BWEA response to Scottish Grid Codes Review Panel Consultation SB/2002

Response to Grid Code Changes and Guide "Transmission Connection Requirements for Wind Farms".

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1 Introduction

This is a draft response for comment by BWEA members. It is a direct response to the documents issued in the consultation. Which are:

1) "Transmission Connection Requirements for Wind Farms" version 1.9

2) Grid Code modifications to Data Registration Code, Connection Conditions, Scheduling and Despatch Code and Definitions.

The Section numbers below refer to the document "Transmission Connection Requirements for Wind Farms"

Appendix 1 summarises all proposed changes to the Grid Code indicating whether these have been accepted or whether modifications are requested.

2 Section 8.1 Control of the Wind Farm

Grid control will always maintain the right to trip the generator off the grid (via remote control of a circuit breaker) in case of an emergency or if the wind farm is not adhering to the Connection Agreement, Grid and/or Distribution Codes.

BWEA expects that most control functions will be implemented automatically, either by on site equipment or by remote signals received from Grid Control. The wind farm operators should therefore be allowed to make a commercial decision as to how wind farms are controlled and operated and as to when and how their staff can be contacted to avoid the ultimate sanction of disconnection.

It is likely that wind farm operators will be continuously monitoring the automatic operation of their wind farms on an exception basis as downtime is very costly and under BETTA they will be penalised for not meeting forecast.

2.1 Control Points

There appears to be no requirements for the staffing of Control Points for any Users within the existing Grid Code

2.2 BWEA Recommendation

BWEA recommends that there are no Grid Code requirements for staffing of Control Points, as this is a market decision.

2.3 Relevant Grid Code changes

Code Section	Resulting Recommendation
CC4.5.1	Delete proposed revision and revert to original wording
CC4.5.2.e	Change **Plant** to **Power Station**

3 Section 8.2 Operational Control

This section is primarily concerned with power ramp rates of wind farms in various circumstances and with constraints.

3.1 Agreed constraints

Where the connection does not provide for secure access to the transmission system, this should be clearly identified by the TSO in the connection assessment. If the Generator agrees to have a connection with a constraint then the circumstances when the constraint would be applied and the methods of applying the constraint should be identified.

3.2 System emergencies

In an emergency situation the grid operator may trip the generation plant if necessary to secure the system. In such circumstance the data pertaining to the situation should be made available to the generator after the event.

3.3 System Operator Requirements

The Grid Operator already experiences power output changes due to load changes and due to faults in existing generating plant, which are outside their direct control, though well understood through experience. Wind farm generation changes are a new additional cause of such changes. The two principle impacts of such changes are:

- The GB load generation balance – which affects frequency (See section 5.)
- The contracted power flows through the Scotland - England interconnector and hence (before BETTA is implemented) this will affect the contractual arrangements in Scotland.

Power ramp rates on wind farms occur due to several events, which include:

- Low wind start
- High wind restart
- High wind speed shutdown
- Grid fault
- Wind power variation

3.4 Low wind start

As the wind speed rises from below to above cut in wind speed the wind farm will start up. This is usually a gradual process due to the slow rise in wind speed. If the wind speed rise is rapid due to unusual weather conditions, a fast ramp rate will occur in one location at a time and will not therefore appear across the whole system at once.

3.5 High wind restart

Following a trip or a high wind shut down the turbines may restart automatically. In the case following a grid fault a rapid restart will help to maintain and /or restore supplies. In the case following a high wind shutdown the wind must fall to a suitable level to allow turbines to restart. This will not happen simultaneously over a whole wind farm or simultaneously between dispersed wind farms.

3.6 High wind speed shutdown

Turbines will shut down automatically in high wind speeds. It is not possible to predict when this might be, apart from shutting down turbines prematurely in all good wind conditions in case of a high wind shutdown, which would make most wind farms unviable.

Under BETTA there will be an incentive for operators to minimise the risk of unpredictable high wind shutdowns, as they will be penalised for not meeting forecast if turbines shut down unexpectedly.

