DISTRIBUTION CODE MODIFICATION PROPOSAL FORM

Modification Proposal submitted By:	**DATE OF SUBMISSION OF PROPOSAL:**	**Modification Proposal Number:** *(to be assigned by Review Panel Secretary)*
Tony Hearne	9th April 2013	#23

CONTACT DETAILS FOR MODIFICATION PROPOSAL ORIGINATOR: (IF NOT DISTRIBUTION CODE REVIEW PANEL

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MODIFICATION PROPOSAL TITLE:	DS3 Reactive Power and voltage control

DISTRIBUTION CODE SECTION(S) AFFECTED BY PROPOSAL

1. Table 5
2. DCC11.4
3. DCC11..5

MODIFICATION PROPOSAL DESCRIPTION *(Clearly state the desired amendment and all text changes. Attach further information if necessary)*

1. Update Table 5: Change from "Voltage Regulation" to Voltage Control". Update references to DCC11.4 AND DCC11.5.2.6, as depicted in Appendix 1
2. Replace the current content of DCC11.4 with the material shown in Appendix 2
3. Create new Section DCC11.5.2.6 with the material shown in Appendix 3
4. Insert new definitions per Appendix 4

MODIFICATION PROPOSAL JUSTIFICATION *(Clearly state the reason for the modification. Attach further information if necessary)*

These modifications have already been made to the Grid Code and it is desirable that the same functionality be made available to distribution connected windfarms

IMPLICATIONS OF NOT IMPLEMENTING THIS MODIFICATION

Without improved reactive capabilities of WFPS and use of voltage control, there will be implications around system stability for higher penetrations of wind. Conventional generation will be displaced by wind generation leading to a reduction in reactive capability on the system. Without a revised specification for Controllable WFPS to provide reactive power there will likely be increased curtailment of WFPS.

Localised voltage stability issues may also result on weaker areas of the system where large wind generation exists.

PLEASE SUBMIT MODIFICATION PROPOSALS TO THE PANEL SECRETARY BY E-MAIL TO: DISTCODEPANEL@MAIL.ESB.IE

Appendix 1: Table 5 update

Table 5: Applicability Matrix

	Section	TYPE A	TYPE B	TYPE C	TYPE D	TYPE E
Fault Ride-Through	DCC 11.2	All	≥ 5 MW	≥ 5 MW	≥ 5 MW	≥ 5 MW
FREQUENCY						
Tolerance over Frequency Range	DCC11.3.1	All	All	All	All	All
Participation in High Frequency Control	DCC11.3.2.3	All	≥5 MW	≥5 MW	≥5 MW	≥5 MW
Participation in Low Frequency Control	DCC11.3.2.3	All	≥5 MW	≥5 MW	≥5 MW	≥5 MW
Adherence to Maximum Ramp Rates	DCC11.3.4	All	≥5 MW	≥5 MW	≥5 MW	≥5 MW
Active-Power Control Participation	DCC11.3.2.2	All	≥5 MW	≥5 MW	≥5 MW	≥5 MW
VOLTAGE						
Voltage Control	DCC11.4 DCC11.5.2.6	All	≥5 MW	N/A	N/A	N/A
Voltage Range	DCC11.4.4	All	N/A	N/A	N/A	N/A
Power Factor	DCC11.4.3	N/A	< 5MW	All	All	All
Reactive Power Range	DCC11.4.5	All	≥5 MW	N/A	N/A	N/A
SIGNALS/COMMUNICATIONS/CONTROL						
Signal List 1	DCC11.5.1.1	All	≥5 MW	≥5 MW	N/A	N/A
Signal List 2	DCC11.5.1.2	N/A	N/A	N/A	≥5 MW	≥5 MW
Signal List 3: Availability	DCC11.5.1.3	All	≥5 MW	≥5 MW	≥5 MW	≥5 MW
Signal List 4: Active-Power Control	DCC11.5.1.4	All	≥5 MW	≥5 MW	≥5 MW	≥5 MW
Signal List 5: Frequency Control	DCC11.5.1.5	All	≥5 MW	≥5 MW	≥5 MW	≥5 MW
Signal List 6: Meteorological Data	DCC11.5.1.6	All	≥10 MW	≥10 MW	≥10 MW	≥10 MW
Signal List 7: DSO SCADA Signals	DCC11.5.1.7	N/A	≥2 MW <5 MW[1]	≥2 MW <5 MW[2]	≥2 MW <5 MW[2]	≥2 MW <5 MW[2]
Ability to Accept Control Signal-Active-Power Control	DCC11.5.2.1	All	≥5 MW	≥5 MW	≥5 MW	≥5 MW
Ability to Accept Control Signal-Frequency Control Curve Mode Change	DCC11.5.2.2	All	≥5 MW	≥5 MW	≥5 MW	≥5 MW
Ability to Accept Control Signal-Voltage Control	DCC11.4.1 DCC11.4.2	All	≥5 MW	N/A	N/A	N/A
Installation of recloser at the Windfarm Power Station site for network protection	DCC11.5.2.8	N/A	All medium voltage connections			
Ability to receive Network Operator Initiated Shutdown command from DSO via RTU[2] **or** **ability to be remotely disconnected by DSO via device located at or near Wind Farm Power Station[3]**	DCC11.5.2.4	N/A	Medium voltage connections ≥ 2MW and <5MW			

