



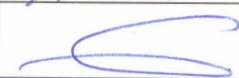


BWEA Grid Code Consultation Response

Supplementary Comments

Econnect Project No: 1294

Prepared For	BWEA Renewable Energy House 1 Aztec Row Berners Road London N1 0PW
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	Name	Date	Signature
Prepared By	G Nicholson	21/3/05	
Checked By	S Cowdroy	22/3/05	
Approved By	G Nicholson	22/3/05	

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1	Richard Ford	BWEA
2	Econnect (Client File)	Econnect Ltd
3	Econnect (Project File)	Econnect Ltd

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1 Introduction

The BWEA submitted a response¹ to Ofgem's Regulatory Impact Assessment on Grid Code Consultations H/04 and SA/2004 in February 2005.

A meeting was held with Ofgem on 9th March 2005 to review the response and clarify some items.

This document provides additional BWEA views on:

- The active power recovery post fault or voltage dip.

BWEA's response on active power was contained in Section 4.2 of the consultation response.

BWEA has considered the NGC Grid Code Consultation Document H/04 issued 23 June 2004 and in particular Appendix 2 Section 5.1.

BWEA recognises the need for the proposals in Ofgem's consultation, but is concerned that their premature introduction will lead to significant delays to wind energy developments.

¹ BWEA response to Grid Code Consultation H/04 and SA/2004 and Ofgem Regulatory Impact Assessment compiled by Econnect for the BWEA dated 23/03/05.

2 Current situation

In their document, NGC have stated that the loss of 500MW of wind for 5 seconds simultaneously with the loss of 1320MW of infeed to the transmission system would result in an additional frequency dip of 0.44Hz, which would cause the disconnection of loads on low frequency relays. There is already over 800MW of wind energy connected to the GB system most of which was not specified with any fault ride through (FRT) capability. If this wind generation were to be affected by a fault and consequently lose power, it would take much longer than 5 seconds to recover under the existing protection and control schemes fitted (see Section 3 below).

Given that there is the capability and the capacity of wind to cause a low load disconnection at present we conclude that either:

- 1) The risk of such an occurrence is insignificantly low.
- 2) The risk is being successfully managed.
- 3) A combination of both.

NGC have presented transmission system fault data Table 5.1 and Figure 5.5². This data however does not show losses of generation or infeed, nor does it indicate whether simultaneous faults and infeed losses have occurred.

2.1 Risk

The risk of a load disconnection is lowered due to the combination of risks:

- The risk of a 3 phase fault occurring;
- The risk of a 3 phase fault and a simultaneous loss of infeed/generation;
- Both these risks occurring at higher wind speeds (especially as lightning is the major cause of faults³ and lightning is usually associated with low winds);
- The risk of tripping a number of windfarms during a fault being reduced due to the higher retained voltages at embedded windfarms and the rapid clearance time and post fault voltage recovery for supergrid transmission faults.
- The probability of a worst-case frequency dip occurring. (The largest frequency excursions from loss of conventional plant and infeeds are likely to be in the summer when there is less rotating plant and therefore inertia connected to the system which will also tend to coincide with low wind power production).

The reporting of Rate Of Change Of Frequency (ROCOF) and major system faults to the GB Grid Code Review Panel has been in place since 1998 and now includes the major transmission incidents. The lowest frequency event recorded was 49.418Hz on 26 May 2004. This event still allows over 0.6Hz additional frequency reduction before the 48.8Hz⁴ is reached where load disconnection occurs. The largest loss of embedded generation recorded in the ROCOF report was 54 MW on the same date (although the type of plant and /or mix of plant lost is not specified).

² NGC H/04 consultation June 2003.

³ "Lightning is the most significant source of 3-phase faults followed by equipment failures, then rain, gales, and so forth." Page 170, NGC H/04 consultation June 2003.

⁴ According to SKM report "New generation technologies and GB Grid Codes" Chart on page 24.

BWEA understands that as wind power projects grow in capacity and as more windfarms are connected to the system this risk increases. Hence it is accepted that the requirement for rapid real power recovery, in some form, will need to be included in the future.