3.7 Grid fault

The most common cause of wind farms tripping is due to Grid Faults. The voltage ride through capability is discussed in Section 8. If there is a fault that trips the wind farm there is no option to control the ramp rate. Following a fault it is beneficial to restore generation to full capacity as quickly as possible.

3.8 Wind power variations

Variation in wind speeds across a wind farm will lead to power ramps rates that may exceed the limits proposed. Limiting power ramps rates as proposed may therefore impose significant and unnecessary production loss during periods of varying wind speeds.

3.9 Smaller generating units

Compared to conventional plant, wind farms comprise a large number of small generating sets and are therefore the failure of any one genset does not result in a significant loss of generation to the system.

3.10 Commercial implications

If the wind farm is tripped due to a grid fault and is not able to come back on the system to its pervious output once the grid is restored, the Generator will be further exposed to commercial loss, especially under BETTA.

3.11 Comparison with other generators

There are no Grid Code limits on ramp rates for other generators although the despatch process does mean that ramp rates are notified to Grid Control in advance.

3.12 Conclusions – Ramp rate

If this is an issue at all, it is an issue for the longer term and for very large wind farms. It may well be largely resolved by BETTA. It is not possible to restrict wind farm ramp rates in all circumstances, as it is not possible to prevent any generators tripping. Therefore Grid Control must learn to manage the various ramp rates of real wind farms.

The main problem in the short term is the affect on Interconnector trades and this is a market issue rather than a Grid Code issue.

3.13 Relevant Grid Code changes

Code Section	Resulting Recommendation
CC4.3.1.e	Delete this additional section.
SDC2 para 4.2b	Delete this additional section.

4 Section 8.2.4 Registered Capacity

The proposed change to the definition of Registered Capacity is very significant. Up to now there have been no parameters in its definition. It is understood here that the concern is the variable output of wind turbines in relation to the thermal loading of circuits and equipment.

4.1 Averaging period

An averaging period of 10 minutes would be more appropriate as it would tie in with the IEC standard for wind turbine power measurement and is a reasonable time period for thermal impacts on the network.

4.2 Impact on existing generators

What impact will it have on existing generators and existing wind farm generators? Has an assessment of any existing generators (wind or other) been carried out to test this?

4.3 Measurement and monitoring

How will the TSO measure and monitor the Registered Capacity? Will this be carried out on all generators or just wind farms? As this is unlikely to be carried out at every Generating Unit as required in the definition would it not be better to address this through a new definition of Export Capacity?

4.4 Maximum Generation

How does the concept of **Maximum Generation** relate to the new definition of **Registered Capacity**?

4.5 Relevant Grid Code changes

Code Section	Resulting Recommendation
Definitions: Registered Capacity	Re-write to average over 10 minutes

5 Sections 8.3 Grid Frequency & 8.4 Frequency Control

5.1 System Operator Requirements

If there is a disturbance caused by a fault or loss of a large load or generator or sudden increase in demand this may result in abnormal system frequencies. From the system operator's point of view it is important that the system can return to a normal stable condition following such a disturbance. The system operator must therefore ensure that large amounts of generation do not trip during the frequency swing and that sufficient frequency responsive plant is on the system to stabilise any disturbance.

5.2 Normal operating capability

The proposals to extend to the normal frequency operating range for wind farms from 49.5 –50.5Hz specified by Engineering Recommendation G59/1 to the wider range of 47 - 52 Hz is a considerable change. Although G75 applies to projects over 5MW, G59/1 protection settings are sometimes specified in the connection agreements of larger generators.

Although this may not be a problem for most variable speed wind turbines, fixed speed, stall regulated machines with conventional induction generators may not be able to fulfil all of these operating conditions.

Specifically these generators cannot necessarily maintain the requirements of CC4.3.1.b in that depending on the wind speed the decrease in active power with frequency may be more than pro rata.

5.3 Reducing power at high frequency

All wind farms are capable of being tripped off on over frequency settings. It would be relatively simple and inexpensive for a wind farm to trip off turbines as frequencies rose (for example over 51Hz) and to trip off the whole wind farm at some higher frequency.

