be a minimum of 1 % of **WTG** rated capacity per second (MW/second). The **Frequency Response System** shall continuously monitor the **Transmission System Frequency** in order to continuously determine the ~~**Wind Farm Power Station**~~**Controllable WFPS's** appropriate **Active Power** output by taking account of the ~~**Wind Farm Power Station**~~**Controllable WFPS's Available Active Power** or **Controlled Active Power**.

WFPS1.5.2.2.10 If the **Transmission System Frequency** rises to a level above 'D'-'E', as defined by the *Power-Frequency Response Curve in Figure WFPS1.2*, the **TSO** accepts that **WTG**s may disconnect. Any **WTG** which has disconnected shall be brought back on load as fast as technically feasible (provided the **Transmission System Frequency** has fallen below 50.2 Hz).

WFPS1.5.2.3 Procedure for Setting and Changing the *Power-Frequency Response Curves*

Two *Power-Frequency Response Curves* (Curve 1 and Curve 2) shall be specified by the **TSO** at least 120 **Business Days** prior to the ~~**Wind Farm Power Station**~~**Controllable WFPS's** scheduled **Operational Date.** The ~~**Wind Farm Power Station**~~**Controllable WFPS** shall be responsible for implementing the appropriate settings during **Commissioning**. The **Frequency Response System** shall be required to change between the two curves within one minute from receipt of the appropriate signal from the **TSO**. The **TSO** shall give the ~~**Wind Farm Power Station**~~**Controllable WFPS** a minimum of 2 weeks notice if changes to either of the curve's parameters ***(i.e.*** F_A, F_B, F_C, F_D, F_E, P_A, P_B, P_C, P_D or P_E***)***, are required. The ~~**Wind Farm Power Station**~~**Controllable WFPS** shall

formally confirm that any requested changes have been implemented within two weeks of receiving the **TSO's** formal request.

WFPS1.5.3 RAMP RATES

WFPS1.5.3.1 The **Wind Farm Control System** shall be capable of controlling the ramp rate of its **Active Power** output with a maximum MW per minute ramp rate set by the **TSO**. There shall be two maximum ramp rate settings. The first ramp rate setting shall apply to the MW ramp rate average over one (1) minute. The second ramp rate setting shall apply to the MW per minute ramp rate average over ten (10) minutes. These ramp rate settings shall be applicable for all ranges of operation including start up, normal operation and shut down. The **TSO** acknowledges that falling wind speed or **Frequency Response** may cause either of the maximum ramp rate settings to be exceeded.

WFPS1.5.3.2 It shall be possible to vary each of these two maximum ramp rate settings independently over a range between 1 and 30 MW per minute. The **Wind Farm Control System** shall have the capability to set the ramp rate in MW per minute averaged over both one and ten minutes.

WFPS1.5.3.3 Procedure for Setting and Changing the Ramp Rate Control

The ramp rate settings shall be specified by the **TSO** at least 120 **Business Days** prior to the ~~**Wind Farm Power Station**~~**Controllable WFPS's** scheduled **Operational Date.** The ~~**Wind Farm Power Station**~~**Controllable WFPS** shall be responsible for implementing the appropriate settings during **Commissioning.** The ramp rate settings may need to be changed from time to time depending on system needs. The **TSO** shall give the ~~**Wind Farm Power Station**~~**Controllable WFPS** a minimum of two weeks notice if a change is required. The ~~**Wind Farm Power Station**~~**Controllable WFPS** shall formally confirm that any requested changes have been implemented within two weeks of receiving the **TSO's** formal request.

WFPS1.6 TRANSMISSION SYSTEM VOLTAGE REQUIREMENTS

WFPS1.6.1 TRANSMISSION SYSTEM VOLTAGE RANGE

~~**Wind Farm Power Station**~~**Controllable WFPS****s** shall remain continuously connected to the **Transmission System** at maximum **Available Active Power** or **Controlled Active Power** output for normal and disturbed system conditions and for step changes in **Transmission System Voltage** of up to 10 %. The following are the ranges which may arise during **Transmission System** disturbances or following transmission faults:

(a) 400 kV system: 350 kV to 420 kV;
(b) 220 kV system: 200 kV to 245 kV;
(c) 110 kV system: 99 kV to 123 kV.