[1] In certain circumstances, depending on future changes to the network connection, topology, the amount of embedded generation on the particular network and system reasons, generators with an MEC <2MVA may be required to provide telecommunication infrastructure for SCADA.

[2] As advised by DSO

[3] For medium voltage connections ≥ 2MW and <5MW, provided that adequate media coverage exists, remote operation of the recloser deployed to satisfy DCC10.5.2.8 may also be used to implement the requirements of DCC10.5.2.4 and DCC10.5.1.7.

	Section	TYPE A	TYPE B	TYPE C	TYPE D	TYPE E
Ability to receive Nework Operator initiated Shutdown command from DSO via DSO RTU	DCC11.5.2.4	N/A	38kV connections ≥ 2MW and <5MW			
Ability to receive Network Operator Initiated Shutdown command from DSO or TSO via TSO RTU	DCC11.5.2.4	All	≥5 MW			
Responsible Operator	DCC11.5.2.6.1	N/A	All	All	All	All
Responsible Operator	DCC11.5.2.6.2	All	N/A	N/A	N/A	N/A
Declarations	DCC11.5.4	≥30 MW	≥30 MW	≥30 MW	≥30 MW	≥30 MW
Wind Power Forecasts	DCC11.5.3	≥30 MW	≥30 MW	≥30 MW	≥30 MW	≥30 MW

Appendix 2: Distribution Code body content: DCC11.4

DCC11.4 VOLTAGE CONTROL REQUIREMENTS

DCC11.4.1 For DSO Type A Controllable WFPSs irrespective of Registered Capacity and DSO Type B Controllable WFPSs with Registered Capacity ≥5MW, under steady state conditions, the Voltage Regulation System shall be capable of implementing the following Reactive Power control modes, as specified in DCC11.5.2.6, which shall be available to the DSO or TSO as agreed between DSO and TSO

DCC11.4.1.1 Wind Farm Power Stations 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.

DCC11.4.1.2 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 DSO at least 120 business days prior to the Wind Farm Power Station's scheduled Operational Date. The Wind Farm Power Station shall be responsible for implementing the appropriate settings during Commissioning. The slope setting may be varied from time to time depending on System needs. The DSO shall give the Wind Farm Power Station a minimum of two weeks notice if a change is required. The Wind Farm Power Station shall formally confirm that any requested changes have been implemented within two weeks of receiving the DSO's formal request.

DCC11.4.1.3 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 shall achieve 90 % of its steady-state Reactive Power response within 1 second

DCC11.4.2 Additional requirements for Type A Controllable WFPS's

DCC11.4.2.1 DSO Type A Controllable WFPSs irrespective of Registered Capacity shall remain continuously connected at maximum Available Active Power or Controlled Active-Power output for normal and disturbed system conditions and for step changes in voltage of up to 10%. The ranges that may arise during disturbances or following faults are given in Table 5A:

DCC11.4.3 POWER FACTOR

Wind Farm Power Stations, with connection types B with a Registered Capacity of <5MW and connection types C, D or E, shall keep power factor between 0.92 and 0.95, as measured at the connection point, such that VARs are absorbed by the Wind Farm Power Stations from the Distribution System. This power factor range is illustrated in Figure 12a.