5.4 Governing mode

Some variable speed wind turbines are now developing control systems to provide governing (i.e. responding to increased frequency with reduced power and falling frequency with increased power). To deliver these services, turbines have to operate at less than optimal power performance and spill wind. Even if this capability were fitted, it is highly unlikely that this service would be undertaken by wind turbines in a market in the foreseeable future (see Economics below).

5.5 Frequency control requirements

The frequency of the GB system is identical in all parts of the system and therefore requirement for frequency control is a GB rather than a Scottish requirement for an interconnected system. Indeed SDC3 Section 4 states:

"**The Company** has authorised the **National Grid Company** to control **System Frequency** on its behalf as long as the **GB System** remains interconnected"**.**

Therefore if there were a requirement for wind farms to provide frequency control this would be a GB wide requirement and should be introduced to all GB Grid Codes simultaneously.

If Scotland has to cope with a rare case of islanded operation (as other parts of the system may) it would be more cost effective for wind farms to cease generating in these rare circumstances rather than install equipment to provide frequency control services.

5.6 Frequency Markets

Given that a market for frequency provision is likely to be established in the next few years, any requirement for wind turbines to provide these capabilities is premature and highly unlikely to be economic in a GB context in the short term

5.7 Economics

It is highly unlikely that it is economic for wind turbines to provide active frequency control in preference to other plant. If wind were to participate in such a market, the wind farm would lose the value of electricity production, with no accompanying saving in fuel costs, and also the more valuable green certification (ROCs). It is inconceivable that frequency response cannot be provided from some other Scottish Generators (let alone UK generators) at a lower cost.

5.8 Conclusions - Frequency

- Wind farms under 30MW should be exempt from any requirements.
- Wind farms over 30MW should have a frequency operating range of at least 47.5-50.4Hz. and be able to operate for at least 20secs below 47.5Hz but above 47Hz.
- Governor operation should only apply to wind farms over 300MW constructed now and wind farms over 100MW constructed after Jan 2005.

5.9 Relevant Grid Code changes

Code Section	Resulting Recommendation
CC.4.3.2 b	Re-write so that speed governing applies to wind farms over 300MW constructed now and wind farms over 100MW constructed after Jan 2005.

6 Section 8.5 Voltage Control

6.1 System Operator Requirements

The system operator has to obtain a sufficient amount of Reactive Power (VAr) in order to maintain system voltage limits under different operating conditions. Synchronous machines are able to operate at various VAr levels by action of the AVR. The system operator may also obtain VAr from suitable apparatus placed at particular points on the network where generator VAr are not available, especially to increase the power transfer performance of the network. There are two fundamental issues in discussing the requirement for wind farms: capability and control.

6.2 Capability

Currently the Grid Code requires a capability of 0.85 Lagging (VAr export) to 0.95 Leading (VAr import) power factor at rated power (CC4.3.1a). Historically, wind farms have operated, and often been required by system operators to operate, with a leading power factor in order to limit voltage rise and reduce the risk of damage due to the potential effects of self-excitation. The step change in requiring the operation limits to be extended not only to 0.9 lagging but to require rated reactive power to be delivered through-out the full power range of the wind farm is a massive change in operating philosophy. In many cases such a requirement would require large investment in reactive compensation at the wind farm in the form of capacitors, static VAr compensators or overrated inverters. These measures will be costly, would not be capable, in many cases, of being utilised and may, in certain cases, be detrimental to the system (see section 6.4).

6.3 Control

Wind farms are normally asked to operate within a given range of power factor output and not to a specific voltage level. The consultation contemplates wind farm operating in voltage control. Given the wide range of methods of controlling and despatching VAr and hence influencing voltage it is considered premature at this stage to specify control requirements in the Grid Code and these should be agreed on a site by site basis to suit local system and connection requirements. Options include:

- System operator specifies VAr requirements
- System operator specifies Power Factor
- System operators specifies voltage range
- Wind farm operates to a target voltage and System operator despatches VAr with tap changer control.