WFPS1.6.2 AUTOMATIC VOLTAGE REGULATION

WFPS1.6.2.1 ~~**Wind Farm Power Station**~~**Controllable WFPS****s** shall have a continuously-variable and continuously-acting **Voltage Regulation System** with similar response characteristics to a conventional **Automatic Voltage Regulator** and shall perform generally as described in BS4999 part 140, or equivalent European Standards.

WFPS1.6.2.2 The **Voltage Regulation System** shall be capable of receiving a **Voltage Regulation Set-point** for the **Voltage** at the **Connection Point**. The **Voltage Regulation System** shall act to regulate the **Voltage** at this point by continuous modulation of the ~~**Wind Farm Power Station**~~**Controllable WFPS****'s Reactive Power** output, within its **Reactive Power** range and without violating the **Voltage Step Emissions** limits as set out in the IEC standard 61000-3-7:1996 *Assessment of Emission limits for fluctuating loads in MV and HV power systems*. A change to the **Voltage Regulation Set-point** shall be implemented by the ~~**Wind Farm Power Station**~~**Controllable WFPS** within 20 seconds of receipt of the appropriate signal from the **TSO**.

WFPS1.6.2.3 The slope setting of the **Voltage Regulation System** shall be capable of being set to any value between 1 % and 10 %. The setting shall be specified by the **TSO** at least 120 **Business Days** prior to the ~~**Wind Farm Power Station**~~**Controllable WFPS****'s** scheduled **Operational Date.** The ~~**Wind Farm**~~

~~Power Station~~Controllable WFPS shall be responsible for implementing the appropriate settings during **Commissioning**. The slope setting may be varied from time to time depending on **Transmission System** needs. The **TSO** shall give the ~~Wind Farm Power Station~~Controllable WFPS a minimum of two weeks notice if a change is required. The ~~Wind Farm Power Station~~Controllable WFPS shall formally confirm that any requested changes have been implemented within two weeks of receiving the **TSO's** formal request.

WFPS1.6.2.4 The speed of response of the **Voltage Regulation System** shall be such that, following a step change in **Voltage** at the **Connection Point** the ~~Wind Farm Power Station~~Controllable WFPS shall achieve 90 % of its steady-state **Reactive Power** response within 1 second.

WFPS1.6.2.5 *Figure WFPS1.3* shows the relevant points appropriate to the **Voltage Regulation System** for a ~~Wind Farm Power Station~~Controllable WFPS. *X* is the HV side of the **WTG** transformer, *Y* is the lower voltage side of the **Grid Connected Transformer** and *Z* is the **Connection Point**.

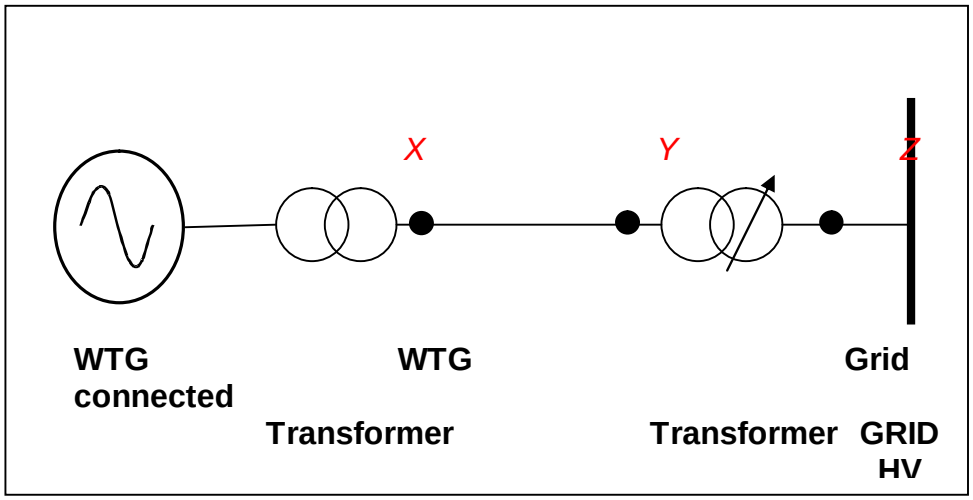


*Figure WFPS1.3 - Locations for **Voltage Regulation** set-point (Z) and the **Power Factor** range (Y). The HV side of the **WTG** transformer is (X).*