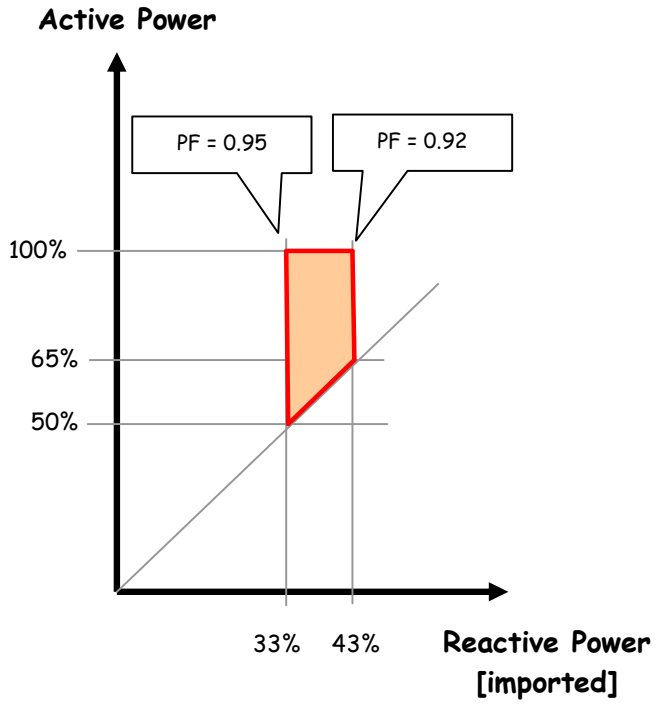


Figure 12a

DCC11.4.4 TYPE A WIND FARM POWER STATION'S 110KV STEP-UP TRANSFORMER

DCC11.4.4.1 The 110kV step-up Transformer shall be designed such that the reactive power capability is possible over the full range of 110kV voltage specified in Table 5A

DCC11.4.4.2 Each 110kV step-up Transformer shall have on-load tap changing facilities. The tap step shall not alter the voltage ratio at the HV terminals by more than 2.5% or as agreed with the DSO.

DCC11.4.4.3 110kV step-up Transformers shall be connected either:

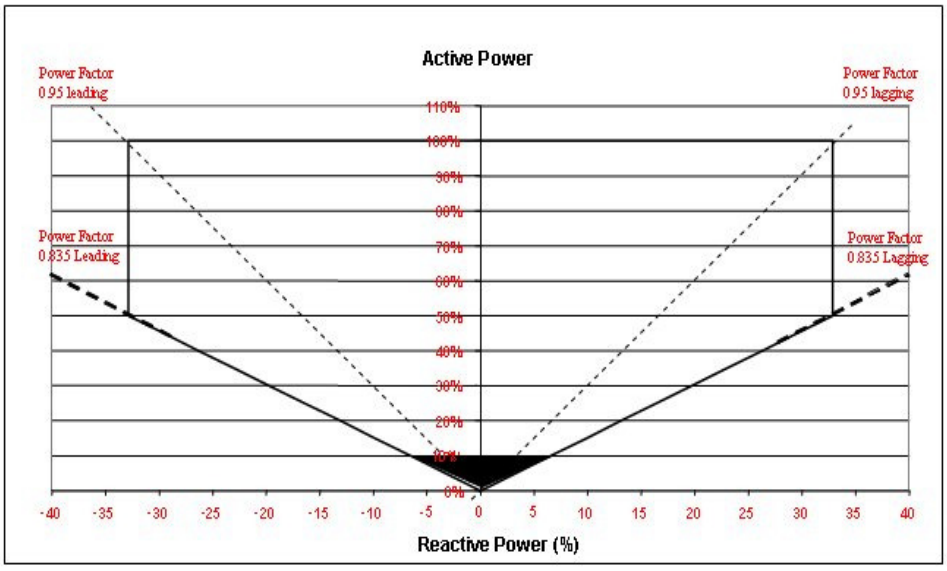
- In delta on the lower voltage side and in star (with the star point or neutral brought out) on the higher voltage side; or
- In star on both higher and lower voltage sides with a delta tertiary winding provided.

DCC11.4.4.4 Provision should be made for the earthing of the 110kV neutral of any transformer connected to the 110kV system by bringing out the neutral and ensuring that the insulation is such that the transformer can be operated unearthed.

DCC11.4.5 REACTIVE POWER CAPABILITY

DCC11.4.5.1 Wind Farm Power Stations, Type A connected, shall be capable of operating at any point within the Power Factor ranges illustrated below in Figure 13 as measured at the lower voltage side of the 110kV step-up Transformer (point Y in Figure 12), for any Voltage at the Connection Point within the range specified above.