6.4 Problems of Exporting Reactive Power

The required leading operation range proposed is not onerous for wind farms in most cases. However, requiring operation to 0.85 lagging power is very onerous commercially and contrary to conventional good practice for wind farms. Firstly, with many connections at 33kV and below the system would not be capable of accepting such high levels reactive power due to voltage rise limits. Secondly, voltage step and flicker are likely to increase significantly at low lagging power factors. Fundamentally, it is not appropriate to use intermittent generation to deliver substantial reactive power to support voltage on the distribution system.

As an illustration, if a wind farm is operating at low output supplying rated reactive power to the system then the effect of a small drop in wind speed and subsequent low wind speed cut-out would be a severe system voltage reduction outside the limits of Engineering Recommendation P28.

6.5 Reactive Power Markets & Economics

There are no reactive power markets in Scotland at present.

The following are drivers for wind farm generators to provide voltage control on site:

- Lack of voltage control means turbines may trip due to voltage excursions or be unable to start in some conditions
- If turbines cannot ride through faults they will trip out and such emergency trips will cause cumulative damage to the turbines
- Under BETTA/NETA the generator will be penalised for loss of output and is therefore incentivised to ride through grid faults.

In addition, existing thermal synchronous generators will probably lose market share as wind farms develop, however these sets will be required for reserve purposes during low wind periods. Reactive power markets will provide these generators with an opportunity for additional income encouraging them to remain available to the system.

Requiring wind farms to provide reactive power may not be the most cost effective way of delivering this to the system, as

- Alternative VAr sources will be required anyway when the wind farms are not generating.
- Wind farms may not be located where VAr are needed on the system.
- Local voltage effects may limit the despatch of VAr from individual wind farms.

6.6 Conclusions Reactive Power /VAr

1) Wind farms connected to the Distribution system should be exempted from VAr requirements, except those agreed to meet their distribution connection requirements.
2) Wind farms under 30MW should not be required to control or despatch VAr as the costs would normally exceed the small benefit to the system.
3) Wind farms under 30MW may agree to use VAr control to manage system voltage to achieve a lower cost connection.

6.7 Relevant Grid Code changes

Code Section	Resulting Recommendation
CC.4.3.1 a	Re-write to exempt power stations under 30MW and those connected to Distribution System.
CC 4.3.1 b	Re-write to exempt all wind farms or relax the "pro-rata" requirements to allow for compliance of mainstream turbine technologies.
CC.4.3.2 d	Agreed.

7 Section 8.5.4 Voltage Steps

There are no Grid Code changes proposed to the assessment of voltage changes, flicker or imbalance. The Guide however offers interpretations of existing standards and requirements.

8 Section 8.6.1 System Faults

A fault on the 275kV or 400kV system will propagate through the whole Scottish system to a large extent. If a significant number of generators trip off as a result there could be a black out. However a fault on a 132kV or 33kV system will produce a lesser voltage dip on the rest of the system. Loss of a large number of small wind farms will not jeopardise the UK system which is designed to cater for the simultaneous loss of 2x660MW sets (i.e. 1320MW).

8.1 Conclusion Fault Ride Through

It is therefore proposed that fault ride through should only apply to wind farms of 30MW and above. And that they should be capable of riding through a zero voltage fault appearing at a set point the 275kV system and also a identical fault appearing at a set point on the 400KV system. The actual voltage that the wind farm must ride through will depend on modelling the wind farm and system with the fault under normal system conditions and rated wind farm output. These faults have a 100ms target clearance time and therefore this should be the ride through capability.

In addition wind farms up to 50MW should be allowed to trip off the system provided they reconnect to the system within 5 seconds under the stated fault conditions.

8.2 Relevant Grid Code changes

Code Section	Resulting Recommendation
CC.4.3.1 f	Re-write so that: • Wind farms under 30MW are exempt • The voltage dip applies to two specific nodes, one on the 275kV and one on the 400kV systems. • The duration of the voltage dip is 100ms. • Wind farms under 50MW can trip provided that they reconnect to the system within 5 seconds.

9 Sections 8.6.2/3/4 Voltage Tripping and Islanding

These proposals are accepted.