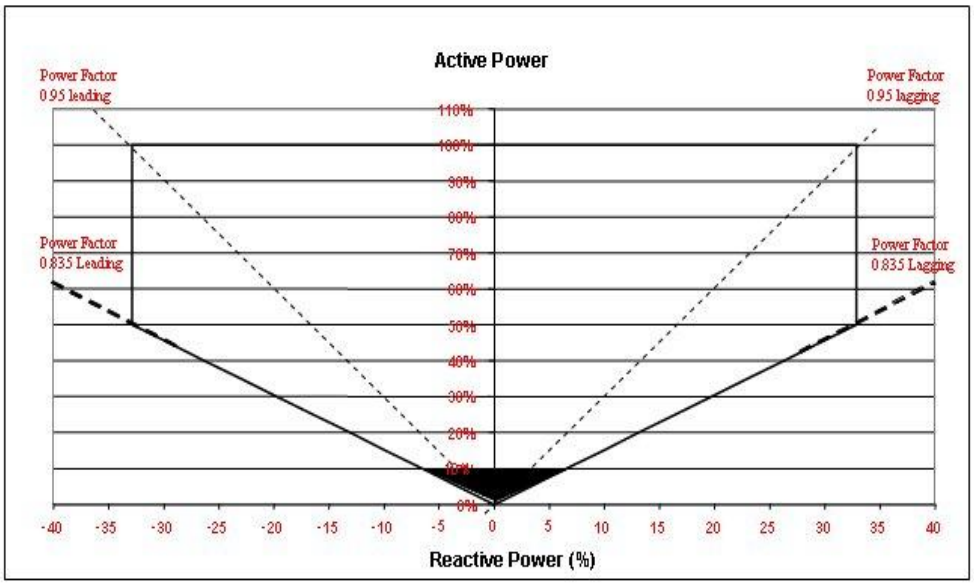
WFPS1.6.3 REACTIVE POWER CAPABILITY

WFPS1.6.3.1 ~~**Wind Farm Power Station**~~**Controllable WFPSs** shall be capable of operating at any point within the **Power Factor** ranges illustrated in *Figure WFPS1.4,* as measured at the lower voltage side of the **Grid Connected Transformer** (point *Y* in *Figure WFPS1.3*).

The design reference voltage for the **Reactive Power** capability shall be the nominal voltage at point Y.

The **Grid Connected Transformer** tap changing range must be capable of ensuring nominal voltage at point Y for any **Voltage** at the **Connection Point** (Point Z) within the ranges specified in WFPS1.6.1.

WFPS1.6.3.2 For ~~**Wind Farm Power Station**~~**Controllable WFPSs** where the **Connection Point** is remote from the **Grid Connected Transformer**, any supplementary **Reactive Power** compensation required to offset the **Reactive Power** demand of the HV line, or cable, between the **Connection Point** and the ~~**Wind Farm Power Station**~~**Controllable WFPS** shall be identified during the **TSO's Connection Offer** process.



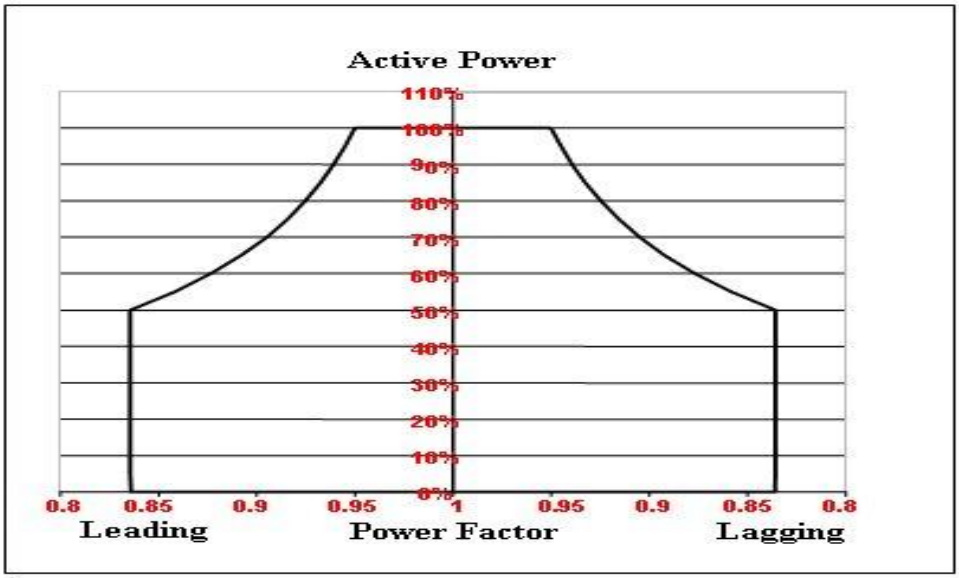


Figure WFPS1.4 - **Reactive Power** Capability of ~~**Wind Farm Power Station**~~**Controllable WFPS**