3 Wind turbine behaviour

Consider a network fault and the impact on wind turbines. During the voltage depression caused by the fault, the wind turbine is only able to deliver real power to the network in proportion to the retained voltage. Therefore, the power difference between the power infeed from the rotor and the power taken from the generator will appear as acceleration power, speeding up the rotor and drive train and accumulating energy in stored inertia. If this situation is allowed to continue unchecked the wind turbine will eventually reach its overspeed design limit and shut down on overspeed. To avoid this occurring the turbine must either

- Control the pitch of the rotor to reduce the incoming power, or
- Isolate or separate the generator from the network, maintain full voltage at the generator terminals and introduce a dump load to dissipate the power that cannot be absorbed by the network (and hence avoid pitching the blades).

Historically, wind turbines have not been designed to react rapidly to a voltage dip. If the turbines remain connected during a voltage dip this has been to the advantage of the user (more output and revenue) and the manufacturer (less wear and tear and maintenance). If the wind turbine overspeeds (e.g. due to a severe voltage dip), it will shut down. If the voltage dip exceeds the G59 limits specified in the connection agreement the site protection will shut down the windfarm and is generally programmed to restart after 10 minutes of stable network voltage.

So if the voltage dip is short and wind turbines have not acted to pitch blades, we do not envisage a significant problem in achieving a rapid active power recovery. If the voltage were to recover to 90% within say 150ms we would not expect pitch action to have been initiated. Therefore we would expect turbines to meet the 0.5s recovery time to 90% of pre-fault power.

If the voltage dip is of a longer duration the wind turbine must activate its pitch control (or use a partial isolation and dump load control system).

The Grid Code does not specify how quickly the voltage will recover to 90% voltage following a supergrid fault – therefore it is impossible for manufacturers to say on a generic basis whether or not they comply with the code requirements.

Once the turbine has operated its pitch control the control system must maintain real power proportional to voltage and yet avoid overspeed. Once the voltage has returned to nominal the pitch control system must again deliver the exact power required by the code without overspeeding. All this is required very quickly and in varying wind conditions and turbulence. A rapid return to real power can result in transient overpowering, which can cause the turbines to overspeed and trip as well as apply damaging torque spikes to the gearbox.

It should also be recognized that in a windfarm the turbines would probably be in different states at the instant of a fault occurring. Some turbines will be closer to their overspeed rating than others and therefore will have less leeway for acceleration before having to activate the pitch control.

4 BWEA proposals

BWEA believe that to develop either solution (pitch control or dump load) will take most manufacturers at least one year. Given the duration for the tendering, financing and construction of projects this means that the earliest application date for this requirement is April 2007.

In addition BWEA believes the specification should be refined to allow for imperfection in the wind turbine controls and for some occasional turbine tripping of individual turbines during faults, e.g. due to mechanical failures co-occurring with fault ride through events.

Revising the wording in CC 6.3.15 to require power to be restored to 80% of its pre fault level when voltage has returned to 90% of nominal would go some way to meeting this second issue.

5 Feedback from manufacturers

The feedback from manufacturers is confidential but out of six manufacturers contacted, none have indicated opposition to the BWEA proposal to delay the application date for the requirement for rapid active power recovery until April 2007. BWEA through Econnect will offer a confidential response to Ofgem with further details, which are not for publication.

Econnect has made contact with:

- Bonus
- Vestas
- GE Wind
- Gamesa
- Nordex
- REpower

The responses are as follows:

- 1) None of the manufacturers consulted has indicated that they oppose the BWEA proposed implementation timescale.
- 2) One manufacturer has not yet responded.
- 3) Two manufacturers must go through a formal internal process before they can make a written response.
- 4) One has stated verbal support for BWEA's proposed delay to refine their solution.
- 5) Two turbine manufacturers have given written support for the BWEA proposal.
- 6) Three have indicated concerns regarding power and torque transients following such a rapid recovery in power.
- 7) One has indicated concerns over the speed of the pitch control system.
- 8) One manufacturer has noted that EoN and Vattenfall (Germany) are more concerned with stabilising voltage post fault and less concerned with active power recovery.

BWEA notes that the resources of wind turbine manufacturers are limited and the engineering departments in particular have substantial workloads. They are operating in global markets and therefore are faced with designing developing and testing control software and requirements for many markets (and Grid Codes).