DCC11.4.5.2 Wind Farm Power Stations, Type B with Registered Capacity ≥5MW, shall be capable of operating at any point within the Power Factor ranges illustrated in Figure 13. The capability must be implemented at the Connection Point



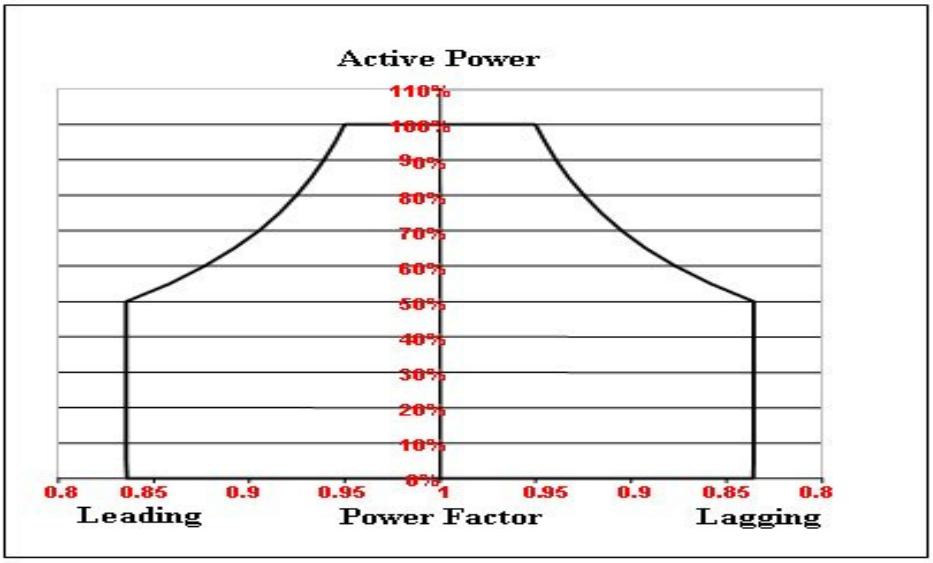


Figure 13 - Reactive Power Capability of Wind Farm Power Station

DSO Type A Controllable WFPSs and DSO Type B Controllable WFPSs with Registered Capacity ≥5MW, operating in **Power Factor** control mode, Voltage Control Mode or Constant Reactive Power mode shall be at least capable of operating at any point within the P-Q capability ranges illustrated in *Figure 13,* as measured at the **Connection Point** and shall be capable of providing this capability over the full range of voltages specified in Table 5A.

Referring to *Figure 13:*

Point A represents the minimum Mvar absorption capability of the **Controllable WFPS** at 100% **Registered Capacity** and is equivalent to 0.95 power factor with the **WFPS** importing VArs;

Point B represents the minimum Mvar production capability of the **Controllable WFPS** at 100% **Registered Capacity** and is equivalent to 0.95 power factor with the **WFPS** exporting VArs;

;

Point C represents the minimum Mvar absorption capability of the **Controllable WFPS** at 12% **Registered Capacity** and is equivalent to the same **Mvar** as Point A;

Point D represents the minimum Mvar production capability of the **Controllable WFPS** at 12% **Registered Capacity** and is equivalent to the same **Mvar** as Point B;

Point E represents the minimum Mvar absorption capability of the **Controllable WFPS** at the cut-in speed of the individual **WTGs**;

Point F represents the minimum Mvar production capability of the **Controllable WFPS** at the cut-in speed of the individual **WTGs**;

It is accepted that the values of Points E and F may vary depending on the number of **WTGs** generating electricity in a low-wind scenario;