WFPS1.6.3.3 For operation below 10 % of the ~~**Wind Farm Power Station**~~**Controllable WFPS's MEC**, the ~~**Wind Farm Power Station**~~**Controllable WFPS** shall operate within the shaded triangle in *Figure WFPS1.4*. However, if this cannot be achieved, then the total charging of the ~~**Wind Farm Power Station**~~**Controllable WFPS** network during low load operation (below 10 %) shall be examined during the **TSO's Connection Offer** process. If during this examination it is identified that this charging may cause the voltage on the **Transmission System** to be outside the **Transmission System Voltage** ranges, as specified in WFPS1.6.1, then the **Reactive Power** requirements will need to be altered.

WFPS1.6.4 VOLTAGE STEP EMISSIONS

IEC 61000-3-7:1996 *Assessment of Emission limits for fluctuating loads in MV and HV power systems,* gives a table of the emission limits for **Voltage** changes as a function of the number of changes, R, per hour. This standard shall also apply to ~~**Wind Farm Power Station**~~**Controllable WFPSs**.

WFPS1.6.5 ~~WIND FARM POWER STATION~~CONTROLLABLE WFPS'S GRID CONNECTED TRANSFORMER

WFPS1.6.5.1 All relevant references in the **Grid Code** to **Generator Transformers** shall be interpreted to mean the ~~**Wind Farm Power Station**~~**Controllable WFPS's Grid**

Connected Transformer rather than the individual **WTG** transformers. For ~~**Wind Farm Power Station**~~**Controllable WFPS**s where the **Connection Point** is remote from the ~~**Wind Farm Power Station**~~**Controllable WFPS**, **Grid Connected Transformer** shall be interpreted to mean the HV transformer located at the ~~**Wind Farm Power Station**~~**Controllable WFPS**.

WFPS1.6.5.2 ~~**Wind Farm Power Station**~~**Controllable WFPS**s shall provide on-load tap-changing (OLTC) facilities for all **Grid Connected Transformers**. All ~~**Wind Farm Power Station**~~**Controllable WFPS**s shall liaise with the **TSO** on the design specification for the performance of the tap-changing facility of the **Grid Connected Transformer**.

WFPS1.6.5.3 The ~~**Wind Farm Power Station**~~**Controllable WFPS**'s **Grid Connected Transformers** may be connected either:

(a) in delta on the lower voltage side and in star (with the star point or neutral brought out) on the HV side; or
(b) in star on both HV and lower voltage sides with a delta tertiary winding provided.

WFPS1.7 SIGNALS, COMMUNICATIONS & CONTROL

WFPS1.7.1 SIGNALS FROM THE ~~WIND FARM POWER STATION~~CONTROLLABLE WFPS TO THE TSO

Signals from ~~Wind Farm Power Station~~Controllable WFPS**s** to the **TSO** shall be broken up into a number of logical groups. There shall be different requirements for ~~Wind Farm Power Station~~Controllable WFPS**s** depending on the ~~Wind Farm Power Station~~Controllable WFPS**'s MEC**. The following groups shall apply:

- ***Signals List #1*** - applies to **all** ~~Wind Farm Power Station~~Controllable WFPS**s**;

In addition, ~~Wind Farm Power Station~~Controllable WFPS**s** shall be required to provide signals from *Signals Lists 2, 3, 4 and/or 5*. These lists relate to:

- ***Signals List #2*** - Meteorological Data;
- ***Signals List #3* - Availability** Data;
- ***Signals List #4*** - **Active Power Control** Data;
- ***Signals List #5*** - **Frequency Response System** Data.