9.1 Relevant Grid Code changes

Code Section	Resulting Recommendation
CC.4.3.1 g	Agreed

10 Section 8.7 Power system stabiliser

Power swings on the Scotland England interconnector can occur at 0.5 to 1.5 Hz due to the dynamics of the interconnected systems and synchronous machines. There is concern form the System Operators that wind farms will exacerbate this instability, especially due to power fluctuations induced by blades passing the towers.

10.1 Conventional induction turbines

Induction wind turbines are expected to inherently damp these oscillations.

Not all turbines would have the same blade pass frequency therefore this should not be a common mode problem.

10.2 DFIG variable speed wind turbines

Doubly fed turbines could potentially be controlled to damp these oscillations and will not produce such oscillations from blades passing towers.

10.3 Conclusions PSS

1) More research is needed in this area.
2) Market for this ancillary service may assist in provision of capabilities.
3) It is premature to place requirements on wind farms at this stage.

10.4 Relevant Grid Code changes

Code Section	Resulting Recommendation
CC.4.3.2 b	Delete the last paragraph stable control over the whole range of operating conditions may be impossible to achieve. It is normal in wind turbines for control systems to run through unstable conditions.

11 Section 8.8 Harmonics

No changes are proposed to Grid Code requirements on harmonics for wind farms.

12 Section 9 SCADA requirements

No changes are proposed to Grid Code requirements on SCADA for wind farms.

13 Section 10 Provision of modelling information.

There is a problem in that there is no suitable generic model for DFIGs in power system simulation software in order to study the impacts of there wind turbines on the system, whereas there are models for conventional synchronous plant.

The BWEA is aware that work is being done on developing these models by manufacturers, academics, consultants and power system software providers.

Unlike synchronous machines, there are significant commercial, confidentiality and intellectual property issues with DFIG models. When the first synchronous machines were used, it is assumed that no models were available.

It is unreasonable to limit the deployment of DFIG wind turbines at this stage because good models are not yet available.

13.1 Relevant Grid Code changes

There are no proposed Grid Code changes relating to Provision of Modelling Information

14 Section 11 Fault recorder

No changes are proposed to Grid Code requirements on Fault Recorders for wind farms.

15 Section 12 Wind farm commissioning

No changes are proposed to Grid Code requirements on commissioning for wind farms.

16 Section 13 Submission of Grid Code Compliance Test Report

No changes are proposed to Grid Code requirements on submission of Grid Code compliance test report for wind farms.

17 Section 14 Testing

The Guidance document has a number of sections on testing. These tests need considerable further development before they can be properly assessed. It is noted that

- These tests are more prescriptive than those for other generators.
- It may be better if some of the tests were achieved as type test and some as factory tests.

No changes are proposed to Grid Code requirements on testing for wind farms.

18 Section 15 Summary of Requirements

No changes are proposed to Grid Code requirements for wind farms under this section.

19 Data Registration Code

This code need to be further modified to take account of the performance of the Power Station rather than the individual generating units, as the performance requirements of the wind farm may be achieved at the point of connection with additional or ancillary equipment as well and the wind turbines themselves.

20 Appendix 1– Summary of proposed Grid Code changes

This section covers all proposed changes to the Grid Codes and states whether these are agreed or not

Section	**Agreed**	**Not Agreed – See sections above for details**
CC4.2.4	Agreed	
C.C 4.2.5	Agreed	
C.C.4.3.1.a		Not Agreed
C.C. 4.3.1.e		Not Agreed
C.C.4.3.1 f		Not Agreed
C.C.4.3.1 g	Agreed	
C.C.4.3.2 b		Not Agreed
C.C. 4.3.2.d	Agreed.	
C.C.4.5.1		Not Agreed
C.C.4.5.2 e		Not Agreed
SDC2 Para 4.2a	Agreed	
SDC2 Para 4.2 b		Not Agreed
SDC2 Para 4.3	Agreed	
Definitions:		
Generating Units	Agreed	
Non synchronous Generating Unit	Agreed	
Registered Capacity		Not Agreed
Synchronous Generating Unit	Agreed	
Data registration Code		Not Agreed

Please note the following new contact information that applies from 24 June 2002

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