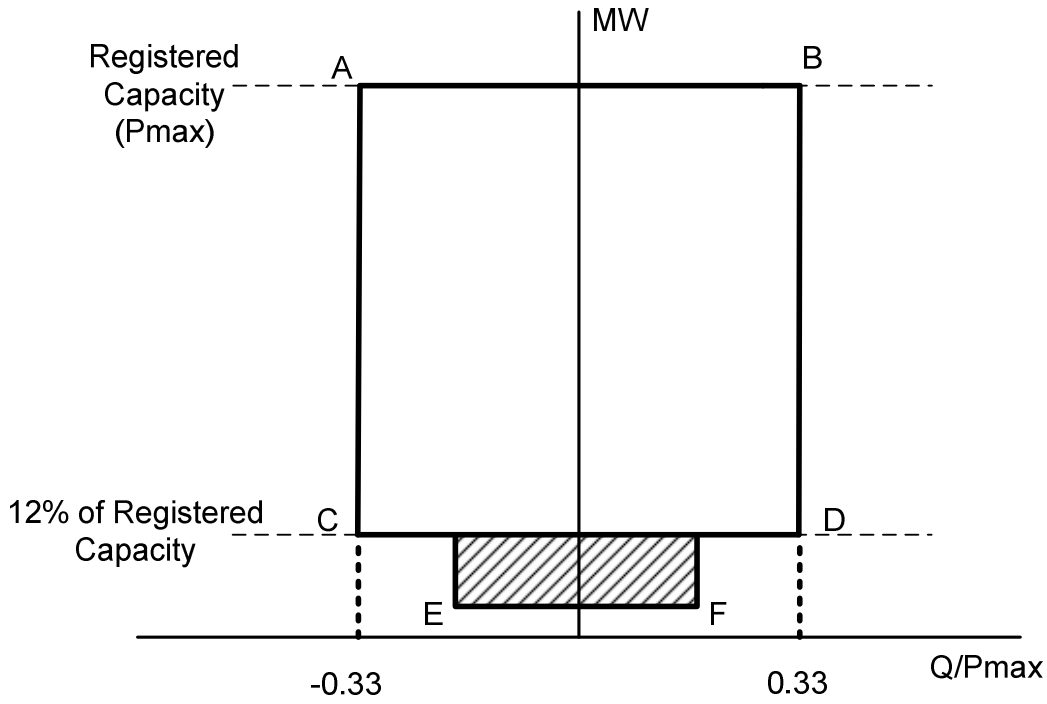


Figure 13

Figure 13 represents the minimum expected reactive power capabilities of the **Controllable WFPS**. The **Controllable WFPS** is obliged to tell ESB Networks if it can exceed these capabilities, and submit the actual P-Q capability diagram based upon the installed plant and **Collector Network** characteristics to the **DSO** during **Commissioning**.

Appendix 3: Distribution Code body content: DCC11.5

DCC11.5.2.3 **VOLTAGE CONTROL**

For DSO Type A Controllable WFPSs irrespective of Registered Capacity and DSO Type B Controllable WFPSs with Registered Capacity ≥5MW, under steady state conditions, the Voltage Regulation System shall be capable of implementing the following Reactive Power control modes which shall be available to the DSO or TSO as agreed by DSO and TSO

(a) The Controllable WFPS shall be capable of receiving a Power Factor control (PF) set-point to maintain the Power Factor set-point at the Connection Point;

(b) The Controllable WFPS shall be capable of receiving a Reactive Power control (Q) set-point to maintain the Reactive Power set-point at the Connection Point;

(c) The Controllable WFPS shall be capable of receiving a Voltage Regulation (kV) 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 Controllable WFPS's Reactive Power output, 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.

(d) A change to the Power Factor control (PF) set-point, Reactive Power control (Q) set-point or Voltage Regulation (kV) Set-Point shall be implemented by the Controllable WFPS within 20 seconds of receipt of the appropriate signal, within its reactive power capability range as specified in DCC11.4.5

Appendix 4: New / Revised Definitions

COLLECTOR NETWORK: The network of cables and overhead lines within a **Controllable WFPS** used to convey electricity from individual **WTGs** to the **Connection Point.**

Rise Time: In relation to reactive current response from **Controllable WFPS**, it is the length of time from **Fault Inception** for reactive current to reach 90% of its steady-state value

Settling Time: **In relation to reactive current response from Controllable WFPS, it is the length of time from Fault Inception for reactive current to settle within +/-10% of its steady-state value.**

Stable / Stability: A **Generation Unit** is adjudged to be stable if the various machine states and variables, including but not limited to rotor angle, active power output, and reactive power output, do not exhibit persistent or poorly damped oscillatory behaviour, when the **Generation Unit** is subjected to a **Fault Disturbance** or other transient event on the **Distribution System**

Transmission System Disturbance Any type of fault including, but not limited to, single line to ground, line to line and three-phase short-circuits, in any single item of Plant anywhere in the Transmission System where the operation of the TSO protection will not disconnect the Generator Plant from the existing or planned Transmission System under normal or Scheduled Outages conditions. For the avoidance of doubt this Fault Disturbance can include bus zone protection.

Voltage Dip: This is a short-duration reduction in phase to phase Voltage on any or all phases, resulting in Voltages outside the ranges as specified in Table 5A, and more generally, bus Voltages or terminal Voltages of less than 90% of nominal voltage on any or all phases. Percentage Voltage Dip shall be calculated with respect to nominal voltage.