WFPS1.7.1.1 *Signals List #1*

The ~~Wind Farm Power Station~~Controllable WFPS shall make the following signals available at the designated **TSO Telecommunication Interface Cabinet** for that ~~Wind Farm Power Station~~Controllable WFPS:

a) **Active Power** output (MW) at the lower voltage side of the **Grid Connected Transformer**;
b) **Reactive Power** output/demand (+/-Mvar) at the lower voltage side of the **Grid Connected Transformer**;
c) Voltage (in kV) at the lower voltage side of the **Grid Connected Transformer**;
d) **Available Active Power** (MW) at the lower voltage side of the **Grid Connected Transformer**;
e) **Grid Connected Transformer** tap positions
f) **Voltage Regulation Set-point** (in kV);

g) On/off status indications for all **Reactive Power** devices exceeding 5 Mvar[2];

h) Circuit-breaker and disconnect position indication shall be required. These may include indications from MV circuit-breakers on individual **WTG** circuits. Signals from individual **WTG** circuit-breakers shall not be required. The actual circuit-breaker and disconnect signals required shall be specified by the **TSO** at least 120 **Business Days** prior to the ~~**Wind Farm Power Station**~~**Controllable WFPS's** scheduled **Operational Date**;

i) A minimum of four sets of normally open potential free auxiliary contacts in each **Grid Connected Transformer** lower voltage bay for fault indications.

j) On/off status of **TSO** remote control enable switch, which disables the ability of the **TSO** to send commands to the ~~**Wind Farm Power Station**~~**Controllable WFPS**.

For the ~~**Wind Farm Power Station**~~**Controllable WFPS's** where the Connection Point is at the HV side of the **Grid Connected Transformer**, signals a), b) and c) above will also be required from the HV side of the **Grid Connected Transformer**

WFPS1.7.1.2 ***Signals List #2***

WFPS1.7.1.2.1 ~~**Wind Farm Power Station**~~**Controllable WFPS**s with a **MEC** in excess of 10 MW shall make the following meteorological data signals available at the designated **TSO Telecommunication Interface Cabinet** for that ~~**Wind Farm Power Station**~~**Controllable WFPS**:

		[Units, Range]
a)	Wind speed (at hub height) - measurand signal;	[m/s, 0-70]
b)	Wind direction (at hub height) - measurand signal;	[deg, 0-360]
c)	Air temperature- measurand signal;	[deg C, -40-70]
d)	Air pressure- measurand signal.	[mBar, 735-1060]

WFPS1.7.1.2.2 The meteorological data signals shall be provided by a dedicated **Meteorological Mast** located at the ~~**Wind Farm Power Station**~~**Controllable WFPS** site or, where possible and preferable to do so, data from a means of the same or better accuracy. For ~~**Wind Farm Power Station**~~**Controllable WFPSs** where the **WTG** are widely dispersed over a large geographical area and rather different weather

[2] Typically the position indication from capacitor/ SVC circuit breakers

patterns are expected for different sections of the ~~**Wind Farm Power Station**~~**Controllable WFPS**, the meteorological data shall be provided from a number of individual **Meteorological Masts**, or where possible and preferable to do so, data from a source of the same or better reliability for groups of **WTG** (e.g. 1 set of meteorological data for each group of XX **WTG** within the ~~**Wind Farm Power Station**~~**Controllable WFPS**). It is expected that **WTG** within an individual group shall demonstrate a high degree of correlation in **Active Power** output at any given time. The actual signals required shall be specified by the **TSO** at least 120 **Business Days** prior to the ~~**Wind Farm Power Station**~~**Controllable WFPS's** scheduled **Operational Date.**

WFPS1.7.1.3 ***Signals List #3***

WFPS1.7.1.3.1 ~~**Wind Farm Power Station**~~**Controllable WFPS**s with a **MEC** in excess of 10 MW shall make the following signals available at the designated **TSO Telecommunication Interface Cabinet** for that ~~**Wind Farm Power Station**~~**Controllable WFPS**:

a) ~~**Wind Farm Power Station**~~**Controllable WFPS** **Availability** (0-100 % signal);

b) Percentage of **WTG** shutdown due to high wind-speed conditions (0-100 %);

c) Percentage of **WTG** not generating due low wind-speed shutdown (0-100 %).

WFPS1.7.1.3.2 For ~~**Wind Farm Power Station**~~**Controllable WFPS**s with a **MEC** in excess of 10 MW, where the **WTG** are widely dispersed over a large geographical area and rather different weather patterns are expected for different sections of the ~~**Wind Farm Power Station**~~**Controllable WFPS**, the above data set (ref. WFPS1.7.1.3.1) shall be provided for a number of groups of **WTG** (e.g. 1 signal for each group of XX **WTG** within the ~~**Wind Farm Power Station**~~**Controllable WFPS**). It is expected that **WTG** within an individual group shall demonstrate a high degree of correlation in **Active Power** output at any given time. The actual signals required shall be specified by the **TSO** at least 120 **Business Days** prior to the ~~**Wind Farm Power Station**~~**Controllable WFPS's** scheduled **Operational Date.**

WFPS1.7.1.4 ***Signals List #4***

The ~~Wind Farm Power Station~~Controllable WFPS shall make the following signals available at the designated **TSO Telecommunication Interface Cabinet** for that ~~Wind Farm Power Station~~Controllable WFPS:

a) ~~Wind Farm Power Station~~Controllable WFPS **Active Power Control Set-point** value (MW);

b) ~~Wind Farm Power Station~~Controllable WFPS **Active Power Control** status indication (ON/OFF).

WFPS1.7.1.5 ***Signals List #5***

The ~~Wind Farm Power Station~~Controllable WFPS shall make the following signals available at the designated **TSO Telecommunication Interface Cabinet** for that ~~Wind Farm Power Station~~Controllable WFPS:

a) **Frequency Response System** mode signal (i.e. *Power-Frequency Response Curve 1 or 2*);

b) **Frequency Response System** status indication (ON/OFF).

WFPS1.7.1.6 Time Delays and Data Quality

WFPS1.7.1.6.1 Digital signal changes from the ~~Wind Farm Power Station~~Controllable WFPS shall be relayed to the **TSO Telecommunication Interface Cabinet** within 1 second of the associated change of state event. Analogue signal changes shall be relayed within 5 seconds and with an error of 0.5% or less, with the exception of the Meteorological Data required as per **WFPS1.7.1.2.1**, which shall be updated within 5 seconds and with an error of 2.5% or less.

WFPS1.7.2 CONTROL SIGNALS FROM THE TSO TO ~~WIND FARM POWER STATION~~CONTROLLABLE WFPS~~S~~

WFPS1.7.2.1 The control signals described in WFPS1.7.2 shall be sent from the **TSO** to the ~~Wind Farm Power Station~~Controllable WFPS. The ~~Wind Farm Power Station~~Controllable WFPS shall be capable of receiving these signals and acting accordingly.

WFPS1.7.2.2 **Active Power Control**

An **Active Power Control Set-point** signal shall be sent by the **TSO** to the **Wind Farm Control System**. This set-point shall define the maximum **Active Power** output permitted from the ~~Wind Farm Power Station~~Controllable WFPS. The **Wind Farm Control System** shall be capable of receiving this signal and acting

accordingly to achieve the desired change in **Active Power** output. This signal shall be in the form of a single analogue value and a strobe pulse to enable.

The ~~**Wind Farm Power Station**~~**Controllable WFPS** is required to make it possible for the **TSO** to remotely enable/ disable the **Active Power Control** function in the **Wind Farm Control System**. The associated status indication is described in WFPS1.7.1.4.

WFPS1.7.2.3 **Frequency Response**

This signal shall be sent by the **TSO** to the ~~**Wind Farm Power Station**~~**Controllable WFPS** in the event that a change from *Power-Frequency Response Curve 1* to *Power Frequency Response Curve 2*, or vice versa, is required.

The ~~**Wind Farm Power Station**~~**Controllable WFPS** is required to make it possible for the **TSO** to remotely enable/ disable the **Frequency Response System**. The associated status indication is described in WFPS1.7.1.5.

WFPS1.7.2.4 **Voltage Regulation**

This signal shall allow the **TSO** to send a **Voltage Regulation Set-point** for **Voltage Regulation** purposes. This signal shall be in the form of a single analogue value and a strobe pulse to enable.

WFPS1.7.2.5 **Black Start Shutdown**

Means shall be provided by the ~~**Wind Farm Power Station**~~**Controllable WFPS** to facilitate the disconnection of the ~~**Wind Farm Power Station**~~**Controllable WFPS** by the **TSO** and to also prevent re-connection in the event of **Black Start**. The **TSO** shall send a **Black Start Shutdown** signal and upon receipt, the ~~**Wind Farm Power Station**~~**Controllable WFPS** shall be required to trip the circuit-breaker(s) at the ~~**Wind Farm Power Station**~~**Controllable WFPS's Connection Point** and shutdown the ~~**Wind Farm Power Station**~~**Controllable WFPS** in a controlled manner. The precise circuit-breakers for which this facility shall be provided shall be specified by the **TSO** at least 120 **Business Days** prior to the ~~**Wind Farm Power Station**~~**Controllable WFPS's** scheduled **Operational Date.** ~~**Wind Farm Power Station**~~**Controllable WFPSs** may only be reconnected (i.e. made live) when the **Network** is fully restored following instruction from the **TSO**[3] and only earlier if the **TSO** deems it acceptable to do so.

[3] Typically this instruction will be in the form of a Blackstart Shutdown OFF command

WFPS1.7.2.6 Time Delays and Data Quality

WFPS1.7.2.6.1 Digital output commands from the **TSO Telecommunication Interface Cabinet** shall be relayed to the ~~**Wind Farm Power Station**~~**Controllable WFPS** equipment within 1 second. Set-point output signals shall be relayed within 5 seconds and with an error of 0.5% or less.

WFPS1.7.3 RESPONSIBLE OPERATOR

A designated **Responsible Operator** shall be contactable by the **TSO** at all times to discuss operational matters without undue delay and in any case within 15 minutes. Following a request from the **TSO**, the **Responsible Operator** shall be present at the ~~**Wind Farm Power Station**~~**Controllable WFPS's Connection Point** without undue delay and in any case within one hour and shall be capable of taking any required appropriate actions. The **Responsible Operator** shall be contactable 24 hours a day, 365 days a year.

WFPS1.7.4 DATA AND COMMUNICATIONS SPECIFICATIONS

WFPS1.7.4.1 The location of the **TSO Telecommunication Interface Cabinet** shall be agreed between the **TSO** and the ~~**Wind Farm Power Station**~~**Controllable WFPS** at least 120 **Business Days** prior to the ~~**Wind Farm Power Station**~~**Controllable WFPS's** scheduled **Operational Date**. A standard interface for signals will be made available to the ~~**Wind Farm Power Station**~~**Controllable WFPS** by the **TSO**,

WFPS1.7.4.2 The necessary communications links, communications protocol and an individual ~~**Wind Farm Power Station**~~**Controllable WFPS** signal list shall be specified by the **TSO** at least 120 **Business Days** prior to the ~~**Wind Farm Power Station**~~**Controllable WFPS's** scheduled **Operational Date.** Current applicable standards shall apply and the accuracy class for signals shall comply with the prevailing European Standard at that time.

WFPS1.7.4.3 For loss of communications links, persistence (i.e. continuing to operate with the most recent data set) shall be used in terms of set-points until the designated **Responsible Operator** has been contacted by the **TSO**.

WFPS1.7.4.4 If **Active Power Control**, **Frequency Response** or **Voltage Regulation** facilities for the ~~**Wind Farm Power Station**~~**Controllable WFPS** become unavailable, the ~~**Wind Farm Power Station**~~**Controllable WFPS** shall contact the **TSO** without undue delay.

WFPS1.7.4.5 Where signals or indications required to be provided by the ~~**Wind Farm Power Station**~~**Controllable WFPS** under WFPS1.7.1 and WFPS 1.7.2 become unavailable or do not comply with applicable standards due to failure of the ~~**Wind Farm Power Station**~~**Controllable WFPS****'** technical equipment or any other reason under the control of the ~~**Wind Farm Power Station**~~**Controllable WFPS**, the ~~**Wind Farm Power Station**~~**Controllable WFPS** shall, acting in accordance with **Good Industry Practice**, restore or correct the signals and/or indications as soon as possible.

WFPS1.7.5 WIND POWER FORECASTS

Wind power forecasts shall be provided by ~~**Wind Farm Power Station**~~**Controllable WFPS****s** ~~with a **MEC** in excess of 30 MW~~. These forecasts shall be provided at 10:00 a.m. on a daily basis for the following 48 hours for each 30 minute time-period by means of an electronic interface in accordance with the reasonable requirements of the **TSO's** data system.

WFPS1.7.6 CONTROLLABLE WFPS MW AVAILABILITY DECLARATIONS

Controllable WFPSs ~~with a **MEC** in excess of 30 MW~~ shall submit **Controllable WFPS MW Availability Declarations** whenever changes in **Controllable WFPSs' Availability** occur or are predicted to occur. These declarations shall be submitted by means of an electronic interface in accordance with the reasonable requirements of the **TSO**'s data system.